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## **Evaluating Gentrification in Newark, New Jersey: Would Gentrification As A Model for Economic Development be Positive for Newark, New Jersey? By Victoria D Rengel**

Gentrification refers to a model of development in which affluent residents are encouraged to move to previously impoverished areas associated with lowering crime rates<sup>2</sup> and an increased standard of living. This model has been positive throughout American cities<sup>3</sup> such as the Bay Area in California, as cities have aimed to increase their wealth by encouraging an increase in luxury housing and high-end retail. However, this approach has been criticized, as an increased standard of living has only been experienced by the wealthy. Hence, this paper will seek to evaluate gentrification as a model for development by considering possible economic benefits and by evaluating the practice's impact on native Newarkers. To examine this topic, I partook in a series of interviews with individuals who interact with gentrification daily — Kikis advocates for this model of development, whereas Wharton and Monterossa warn against the practice's effects— allowing me to widen the scope of my research by taking in opposing perspectives.

Proponents argue gentrification is the only way in which a city can experience economic development. My engagement with Nicholas Kikis, Vice President of the New Jersey Apartment Association representing 50% of homeowners and developers across New Jersey, allowed exploration into the neoliberal model for development. Kikis explained that bringing wealth into a city allows wealth to trickle down to positively affect residents. He explained that the goal is never displacement, but rather that gentrification functions as an investment to attain sustainable economic growth. If displacement does occur, Kikis argues that increasing the supply of housing would bring down its demand, translating to more affordable rents.

To further evaluate gentrification, it is important to consider recent economic data within Newark. As a result of recent development, “crime was down by 13 percent, the lowest level in 50 years; more than 3,000 additional Newark residents became employed; and the city attracted more than \$2 billion in commercial investments”<sup>4</sup>. These figures indicate the city is certainly attracting further direct investment while ensuring the well-being of its residents through reduced crime and higher employment rates, suggesting that gentrification may be positive.

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<sup>2</sup>Linke, Rebecca. “New study: Gentrification triggered 16 percent drop in city crime.” *MIT Sloan*, 21 December 2017, <https://mitsloan.mit.edu/ideas-made-to-matter/new-study-gentrification-triggered-16-percent-drop-city-crime>. Accessed 20 March 2023.

<sup>3</sup>“Gentrification and Neighborhood Revitalization: WHAT'S THE DIFFERENCE?” *National Low Income Housing Coalition*, 5 April 2019, <https://nlihc.org/resource/gentrification-and-neighborhood-revitalization-whats-difference>. Accessed 20 March 2023.

<sup>4</sup>Reddy, Lata. “Newark – A Model of Inclusive Economic Growth.” *Prudential Financial*, <https://www.prudential.com/links/about/corporate-social-responsibility/thought-leadership-perspectives/newark-model-economic-growth>. Accessed 20 March 2023.

Opposingly, this position fails to fully assess the implications of displacement. Through gentrification, the gentry, high-income professionals, are encouraged to enter and take over cities. Wharton describes that this process is fostered by cooperation between corporations and local governments, as both groups benefit financially. Wharton established the “Gentrification Profiteer Paradigm”<sup>5</sup>; politicians provide tax abatements, and spearhead policy to encourage development; investors recognize opportunities to profit and invest; realtors look to bring in “desirable” and financially “independent” residents. There is further quantitative support for this paradigm: from 2000 to 2012, an estimated 135,000 people<sup>6</sup> were displaced nationally directly due to an increase in housing costs.

One important aspect of gentrification that is necessary to understand is the role of local governance. Newark has had to look for external investment as there are social and economic factors hindering its development. The federal government has cut funding for the city in multiple cases<sup>7</sup>, forcing the city to look to privatization as a solution. The trend of “white flight” in the 60s and 70s also caused the city to face waves of disinvestment, as the Newark riots drove up racial tensions in the city motivating businesses to leave the city<sup>8</sup>. Having to search for new ways to foster economic growth, the city emphasized and prioritized gentrifying projects as they cause an increase in surrounding rents, making the area contain more wealth— a common practice amongst cities in the last 30-40 years<sup>9</sup>.

Early phases of gentrification in Newark began when the James administration (1986-2006) focused on renovating the city’s downtown. James used his decision-making power and political capital to publicly support the building of the New Jersey Performing Arts Center, the Light Rail, and the Prudential Center. He also used “federal and state funds to pursue the demolition of ... public housing”<sup>10</sup>, destroying Scudder Homes, Columbus Homes, Walsh Homes, Stella Homes, and Brick Towers. Later, the Booker Administration (2006-2013) maximized development opportunities leading to investment near the waterfront. Booker was also known for selling city-owned land to create competition between investors, causing

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<sup>5</sup>L. Wharton, Johnathon. “Gentrification: The New Colonialism in the Modern Era ” *Stevens Institute of Technology*, 2008, <https://web.stevens.edu/ses/documents/fileadmin/documents/pdf/Oxford%20Journal.pdf>. Accessed 18 November 2022.

<sup>6</sup>Richardson, Jason, et al. “Shifting Neighborhoods Gentrification and Cultural Displacement in American Cities.” National Community Reinvestment Coalition, 19 March 2019, <https://ncrc.org/wp-content/uploads/2019/03/NCRC-Research-Gentrification-FINAL.pdf>.

<sup>7</sup>Morel, D., Drake Rodriguez, A., Sidney, M., Garay, N. B., & Straub, A. (2022). “Measuring and Explaining Stalled Gentrification in Newark, New Jersey: The Role of Racial Politics”. *Urban Affairs Review*, 58(6), 1585–1621. <https://doi.org/10.1177/10780874211046340>

<sup>8</sup>Mumford, Kevin. “Newark: A History of Race, Rights, and Riots in America.” New York University Press, 2007, [https://books.google.je/books?id=\\_NkVCgAAQBAJ&printsec=frontcover&source=gbs\\_vpt\\_read#v=onepage&q&f=false](https://books.google.je/books?id=_NkVCgAAQBAJ&printsec=frontcover&source=gbs_vpt_read#v=onepage&q&f=false).

<sup>9</sup>Morel, “Measuring and Explaining Stalled Gentrification in Newark, New Jersey: The Role of Racial Politics”

<sup>10</sup> Ibid.

corporations such as “Audible, Pitney Bowes, Manischewitz, and Panasonic”<sup>11</sup> to come to Newark. Recently, the Baraka administration (2014-present) followed in the footsteps of the previous administrations<sup>12</sup>. Baraka used up-zoning ordinances, allowing properties to be sold at higher values, and tax abatements to generate waterfront luxury developments and even the Halo building.

However, this administration differentiates itself, having attempted to maintain housing affordability. This models development through a paradigm of distributive justice: dealing with questions of affordable and equitable housing. Baraka has used tax abatements and has partnered with minority-owned businesses in attempts to be inclusive. More notably, he spearheaded the Inclusionary Zoning Ordinance, which forced developments greater than 30 units to maintain at least 20% of their units affordable<sup>13</sup>.

But from my discussion with Victor Monterossa, a housing attorney and a community organizer, I learned of the failures of Baraka's attempts. Monterossa pointed out that rent-control ordinances were not enforced, as the city desired to appease developers. This willingness demonstrates the city’s desire for investment, as they are willing to go to great lengths to generate markets. Monterossa also argued that while Baraka's motivations may be well-intentioned on a theoretical level, they are oftentimes carried out too late to mitigate existing problems. This argument aligns with Morel’s critique of current governance, as cities only act when they recognize that gentrification happened, and at that point, it is too late to reverse the larger effects of gentrification.

As a result of local governance, more than half of Newark is now susceptible to gentrification. As of 2000, approximately half of “Newark’s census tracts were vulnerable to gentrification”<sup>14</sup>, meaning that the areas were susceptible to gentrification, given their financial desirability. Towards the end of 2017, it was found that “66% of the vulnerable tracts”<sup>15</sup> were successfully gentrified. The areas in which gentrification is predominantly occurring are the areas with the highest number of Black, Latino, and impoverished residents<sup>16</sup>— proving a correlation between the social position of those displaced and the rates at which gentrification is occurring.

Another problem raised by gentrification, a model which discourages regulation, is that Newark has become oligopolized. Adar Capital, Harness Homes Group, and Lexington Property Group currently own 47% of Newark’s residential assets<sup>17</sup>. Adar Capital owns \$42.5 million in properties, Lexington Property Group owns \$38.8 million in properties, Harness Home Group

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<sup>11</sup>Ibid.

<sup>12</sup>Ibid.

<sup>13</sup>Ibid.

<sup>14</sup>Ibid.

<sup>15</sup>Ibid.

<sup>16</sup>Ibid.

<sup>17</sup>Troutt, David D., and Rutgers Center on Law, Inequality, and Metropolitan Equality. “WHO OWNS NEWARK?” *Squarespace*, May 2022, <https://static1.squarespace.com/static/5b996f553917ee5e584ba742/t/626fd98bb8357d201cb8dcb5/1651497359130/Who+Owns+Newark+Final+1.pdf>. Accessed 18 November 2022.



owns \$17.2 million in properties, and various anonymous corporations account for \$138.7 million in properties<sup>18</sup>. Wharton argues this amount of economic power serves as non-decision-making power, a form of power in which an entity does not have direct access to government structures but can rather influence government action. Since these corporations have significant capital, they are effectively responsible for the lives of thousands — making it difficult for the government to regulate their business, as regulations would have political and material consequences. Thus, oligopolies provide these corporations with substantial political influence, allowing gentrification to go unchecked.

As a result of this top-level economic activity, the renter population in Newark has been burdened economically. The cost of living increased by 1.6% in the last year<sup>19</sup>, primarily due to an increase in transportation, food, and housing all fueled by gentrification<sup>20</sup>. And, when evaluating rent prices, “...the typical Newark renter pays annual rent that is 34 percent of its income, with 56 percent of the population spending more than 30 percent of their income on rent. Thirty-two percent... spending 50 percent or more of their household income on rent”<sup>21</sup>, demonstrating that as a form of economic development, gentrification burdens a city’s inhabitants.

Upon further interviewing Monterossa, I learned of limitations preventing successful action toward reforming this model of development. From his time being a community organizer, Monterossa described that securing housing affordability was restricted by a lack of financial resources. Despite this, he has used his ideological power to successfully stop numerous demolitions of buildings in Newark. This application of ideological power has occurred both through grass-roots organizing and by making appeals with policy-makers, to ensure success. And, as an attorney, Monterossa detailed that while there exists legal ground to sue landlords, bourgeoisies’ rights claims tend to be overwhelmingly favored in courts of law. Courts are more persuaded by property rights claims by the bourgeoisie<sup>22</sup>, as they are thought to be taking an economic risk rather than the individual tenant, suggesting there exist barriers to rights protection.

To evaluate gentrification on a theoretical level, I interviewed Urban Affairs and Political Science Professor Johnathon Wharton. Approaching the issue from a Marxist anti-colonial perspective, he explained that gentrification functions close to modern forms of colonialism, both being fueled implicitly by colonialism and having similar effects. He points out that the landed gentry was able to dominate judicial and financial systems since the colonial era and is still able

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<sup>18</sup>Ibid.

<sup>19</sup>“Cost of Living Calculator | Cost of Living in Newark, New Jersey.” *Salary.com*, <https://www.salary.com/research/cost-of-living/newark-nj>. Accessed 20 March 2023.

<sup>20</sup>Morel, “Measuring and Explaining Stalled Gentrification in Newark, New Jersey: The Role of Racial Politics”

<sup>21</sup>Neal, Michael, and Daniel Pang. “Newark Housing Pulse.” *Urban Institute*, [https://www.urban.org/sites/default/files/publication/103878/newark-housing-pulse\\_1.pdf](https://www.urban.org/sites/default/files/publication/103878/newark-housing-pulse_1.pdf). Accessed 20 March 2023.

<sup>22</sup>Whitlow, John. “Gentrification and Countermovement: The Right to Counsel.” *Fordham Urban Law Journal*, 2019, <https://ir.lawnet.fordham.edu/cgi/viewcontent.cgi?article=2773&context=ulj>.

to control these institutions today, as can be seen with rights claims. This historical dynamic sets the conditions for neo-colonialism, illustrating that regardless of who is in control of property, the landed class will have more control over the political economy, consequently having more political leadership than the proletariat class. This allows governments to use tax abatements and exemptions, suggesting that the interests of the bourgeoisie are often intertwined with the state.

From this, it can be concluded that gentrification as a form of development functions closely to Galtung's Core-Periphery Model, in which downtown Newark is the economic core, and the East, West, North, and South wards are the periphery. Galtung outlines that the core holds the largest concentration of economic power, holding explanatory power over the actions of local government and the monopolization of the housing industry. Hence, as a form of development, gentrification may be dangerous, as it exacerbates unequal distributions of power, allowing the core to further expand through new developments. As the core expands, other areas are forced to take in the displaced, consequently becoming more burdened and poor, showing further support for the periphery model.

A larger parallel to globalization can be drawn from gentrification through Galtung's model<sup>23</sup>. Just as Newark's downtown has been the economic center, the Global North has functioned as the center. Likewise, the Global North now seeks to expand its political and economic control not by direct colonization, but rather through models of globalization. Rather than reaching for the "Atlantic New World"<sup>24</sup>, the bourgeoisie now seeks to establish their "urban frontier"<sup>25</sup>. The same displacement seen in Newark on a block-to-block basis can be seen through cultural homogenization, as globalization dominates many non-western forms of knowledge. When considering this parallel, just as globalization runs the risk of homogenizing over previously existing cultures, gentrification would be dangerous as it displaces Newark residents.

Therefore, gentrification as a form of economic development is not beneficial for Newark. While there have been increased employment opportunities and decreased crime rates, this approach is unsuccessful insofar as it does not distribute wealth. Instead, gentrification has forced populations to become displaced as they have been burdened by the rising cost of living and has further concentrated wealth in the form of land ownership. This problem is supercharged by the monopoly on the housing market, as three developers can drastically dictate the markets, ensuring their profit quotas are met. And, when adopting this form of economic development, it becomes difficult to fight back against injustices such as evictions or drastic rent increases due to structural inequalities; the current legal system tends to favor poverty rights over claims of positive rights. The flaws within the gentrification model can be explained by the neo-colonial dependence model and Galtung's Core-Periphery model, in which the economic and political power possessed by the economic core allows the bourgeoisie to take over the periphery, serving as a microcosm of globalization.

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<sup>23</sup>Davidson Mark. "Gentrification as Global Habitat: A Process of Class Formation or Corporate Creation?" *Transactions of the Institute of British Geographers*, vol. 32, no. 4, 2007, pp. 490–506. *JSTOR*, <http://www.jstor.org/stable/4626267>. Accessed 15 Mar. 2023.

<sup>24</sup>L. Wharton, "Gentrification: The New Colonialism in the Modern Era".

<sup>25</sup>Ibid.

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## Exploring the Complexities of Aging: Genetic and Environmental Influences By Isaac Oommen

### Abstract

The phenomenon of aging has become increasingly relevant in research spaces as the global average life span continues to rise. Researchers seek to understand the interactions between genetic and environmental factors that contribute to the aging process. Fundamentally, biological aging represents the accumulation of cellular damage that manifests as decreased motor and cognitive function, as well as an increased risk of age-related diseases and mortality. This review aims to explain several key genetic and environmental components that influence the aging process: telomeres, transcription factors, nutrient pathways, and exercise. Through an analysis of these factors, this paper provides insight into the mechanisms behind cellular aging, the implications of these findings, and potential treatments. Gaining a comprehensive understanding of the processes that underlie the aging process can provide new insight into strategies to increase longevity and mitigate the consequences of age-related disease.

### Introduction:

Living a long, healthy, and fulfilling life is a universal goal sought after by humans for centuries. In the early twentieth century, the average life expectancy for both sexes in the US was 47.3 years (1). Just a century later, the average life expectancy increased to 76.8 (National Center for Health Statistics (U.S.) and Gindi). Historically, the human lifespan has been restricted by disease, poverty, and violence. Humanity was at high risk for viral and bacterial illnesses such as tuberculosis, influenza, and smallpox, which drastically shortened the average lifespan, especially for children. In recent years, however, age-related diseases such as cancer and heart disease have become the leading cause of death in humans. This shift is largely due to the advancement of medical technology over the last century as well as improved hygiene, sanitation, and nutrition throughout the world. As improved medical technology continues to mitigate the impact of external factors on the human lifespan, researchers are turning their attention inward to the biology of aging to test the limits of human longevity. In the absence of external threats, the only limit to the human lifespan is the aging of the human body and the age-related diseases that accompany it. Researchers are now exploring methods of extending the average healthspan—the period when a person is in good health—to prevent or delay age-related diseases and promote longer, healthier lives as the world's population continues to achieve higher ages.

Several key factors, such as telomere length, the FOXO3 transcription factor, reactive oxygen species (ROS) from mitochondria, and the AMPk and Akt nutrient signaling pathways have been identified as contributors to the biological aging process (Figure 1). Studies on these factors stemmed from cornerstone findings such as the discovery of telomeres by Hermann Muller and Barbara McClintock (*The Behavior in Successive Nuclear Divisions of a Chromosome Broken at Meiosis*). Telomeres and telomerase were first linked to aging by Elizabeth Blackburn, Carol W. Greider, and Jack W. Szostak who discovered how telomeres protect chromosomes from degradation in cell division (Greider and Blackburn, "The Telomere

Terminal Transferase of Tetrahymena Is a Ribonucleoprotein Enzyme with Two Kinds of Primer Specificity”; Chan and Blackburn; Greider and Blackburn, “Identification of a Specific Telomere Terminal Transferase Activity in Tetrahymena Extracts”). FOXO was first discovered in tumor cells and has since been the subject of several studies regarding human aging and cancer (Davis et al.; Galili et al.). The work of these scientists and several others has laid the foundation for modern research on the factors influencing aging. Researchers are currently analyzing the interaction of these factors and several more to understand the complex process that is biological aging. For example, Allsop et al. recently analyzed the interactions between FOXO3a and telomeres, finding that individuals with FOXO3a allele demonstrate reduced blood leukocyte telomere shortening (Allsopp et al.). Gaining a comprehensive idea of the aging process is the key to slowing or even eliminating the development of age-related diseases and complications.

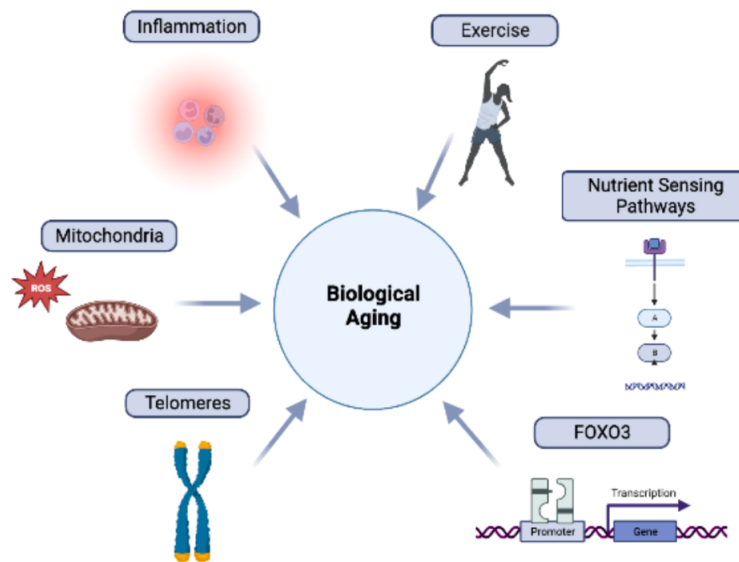


Fig 1. Diagram of factors affecting biological aging including telomeres, mitochondria, inflammation, exercise, nutrient sensing pathways, and the FOXO3 transcription factor (Created with BioRender.com).

### Section 1: Telomeres

Telomeres have been a topic of interest in recent years due to their correlation with aging and disease. Telomeres are the protective cap on the end of a chromosome composed of the repeating DNA sequence TTAGGG and shelterin proteins (Chakravarti et al.). Each time a cell divides, the length of this cap shortens slightly and the rate of shortening can be accelerated by oxidative stress and environmental factors, such as smoking. When telomeres get critically short, cells enter a state of senescence, where the cell can no longer divide, which leads to apoptosis or programmed cell death. Although the process of senescence is essential to maintain tissue

homeostasis, it also contributes to inflammation and is the basis of age-related issues such as diabetes, dementia, and cognitive decline (Burton, 2009). Ultimately, telomere length and senescence limit the lifespan of humans through age-related complications. However, the importance of telomeres cannot be overlooked—their ability to halt a cell's entrance into cell division acts as a vital safeguard against cancer, as rapidly dividing precancerous cells will undergo apoptosis as their telomeres shorten. The enzyme telomerase increases the length of telomeres by synthesizing DNA at the end of the cap. Accordingly, telomerase activity is carefully regulated within cells because it poses a great risk of cancer by allowing cells to divide indefinitely through the continual lengthening of telomeres (Trybek et al.).

## **Mice**

Similar to humans, telomere shortening in mice is associated with age-related disease. When studying telomeres' effect on lung disease, researchers found that shorter telomeres combined with a deficiency in telomerase in lung cells increased susceptibility to emphysema in mice (Alder et al.). The study included data that supports the idea that shortened telomeres can increase the chances of cigarette-induced lung diseases. For example, shortened telomeres are also found to limit the recovery of epithelial cells after cigarette smoke-induced injury. These results demonstrate that shortened telomeres not only increase the chances of illness but also hinder the cell's recovery system in response to stressors, which could expedite the aging process.

Hyper-long telomeres in mice have an array of benefits including lowered LDL cholesterol and higher insulin tolerance and glucose sensitivity (Muñoz-Lorente et al.). This suggests that hyper-long telomeres can slow metabolic aging, as even in older mice with hyper-long telomeres, glucose sensitivity and hence metabolic processes were higher. There was also less incidence of tumors and increased lifespan in hyper-long telomere mice when compared to normal telomere lengths. This contradicts the previous understanding of extended telomeres. An important distinction is that the hyper-long telomeres were not lengthened through overexpression of telomerase, hence the cancerous results of telomerase overexpression are not present and the incidence of tumors decreases.

## **Humans**

Several independent studies have found a correlation between mortality and telomere Length (TL) (Cawthon et al.; Rode et al.; Willeit et al.). One such study found that regardless of ethnicity or age there was a negative correlation between telomere length and mortality risk (Kodali and Borrell). This indicates that despite differences in ethnicity and age, decreased TL is directly associated with increased mortality in humans. In another study that utilized age prediction models, researchers found that shorter telomeres are correlated with increased age (17.) Contrary to findings on physical age, they also noted that shorter telomeres are positively correlated with younger cognitive age. Though this data did not reach significance, the notion that shorter telomeres lead to improved brain function is counterintuitive and challenges our

understanding of telomeres. These findings are not unique to this study; multiple independent studies have also recorded a correlation between increased cognitive function and shorter telomeres (Cohen-Manheim et al.; Huang et al.; Ma et al.).

## **Depression**

Various factors may accelerate telomere shortening and expedite age-related illness. Mental disorders, such as depression and schizophrenia, have also been associated with shortened telomeres (Gurvich et al.). People who have suffered from depression for the majority of their lifetime have significantly shorter leukocyte telomeres (LT) when compared to controls of the same age. When accounting for age, LT aged roughly 7 years faster in patients with lifetime depression versus in healthy controls. When the duration of depression is not taken into account, there is no statistical difference in LT length (LTL) (Wolkowitz et al.). This implies that the presence of depression does not immediately shorten LTL, but rather accelerates the natural process of LT shortening, likely by inducing oxidative stress and systemic inflammation. Interestingly, when lifetime depression is treated with antidepressants, the correlation between the duration of depression and LTL is no longer significant. That is not to say that antidepressants reduce LT shortening. Rather, the outcome can be attributed to a shortened duration of depression when antidepressants are taken, and therefore less time for LT shortening. This demonstrates how treatments for age-related diseases such as antidepressants are useful tools in mitigating the effects of age-related diseases and preventing telomeres from becoming shorter and creating risk for another disease. Individuals with a history of depression are also at higher risk of developing Alzheimer's than healthy individuals. Alzheimer's is an age-related disease that has a rate of development in individuals with depression. It is possible that the LTL shortening caused by depression puts individuals at a higher risk of developing Alzheimer's. This demonstrates a dangerous cycle caused by biological aging in which shortened telomeres are the cause of one disease which then further shortens telomeres putting the affected individual at higher risk of comorbidity.

## **Treatment**

Telomere lengthening, or a reduction in telomere shortening, has emerged as a potential treatment strategy for age-related illness. One study used mice to detail the effect of ultrasound deep brain stimulation (UDBS) on TL. A reduction of telomere shortening was observed in aging mice in response to UDBS (Zhang et al.). UDBS activates telomerase in a cell and therefore allows it to increase TL. Though the efficacy of this process on human telomeres is unclear, this outcome provides insight into a promising treatment for age-related disease. However, as previously mentioned, increasing the activity of telomerase can lead to the progression of cancer, as it enables cells to divide indefinitely. Another promising therapy for telomere shortening and associated age-related diseases is lithium treatment. Lithium's ability to protect neuronal cells from issues that would normally cause cell death has long been studied by researchers (CHIU and CHUANG). Today, lithium is used worldwide to treat neuropsychiatric disorders such as

bipolar disorder which is an age-related disease (BPD). One study researched the correlation between lithium treatment in BPD patients and LTL. LTL increased with lithium exposure upwards of 30 months. However, when accounting for the full treatment duration (3-468 months), the correlation between LTL and treatment duration did not reach statistical significance. BPD patients with longer LTL at the beginning of the treatment responded better to lithium as a treatment for BPD (Martinsson et al.). This finding emphasizes the significance of LTL in aging, as it can change the efficacy of treatments for age-related diseases. Depressive episodes as a result of BPD shorten LTL which demonstrates a dangerous loop as a short LTL causes BPD which further shortens LTL through episodes.

## **Section 2: FOXO3**

Transcription factors are proteins that can activate or repress gene expression to carry out operations in a cell and maintain homeostasis. Forkhead box (FOX) transcription factors are a category of transcription factors and are coded by the FOX genes. FOXOs play crucial roles in cell survival by regulating gene expression in response to environmental stimuli. In response to stress, FOXOs can induce various processes including autophagy and apoptosis. Autophagy is a process in which cells break down and recycle damaged parts of a cell and apoptosis is programmed cell death in response to abnormal cells. FOXOs are regulated by the Akt signaling pathway. When not phosphorylated, FOXO regulates gene transcription in the nucleus and cellular proliferation is inhibited. However, when the Akt signaling pathway is activated, FOXO becomes phosphorylated. Phosphorylated FOXO is the substrate for ubiquitin ligase which marks FOXO for degradation by a proteasome. Therefore, activation of the Akt pathway regulates FOXO and inhibits its transcription abilities, allowing proliferation to occur. Single nucleotide polymorphisms (SNPs) occur when a single nucleotide is altered in a base pair of a DNA sequence. Select SNPs as well as minor alleles of FOXO3 have been associated with exceedingly old age (Kahn).

### **Centenarians and the G-allele**

Centenarians are individuals who achieve an age of 100 years or more. Researching the genetics of centenarians allows researchers to better understand how to promote healthy aging in the general population. Studying the alleles of FOXO3 present in centenarians allows researchers to see the correlation between FOXO3 alleles and healthy aging. On average, FOXO3A3 is more prevalent in long-living Japanese men compared to their average-lived counterparts. Additionally, long-living men have higher self-reported health ratings (Flachsbart et al.). Polymorphisms in FOXO3 are also associated with the ability to reach higher-than-average ages. Differences that are consistent between Japanese, French, or German men and women, which implies that regardless of ethnicity or sex, the FOXO3A3 allele is directly related to achieving a higher-than-average lifespan.

The alleles of FOXO3 present in a cell have been shown to affect longevity. In one study, the minor A3 allele in a genotype (GG or TG) significantly decreased the prevalence of



age-related diseases such as congenital heart disease, cancer, and stroke. Having two G alleles (GG) was found to triple one's chances of becoming a centenarian (Willcox et al.). These results suggest the potential benefits of having the minor allele of FOXO3 and provide a possible explanation of the genetics behind centenarians' ability to achieve higher-than-average age. The direct correlation between the G allele of FOXO3 and age-related disease solidifies the understanding that FOXO3 is a contributing factor to human longevity and aging.

### **Arthritis in Mice**

When comparing the FOXO3 levels in young ( $25 \pm 1$  years) and old ( $56 \pm 1$  years) human menisci, FOXO3 levels are higher in the young menisci. Additionally, osteoarthritic ( $72 \pm 6$  years) (OA) human menisci had significantly lower FOXO3 levels than that of old human menisci (Lee et al.). This indicates that FOXO3 is directly tied to aging, as its levels decrease with increasing age. This could either suggest that decreased levels of FOXO3 due to an external factor are a cause of aging, or that the advancement of age diminishes FOXO3 levels. Further, this data connects FOXO3 with age-related diseases such as OA, which could imply that FOXO3 levels are associated with the development of OA or that OA raises FOXO3 levels. These results remain consistent when looking at the menisci of wild-type mice, where FOXO3 levels significantly diminished in the vascular zone from 6 months to 12 months, demonstrating that FOXO3 levels are also tied to aging in mice. Though the data remains consistent in mice, additional research is needed to confirm its relevance to human FOXO3, as the pathways associated with mice FOXO3 may differ from that of humans.

### **Dietary Restriction**

Dietary restriction (DR) is the reduction of nutrient intake without concern for malnutrition. Dietary restriction is known to delay the development of age-related diseases and has also been found to increase the lifespan of *C. elegans* (Roe et al.; Bronson and Lipman; Wu et al.). Researchers found that DR's ability to increase lifespan and prevent the degradation of locomotor activity as *C. elegans* age is reduced when FOXO is mutated (Johnson et al.). This indicates that FOXO plays a role in DRs' ability to extend their lifespan and prevent age-induced degradation. These results have been reinforced through several studies including one that compared the impact of 30% DR on the lifespan of wild-type mice with the impact on mutated mice with inactive FOXO3 gene. The results supported existing research demonstrating DR's ability to extend lifespan. It also showed that FOXO3 is the key to this benefit as in its absence DR was not able to produce the life-lengthening effect. Interestingly, the study also found that the absence of FOXO3 did not affect DR's ability to prevent cancer (Shimokawa et al.). This means that FOXO3 is exclusively necessary for the DR's lifespan-increasing effect which ties it directly to aging and provides further incentive to research FOXO3 in the study of aging. While these results seem to frame FOXO3 as a cure for age-related issues, FOXO3 also has disadvantages. Overexpression of FOXO3 has been known to induce autophagy (degradation and

removal of cells) meaning researchers cannot simply overexpress FOXO3 to counteract aging (Zhou et al.).

### **Section 3: Mitochondria**

Mitochondria are membrane-bound organelles that are essential in the process of cell respiration which powers the biological reactions in a cell. They utilize oxidative phosphorylation to synthesize the majority of ATP in a cell, which powers essential biological processes. A lesser-known attribute of mitochondria is its use in predicting aging and the likelihood of age-related disease. The mitochondrial free radical theory proposes that free radicals called reactive oxygen species (ROS) form as a byproduct of mitochondrial oxidative metabolism. These intracellular free radicals are unstable and as a result cause oxidative cellular damage. Accumulation of oxidative damage and mitochondrial DNA (mtDNA) damage induced by ROS cause a gradual decline in the cell's ability to function, thus advancing aging. Mitochondrial dysfunction has been linked with various age-related diseases such as cardiovascular disease (J. Yang et al.).

#### **Proteins**

The reduction of mitochondria in early life can be a signal of aging. In a Parkinson's disease model of drosophila, the processes of protein synthesis and degradation diminish with age. Specifically, proteins related to mitochondria are significantly more affected (some proteins increased while others decreased) in aging when compared to other types of proteins (L. Yang et al.). This difference in protein could be a result of declined mitochondrial function. As organisms age, energy-producing processes such as the synthesis of ATP become less efficient and are unable to provide the energy needed to synthesize and degrade proteins. Thus, measuring the levels of specific mitochondrial proteins could be a beneficial way of predicting future age-related complications.

#### **Stress**

Stress can cause a decline in mitochondrial function. Aging can often be a source of stress for individuals, creating a cycle in which stress accelerates mitochondrial dysfunction, creating even more stress. In a study of early-life stress (ES) in the mitochondria of mice, it was found that ES affected the expression of several genes relevant to mitochondrial function. ES also diminished cytochrome C oxidase (COX) levels in the mice through adulthood (Ruigrok et al.). COX sets the pace at which mitochondrial respiration occurs, so a decrease in COX indicates that ES causes decreased mitochondrial function, which may lead to age-related complications. A possible solution was found through long-term dietary restriction, which increased COX and hence increased mitochondrial function. Dietary resection when carried out properly, can counteract a decline in mitochondrial function related to aging without increasing mitochondrial biogenesis (Lanza et al., 2012). This shows that dietary restriction can increase lifespan by improving the function of mitochondria rather than simply creating more

mitochondria. Thus, dietary restriction prevents the development of age-related diseases related to mitochondrial dysfunction.

### **Mito-esc Treatment**

Mitochondria could also be utilized as a treatment for age-related diseases. Atherosclerosis is a disease highly associated with aging. Mitochondria-targeted esculetin (mito-esc) is a novel drug being tested for its effects on oxidative stress and its impact on disorders related to mitochondrial dysfunction. Treating mice with atherosclerosis with mito-esc prevents high blood pressure, a symptom of the condition. Mito-esc treatment also significantly reduces levels of pro-inflammatory markers associated with the disease (Karnewar et al.). Chronic inflammation is known to accelerate the aging process, so by mitigating atherosclerosis' ability to induce inflammation, mito-esc treatment not only lessens the impact of the disease, it prevents advancement in aging which causes the disease.

### **Section 4: Nutrient Sensing**

The ability to detect levels of lipids, amino acids, and sugars is essential for organisms to regulate nutrient levels within cells. Nutrient sensing functions through pathways that detect extracellular and intracellular nutrient levels. In response to abnormal levels, hormone signals are released to activate pathways that restore ordinary levels. When high nutrient levels are detected, anabolic pathways are activated to store the excess energy. When low nutrient levels are detected, cells engage in catabolic pathways, which break down macromolecules (carbohydrates and lipids) and release stored energy. Impaired nutrient sensing pathways can lead to overproduction of reactive oxygen species (ROS), oxidative stress, or cell death if the cell cannot get enough nutrients (Efeyan et al.).

### **AMPK and Akt Signaling Pathways**

Akt (also known as Protein kinase B) is a family of kinases that is essential for cell survival because of its ability to mediate cell growth and inhibit apoptosis. AMP-activated protein kinase (AMPK) is another protein kinase that detects cellular energy levels through AMP: ATP ratios. Upon detection of low nutrient levels, AMPK slows cell growth and proliferation by inhibiting the phosphorylation of Akt and thus allowing apoptosis of unfit cells (Hardie). Akt and AMPK also fight cancer by phosphorylating two important regulators of p53, MDM2 and MDMX respectively. P53 is a tumor suppressor gene that prevents cells from dividing uncontrollably by activating the transcription of p21 when a cell is not fit to pass G1 or G2. P21 is a cyclin-dependent kinase inhibitor that prevents entrance into the next stage of the cycle (S for G1 / Mitosis for G2) by preventing the binding of cyclins to a cyclin-dependent kinase. MDM2 inhibits p53 by inciting E3 ubiquitin ligase activity to mark the p53 for degradation by the proteasome (Vivanco and Sawyers). Akt aids in this process by phosphorylating MDM2 which gives it a higher affinity for binding to p53 (Ogawara et al.). AMPK on the other hand, induces p53 activity through phosphorylation of MDMX which associates it with the 14-3-3 protein and inhibits p53 ubiquitylation (Figure 2) (He et al.). Cells being unfit to duplicate is

often the result of cellular dysfunction and accumulation of DNA damage as an individual ages. Therefore, by reducing the risk of developing cancer earlier in life, AMPK pathways extend the human lifespan by inhibiting the Akt proliferation pathway and phosphorylating MDMX.

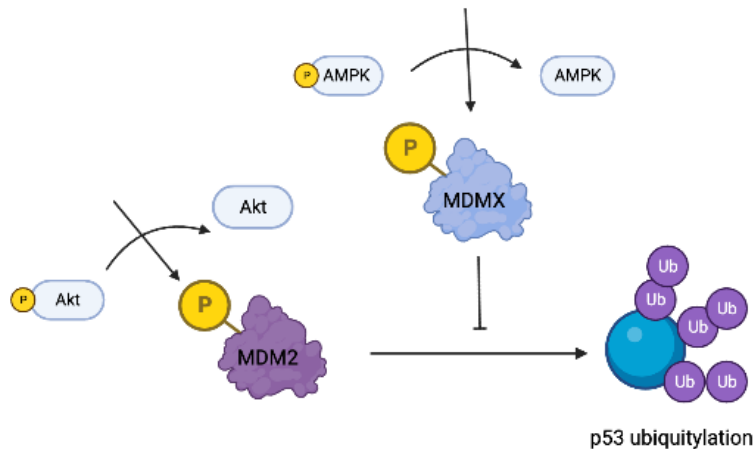


Fig 2. Phosphorylation of MDM2 and MDMX regulators of p53 by Akt and AMPK protein kinases. AKT slows p53 activity by phosphorylating MDM2 to induce ubiquitination of p53, marking it for degradation by a proteasome. AMPK activates p53 through phosphorylation of MDMX to inhibit ubiquitination and preserve p53 (Created with BioRender.com).

### Epigallocatechin Gallate

Epigallocatechin Gallate (EGCG), a compound in green tea, was found to downregulate AMPK and Akt in old age. The downregulation of these mediators demonstrates EGCG's abilities to suppress cell senescence and increase lifespan in humans. These anti-senescent properties suggest an increased risk of cancer, as more cells are able to divide. However, the opposite is true—EGCG has been found to prevent several diseases, including cancer (Du et al.; Sharma et al.). EGCG's ability to decrease cell increases lifespan without the risk of cancer is not fully currently understood by scientists making it a promising topic of research in the study of biological aging.

### Rapamycin treatment

In the presence of short telomeres, nutrient-sensing pathways are essential for survival. The mechanistic target of rapamycin is mTOR, a protein kinase in the PI3K/AKT nutrient-sensing signaling pathway. Rapamycin inhibits mTOR and has been found to delay aging. To test the effect of rapamycin treatment (RT) on longevity, researchers administered rapamycin to wild-type (WT) and telomerase-deficient (TD) mice, which have shortened telomeres. They found that in WT mice, RT increased the median lifespan by 39% as well as an increased maximum lifespan. Notably, RT's ability to increase longevity was higher in male WT

mice (43%) than in female WT mice (23%) when compared to their respective controls. Conversely, in TD mice RT appeared to decrease longevity. RT decreased the lifespan of TD mice by 16%. Longevity was decreased by 19% in males, while the longevity of females stayed the same (Ferrara-Romeo et al.). The study clarifies that RT does not preserve or deplete TL and that it does not induce DNA damage. These results support the notion that mTOR is crucial for survival in the context of shortened telomeres, as inhibition of it proved detrimental in TD mice with shortened telomeres. This is further supported by the finding that the mTOR pathway is upregulated in TD mice.

### **Section 5: Inflammation**

Genetics is not the only factor that determines aging; external factors such as social conditions and exercise play important roles in human aging. Poor social conditions are known to have negative effects on mental health and have recently been attributed to physical effects on a cellular level—namely inflammation. Inflammation is an immune response to irritants in the body. Inflammation can be acute, meaning it occurs and resolves quickly, or chronic, which takes place over long periods. Acute inflammation usually occurs as a response to immediate damage such as cuts or infections. Conversely, chronic inflammation occurs when the body is not able to immediately remove an irritant or heal properly (Pahwa et al.). Although inflammation is crucial to the body's healing process (Goodman and Maruyama), unresolved chronic inflammation is linked with shorter lifespans and age-related inflammatory diseases such as rheumatoid arthritis and Crohn's disease (Roda et al.; Shrivastava and Pandey).

Fortunately, exercise has been researched to have an anti-inflammatory effect, which could aid in preventing inflammatory diseases.

### **Social Support**

Humans are social beings, thus social isolation can have adverse effects on us (Malcolm et al.). It is generally accepted that social isolation triggers pain signals in the brain, leading to inflammation. Social stigmas around age-related diseases can cause individuals with these diseases to feel rejected by their communities and trigger inflammation. For example, stigmas surrounding HIV cause people with HIV (PWH) to gain less support from their communities. When comparing levels of inflammatory factors in PWH versus patients without HIV, poorer social conditions lead to increased levels of inflammatory biomarkers regardless of sex or ethnicity (52). This suggests that social support can influence how an individual ages, specifically that poorer social support can lead to accelerated aging as a result of inflammation. Also, with increasing age, social support for subjects without HIV decreased while support for PWH did not significantly change. This suggests that old age has a similar stigma to HIV, which corresponds with poorer social support, leading to more inflammation and higher chances of inflammatory diseases.

## **Exercise**

Increasing evidence suggests that exercise can be a preventative measure to avoid inflammatory complications. A 10-month Tai Chi training practice decreased fat mass in subjects by  $3.02 \pm 3.99\%$  (Morawin et al.). Increased fat mass is associated with higher levels of inflammatory markers and, as stated prior, inflammation accelerates the aging process. By decreasing fat mass, Tai Chi was able to reduce inflammation and cellular aging as a result. It is important to note that the majority of subjects who participated in this study were classified as overweight prior to the training, thus the results may differ in individuals with a healthy weight. There is an important distinction to be made between acute exercise and chronic exercise (also known as training). Acute exercise is a single session of exercise with immediate effects while chronic exercise is a routine of acute exercises that one partakes in for an extended period (Budde et al.). Interestingly, acute exercise has been found to initially cause inflammation. Pro-inflammatory subtypes of blood monocytes increased by 27% immediately after 45 minutes of treadmill running; however, after 1 hour the levels lowered 49% below the pre-exercise levels (Simpson et al.). Inflammation is viewed in a negative light by the public; however, it is an important aid in the repatriation process after a period of exercise and promptly returns to normal or even below-average levels. The issue with inflammation stems from chronic inflammation that leads to accelerated aging. The source of chronic inflammation in exercise is acute high-intensity exercise such as a triathlon. After an IronMan Triathlon consisting of swimming, cycling and running, athletes had significant increases in the TNF- $\alpha$  IL-6 and IL-10 inflammatory markers which were all undetectable before the race and raised to levels of  $67.47 \pm 10.34$ ,  $55.41 \pm 3.45$ , and  $122.53 \pm 9.69$  respectively (Pinho et al.). Acute high-intensity exercise causes chronic inflammation because due to the lack of routine, the body is not conditioned to handle the strain of the exercise hence increasing the potential for significant muscle damage which cannot be healed through acute inflammation. Thus the most effective exercise for minimizing chronic inflammation while reaping the benefit of exercise is moderate-intensity chronic exercises like walking, biking, or swimming.

## **Discussion**

Understanding biological aging is the key to promoting healthy aging as the aging population increases throughout the world. The complicated processes that culminate into aging could be the key to understanding how to delay aging or even reverse the biological aging process. An important distinction to make is between biological aging and chronological aging. Chronological aging is simply the amount of time a person has existed measured in years. Biological aging, on the other hand, is the gradual accumulation of cellular damage and is measured by assessing an individual's physical and mental capabilities. Biological aging and chronological aging do not always correlate as individuals biologically age at different rates due to genetic and environmental factors. Biological aging is difficult to research as there is no set measure at which a person is deemed biologically old or unhealthy. A comprehensive study comparing the biological ages of participants and using that data to create a set of guidelines

could work to solve this issue. The multifactorial nature of cellular aging makes aging difficult to comprehend. This review speaks of several factors individually. While identifying factors separately provides a strong basis for researchers, it is important to note that biological aging is a complex process in which these factors interact and affect each other.

The current knowledge of aging is difficult to use practically as age-related diseases are the result of various factors and researchers do not yet know how these factors interact. In the future, several steps could be taken to further our comprehension of the aging process. Researching the interactions between known factors of aging, such as nutrient sensing pathways and mitochondrial damage, are a considerable start. Similarly, observing the interactions of factors, or lack thereof, in long-living models provides information that could have positive implications in the field of human aging. Strong candidates for studies concerning biological aging are organisms from the genus Hydra, which appear to lack the process of senescence, making them biologically immortal. Continued efforts to understand the biological aging process, and the factors that affect it, are crucial in promoting healthy aging and improving the quality of life in the aging population.

## **Conclusion**

As advanced technology continues to lessen the threat of infectious diseases, genetic and age-related complications remain the limiting factor of the human lifespan. Scientists have identified several key factors in deciphering the complex process that is biological aging. The shortening of telomeres throughout cell divisions and the ability of telomerase to extend telomere length have been heavily researched as methods of regulating aging. FOXO3, specifically the FOXO3A3 allele, has been tied to centenarians' ability to achieve extended lifespan. Mitochondrial dysfunction and the creation of ROS have been linked to accelerated aging and treatment options such as mito-esc treatment have been proposed to mitigate these effects. AMPk and Akt are cancer-fighting nutrient-sensing pathways that increase with age and help prevent age-related dysfunctions within cells. Inflammation is a significant contributing factor to aging as it is the cause of several age-related diseases. Exercise has been a common method to reduce chronic inflammation and prevent the consequences associated with it. Animal models, specifically *c. elegans* and mouse models, are a window into how aging processes function in nature and provide valuable insight that may aid in the creation of treatment for age-related diseases in humans. Several other factors are associated with human and animal aging which are heavily examined by researchers working to dissect the aging process. Understanding these factors individually and how they interact is the key to slowing down biological aging and developing treatments for age-related diseases to provide people with longer and healthier lives.

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## Gulf War Research Paper By Damian Zhu

The U.S. army won the Gulf War without having to fire a shot. The war was sparked by Iraq's invasion, driven by territorial disputes, economic factors and Saddam Hussein's ambition for reuniting the Middle East. The coalition of the United States and many other countries launched several military operations, which resulted in the liberation of Kuwait and the expulsion of Iraqi forces from the country. Although the United States substantially contributed in the operations in both air and ground attacks, the ground troops that were deployed to sweep up following the air attacks are unnecessary as the traumatic experience with bombing and debris outweighs the benefits they contribute during the war.

In order to understand the territorial and religious conflicts between the middle eastern countries during the 1990s, it is essential to begin with the Iraq Iran War that sparked the sequence. In the late 1960s, as the United Kingdom withdrew from the Persian Gulf area, the long-suppressed territorial difference between Iraq and Iran was unleashed and created tension in the gulf area for decades.<sup>26</sup> Clashes over the border emerged periodically caused by the Iranian Revolution questioning the standing of the temporary peace agreement between Iran and Iraq, creating more tension between the two regimes.<sup>27</sup> However, the United States was not in support of Iran's new government over the seizure of the U.S. embassy by militants.<sup>28</sup> In 1979, led by Saddam Hussein, a new regime called Ba'ath was established to modernize and reunite the regional powers with a very appealing ideology to mid-conflict people, socialism.<sup>29</sup> In addition to these goals, the Ba'ath regime aimed to expand Iraq's influence in the Middle East. With Saddam Hussein's ambition and his belief in Iraq regional dominance, the regime was particularly interested in confronting Iran.<sup>30</sup> Finally in September 1980, the Iraq Iran War began as Iraqi forces marched into Khūzestān and created a 75 mile long frontier within the Iran border by December. However, the Iranian state militia surprised the Iraqi forces with strong resistance and turned the war into a stalemate by April 1981. Although the two powers were focused on territorial dominance, with no end to the war in sight, they began attacking each other's oil resources in the Persian Gulf. This change in direction damaged the two countries oil exports as well as the benefits of countries world wide. In July 1987, the UN Security council had urged a cease-fire between the two, which finally happened in August 1988. This conflict between Iraq Iran War ended with loss of oil resources to many parties as well as Saddam Hussein solidified his influence and control within Iraq.<sup>31</sup>

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<sup>26</sup> 1. "Iran-Iraq War," in *Britannica Academic*, <https://academic.eb.com/levels/collegiate/article/Iran-Iraq-War/42742>.

<sup>27</sup> "Iranian Revolution," in *Britannica Academic*, <https://academic.eb.com/levels/collegiate/article/Iranian-Revolution/476048>.

<sup>28</sup> "Iran-Iraq War,"

<sup>29</sup> Florence Gaub, "Meet Iraq's Sunni Arabs," in (n.p.: European Union Institute for Security Studies (EUISS), 2017), 2, <http://www.jstor.org/stable/resrep17448>.

<sup>30</sup> John F. Devlin, "The Baath Party: Rise and Metamorphosis," *The American Historical Review* 96, no. 5 (1991): 1405, <https://doi.org/10.2307/2165277>.

<sup>31</sup> "Iran-Iraq War,"

Before reaching a peace agreement with Iran, the military leverage began to favor Iraq as Saddam Hussein raised an army of about one million and obtained advanced arms from France and the Soviet Union along with substantial quantities of chemical weapons and weapons of mass destruction.<sup>32</sup> With such a dangerous and powerful army, Hussein's ego was not held back by the peace agreement. Very soon, he turned his attention to Kuwait, a small country with mass oil production that borders Iraq. Oil is the single most important resource to countries and is the main cause of the Persian Gulf War and U.S. involvement. In the 1970s, oil prices skyrocketed in adjusting to global demands, transforming the Gulf into the most sensitive in the world. Gulf oil reserve increases daily as more oil is to be found in the region than anywhere else in the world.<sup>33</sup> The Persian Gulf and its oil quickly became the center of global interest and Kuwait, the smallest country with the largest oil reserve, has received a lot of attention. As the central figure in the Gulf war as well as other conflicts in the middle-east, Saddam Hussein "embodies the ultimate centralization and personalization of power and authority"<sup>34</sup> Being part of Arab culture, he, like many other Arabs, feels "deeply humiliated" that the Arab World has not been united.<sup>35</sup> Another justification for his invasion of Kuwait, Saddam Hussein accused Kuwait of slant drilling into oil fields that belonged to Iraq. Slant drilling is a technique used to extract oil from a reservoir that is located under another country's territory without actually crossing the border above ground.<sup>36</sup> With the three major justifications, Hussein began his invasion of Kuwait on August 2, 1990.

Resistance of the invasion lasted about 36 hours. With an estimated 4,200 Kuwaiti killed, the Iraqi force easily took over Kuwait city. Saddam Hussein's conquest of Kuwait has been unchallenging, the world was concerned that Iraq wouldn't be satisfied with only Kuwait. Conquering Saudi Arabia(borders Iraq and Kuwait) would give Saddam control of more than 40% of the world's oil reserves as well as two of the holiest sites in the Islamic world, Mecca and Medina. On August 6, the United Nations Security Council passed a resolution to ban all trades with Iraq and protect the government of Kuwait. A day later, President George H. W. Bush launched Operation Desert Shield, a coalition of 35 nations to send troops to defend Saudi Arabia and ultimately liberate Kuwait.<sup>37</sup> Over the following months the U.S. military carried out one of its largest overseas deployments, locating over 240,000 troops in the Gulf with another 200,000 on the way. Using the troops in Saudi Arabia as leverage, the United Nations gave Saddam a deadline until January 15, 1991 to withdraw Iraqi force from Kuwait before a direct attack on Iraq by the coalition. However, Saddam did not withdraw his troops, allowing the US to launch Operation Desert Storm, massive air attacks directed by the coalition military campaign. Allied forces had three main objectives during the air campaign: "to establish air

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<sup>32</sup> "Iran-Iraq War,"

<sup>33</sup> Abdulkhaleq Abdulla, "GULF WAR: THE SOCIO-POLITICAL BACKGROUND," *Arab Studies Quarterly* 16, no. 3 (1994): [Page 6], <http://www.jstor.org/stable/41858983>.

<sup>34</sup> Abdulla, "GULF WAR," [8].

<sup>35</sup> Abdulla, "GULF WAR," [9].

<sup>36</sup> Britannica Academic, s.v. "Persian Gulf War," accessed May 14, 2023, <https://academic.eb.com/levels/collegiate/article/Persian-Gulf-War/59340>.

<sup>37</sup> "Persian Gulf War,"

supremacy, to destroy strategic targets, and to degrade Iraqi ground forces."<sup>38</sup> The coalition has gained air supremacy by January 28 after evicting 115 Iraqi aircrafts, destroying almost 150 aircrafts and most importantly neutralizing some 30% of the Iraqi ground forces. By February 11, coalition naval forces also contributed to the campaign against Saddam and sank the last Iraqi (and captured Kuwaiti) naval units. Even with the outstanding efficiency, value and damage caused by air attacks, the coalition still launched Operation Desert Sabre, a ground attack aiming to completely remove Iraqi forces from Kuwait. The U.S. has raised a deployment of almost 500,000 soldiers in the Gulf area. Amongst them was Anthony Swofford, who was deployed to Riyadh, Saudi Arabia shortly after he turned 20.

Swofford was a lance corporal serving as a Scout Sniper Trainee with the Surveillance and Target Acquisition (STA) Platoon of 2nd Battalion, 7th Marines during the Gulf war.<sup>39</sup> His father served in the Vietnam War, and before that, his grandfather served in World War II. Growing up in a military family, Swofford has been very ambitious and excited to join the army, an opportunity he sees as "an entry into manhood"<sup>40</sup>. Along with 240,000 other enthusiastic young men, Anthony joined the marines at an age of 18, seeking to make a difference in the world. However, life in the army was not what he had imagined. Right from the start, they were physically abused and mentally shamed to build a state of mind that is "Kind of a bloodthirst, a desire, for combat, and also an ability to move through combat without being stricken in the midst of it, and, and totally debilitated-cracking up." by "Fear, anxiety, and the desire to live." After being deployed to the front line, the troops waited for 6 months before the war started. During the time period, they were excessively trained in the desert, mock missions but most importantly, chemical or biological attacks. With constant doubts on the gas masks and other safety conditions, "It was totally unknown. Absolutely terrifying."<sup>41</sup>

Even though the air attacks have cleared 30% of Iraqi troops in a month, the soldiers were still sent to the dangerous front line only to march through places that have been bombed and destroyed. The boredom and frustration from thousands of training patrols and dozens of live patrols has driven the soldiers hopeless to the point where "you just want to shoot somebody, because that's what you're trained for."<sup>42</sup> However, the frontline was still dangerous and the constant fear of dying puts soldiers in a fragile mental state.

I return to the disturbing nature of the terrain, the lack of variation, the dead repetition, and constantly, the ominous feeling that one is always in the open. The open, we were told as

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<sup>38</sup> "Persian Gulf War,"

<sup>39</sup> Wikipedia contributors, "Anthony Swofford," Wikipedia, The Free Encyclopedia., last modified April 26, 2023, accessed May 13, 2023, [https://en.wikipedia.org/w/index.php?title=Special:CiteThisPage&page=Anthony\\_Swofford&id=1151877720&wpFormIdentifier=titleform#Chicago\\_style](https://en.wikipedia.org/w/index.php?title=Special:CiteThisPage&page=Anthony_Swofford&id=1151877720&wpFormIdentifier=titleform#Chicago_style).

<sup>40</sup> "Interview With Anthony Swofford; originally published in issue 12/03 of Das Magazin". Berichte aus Amerika. Archived from the original on 3 January 2008.

<sup>41</sup> Swofford, Anthony. Interview. U.S. January 3, 2008.

<sup>42</sup> Swofford, Anthony. Interview. U.S. January 3, 2008.

early as boot camp, is a poor place to find yourself. In the open you die, and your friends, when they try to save you, they die. But the whole goddamn desert is the open.<sup>43</sup>

The soldiers were armed with 50 caliber M16s. However, they were not allowed to hit human targets with them as the 50 calibers do too much damage. Thus, they were given the instructions to "you hit the gas tank on their vehicle, and they get blown the hell up"<sup>44</sup> Under the constant fear of chemical attacks and people yelling "incoming", the soldiers have to take PB pills(pyridostigmine bromide) to ease the stress and reduce the damage of nerve agents.<sup>45</sup> Taking these pills and suffering chemical attacks are part of the reason many soldiers who served in the Gulf war, who have not had a chance to kill people, suffer from Post-traumatic stress disorder (PTSD), also known as the Gulf War syndrome. Another potential cause are the harmful chemicals trapped in the black smoke in the air after burning oil fields. When the unit Swofford was in finally approached an enemy building, his captain followed the order and called in air strikes to minimize U.S. casualty. Swofford was in disbelief as "I watch through my spotter's scope. I've seen thousands of bombs land on targets—but I've never witnessed the extermination of human life. The explosions look, through my scope, about the same size as the artillery explosions that had occurred minutes before occurred directly in front of me. In the dust cloud floating slowly down the ridge I imagine that I can see the last breaths of these men now dead"<sup>46</sup> At the frontline, soldiers are kept from diplomatic news as well as any other information that will "distract" them. These sickening conditions and moral justification during the Gulf War led to the devastation in killing and the loss of a clear goal as of the soldier's purpose of being at the Gulf.

Shoved into this hole in the middle of the middle of nowhere, I consider the fire we've taken. The ground war has not officially begun, but we've been fired at, within close range, twice. I will never know why those men didn't attack us over the rise. Perhaps we shared an aura of mutual assured existence, allowing us to slowly approach one another and prepare to engage, but finally when the numbers were crunched, the numbers were bad for both sides, and the engagement thus sensibly aborted. Men are smart and men are animals, in that they don't want to die so simply for so little.<sup>47</sup>

A month later, the war was over. Although only 154 U.S. soldiers were killed in battle and 65 died from nonbattle causes. 35 of the battle deaths were a result of friendly fire. Moreover, the mental stress and psychological damage affected every soldier who served. Recalling from the war, Swofford remarks, "Like, nobody cares we're going to die, it doesn't really matter, we're grunts in the Marine Corps, we've got targets on our chests, and that's a lonely feeling." This mental suffering could be avoided because throughout a month of air operations, U.S. and allied forces destroyed over 3,000 tanks, 1,400 armored personnel carriers, 2,200 artillery pieces, and countless other vehicles. Ninety-six service members were killed in

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<sup>43</sup> Anthony Swofford, *Jarhead: A Marine's Chronicle of the Gulf War and Other Battles* (New York, N.Y.: Scribner, 2003), [137].

<sup>44</sup> Swofford, *Jarhead: A Marine's*, 158.

<sup>45</sup> Swofford, *Jarhead: A Marine's*, 182.

<sup>46</sup> Swofford, *Jarhead: A Marine's*, 191.

<sup>47</sup> Swofford, *Jarhead: A Marine's*, 199.



action; an estimated 30,000 Iraqi troops were killed.<sup>48</sup> Serving for 2 years in the Middle-east, not being able to contribute to the strategic military effort was not worthy as they only marched through debris, corpses in the sand, family missing following the continuous bombing. The chemical damage to their bodies, the psychological trauma from the war and death as well as the isolation from normal lives outweighs the contribution the soldiers are able to make in the Gulf war.

The Gulf War was significant as it demonstrated the United State's diplomatic strength, appeal for peace as well as military power. The war emerged when Saddam Hussein invaded Kuwait over political, economical causes. The international community, led by the U.S. formed a coalition and launched Operation Desert Shield, Storm and Sabre to liberate Kuwait. The operations showcased a swift and decisive military campaign. However, the damage done to the soldiers at the frontline could be avoided since the airstrikes have neutralized almost 30% of Iraqi forces and has more strategic effect than ground troops. Ultimately, the Gulf War resulted in a decisive victory for the coalition, the deployment of ground troops into the Middle East for almost 2 years was unnecessary as the the air offense has reaffirmed its strength modern warfare and sent a strong message to the Saddam Hussein and the Iraqi forces.

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<sup>48</sup> David Vergun, "Nation Observes Anniversary of Operation Desert Storm," U.S. Department of Defense, last modified January 15, 2022, accessed May 14, 2023, <https://www.defense.gov/News/News-Stories/Article/Article/2879147/nation-observes-anniversary-of-operation-desert-storm/#:~:text=During%20air%20and%20ground%20operations,30%2C000%20Iraqi%20troops%20were%20kil led.>

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## **Immigrant Happiness By Ananya Uddanti**

The American Dream and immigrants are the basis of the United States of America. America created an image as a home to novel ventures, success, and support (Webb 35–58). Per Webb, the world began to adopt the idea, “that the U.S. is the best and greatest nation on earth; that individualism is the key to America's greatness; that democracy, as discovered and perfected by the American people, is the ultimate form of living together; that everyone should try to be successful; that life would not be tolerable if we did not believe in the progress and know that things are getting better; that America is a land of unlimited opportunity”. (Webb 41–2)

Thus, America became a symbol of happiness, genius, economics, entertainment, fashion, and technology, leading young immigrants to believe that America was a place to fulfill dreams (O’Hagan). Yet, how true this idealized version of the United States is for immigrants, in terms of obtaining happiness and all that the US has to offer, is not clear. Identifying the validity of this image is crucial to understanding the circumstances of immigrants in America and their ability to obtain happiness. This paper aims to evaluate the variety of and identify the factors that affect the process for immigrants to obtain happiness in their idealized America. It is the opinion of the author that migration is not key to immigrants obtaining happiness in America. Despite the idea that they are gaining various economic benefits that should promote life satisfaction, the inability to gain good quality homes, culture-related stressors, and lack of certain employment counteract the benefits, leading to a lack of happiness.

Happiness can be understood as made of two subjective components: emotional well-being and life evaluation. As per Kahneman and Deaton, emotional well-being can be defined as the quality of everyday experiences and frequency of positive emotions, while life evaluation is an individual's thoughts on their own respective life, recorded on a scale of satisfaction (0 being the lowest, 10 the highest) called the Cantril Self-Anchoring scale (16489–93). As this paper aims to evaluate the variety of factors that affect the obtaining of happiness, it must be understood that each factor will have varying relations with life satisfaction and emotional well-being.

The Easterlin Paradox finds that wealthier countries possess happier people on average. Nonetheless, this does not mean migration is key to obtaining happiness, as migration to a wealthy country to obtain higher incomes has consequences that counteract outweigh the positive influences on happiness. One such consequence is the relative position and status of a migrant in the workplace (Bartram 57–76). The lack of respect from a higher position in the workplace may lead to lower life satisfaction, as the migrant is not satisfied with their current state. Per Kahneman and Deaton, higher-income results in a higher life evaluation yet do not entirely result in a “happier” individual (16489–93). Circumstances in which income results in higher life evaluation may not entirely result in higher emotional well-being, and both aspects are crucial to be considered a “happy” individual. Such reasons for the lack of emotional well-being in light of life satisfaction may be material instability and lack of higher employment opportunities (Bartram 57–76).

The relationship between migrants and happiness is consistent with the Threshold Effect regarding the value's implications. Easterlin (qtd. in Bartram 57–76) found that despite wealthier countries possessing happier people, the relationships between income and happiness within the country were weak, suggesting a 'threshold effect,' which was corroborated by Kahneman and Deaton. Kahneman and Deaton find the threshold for emotional well-being improvement to be at a salary of \$75,000 a year, noting beyond this point, any income increases do not directly correlate with an improvement in stress and worry but do correlate with an increase in life evolution (16489–93). The median annual household income in 2018 the US for migrant families is \$59,000 (Budiman et al.). This is well below the value for which the effect of income on emotional well-being stabilizes, determined by Kahneman and Deaton. Thereby, the Threshold Effect indicates a probable reason for the lowered probability of reporting high life satisfaction. Below \$7500, life quality is drastically more difficult (Kahneman and Deaton 16489–93): health conditions, divorce, and poor living conditions become more common. These factors result in higher levels of stress and worry that can result in dissatisfaction with one's living situation and living standards, causing the lowered probability of migrants reporting high life satisfaction. Hence, the Threshold Value indicates the average immigrant's household income, though on par with that of natives, is insufficient to improve migrants' life satisfaction.

Despite immigrants living longer lives and experiencing lower rates of cancer, the cultural differences between immigrants and their host country limit immigrants' ability to obtain the sense of emotional well-being and life stratification they are lacking due to the stress they entail. This counteraction to the happiness that ought to be obtained from the economic opportunities of America demonstrates the disparities in the obtaining of happiness between natives and immigrants, indicating that higher income is not sufficient for life satisfaction: cultural assimilation must also be achieved. Angelini et al. note a direct relationship between immigrants' well-being and their degree of cultural assimilation regarding linguistic and ethnic differences (817–44). Indicating a need for action to catalyze cultural assimilation by the host nation, Angelini et al. find that interventions through the host country will allow immigrants to combat the negative effects of the lack of cultural assimilation (817–44); such interventions may take the form of action to limit ethnic enclaves in housing and language education programs. Hence, it can be understood that cultural differences between immigrants and their host country limit immigrants' ability to obtain the sense of emotional well-being and life stratification they are lacking due to the stressors and effects of cultural differences.

The disparities in the type of stressors between natives and immigrants serve as evidence to indicate that immigrants will consistently face counteractants to their benefits of increased income. It may be noted that immigrants have a lower mortality rate than native-born Americans. This gives the impression that immigrants possess higher living standards and health and, thereby, happiness. However, the higher mortality of native-born Americans is attributed to the higher presence of habitual smoking practices in this demographic (Boen and Hummer 434-52). Accepting that immigrants should be more satisfied in America due to their longer life span, the idea that smoking is primarily to blame for lower life satisfaction emphasizes the role of cultural

norms. Further, it emphasizes that low life satisfaction among immigration is ascribed to cultural stressors to which immigrants are vulnerable (Boen and Hummer 434–52). Further, though immigrants should be seemingly more satisfied with their pay than natives, given the economic gains available in the United States, immigrants are not necessarily satisfied with their overall living conditions, indicating there are more variables unaddressed. Bartram found that higher income increased the probability of higher life satisfaction for immigrants than for natives of the USA (57–76). Yet, it was also found that being an immigrant in the US is correlated with a lower probability of self-reporting and a higher level of life satisfaction. This seemingly paradoxical statement from Bartram can be understood as income increases for immigrants, they are more likely to have a higher life satisfaction than natives; however, on average, immigrants are less likely to report high levels of life satisfaction.

This paper aims to evaluate and identify the factors that affect immigrants' ability to obtain happiness in their idealized America. The argument was that migration was not the key to obtaining happiness in America, the home of happiness, genius, and economics. Migration to a wealthy country to obtain higher incomes comes with consequences that counteract the emotional benefits of higher income, as understood from the aforementioned studies extrapolating that immigrants, despite incomes on par with the U.S. average, are not necessarily satisfied with their overall living conditions. The inability to gain higher standards of and better quality of living is a key factor in the lower life satisfaction found among immigrants immigrating from less developed countries. Likewise, the cultural differences between immigrants and their host country limit immigrants' ability to obtain the sense of emotional well-being and life satisfaction they are lacking due to the stress the cultural barriers entail, indicating that higher income is not sufficient for life satisfaction: cultural assimilation must also be achieved. Interventions, such as action to limit ethnic enclaves in housing and language education programs through the host country, will allow immigrants to combat the negative effects of the lack of cultural assimilation; Likewise, easier access to banks/loans and properly upheld standards for property assessment procedures to combat lower quality and valued housing clusters for immigrants.

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## **Should Regulations in Medicine Be Reduced to Increase Scientific Progress in the Medical Field? By Jude Jamison**

Solving complex problems requires attention, careful thought, creativity, intuition, and applied experience. Medical problems should be no different. However, in the highly regulated environment in which our health system operates today, the approach of healthcare providers is often prescriptive, rather than dynamic, in nature. Educators, the government, and employers play a role in creating and driving regulations that create this prescriptive effect in an effort to both limit liability and increase safety.

Medical regulations have been created to keep the public safe from medicines and treatments that have not been properly studied for safety and efficacy, and to standardize the knowledge shared with students in the medical field so that a minimum standard of care can exist. This regulation has had the unintended consequence of teaching students that there are certain expected outcomes in a patient sample, or that identifying specific symptoms or complaints will necessarily lead to a predetermined diagnosis. The curriculum taught in medical courses is up to date, but the way that the students are taught does not allow much freedom in thinking, because, “In medicine, we speak of knowledge, sensitivity, intuition and luck. Logical thinking and intelligence, interest and inquisitiveness, perseverance and steadiness, technical ability, experience and information, are indispensable for a potential success.” (Ohray 1).

This pressure to conform continues into the medical careers of many physicians. Government regulations put into place may limit a particular area of study from being researched fully due to cost or resource constraints, or legal requirements and protections designed to protect lives and limit liability can prevent research findings from being used with the general public for many years. Currently, there is no real solution to the increasing amount of conformity in the medical field, as we continue to see more regulations being put into place. Medical students and residents need to be taught certain required content of the course, but there needs to be a greater focus on creativity facilitated as well. While there is efficiency to be gained in prescriptive diagnosis, what is lost is the opportunity to find better treatment options and more accurate diagnoses earlier. Similarly, regulations in the medical world are necessary, but they need to be reduced to prevent progress from being slowed.

The human brain tends to lean heavily on outside influences when gathering information and forming a conclusion. When this outside information does not directly match our own thoughts and ideas, we tend to change our stance to fit in with the crowd, and it is found that, “Not only did synchrony suppress the initial urge to argue for one’s unique opinion, it also suppressed the desire to continue to argue for one’s own opinion, thereby reducing healthy group dissent” (Taylor 4). While this trait may be beneficial when looking to maximize group efficiency, it can in many cases prevent others from saying what they believe, even when what they believe is correct.

This characteristic does not go away even when the information is vital to treatment, as it has been found in the medical community as well. A study within a residential program found,



“Of the 166 participants, a total of 149 (89.8%) identified the pressure to conform occurring at least sometimes or more often, i.e., ratings of three or more on the five-point scale, in at least one postgraduate setting” (Grendar, Beran, and Oddone-Paolucci 14). Even if this is just a one-time occurrence for some, that one time where a resident conformed was harmful to the resident and potentially being harmful to the patient involved. This possibility seems even more likely to occur when considering the places that the most students most feel the need to conform, as a study found that, “The highest frequency of reported pressure to conform occurred during the on-service operating room” (Grendar, Beran, and Oddone-Paolucci 12). This is concerning because the operating room is a place where a physician, when faced with a difficult or unexpected situation, should feel comfortable making a judgment call that could save a patient’s life.

Regulatory agencies seek to standardize healthcare in an effort to benefit patients and the overall healthcare system. According to the website for the Federation of State Medical Boards, a professional organization of state regulatory agencies, “The decisions state medical board members make significantly impact patients, families and physicians – and are vital in protecting the public from harm and enhancing the quality of medical practice” (Federation of State Medical Boards 2). While this does seem to make sense on the surface, too much regulation can slow progress and harm the integrity of the research, and ultimately hurt patient care. However, that does not have to be the case, as noted by Peter Pitts of the Center for Medicine for the Public Interest, who said, “Importantly, it is critical to understand that new approaches to clinical programs and shorter review via expedited review pathways do not mean a less rigorous FDA interrogation of the data. It means a different, yet scientifically rigorous, approach with different roles and responsibilities on the part of both agency and sponsor and acknowledging the needs and preferences of patients living with serious diseases.” (Pitts 6). Limiting regulations does not mean that the public is in any more danger than when the extra regulations were in place.

Additionally, not all regulations put into place are designed for the safety of the public. Some regulations are put in place to protect the developing corporation or individual from litigation or financial loss. Overregulation can also impede progress, and sometimes create roadblocks that can be difficult for members of the public to navigate. The general population seemingly has the same opinion, as noted by researchers Gary Marchant and Lynda Pope, who wrote, “A study by the National Science Foundation found that while 84% of Americans are positive overall about the prospects of science, more than half of respondents nevertheless agreed that ‘scientific research these days doesn’t pay enough attention to the moral values of society’ and that ‘scientific research has created as many problems for society as it has solutions’” (Marchant and Pope 13). By allowing too many regulations to be put in place, we could potentially be harming research and preventing patients from benefiting from the results.

A great example of what can happen when regulations are limited is the development of the COVID-19 vaccine. Typically, vaccines take about five to ten years, or more, to be developed and released to the public (Johns Hopkins Coronavirus Resource Center 3). However, the COVID-19 vaccine took only one year. While the quick delivery to the market did cause some

people to be hesitant to get the vaccine, the end result was a highly effective and safe vaccine that undoubtedly saved thousands of lives. This rapid development was able to happen, at least in part, because, “WHO approved BNT162 for emergency use on December 31, 2020, to allow for easier global manufacturing and distribution. Similar EUA processes were adopted by several countries including, United States, Canada, Russia, China, and India to approve different COVID-19 vaccine candidates (CVCs) and the list is growing” (Kashte, Gulbake, El-Amin III and Gupta 3). By disrupting pre-existing regulations, WHO allowed for multiple vaccines to be tried and researched simultaneously. By allowing for this rapid and intense research, lives were saved, infection severity was lessened, and society benefited from the relief provided to over-extended healthcare systems. As the COVID vaccine example illustrates, it can be argued that those in the medical field have a moral obligation to save lives by bypassing regulations.

The field of medicine is often intertwined with politics, and politics is complicated by competing interests, lobbying, election years, and more. Within politics, there are competing agendas that could influence the regulations put into place. Lawmakers do not always regulate medicine with the public's best interest in mind, but instead, in consideration of certain priorities, that may change. Research by the government suggests, “This can occur when decision-makers distort, mischaracterize, or suppress scientific and technical research results that conflict with desired policy directions, or when they interfere in the research process to obtain desired results” (Lander 11). In fact, in 2007, *The New York Times* reported that “Former Surgeon General Richard Carmona told congressional investigators that federal officials weakened or suppressed public health reports to support a political agenda” (Harris 17). When politicians influence medical and scientific research in a way that creates more regulations, the efficient processes and integrity of the research process are harmed.

In this environment of extensive medical regulation, not all hope is lost. Expanding the use of emergency medical relief, such as the legislation used to allow the COVID-19 vaccine to be rapidly created and distributed, could be beneficial. The emergency steps taken for the COVID-19 vaccine allowed researchers to spread work across a number of companies and researchers. The coordinated effort across different companies and individuals led to a faster result because all researchers benefited from the input and ideas of others in real-time. In this way, not only were researchers able to quickly develop a vaccine for COVID-19, but they were also able to develop an array of vaccine technologies, known as vaccine platforms, that can be used in the development of vaccines for other diseases. This method of widespread work distribution working to achieve a common goal, with additional advances as a byproduct, was discussed in a *Health Research and Policy Systems* article as a way to accelerate innovation. According to the authors, “...the development of technologies, such as vaccine platforms, [allows] a range of conditions to be rapidly addressed. It would be useful to consider how far such approaches might contribute to other areas” (Hanney 5). By allowing many different problems to be solved simultaneously, researchers were able to create a vaccine in significantly less time than most vaccines take to be created, and they created additional technologies that can be used for future vaccines at the same time. If existing regulations were amended to allow for

this same kind of simultaneous development by coordinated groups, we could all benefit from the faster development of new treatments.

Another solution that could be used in conjunction with the previously mentioned one would be to limit the number of frivolous lawsuits against medical researchers and technologists. Excessive regulation creates an environment where loopholes can be found and exploited, which creates more opportunities for lawsuits. There is a phenomenon in the medical field known as “defensive medicine,” which suggests that healthcare providers may order more tests and spend more time and money confirming a diagnosis due to their fear of being sued. “The relationship between doctors and the medical malpractice system has long been tense. Doctors claim that the system ‘forces’ them to order extra, or unnecessary, tests in order to protect themselves if a patient decides to sue” (Cline 4). This fear of litigation is also felt by pharmaceutical companies, which can face billion-dollar lawsuits for drug side effects. If we were to limit liability and punish those who bring unwarranted lawsuits against physicians or researchers in an attempt to win a large settlement, we can provide a greater sense of security for researchers and allow greater freedom to explore possibilities.

A third solution would be to shorten the FDA approval process. There are a number of ways this process could be expedited, and there have already been some advances in this regard. The FDA allows companies to pay to expedite a drug’s approval, for example, which allows drug companies to earn revenue and recoup expenses from their developments earlier. Other ideas for speeding up the process exist as well, such as the idea that “the mandate of the FDA should be changed to require it to evaluate and certify only the safety of a proposed new drug, not its efficacy. Such a change would keep dangerous drugs off the market but allow safe drugs to be distributed sooner. That way, people who could benefit from new drugs could obtain them faster, cutting the time in which manufacturers were left uncompensated for their efforts. This reform would reduce the high cost of drug development” (McQuillan 2). By decreasing the complexity of the FDA requirements and increasing the speed of the process, we could drastically reduce the time it takes for medicines to reach the public.

To implement these solutions, the U.S. could create a separate medicine-focused governing body, composed of nonpartisan, appointed leaders with medical experience and expertise. Though it is impossible to completely remove politics from the medical world, creating this new body would allow medicine to get some separation from unjust laws and political agendas. To ensure that this elected body is concerned more with helping the public and the field of medicine instead of focusing on reelection, it would be important to have longer terms for these appointed officials.

The regulation of medical treatments, research, and practices is a complicated one, as is public health in general. While there is no easy answer to finding the right balance between regulation and innovation, there are steps that can be taken to lessen the negative effects of regulation. It is a worthy pursuit to spend more time, money, and human resources to identify nonpartisan ways to support innovation and effective patient care at the same time.

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# **The Comparison of USDA Grading Standards and Consumer Preferences for Tomatoes By Aanya Khandelwal**

## **Introduction**

Today's consumers demand that the fruits and vegetables they buy "look good" all year. To satisfy this need, growers and retailers discard large amounts that don't meet those aesthetic standards. (Walmsley, 2017). A lot of produce fails these standards, not because of disease or damage that may negatively affect taste or nutritional quality, but simply because of inherent variation in natural growth. In fact, U.S. retailers throw away \$15.4 billion of edible produce each year (Buzby et al., 2014), and farmers discard up to 30% of their crops because of cosmetic imperfections (Berkenkamp and Meehan, 2016). Though it can be noted only a small share of food waste is wasted within the retail supply chain itself, it is consumer decisions at the point of purchase that influences retailers' decisions on what foods are offered, that subsequently impacts food waste upstream in the supply chain (Rohm et al., 2017). In addition, it is important for food waste to be regulated, as it poses damaging consequences for the environment: the decomposition of 96% of wasted food in landfills releases methane, a greenhouse gas that traps solar radiation and fuels climate change. (Environmental Protection Agency, 2023). In addition, food waste also results in the loss of valuable resources: 25% of the world's freshwater is used to grow the produce that is later thrown out. (Hall et al., 2009; Owen, 2005).

Costing about \$400 billion annually, between 30% and 50% of edible produce never makes it to supermarket shelves, posing a serious danger to global sustainability. Especially since fruits and vegetables are also the foundation of a healthy diet. (Gustavsson et al. 2011; The New York Times Editorial Board, 2015). A meta-analysis found that less than 500 grams of fruit and vegetables per day may be responsible for between 5.6 million and 7.8 million premature deaths globally in 2013 (Aune et al. 2017). In addition, eating ten servings of fruits and vegetables daily was associated with a 24% reduced risk of heart disease, a 33% lower risk of stroke, a 28% lower risk of cardiovascular disease, a 13% lower risk of cancer, and a 31% lower risk of early mortality. Given that fruits and vegetables are essential to human health, it's imperative to protect the world's supply and work to reduce food waste. (Cooremans & Geuens, 2019). In fact, all the hungry people in our world could be fed with less than a quarter of the food wasted in Europe and the US alone. Therefore, in a world in which 800 million people already suffer from hunger, and where the population is expected to grow over 2 billion by 2050, safeguarding our food supply could immensely help people (World Counts, 2023).

## **USDA Grading**

Nearly 10 million tons of cosmetically imperfect or unharvested food are lost each year due to strict beauty standards alone, which is partially due to USDA's strict grading grading (CBS, 2019). U.S. Grade Standards are the minimum quality standards assigned to imported produce on the basis of the produce's physical characteristics, and U.S. Farmers and/or distributors pay USDA to inspect their produce and assign it a grade (USDA, 2023).

In particular, tomatoes undergo rigid grading from USDA inspectors, on a scale from “No. 1” (best) to “No. 3” To receive a grade, tomatoes must be safe to eat and be mature, clean, and well-developed; not overripe or soft; and free from decay or freezing injury. The differences between the grades are mostly in texture (No. 1’s must be “fairly smooth”) and formation (only No. 3’s may be “misshapen”) and the degree of damage by another cause (No.1’s must be “not damaged by another cause”) (Figure. 1). Using this grading system, retailers and restaurants typically make their purchasing decisions. Retailers, only wanting the best for their customers, may buy only the higher-graded tomatoes. Therefore, by grading produce, USDA is picking which tomatoes will “win” or “lose” (Kenny, 2018).

Parameters	USDA grade 1	USDA grade 2	USDA grade 3
Similar varietal characteristics	x	x	x
Mature	x	x	x
Not overripe or soft	x	x	x
Clean	x	x	x
Well developed	x	x	x
Well formed	Fairly well formed	Reasonably well formed	May be misshapen
Skin texture	Fairly smooth	Not more than slightly rough	May be rough
Free from decay	x	x	x
Free from freezing injury	x	x	x
Free from sunscald	x	x	x
Damaged by any other cause.	Not damaged by any other cause.	Not seriously damaged by any other cause.	Not very seriously damaged by any other cause.

**Fig. 1.** Using information from usda.gov, I created a chart showing the parameters that stayed constant throughout the different grades of tomatoes (marked with x) and the parameters that differed (highlighted). The categories of formation, texture, and damage differentiated No.1 and No.3 tomatoes. This was used to design six independent variables (one No.1 and one No. 3 tomato for each parameter). No.2 was omitted for the purpose of the study because it was not necessary in order to understand the implications of the marketing order.

Farmers are more likely to leave unharvested or cull less perfect produce that will receive a lower grade, since its value in the market is diminished (Gunders, 2012). The standards may also cause farmers to breed produce for uniform appearance over other factors, such as taste or nutrition. The grading system may bunch together different kinds of imperfections (some acceptable to consumers and some not) or a marketing order may prohibit the sale of any imperfect produce (Kenny, 2018). Therefore, it can be questioned whether or not these standards are truly aligned with consumer preferences, as lower-grade produce may be being wasted unnecessarily.

A mandatory marketing order requires tomatoes to have received at least a “No. 2” grade for field-grown tomatoes sold October-June and requires they are at least 2 9/32-inches in diameter (USDA, 2023). The marketing order was developed and is regularly updated by

industry, then approved by USDA. Due to this consumers are not able to purchase ungraded, lower-graded, or smaller tomatoes. The grading system is used to assign a grade to Mexican tomatoes, and bans imports of all Mexican No. 3 tomatoes in the months October-June as a part of this marketing order (USDA, 2023).

### **Potential Motives of the Marketing Order**

Because there were no attempts made to solicit public input, it can be assumed that the USDA's decision to ban No. 3 tomatoes from being marketed during the months of October-June was made for reasons other than protecting the safety of tomatoes for consumers. Through investigating price data on tomatoes, it can be theorized the marketing order was made in order to prevent devastation of the US economy, and to favor the domestic tomato industry by reducing foreign competition. After all, there is a history of competition from Mexico as the US tomato production has been on the decline. 90% of the imported tomatoes in 2015 came from Mexico. More than three times as many tomatoes were imported as there were produced in Florida (Guan et al., 2018). This is likely due to Mexican producers having more favorable government policies and cheaper labor costs than their US rivals, giving them a competitive advantage and allowing their production to steadily increase. In fact, an analysis of labor costs confirms that Central Mexico has much lower labor costs than Florida (Wu et al., 2017). Therefore, it can be theorized that the USDA, as a government agency, may have been using their power to favor the domestic tomato industry. Evidence points at this, showing that when the marketing order is in place from October to June, there are less Mexican imports and tomato prices within the country higher (US Bureau Of Labor Statistics, 2023), though in this time period there are fluctuations in the prices due to the two Florida peak harvesting seasons (Guan et al., 2018). In the three months when the marketing order was not enforced (July through September), prices for tomatoes remained drastically lower, likely due to increased imports from Mexico. As evidence strongly indicates that the marketing order is correlated with price fluctuations to favor domestically grown tomatoes, it suggests the USDA may have an economic motive. This brings up the question of if the implementation of such a marketing order is truly justifiable, especially since it is a heavy contributor to food waste.

### **Purchase Behavior/Perceived Quality Of Suboptimal Produce**

At point-of-purchase, consumers select 'optimal' products and avoid 'suboptimal' products (Aschemann-Witzel et al., 2017). Food that is suboptimal is nonetheless good to eat, though not optimal according to perception. However, it is important to note this is not a fixed concept and can be subjective. Whether a food is optimal or not depends on the respective person judging it in relation to the purpose that the food should serve for him or herself (De Hooge et al., 2017).

Furthermore, humans have evolved to use the appearance of other humans and objects to infer appearance-unrelated characteristics such as quality, according to evolutionary theory (Griffin and Langlois, 2006). Often when they form a negative opinion on the quality of produce,

it can be attributed to the negative halo effect, which induces a carryover of a first negative impression (abnormal and less attractive) to evaluations of other attributes of the product (Cooremans & Geuens, 2019). Therefore, sub-optimality may influence consumer perceptions of taste, attractiveness, and safety, even though the objective quality has not changed (Shao et al., 2020). Since negative perceptions drive lower purchase intentions even when the objective quality has not changed, understanding how perceptions and purchase behavior relate to each other will help accurately assess consumer preference.

The Theory of Interpersonal Behavior predicts that consumers' intentions (what consumers intend to do) and behaviors (automatic behaviors, i.e. what they routinely do) will influence their behavior with suboptimal food products (Chatterton, 2011). Intentions towards suboptimal foods are formed by attitudes, social norms (i.e. perceived social pressure to consume or avoid the food), and the feelings and emotions elicited by the food. Attitudes are created after one evaluates the potential positive and negative consequences of consuming the product, using information stored in long-term memory and specific information about the product (Eagly & Chaiken, 1993). Therefore, external factors are expected to influence both consumers' intentions about suboptimal foods, as well as their intended behavior. In this sense, a crucial question in relation to suboptimal foods is the extent to which consumers perceive that the food in question is affected in its quality, as it is related to its perceived benefits and potential negative consequences. When people assess the quality of food, they can look at various dimensions such as sensory quality, convenience, healthiness and safety (Cooremans & Geuens, 2019).

When consumers receive a discount that fits the suboptimality, almost every kind of suboptimal product can be sold. Moreover, the type of flaw plays a role in the decision consumers show different preferences for products that deviate in terms of appearance (Shao et al., 2020). In the past, consumers have expressed they are open to purchase products and consume products that deviate especially on the basis of their shape, best-before date, or damaged packaging (Hooge et al., 2017). Thus, if consumers are presented with lower-grade tomatoes (No.3) that won't qualify for the market, there is still a likelihood they express openness towards misshapen produce along with other types of suboptimality.

Overall, there have been calls towards conducting more supermarket actions towards the goal of reducing food waste of suboptimal food (Aschemann-Witzel et al., 2016). Suboptimal products have been shown to raise different associations compared to optimal products and lead to relatively lower quality perceptions, with differences though, between food categories and the type of suboptimality (Giménez et al., 2020). In the past, consumers have expressed they are open to purchase and consume products that deviate from the norm, so there is still a likelihood they will express openness to purchasing lower-grade tomatoes (No.3) that won't qualify for the market, especially misshapen produce. Currently, there are gaps in our understanding of consumers' perceptions and behavioral intentions toward different types of suboptimal food (Cao & Miao, 2021). Therefore, this study will evaluate people's purchasing behaviors as well as their quality perceptions.



## **The Present Study**

While developing the tomato grading system, the USDA only took significant input from industry. There was an opportunity for public comment, but it was not well-utilized by consumers, with there being no comments received and no changes proposed to the amendments (Agricultural Marketing Service, 2020). Consumer views are being underrepresented with the current USDA grades, which is ironic as the industry heavily depends on their views. Many tomatoes that are going to waste based on industry's standards may, in fact, be accepted by consumers more than the industry thinks, making it important to understand consumers' opinions. Thus, the present study aims to measure consumer preferences on the current USDA grading standards for tomatoes.

## **Research Question and Hypotheses**

Research Question: This research aims to evaluate consumer preferences on USDA grading based on their perceived quality and purchase behavior on tomatoes. Thus the following questions can be proposed:

1. Is there a significant difference in the perceived quality and purchase behavior for a US No. 1 tomato and US No. 3 tomatoes of different categories (damage by another cause, formation, and texture)?
2. Which category of the US No. 3 tomato (damage by another cause, formation, and texture) is most acceptable to consumers?

### Hypotheses:

1. There will be a significantly higher perceived quality and purchase behavior for US No. 1 tomatoes compared to US No. 3 tomatoes in the categories of damage by another cause and texture.
2. There will not be a significant difference between the perceived quality and purchase behavior of US No. 1 tomatoes compared to US No. 3 tomatoes in the category of formation.
3. Of the US No. 3 tomatoes presented, participants will rate tomatoes in the category of formation (misshapen) with significantly higher perceived quality and purchase behavior when compared with the ratings in the categories of formation (rough) and damage by another cause (not very seriously damaged).

## **Research Methods**

Once IRB approval was granted, the online experiment was distributed to participants of all ages, genders, and races, and participants were given an online survey via SurveyMonkey. I distributed the online experiment to the students of X High School, and asked them to pass it on to their parents and friends to include a greater variety of ages in the population. Teachers in the school were given the link to the online experiment and asked to spread it to their students.

## Participants

A total of 126 subjects completed the experiment. Subjects' ages ranged from 11-60 years old with 73 identified as female (72.4%), 49 identified as male (24.9%), and 4 preferred not to say (1.8%). In terms of race, 44 identified as white (34.9%), 1 identified as black (0.8%), 77 identified as Asian (61.1%), and 4 identified as Hispanic (3.2%).

## Materials

For each of the tomatoes presented, participants were asked to answer questions on perceived quality and purchase behavior (see Appendix A). All tomato images were independently designed using Photoshop. The images were based off of the pre-existing USDA tomato grades and were presented along with a description directly taken from the USDA website (see Appendix B).

## Procedure

1. Upon opening the survey, participants were presented with the following:

*Hello, my name is X and I am a Social Science Research student at X High School in X. Thank you for your interest in my research. I would like to study consumer behavior when purchasing different tomatoes. If you agree to participate, you will first be asked to answer a few demographic questions. Then you will answer questions based on different tomatoes. The questions will deal with your purchasing preferences.*

*All of the information will be kept confidential and your contact information will be coded by a third party assistant so the confidentiality of your survey will remain anonymous. All subject data will be stored on a password-protected computer. Although your IP address will not be stored in the survey results, there is always the possibility of tampering with an outside source when using the Internet for collecting information. While the confidentiality of your responses will be protected once the data is downloaded from the Internet, there is always the possibility of hacking or other security breaches that could threaten the confidentiality of your responses. Furthermore, there is a possibility that some questions included in this study may make the participant feel uncomfortable. If you wish to quit the study, you may exit the survey at any time by leaving the web page.*

*There will be no direct benefit to you for taking part in the study. The researcher will learn more about consumer purchasing behaviors. If you decide to participate, please answer all questions honestly. It will take you approximately 10 - 15 minutes to complete the entire study. If you have further questions about this study or would like verification of this study's legitimacy, you may send an email to X and my research teacher will contact you. Thank you for participating!*

Subjects were asked to provide informed consent by typing the following: "I agree to participate in this study." Participants were then presented with demographic questions including age, gender, and race. Along with that, they were asked if they had purchased any fruits or vegetables in the last month, and if they had ever purchased or consumed tomatoes.

After answering the demographic questions, participants were presented with the following:  
*Thank you for answering the demographic questions.*

*Now I will show you an image of a tomato. Please view the tomato closely and answer the questions that follow. The questions will focus on the overall quality of each tomato as well as your purchasing preferences. Please take your time viewing each image/description and answer the questions as honestly as possible. There are no right or wrong answers.*

*Although some of the pictures you will see in this survey are repeated, the descriptions for each tomato are different. **Please make sure you pay attention to the characteristics in the description for each image you are shown in the survey.***

*When you are ready for the first tomato, please click on the next button. Thank you.*

Before moving on, respondents were asked to type “I will read the description for each image” upon reading the directions.

In my study participants were randomly assigned one of the categories of the US No. 1 tomatoes and a US No. 3 tomato of the same category (damage by another cause, formation, and texture). In other words, every person was randomly presented with the three controls of the US No. 1 tomato with a description for its well formation, smoothness, or absence of damage and presented with a flawed tomatoes for the same category (the US No. 3 tomato) with a description for their mishapness, roughness, or presence of damage. These categories were chosen to be assessed in the tomatoes because they differentiated No.1 tomatoes from No.3 tomatoes (Figure.

Another study measured perceived quality on seven-point semantic differential scales of (“unhealthy– healthy”), (“low in nutritional value–high in nutritional value”), (“untasty–tasty”), (“unappealing–appealing”), (“risk-free–risky”), (“large effort to prepare–small effort to prepare”), and (“abnormal–normal”), presented in random order (Cooremans & Geuens, 2019). The present study replicated these variables, however, participants were shown a likert scale instead of a differential scale to keep the scale used consistent throughout the study, so statistical analyses could be more readily conducted between the variables. Participants were then asked to answer five additional questions that were independently created, asking for the likelihood they would purchase the tomato. These questions incorporated different scenarios and asked how likely they would purchase the tomato in different scenarios (Appendix A). This is in accordance with the Theory of Interpersonal Behavior which states that consumer behavior in relation to suboptimal food products is expected to be determined by their intentions (what consumers intend to do) (Chatterton, 2011). In another study, they created one scenario and kept the purchase intention constant throughout the experiment to prevent the intention from acting as a confounding variable (Shao et al., 2020). This study sought a broader view of purchase behavior that would account for a variety of scenarios in which participants may have many different intentions. As such, two scenarios were created for the purpose of this study to peel the tomato, two scenarios where the participant used the tomato raw, and one neutral scenario questioning to see how likely they would buy the tomato without being given a scenario. This was also assessed

using a 7-point Likert scale (1 = Extremely unlikely, 7 = Extremely likely). There was no reverse scoring in data analysis.

At the end of the survey, participants saw the following message:

*Thank you for participating in this study. If you know any other people who may be interested in participating as well, please feel free to share this link: XXX*

## **Results**

All data was analyzed using IBM's SPSS Version 24.0. Tests of statistical significance were performed at the  $p < 0.05$  level to observe statistically significant differences between target variables.

### **Damage By Another Cause**

A non-parametric Mann-Whitney U test found no significant difference between the tomato with no damage by another cause and the tomato damaged by another cause in purchase behavior and perceived quality. These findings refute hypothesis one.

### **Formation**

A non-parametric Mann-Whitney U test found no significant difference between the well-formed and misshapen tomato in purchase behavior. This finding supports a part of hypothesis three. However, significant differences between the well-formed and misshapen tomato ( $p < 0.05$ ) in their perceived quality was found. The mean of the perceived quality of the fairly well formed tomato was 5.86 was significantly greater than the mean of 3.60 for the misshapen tomato. This finding refutes a part of hypothesis two.

### **Texture**

A non-parametric Mann-Whitney U test found no significant difference between the smooth and rough tomato in purchase behavior and perceived quality. These findings refute hypothesis one.

### **No. 3 tomatoes**

A non-parametric Kruskal-Wallis test on the three variables (damaged by another cause, misshapen, and rough) to identify any significant differences. The tables below showcase median, average, and standard deviation for the perceived quality and purchasing behavior for US No. 3 tomatoes.

#### Perceived quality

<b><u>US No. 3 tomatoes</u></b>	Median	Average	Standard Deviation
Damaged by another cause	3.6	3.5	1.4

Misshapen	3.7	3.6	1.5
Rough	3.9	3.7	1.3

Purchasing behavior

<u>US No. 3 tomatoes</u>	Median	Average	Standard Deviation
Damaged by another cause	2.4	2.9	1.6
Misshapen	3	3.1	1.7
Rough	3	3	1.6

Participants did not rate misshapen tomatoes with significantly higher perceived quality when compared with the ratings of rough and damaged tomatoes. These findings refute hypothesis three.

**Discussion**

The current study suggests that people are willing to buy Grade No. 3 tomatoes in all categories (rough, misshapen, and damaged), as there was no significant difference between the purchase behavior for No.1 and No.3 tomatoes. This refutes the first and second hypotheses, however this may be due to the majority of the participants coming from a higher education level and a majority of them coming from Generation Z. Among this generation there is an increased awareness through social media access and popularity of nutrition. Generation Z has grown up with more information about the benefits of fresh foods versus processed foods (Mason & Wagstaff, 2020). As such, it is possible that the participants in my study likely possessed more awareness, and were able to reason that the appearance of the tomato didn't necessarily serve as an indicator of its intrinsic characteristics, therefore rating it better than older, less educated shoppers would. It was found that people don't hold significant negative views on most categories (besides formation) of Grade No. 3 tomatoes when compared with Grade No. 1 tomatoes. Misshapen tomatoes invoked a significantly more negative perceived quality, contradicting another study that had stated people had expressed openness to buy suboptimal products that deviated on shape (Shao et al., 2020). This could simply be due to the fact that different people may elicit a different emotional response to abnormal shape. Such could be due to attitudes based on the evaluation beliefs about the benefits and potential negative consequences of consuming the product, using information stored in long-term memory and specific information about the product (Eagly & Chaiken, 1993). However, when taken together, these findings strongly imply that the current USDA marketing order (eliminating Grade No. 3 tomatoes) is not aligned with consumer preferences, and that the USDA is unnecessarily banning the sale of edible No. 3 tomatoes based on restrictive grading standards.

Since consumers have indicated that they are willing to purchase No.3 tomatoes and that are being thrown out or being left unharvested (Kenny, 2018), the USDA standards play a role in exacerbating food waste in the tomato industry. If these patterns of food waste continue, people will be left to deal with the devastating environmental consequences, such as the increased methane emissions which will contribute to global warming (Environmental Protection Agency, 2023). This is especially important considering that the tomato segment contributes the largest share of 18.84% in 2021 in the global market revenue and is expected to grow with a CAGR of 3.1% from 2022 to 2028 (US Bureau of Labor Statistics, 2023), meaning the impact on the environment will only intensify with time. Furthermore, combating food waste has become increasingly important in response to the growing population and the challenge of providing food for a global population that is projected to reach 10 billion by 2050 (Damiani et al., 2020). The results of the current study provide more reasons for people to focus efforts on reducing the food waste within the food supply chain.

Furthermore, when observing price fluctuations during October - June (when marketing order is enforced), tomato prices are generally higher. So, people are forced to pay the high price for tomatoes nine months a year, due to the ban of No.3 imports from Mexico (US Bureau of Statistics, 2023). Since participants indicated they had been open to buying No.3 tomatoes, they would likely object to the current marketing order. This suggests it would be helpful for people to better utilize the opportunity for public comment given by USDA to express their dissatisfaction in similar future policies.

### **Limitations and Future Works**

The current study may lack accuracy due to people rushing, not being honest, or simply not reading the descriptions for each tomato properly. Furthermore, the study lacks generalizability due to a high percentage of young participants, with 42.9% of the participants being 16-17 years in age and the mean age being 25.2 years. This does not represent the country's population well, as the average age for grocery shoppers in the United States is 40 years (Zippia, 2021). Though the younger population may be unrepresentative of current grocery shoppers, they may be representative of consumer preferences in the upcoming generations of grocery shoppers. Regardless, 61% of the population was Asian and .8% was African American which differs drastically from the country's demographics, with Asian shoppers making up only 5.8% of the country's shoppers and African Americans making up to 10% of the grocery shoppers in the United States (Zippia, 2021).

While the current study solely surveyed consumers, retailers can be surveyed to understand if they are open to embrace loosened USDA standards and stock less perfect produce, or if they would impose new specifications just like the USDA grade standards in place now. Furthermore, the impact of loosening grade standards on farmers should be examined. For example, would the sale of less uniform produce impact the operation of harvesting, washing, and packing machinery? Would the sale of imperfect produce harm producers' reputations or reduce overall sales? (Kenny, 2018). By better understanding what implications the loosening of

grading standards could hold on various parties involved under the entire umbrella of the food retail supply chain, it can be decided if warranting the best course of action to address food waste in the tomato industry.

Similar assessments can be run for other fruits and vegetables that undergo USDA grading and have marketing orders. Take sweet peppers, for example. The USDA assigns them one of three grades—Fancy, U.S. No. 1, or U.S. No. 2—based on criteria such as size and how well-shaped they are. Regardless of the grade, the peppers must also be free of decay and injury from hail, sunburn, disease, insects, and other causes (USDA, 2023). Similar to tomatoes, they are thrown out and left unharvested due to their strict grading standards. Since there are countless fruits and vegetables undergoing strict grading standards, the accumulation of food waste is massive and has a great environmental impact, which people can focus on finding solutions to address. Like tomatoes, other fruits and vegetables also have enforced marketing orders at various points throughout the year (USDA, 2023), and marketing order's economic implications on the US economy can be further investigated and analyzed using the laws of supply and demand.

## **Conclusion**

Through assessing consumer preferences on the current USDA grading standards on tomatoes, the present study states the following:

- People do not perceive USDA No.3 tomatoes significantly different than USDA No.1 tomatoes in texture and damage by another cause, though they do perceive well formed tomatoes to be significantly better than misshapen tomatoes.
- People's purchase behavior is not significantly different between USDA No.3 tomatoes and USDA No.1 tomatoes in all categories (texture, damage, and formation)
- When people are presented with all USDA No.3 tomatoes, there is no significant difference in their purchase behavior and perceived quality between the different tomatoes (rough, slightly damaged, and misshapen), indicating they are not significantly more accepting towards any certain flaw in lower graded tomatoes.

Overall, these results imply that the USDA should consider reevaluating the grading standards and their enforcement of the marketing order, as they do not align with current consumer preferences.

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# Exploring Informational Variations in COVID-19 Coverage on Fox News and CNN By Lana Kazakevich, Daniel Olivo, Cristal Cornelio, Emily Chen<sup>49</sup>

## Abstract

The COVID-19 pandemic has been one of the most significant events of our time, with news coverage playing a critical role in shaping public understanding and response. This study investigates the prevalence of informational discrepancies or consistencies between two politically biased news channels, Fox News and CNN, during three major periods of the pandemic. A content analysis of news articles within these channels was conducted to identify patterns of informational discrepancy or consistency. The results indicate that in the first time frame, there were mostly informational consistencies while the last two time frames had majority discrepancies. These findings have important implications for public health communication, as the prevalence of informational discrepancies between CNN and Fox News suggests contrasting perspectives and narratives, which can shape public perceptions and response to the pandemic.

## Literature review—Defining Politically Biased News Sources

The global crisis created by the COVID-19 pandemic has impacted the lives of countless people socially, economically, and medically. As the world continues to overcome the challenges posed by the pandemic, the role of the media in shaping public response and perception has become more critical (Ananyev et al.). With a wide range of news outlets available to consumers at all times, the Covid-19 pandemic is the largest medical emergency to play out in the modern media landscape. One source of information includes politically biased news outlets, which are sources that contain biases toward certain political ideologies or candidates (Bernhardt et al.).

These news outlets often tailor to an audience with a preference for a particular political party or candidate, also known as partisanship or a partisan audience. Thus, it has been found that biased outlets often suppress information that may be unfavorable to their viewers because they depend on audience ratings to maximize profits (Bernhardt et al.). Through a survey, Elejalde found that political bias impacts how controversial topics are covered in newspapers to align with the affiliation of the newspaper. This is done using specific word choices or the mentioning of certain people (Elejalde). However, the definition of media bias used in this source includes both socio-economic and political viewpoints, meaning that it was not exclusive to political bias in the media. Within the context of the recent Covid-19 pandemic, Gollwitzer and others highlight that “tuning in to right-wing news (such as Fox News) might communicate very different information about the risks of the pandemic—and how to prevent its spread—than

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more left-leaning sources.” This highlights that the type of information across biased news sources could vary, impacting information gained by viewers (Gollwitzer et al.).

Additionally, a study by Levendusky et al. and another by Druckman et al. found that politically biased news creates affective polarization between partisans, and Druckman’s work defines affective polarization as distrust and dislike of those from the opposite political party. This polarization creates echo chambers, which harden pre-existing beliefs (Levendusky et al.) (Druckman et al.). In a different study, Druckman and Levy assert that affective polarization tarnishes social relationships between people with different political affiliations (Druckman and Levy). Furthermore, Druckman found that partisans may react to policies or actions in opposition or in support due to the political affiliation of the official imposing the policy or action rather than rationally considering the policy. This is evident in Druckman’s study when he found that as Democrats get more polarized, they lower their evaluations of Trump’s response to the pandemic by -0.903 (this relationship was statistically significant). On the contrary, as polarization increases among Republicans, they increase their evaluations of Trump’s response to the pandemic by 1.208. This suggests that the political affiliation of the official likely played a role in how a polarized partisan public reacted to government responses during the pandemic. It is also important to note that partisans who were less polarized did not “politicize” their evaluations of the US’ response to the pandemic (Druckman et al.). Polarization has also been found to impact voting behavior. Using survey data, Alan I. Abramowitz and Steven Webster find that those who voted more negatively of the opposing party were more likely at a statistically significant level to support the candidate that matched their political stance. This highlights that polarized voters are less likely to vote for the candidate with the opposite political party and are more likely to stay “loyal” to their current affiliation, regardless of the policies proposed by the candidate (Abramowitz);(Webster).

### **Possible Causes of Biased News Consumption**

Studies have attempted to determine why biased media is consumed. One possible explanation is that the consumption is unintentional, as viewers may be unaware that the information they are viewing is biased. A study published on Sage Journals had participants classify the political stance of a given biased source using a scale. It was found that participants would classify biased sources that matched their political affiliations as less biased than sources of the opposite affiliation, illustrating their lack of awareness (Spindle et al.). These findings are also supported by a survey conducted by Pennycook and Rand, who found that participants who were “more analytic” were able to identify fake news, regardless of the participant’s political affiliation. The study thus highlights that consuming fake news is driven by “lazy thinking” or cognitive biases rather than partisan bias (Pennycook and Rand). Although, these findings are limited as they exclusively focus on fake news, while not all biased news sources contain fake news. Still, there is evidence that lack of awareness regarding inaccurate information in news sources can contribute to their consumption.

However, some researchers argue that viewers are aware of the biases within the sources they read and deliberately choose to read them. This concept is called selective exposure, defined as selecting media based on pre-existing beliefs (Stroud). Stroud found that Republicans are more likely to consume information from a Republican-leaning outlet than a Democratic-leaning outlet and Democrats are more likely to consume information from a Democratic-leaning outlet than a Republican-leaning outlet, suggesting that partisanship guides media selection. These findings were statistically significant (Stroud). Additionally, a study conducted by Whicks and others identified selective exposure beyond just news sources and found that conservatives and liberals would select information from conservative talk radio and Facebook messages that aligned with political beliefs, respectively (Whicks et al.). Moreover, Steppat and others found that being in an environment with polarized information was positively correlated and statistically significant with a persons tendency to select sources that reinforce pre-existing beliefs (Steppat et al.). However, even though people may be aware of the bias within their selected source, that bias is not explicitly communicated in the source, making it difficult to identify what information is biased or unbiased (Elejalde). As a result, viewers may be unable to recover the information omitted from the source, impacting the information they perceive to be accurate (Bernardt et al.).

### **Politically Biased News Media, Partisanship, and COVID-19**

During the COVID-19 pandemic, various studies have identified differences in health-related behaviors between those with different political affiliations. Marcus Painter and Tian Qiu found that those in Republican-leaning counties social distanced less than those in Democratic-leaning counties after state-manded stay-at-home orders had been implemented. The study found that 9 days after COVID-19 state policies were enacted, medians social distance differed by almost 0.05 percentage points, highlighting their differences in behaviors (Painter and Qiu). Similar to these findings, using GPS data from participants' smartphones, Anton Gollwitzer and others found that counties that voted for Donald Trump in the 2016 election social distanced 14% less than those who voted for Hilary Clinton in the 2016 election. The study found that pro-Trump counties would have had 1.17 percent less infection growth per day if they had social distanced as the average county had, suggesting that the difference in health behaviors could have contributed to infection rates (Gollwitzer et al). Although, a study conducted by Jonathan Spiteri found no significant relationship between viewing right-leaning sources and a positive COVID test (Spiteri). The differences in results could be attributed to differences in demographic characteristics within the participants in each study or measures of social distance, etc. However, the results of each should be acknowledged regardless of their differences. Various studies have analyzed factors that could have contributed to behavioral discrepancies, which include behaviors that aim to limit virus infection and transmission. Erfei Zhao and others found a link between a preference for either CNN or Fox News and differences in health behaviors. The study found a statistically significant relationship between those who had a higher trust for CNN and taking more preventative measures including "wearing face

masks,” “avoiding public places,” and other noted behavioral differences than those who trusted Fox news; The study also identified another statistically significant relationship between those who trusted Fox News and engagement in riskier behaviors during the pandemic, including “having visitors at residence,” “attending a gathering of 10+ people,” and other behaviors than those who trusted CNN more (Zhao et al.).

### **Filling the Gap**

The current study aims to fill a gap in the literature by identifying whether there were informational discrepancies or consistencies between Fox News and CNN during the COVID-19 pandemic. Informational discrepancies refer to information prevalence between outlets that are different, and informational consistencies refer to information prevalence between the outlets that are similar. As mentioned previously, Zhao and others found behavioral discrepancies between individuals who trusted Fox News or CNN more (Zhao et al.). However, this study was correlational, leaving the possibility that other factors besides media exposure could have caused the discrepancies. There is a growing consensus in social science literature that many individuals selectively expose themselves to information that matches pre-existing beliefs, meaning that they selectively expose themselves to other forms of media besides biased news; exposure to any other biased media platform could have contributed to the behavioral discrepancies. As a result, a study that extends Zhao’s findings by analyzing the actual content of Fox News and CNN could determine if differences in behaviors were influenced by differences in information.

Hart et al. conducted a content analysis on politically biased news sources during the pandemic but only examined politicization and polarization. Hart defines politicization as “the degree that politicians are mentioned in conjunction with the issue” and defines polarization as “how discussion varies based on the presence of actors from different political parties” (2020). The present study will extend Hart’s research by not only analyzing politicization and polarization but also identifying other topics covered by Fox News and CNN, such as public health. As a result, this study extends Hart’s study by comprehensively analyzing all the topics covered in politically biased news sources.

Ultimately, various studies have analyzed similar topics to the present study, including how local newspapers covered the Covid-19 pandemic (Zafri et al., 2021), how right-leaning media coverage of the pandemic spread misinformation (Motta et al., 2020), and the impact of misinformation during the pandemic (Ferreira et al., 2022). However, there haven’t been any studies that analyzed whether CNN and Fox News, two biased news outlets with opposite political affiliations (Zhao et al. 2020), contained informational discrepancies or consistencies during the Covid-19 pandemic. This leads to the question: were there informational discrepancies or consistencies in COVID-19 coverage on Fox News and CNN?

## **Materials and Methods–Content Analysis**

CNN and Fox News articles were analyzed for this study to identify either informational discrepancies or consistencies in Covid-19 coverage during the pandemic. A content analysis was conducted qualitatively, and the frequencies of codes were analyzed quantitatively, making this study a mixed method. The use of CNN and Fox News for this study was influenced by Zhao et al., who identified behavioral discrepancies among individuals who trusted either CNN or Fox News. Zhao et al.'s study was correlational and did not consider the actual content of the news sources, meaning that other factors may have influenced viewer behaviors. Therefore, analyzing CNN and Fox News could extend the understanding of Zhao's findings by further determining if these politically biased news channels could have impacted health behaviors during the pandemic (Zhao et al.). This study's method is based on Hsieh and Shannon's description of conventional content analysis. Through a conventional content analysis, words and phrases that captured key concepts were created into codes as the text was read; initial analysis was recorded for each highlighted text. Hsieh et al. mentioned that one challenge of conventional content analysis is not recognizing crucial categories as a result of an incomplete understanding of the content (Hsieh et al.). To address this, each article was analyzed twice in order to capture missed details in the initial analysis.

## **Time-Frames**

To optimally analyze the content within CNN and Fox News sources, the pandemic was broken up into three time-frames. The dates of each time-frame were taken from the Centers for Disease Control and Prevention, the national public health agency of the United States. The first time-frame is defined as the period from the first knowledge of the pandemic to the official lockdown date (December 12, 2019, to March 15, 2020). The second time-frame covers the period from the official lockdown date to the release of the first Covid-19 vaccine to the public (March 15, 2020 to December 14, 2020). The third time-frame spans from the release of the first Covid-19 vaccine to the public to the last state to end the mask mandate (December 14, 2020 to March 8, 2022) (CDC Museum COVID-19 Timeline). Notably, the change from the second to the third time-frame also encompasses a change in presidency from Donald Trump to Joseph Biden, changing the political party of the presidential administration from Republican to Democrat. These time-frames were chosen to isolate as many changing variables as possible across the pandemic. In the first time-frame, there was only preliminary information as the virus was new and not much was known. In the second time-frame, social, economic, and educational norms were changed as the country went into lockdown. These changing factors likely impacted information published in the news. Finally, in the third time-frame, the vaccine was released to the public, resulting in a likely influx of news articles covering vaccine-related information and its availability. Additionally, the change in presidency from Donald Trump (first and second time-frames) to Joseph Biden (third time-frame) may also have influenced what news sources discussed as the news would most likely shift from discussing Trump to discussing Biden. Thus, information across time-frames would likely differ as the pandemic progressed. The decision to

separate the pandemic into three time-frames was made to limit inaccurate results since the random sampling of sources could inadvertently include articles from CNN and Fox News that were published at different points in time.

### **Sample**

To select the sample for the study, the keywords “Covid,” “Pandemic,” “Covid-19”, and “Coronavirus” were separately entered into search boxes of each outlet to gather relevant sources for this study. The first 12 sources for each keyword were considered for the population, creating a population size of 48 for each news outlet's time frame. The articles were randomly selected from the CNN and Fox News websites and were not organized in chronological order by date to remain inclusive of information published at different points in the time-frame. From these 48 sources, 7 were randomly selected using a random number generator. This was repeated for all three time-frames within each news outlet, resulting in 42 total sources for the sample size. 42 sources were selected for the sample size because there were three established time-frames within each news outlet. In other words, the sample size had to be divisible by 6 to have an equal number of sources in each news outlet and in each time-frame and be feasible within a limited time constraint.

### **Analysis**

The codes were then organized into categories based on how they were related to one another. For example, “washing hands” and “social distancing” codes would be categorized as “preventative measures.” Within each time-frame and news outlet, the percent frequency of each category was calculated by adding the total number of codes in a category and dividing it by the number of total codes within its respective news outlet and time-frame. A comparison of the percent frequencies was made to determine if there were informational discrepancies or consistencies between a category in CNN and Fox News. This was done by adding the percent frequency of a category in CNN to the percent frequency of the same category in Fox News and then dividing the percentage frequency of one outlet by that total. If the resulting calculation was between 0 and 0.25 or between 0.75 and 1, it was considered an informational discrepancy. If the calculation was between 0.25 and 0.75, it was considered an informational consistency. This means that a perfect discrepancy would be indicated by a score of 0 or 1, as one news outlet would have no instances of a category while the other would have at least one. Conversely, a perfect consistency would be indicated by a score of 0.5, as both news outlets would have an equal frequency of occurrence for a category. 0.25 and 0.75 was the cut-off between consistency and discrepancy because it is the midpoint of the scale. Using this assessment allowed for an objective assessment of the prevalence of informational differences or similarities between the two outlets. Finally, to determine whether there was a majority informational discrepancy or consistency within each time, the number of categories exhibiting discrepancies or consistencies was tallied, and the majority indicated the dominant trend of information within that time-frame. Each category was grouped into larger themes to allow for a more comprehensive analysis of the



data and a greater understanding of the implications of the patterns identified. This process was done separately for each time-frame.

### Results–First Time-Frame

Data from the first time-frame suggests that 42% of topics identified through the conventional content analysis were discrepancies across CNN and Fox News, and 58% of the topics identified had consistencies, revealing a slight majority of informational consistency.

Categories derived from the raw data were placed into overarching themes to create conclusions about what type of information was similar and/or different. 8 of the developed categories fit under the public health theme (See Appendix), with all except one category having informational consistencies. In other words, viewers of CNN or Fox News would be consuming a similar amount of information pertaining to public health, regardless of the opposing political biases within each channel. The prevalence of informational consistencies in the public health theme is significant because it may provide a common perception of the status and severity of the virus. However, preventative measures were one category within the public health theme that contained informational discrepancies. Fox News discussed preventative measures 17% of the time, while CNN only discussed them 5% of the time. The impacts of such discrepancies may be widespread as viewers of CNN News may not have received as much information pertaining to the most effective mitigation strategies to avoid the virus compared with viewers of Fox News.

Additionally, 2 categories within the first time-frame fit under the economic outlook theme (See Appendix). Although, both categories contained large informational discrepancies across CNN and Fox News. CNN covered the economic outlook for a total of 19% of the time within this time-frame (with 17% of this time being from a negative economic outlook), while Fox News did not cover the theme at all. Information about how the pandemic has or will impact economic activity can change perceptions about the security of current jobs, the value of held assets, and other aspects of personal finance that may be impacted by economic hardship. Because CNN highly stresses this topic while Fox News does not, readers of CNN sources may perceive the pandemic to be more severe than those who read Fox News.

**Figure 1**

First time-frame				
Fox News %	Category	CNN %	Discrepancy or consistency	
0%	Negative economic outlook	17%	0	
0%	Positive economic outlook	2%	0	
17%	Preventative measures	5%	0.23	Key for Themes:
7%	Government response	2%	0.22	Economic
9%	Public health response	12%	0.43	Public Health
11%	Travel restrictions	12%	0.48	Gov Response
6%	Covid spread	7%	0.46	Politicization
9%	Covid positive reinforcement	9%	0.5	
9%	Covid negative reinforcement	10%	0.47	
19%	Covid cases	15%	0.44	
10%	Covid deaths	8%	0.44	
2%	Negativity towards government response	0%	0	
	5/12 or 42% of topics had discrepancies			
	7/12 or 58% of topics had consistencies			

## Second Time-Frame

Data from the second time-frame supports a large majority of informational discrepancies between CNN and Fox News, with 80% of topics having discrepancies and only 20% of topics having consistencies.

In this time-frame, there were 11 categories that fit under the public health theme, but 8 had informational discrepancies while only 3 had informational consistencies. As mentioned previously, the availability of information regarding public health is crucial as it provides insight as to how impactful the pandemic is to safety and how people can avoid infection. CNN covered the theme of public health 55.5% of the second time-frame (excluding categories with informational consistencies), while Fox News covered this theme only 16% of the time (excluding categories with informational consistencies). The prevalence of this wide discrepancy suggests that viewers of CNN would be receiving information about public health at a higher frequency than viewers of Fox News. Additionally, one of the largest discrepancies within this theme, similar to the first time-frame, was preventative measures, with CNN discussing this category 11% of the time while Fox News only discusses it 1% of the time, suggesting that viewers of Fox News may not be receiving information about what preventative measures to take nearly as much as viewers of CNN.

In the second time-frame, a new theme with high prevalence emerged in both CNN and Fox News: Politicization (See Appendix). There were 6 categories that fit under the theme of politicization; 5 of the categories had informational discrepancies across CNN and Fox News, and one contained consistencies. There were high levels of support towards the respective party and opposition towards the other party. In Fox News, 11% of the codes fell in alignment with the outlook's political affiliation, defending the Republican party and critiquing the democratic party. In CNN, the inverse occurred; 24% of the codes fell in alignment with the outlook's political affiliation, defending the Democratic party and criticizing the Republican party. As a result, viewers that read Fox News or CNN through selective exposure are reinforcing their pre-existing beliefs, which could thus contribute to the growing polarization between the two parties (Levendusky et al.) (Druckman et al.). However, in Fox News, 9% of the codes defended the republican party, and 7% of the codes critiqued the republican party, suggesting that Fox News presented two perspectives on its affiliated party. As a result, viewers of Fox News may not be looking at extremely polarized information pertaining to the republican party. However, in CNN, 3% of the codes defended the democratic party, and 0% critiqued the democratic party, suggesting that CNN viewers would receive slightly more polarized information pertaining to democrats since only positive codes are being discussed. Ultimately, the theme of politicization occurred in 27% of Fox News codes and 24.5% of CNN codes, which is a significant portion of the information covered in this time-frame, exposing viewers of both outlooks to politicized information.

With one of the largest discrepancies in the second time-frame, tangentially related topics, which are topics that connect to the pandemic but are not relevant (“pandemic being number one word on Merriam-Webster,” for example), had a frequency of 20% in Fox News but

a frequency of 0% in CNN, suggesting that from the articles analyzed, a large amount of pandemic-related information discussed in Fox News was not about the pandemic itself. This could mean that important relevant information regarding the pandemic may not be viewed by consumers of Fox News.

**Figure 2**

Second time-frame				
Fox News %	Category	CNN %	Discrepancy or consistency	
8%	Negative economic impact	0.50%	0.06	
1%	Preventative measures	11%	0.08	
9%	Defending republican party	0.50%	0.05	
0%	Defending democratic party	3%	0	
7%	Critiquing republican party	13%	0.35	
2%	Critiquing democratic party	0%	0	
9%	Democrats and republicans conflict	0%	0	
0%	Experts "correcting" trump	8%	0	
7%	Government response	1%	0.13	
0%	Public health response	7%	0	
2%	Covid spread	5%	0.29	
13%	Covid positive reinforcement	0.50%	0.04	
12%	Covid negative reinforcement	7%	0.37	
2%	Covid cases	10%	0.17	
8%	Covid deaths	7%	0.47	
20%	Tangentially related topics	0%	0	
0%	Vaccine/drug uncertainty	3%	0	
0%	Vaccine/drug works	10%	0	
0%	Research being done	8%	0	
0%	Health department struggle	6%	0	
16/20 or 80% of topics had discrepancies				
4/20 or 20% of topics had consistencies				

Key For Themes:

- Economic
- Gov Response
- Public Health
- Politicization

### Third Time-Frame

Data from the third time-frame suggests that CNN and Fox News had a majority of informational discrepancies, with 72% of topics having discrepancies and 28% of topics having consistencies.

22 of the categories fit under the public health theme, with 15 of the categories having discrepancies and 7 having consistencies. The large amount of discrepancies suggest that viewers of CNN and Fox News may have received different information related to public health at this time. Although, this time-frame also had a considerable amount of informational consistencies within the public health lens, suggesting that some categories within this theme were covered similarly and others were covered differently.

Unlike the second time-frame, which dedicated significant information to politicization, the third time-frame discussed the theme infrequently. 1% of the codes in Fox News fell into the theme, and 5% of the codes in CNN fell into the theme; all categories within the theme contained discrepancies. Although the frequency of this theme was minimal, it is important to note that the information is still in line with the political affiliation of the source. In CNN, 5% of the categories fell in alignment with its political affiliation (positivity towards the present party and negativity towards the opposite party). In CNN, 1% of the categories aligned with its political

affiliation. Although exposure may be low, viewers of Fox News and CNN may still receive politicizing information.

The economic theme was discussed somewhat frequently on CNN (14% of the third time-frame) but not at all in Fox News, suggesting that viewers of Fox News may not have consumed information about the economic outlook while viewers of CNN had. As mentioned previously, the consumption of economic-related news may benefit viewers as their finances may be impacted based on the state of the economy. As a result, viewers of CNN may be more informed of the state of the economy with regard to pandemic disruptions than viewers of Fox News as the analyzed articles in Fox News showed no mention of economic impact while the analyzed articles in CNN mentioned economic impact in 14% of the codes.

**Figure 3**

Third time-frame				
Fox News %	Category	CNN %	Discrepancy or consistency	
0%	Negative economic impact	11%	0	
4%	Preventative measures	6%	0.4	
3%	Government response	5%	0.38	
3%	Public health response	3%	0.5	
1%	Covid spread	9%	0.1	
10%	Covid cases	3%	0.23	
13%	Covid deaths	14%	0.48	
0%	US could have prevented deaths	2%	0	
4%	Telling people to get vaccinated	1%	0.2	
3%	Vaccine works	4%	0.43	
0%	Vaccine uncertainty	4%	0	
0%	New mandates	5%	0	
0%	People opposing mandates	2%	0	
4%	Amount vaccinated	7%	0.36	
0%	People losing benefits	3%	0	
1%	Covid positive reinforcement	3%	0.25	
4%	Covid negative reinforcement	5%	0.44	
1%	Health department struggle	6%	0.14	
0%	Biden positivity	1%	0	
1%	Biden negativity	0%	0	
5%	Childbirth complications due to covid	0%	0	
1%	No childbirth complications due to covid	0%	0	
0%	Criticizing Trump response	4%	0	
1%	Nothing helps long covid	0%	0	
8%	Unequal covid impact	0%	0	
8%	Researching origin	0%	0	
4%	Other drugs work	0%	0	
5%	Vaccine not preventing sick	0%	0	
10%	Covid symptom	0%	0	
4%	Negativity towards unvaccinated	0%	0	
	21/29 or 72% of topics had discrepancies			
	8/29 or 28% of topics had consistencies			

Key For Themes:

- Economic
- Gov Response
- Public Health
- Politicization

## **Conclusion–Relevance**

In the present study, a conventional content analysis was conducted to identify whether CNN or Fox News covered similar or different information regarding Covid-19 at the time of the pandemic. This study's results indicate that two of the three time-frames mostly contained informational discrepancies, with a high prevalence of politicization in the second time-frame and changing levels of discrepancies and consistencies for each theme within each time-frame. Zhao et al.'s identification of a correlation between trust in either CNN or Fox News and behavioral discrepancies is in alignment with the analysis of the second time-frame in the present study. His data was gathered from a time period that roughly aligns with the second time-frame defined in this study. Since Zhao's study is correlational, it is probable that viewing CNN or Fox News did not impact behaviors during the pandemic, and the differences were driven by other factors. Although, data from the second time-frame suggested a higher prevalence of informational discrepancies than informational consistencies between topics, especially public health ones, highlighting the possibility that viewers consumed different information. This finding strengthens Zhao's connection as viewing different information could have contributed to different health behaviors (Zhao et al.). Allcott et al., found gaps in the perception of Covid-19 severity between republicans and democrats (Allcott et al), which is in alignment with the findings of the present study. Identified informational discrepancies in the second and third time frames could have contributed to these differences in perceptions. However, Allcott et al.'s study does not align with identified informational consistencies in the first time frame.

Moreover, Hart et al.'s findings agree with the data from the second time-frame but disagree with data from the first and third time-frame in the present study. His study identified high levels of politicization and polarization in biased news channels during the pandemic (Hart et al.). Similar to these findings, data from the second time-frame contained high levels of politicization but contained none in the first time-frame and contained minimal amounts in the third time-frame. Additionally, data related to politicization within the second and third time-frames is in alignment with the findings of Bernhardt et al.'s study. Bernhardt et al. found that politically biased news do not expose their partisan audiences to information that would be considered unfavorable (Bernhardt et al.). Similarly, in the present study, there were high levels of support for the respective party (Fox News defending the republican party for example) and high levels of negativity for the opposing party (Fox News critiquing the democratic party for example) within the second and third time-frame. Although, findings in the first time-frame do not relate to Bernhardt's findings as there was no identified politicization.

## **Limitations**

While the method of this study was chosen to reduce bias, there are still limitations that occur. Even with the random selection of CNN and Fox News sources, not every article discusses the same topics. Thus, a topic covered by both CNN and Fox News may have only been selected from one outlet for the study, impacting the comparison between the two news sources. Additionally, content analysis is a subjective method, and while various practices, such

as conducting two run-throughs of the data, were implemented to minimize this subjectivity, this study may still be impacted by this limitation. Moreover, this study is limited to just CNN and Fox News, and while they are some of the most popular politically biased news outlets, others may prefer other popular or more extremely partisan outlets. As a result, the findings of this study cannot be generalized to all politically biased news sources and all audiences.

### **Future Directions**

The identified informational discrepancies in CNN and Fox News could have impacted perceptions of the pandemic, but this was not assessed in this study. As a result, perhaps future studies could identify whether trust in either CNN or Fox News led to differences in perceptions of the pandemic. The proposed study's purpose is significant as it could provide a more comprehensive understanding of whether politically biased news could have impacted behaviors, as differences in perceptions of severity and risks may drive health behaviors. Additionally, since this study is limited to just CNN and Fox News, future studies could replicate the method within this study but examine other politically biased news sources. The proposed study's findings, in harmony with the present study, would capture a larger population of viewers as media consumption is not limited to one news outlet. As a result, the findings of both studies would be more generalizable and would provide an extended understanding of what information could have driven behaviors during the pandemic.

### **Implications**

In the first time-frame, there was a slight majority of informational consistency. The importance of informational consistencies, especially in public health, is significant as it may create a common understanding of the risks and severity of the pandemic. Although, the prevalence of discrepancy within economic outlook in all three time-frames is significant as it can impact perceptions of the security of one's wealth as it is impacted by the state of the economy. As a whole, there were more informational discrepancies in the second and third time-frames, many of which regarding public health. The differences in information between politically biased news sources may communicate varying information about the risks and severity of the pandemic (Gollwitzer et al.), which could impact perceptions. This, as a result, could explain the link between the consumption of politically biased news sources and behavioral discrepancies, which could impact covid-19 infection and fatality (Zhao et al.; Simonov et al.; Spiteri et al.). The identification of politicization in the second and third time-frame could lead to the polarization of viewers, creating an increase of negativity and distrust towards those of the opposing party; this results in an inability to compromise when creating policies, especially ones regarding public health (Druckman et al.). Since informational discrepancies were found within this study, prioritizing neutral sources over politically biased ones may be most effective, especially when making health decisions during public health crises like the Covid-19 pandemic.

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## **Leveraging Financial Statement Analysis to predict company performance - A Case Study with Intuitive Surgical By Prisha Balan**

### **Abstract**

Detailed analysis of financial statements such as balance sheet, income statement and cash flow statements can provide insights into a company's business model, strategic and operational levers, and overall financial health of the company. This paper delves into the financial statements of Intuitive Surgical, a medical technology company specializing in the development and commercialization of robotic surgical systems. Intuitive Surgical has created a great presence in the healthcare industry with an increasing demand in minimally invasive medical procedures. A comprehensive analysis of Intuitive Surgical's financial statements provides valuable insights into the company's business model, indicating that it is built on solid business fundamentals with a strong balance sheet, steady gross margin, cash flow and strong growth metrics driven by market demand. We then project future financial projections and leverage market indicators and risk factors to arrive at an investment thesis for the company.

### **Intuitive Surgical's Business Model**

Intuitive Surgical hopes to create a world in which healthcare is less invasive, and where diseases are rapidly diagnosed and cured. In order to help improve outcomes and efficiency, this connected ecosystem consists of systems, instruments and accessories, learning, and services that are all connected by a digital portfolio enabling actionable digital insights also improving capabilities, intraoperative guidance, decision support, and a personalized learning journey. Despite the fact that surgical and acute therapies have considerably improved in recent years, there is still a critical need for better results and a reduction in the heterogeneity of these outcomes among care teams. In comparison to current treatment, Intuitive Surgical strives to reduce the overall cost to treat each individual patient. Intuitive's network of field service engineers in the U. S. , Europe, and Asia provides a comprehensive range of services to customers, including installation, repair, maintenance, technical support, and proactive system health monitoring ensuring the maximization of customer care. Preparedness and Upkeep Support is crucial for a seamless transition to and acceptance of new technologies and systems. The support for maintenance improves productivity and minimizes equipment downtime including software updates, on-site monitoring, support teams, service care plans, and a client portal.

Intuitive Surgical's business strategy aims to create value for patients, surgeons, and hospitals by utilizing smart systems, robotic technologies, advanced imaging, and informatics. The adoption of Intuitive Surgical's technology occurs procedure by procedure and market by market, driven by the relative patient value and total treatment costs of da Vinci procedures compared to alternative treatments. The company also offers training for physicians and their operating room staff, an ergonomic platform, and cloud-based analytics for surgeons.

## **Sales & Customer Support**

The company offers products and services through direct sales organizations in the U.S., Europe, China, Japan, South Korea, India, Taiwan, and Canada. Their capital sales activities involve educating surgeons and hospital staff on the benefits of robotic-assisted surgery with a da Vinci Surgical System or robotic-assisted bronchoscopy with an Ion endoluminal system, total treatment costs, and clinical applications.

The clinical sales team both interacts with surgeons, operating room staff, and hospital administrators to develop and sustain successful programs while also providing clinical information on robotic-assisted surgery practices and new product applications. Intuitive Surgical has seen seasonal fluctuations, with sales of da Vinci Surgical Systems typically higher in the fourth quarter and lower in the first quarter due to hospital budgets. The COVID-19 pandemic has disrupted historical procedure patterns, affecting the timing of instruments, accessories, and capital purchases. In addition to this Intuitive Surgical offers a full complement of services, including installation, repair, maintenance, 24/7 technical support, and proactive system health monitoring, through comprehensive service contracts and time and material programs.

Intuitive Surgical manufactures systems and instruments in Sunnyvale, California, Durham, North Carolina, and Peachtree Corners, Georgia while purchasing components from numerous suppliers adhering to strict quality specifications. They face competition from existing open surgery, conventional MIS, drug therapies, radiation treatment, and emerging diagnostic and interventional surgical approaches. They also face competition from larger companies like Johnson & Johnson and Medtronic plc, as well as research efforts utilizing computers and robotics for medical procedures.

Intuitive Surgical heavily invests in research and development (R&D) as a means of continuously improving their robotic platforms in order to expand their capabilities. Their R&D efforts focus on refining robotic technology while also developing advanced instruments and accessories, and exploring new applications for robotic surgery across a plethora of medical specialties.

## **Intuitive Surgical's Balance Sheet**

The first component of the fundamental analysis pipeline begins with the balance sheet. A company's balance sheet is one of the three core financial statements that provide a company's assets, liabilities, and shareholder equity. We can obtain the company's balance sheet directly from the 10-K annual report found in the EDGAR website. The balance sheet traditionally reports data from the past two years. For example, if you are looking up the balance sheet for Intuitive Surgical in 2023, you would be able to acquire data from 2021 and 2022.

The first component of a balance sheet is assets, which is any resource owned by an economic entity. Below is an Excel spreadsheet containing data directly imported from the SEC website (Table 1).

			2022	2021
<b>Current Assets</b>				
Cash and Cash Equivalence			1581.2	1290.9
Short-Term Investments			2536.7	2913.1
Accounts Receivable			942.1	782.7
Inventory			893.2	587.1
Prepaid and other current assets			299.8	271.1
<b>Total</b>			<b>6253</b>	<b>5844.9</b>
Property, plant, and equipment (Net)			2374.2	1876.4
Long-term investment			2623.6	4415.5
Deferred tax asset			664.6	441.4
Intangible and other assets (Net)			710.1	633.2
Goodwill			348.5	343.6
<b>Total Assets</b>			<b>12940</b>	<b>13555</b>

Table 1. Balance sheet (Assets) for Intuitive Surgicals comparing 2021 vs. 2022

This is data directly imported from Intuitive Surgical’s 10-K annual report (Please note that these numbers are in millions of dollars. i.e., 14,111 = \$14,111 million dollars, or \$14.1 billion dollars) The first category that we should primarily look at is cash and cash equivalents, which is also known as the company’s emergency reserve. Intuitive Surgical’s high cash reserve gives investors the confidence that the company can pay off its liabilities whenever necessary. When comparing between 2022 and 2021, Intuitive Surgical’s cash reserve increased from \$1.2909B to \$1.5812B, suggesting a strong cash balance sheet. It also appears that the company’s short-term investments have shrunk from \$2.9131B to \$2.5367B. This is likely because many asset classes have dropped in prices throughout 2022 due to persistent inflationary concerns and the Federal Reserve raising interest rates. Therefore, it is unsurprising that Intuitive Surgical may have deployed some of its securities into safer vehicles, such as treasury bills and other cash equivalents.

We can also look at net accounts receivables and inventories, which represent credits owed to the company. From 2021 to 2022, this value has increased from \$782.7M to \$942.1M, suggesting that many consumers are purchasing Intuitive Surgical products on credit. When Intuitive Surgical exercises the right to collect money from their consumers, this value will be converted into cash & cash equivalents. Additionally, we should also try to look for companies that don't have too much stake in inventory. A high inventory may suggest that the company is having a difficult time selling those products, which might indicate diminished demand for their products and services. Indeed, one downside about Intuitive Surgical is that its inventory valuation seemed to have substantially increased from \$587.1M to \$893.2M, which may indicate a decreasing demand for its products.

Other than that, when we compare the total assets between 2021 and 2022, there is a net decrease from \$1.355B to \$1.294B. This is largely attributed to the company's decline in long-term investments (Intuitive Surgical may have needed to liquidate a large portion of its long-term investments either to reduce liabilities before the Federal terminal funds rate continues to rise). While a net decrease in the company's assets may not sound too enticing, 2022 has been a contractionary period for many corporations. As long as Intuitive Surgical don't continue to reduce their cash positions throughout 2023, the company should be financially strong.

The other side of the balance sheet would be the liabilities and shareholder's equity. Liabilities include any form of debt that the company owes, while shareholder's equity represents how much the shareholders of the company have invested into the business.

				<b>2022</b>	<b>2021</b>
Current Liabilities					
Accounts Payable				147	121.2
Accrued Compensation & Employee Benefits				401.6	350.1
Deferred Revenue				397.3	377.2
Other Accrued Liabilities				476.2	301.3
Other Long Term Liabilities				439.3	453.7
<b>Total Liabilities</b>				<b>1861.4</b>	<b>1603.5</b>
Shareholder's Equity					
<b>Total</b>				<b>11112.6</b>	<b>11951.5</b>
<b>Total Liabilities and Equity</b>				<b>12974</b>	<b>13555</b>

Table 2. Balance Sheet (Liabilities) for Intuitive Surgical between 2021 vs. 2022

Comparing between 2021 and 2022, the total liabilities have increased from \$1.6035B to \$1.8614B (Table 2). Many people would generally have a negative viewpoint towards a company with increasing debt. However, this is a perfectly normal process in the business cycle. After all, if a company is producing more and more products, the cost of upkeep, maintenance, labor, and capital would all increase, which is directly reflected in the liabilities portion of the balance sheet. As long as the total assets exceed total liabilities for consecutive years, there is good faith in the company's financial stability. And of course, the remaining gap between the assets and liabilities would be the shareholder's equity. It's important to note that the total assets vs. total liabilities & equity must contain equal values.

### **Intuitive Surgical's Income Statement**

After reading through the balance sheet, we can glance at the company's income statement, which is a financial statement that summarizes all total income and expenses over a given period of time.

			<b>2022</b>	<b>2021</b>	<b>2020</b>
<b>Revenue</b>					
Product			5198	4793.9	3634.6
Service			1024.2	916.2	723.8
<b>Total Revenue</b>			<b>6222.2</b>	<b>5710.1</b>	<b>4358.4</b>
<b>Cost of Revenue</b>					
Product			1700.3	1464.1	1230.3
Service			325.9	287.5	266.9
<b>Total Cost of Revenue</b>			<b>2026.2</b>	<b>1751.6</b>	<b>1497.2</b>
<b>Gross Profit</b>			<b>4196</b>	<b>3985.5</b>	<b>2861.2</b>
<b>Operating Expense (OpEX)</b>					
Selling, general, and administrative			1739.9	1466.5	1216.3
Research and Development			879	671	595.1
<b>Total OpEX</b>			<b>2618.9</b>	<b>2137.5</b>	<b>1811.4</b>
Income from Operations			1577.1	1821	1049.8
Interest and other income (Net)			29.7	69.3	157.2
Income before taxes			1606.8	1890.3	1207
Income tax expense			262.4	162.2	140.2
<b>Net Income</b>			<b>1344.4</b>	<b>1728.1</b>	<b>1066.8</b>

Table 3. Income Statement for Intuitive Surgicals between 2020-2022

This is Intuitive Surgical's income statement directly imported from the SEC EDGAR website (Table 3). According to the 10-K report, Intuitive Surgical's primary product is the OUS da Vinci surgical system, while its services included items such as hernia repair, cholecystectomy, bariatric procedures, as well as gynecologic and urologic procedures. From 2021 to 2022, Intuitive Surgical experienced a net growth in both product and service revenue. However, its net income year-to-year seemed to have declined from \$1.7281B to \$1.3444B. One of the macroeconomic reasons is due to foreign currency impacts. Throughout 2022, the U.S. dollar has dominated the global currency, which implies that any net income from overseas institutions would correspond to reduced net income in terms of U.S. dollars. Therefore, the overall decrease in net income could be due to macroeconomic concerns, as opposed to waning demand for the company's products and services.

Another reason as to why the decline in net income could be misleading is that Intuitive Surgical's gross margin (profit) has actually increased from \$3.9855B to \$4.196B, which likely rules out the possibility that the corporation is losing money. Higher gross margins imply that

Intuitive Surgical is becoming more efficient with its operating costs while maximizing incoming cash flow. We can also compare year-over-year gross margin percentages, which can be calculated by taking the net profit divided by the net revenue.

	2022	2021	2020
Net profits	\$4.196B	\$3.9855B	\$2.8615B
Net revenue	\$6.222B	\$5.710B	\$4.3584B
Gross Margin %	67.44%	69.80%	65.64%

Table 4. Intuitive Surgical's Gross Margins between 2020 and 2022

As we can see, the gross margin percentages have fallen slightly from 69.8% to 67.44% between 2021 and 2022. This is again, likely due to economic contractions throughout 2022 that made it difficult for companies to maintain positive earnings. However, it is important to note that a gross margin percentage above 50% is extraordinarily high for the vast majority of companies (Remember, a high gross margin implies that companies are highly efficient at managing its costs of revenue). A high profit margin is key to a company's financial health—companies will allocate this cash to re-invest into their companies for growth, pay out dividends to shareholders, pay off liabilities, and/or increase cash reserves.

Another important element that I like to scrutinize in a company's income statement is the year-over-year comparison in Selling, General, and Administrative (SG&A) vs. Research and Development (R&D) operating expenses. Broadly speaking, SG&A operating expenses relate to companies spending money on advertisement of their products and services. On the other hand, R&D is related to expenses used for expanding the company's growth (e.g., more equipment, consulting fees, and any research-related expenses). Between 2021 and 2022, it's calculated that SG&A expenditure has increased from \$1.466B to \$1.739B, or approximately 18.64%. On the other hand, R&D expenditure has increased from \$671M to \$879M, or approximately 31% increase. This is very valuable information because it shows that Intuitive Surgical is devoting more money on expansion of its capital, rather than spending more money on advertising its products and services. When a company does not rely too much of its operating costs in SG&A, this is likely because the demand for that company's products and services is already very high. Therefore, Intuitive Surgical is much better off spending more operating expenses on research and development of newer products, rather than advertisement.

### Financial Summary Report

It is also essential to understand some of the important corporate metrics prior to performing a full-scope fundamental analysis of a company. Websites like Yahoo Finance can provide up-to-date information about every individual stock's financials every trading window.

In this section, we will focus on five core elements of a stock's financial summary report: Volume, Market Capitalization, Beta, P/E Ratio, and EPS.

Volume isn't necessarily a corporate metric that helps determine a stock's price, but it provides very vital information about the stock: its liquidity (Investopedia). Stock trades only occur if an equivalent balance of supply and demand for the security persists. The higher the trading volume, the higher likelihood that the order would be fulfilled. In this example, Intuitive Surgical's trading volume from the previous trading day was approximately 1.8 million shares, which implies that 1.8 million share quantities were actively traded in the open market.

Market capitalization is an equivalent term for the company's net worth (a.k.a. "The fair value") (Investopedia). Mathematically, a company's market capitalization is calculated by multiplying the current price of a stock by the total number of issued shares by Intuitive Surgical. Because market capitalization is subject to the underlying stock's price variations, it constantly changes on a daily basis. Intuitive Surgical currently has a market cap of around \$87.4 billion dollars. While the market cap shouldn't be the sole benchmark when evaluating a company's financial health, it is generally true that companies with greater market capitalization tend to have greater pricing power, and thus, their fundamental valuation is deemed strong and financially stable.

In the stock market,  $\beta$  refers to the measure of a stock's volatility relative to the S&P 500 index (Investopedia). S&P 500 is an index that tracks the performance of 500 top companies in the United States, and it is used as a reference standard to quantify the risk-level of individual stocks. If a stock has a  $\beta$  equal to 1.0, then the price performance of that stock moves in parallel to the S&P 500 (If the S&P 500 rises 5% for the year, this stock would also rise by 5%). If a stock has a  $\beta$  less than 1.0, it is deemed less risky but at the same time, it will provide significantly lower returns than the S&P 500. On the other hand, if a stock has a  $\beta$  greater than 1.0, it is deemed riskier but at the same time, it will provide significantly higher returns compared to the S&P 500. These stocks usually experience high price volatility because many investors actively trade in and out of these stocks. Because Intuitive Surgical has a  $\beta$  of 1.29, its price performance is approximately 1.29 times more volatile compared to the S&P 500. This doesn't necessarily mean a bad outlook for Intuitive Surgical—a healthy growth company should have a higher  $\beta$  value, albeit too high value can indicate that the company is overvalued.

Earnings-per-share, or EPS, is an estimate for evaluating a company's stock price. A company's EPS is determined by fluctuations in earnings and the total number of shares outstanding (Investopedia). EPS can be boosted by either increasing its earnings or reducing its share counts through stock buybacks. The main limitation of using EPS to value a company's stock is that EPS is calculated using net income. The net income of a company is influenced by many factors, including tax & interest payments, non-operating expenses, depreciation, and amortization. Because of these huge variations that influence the company's net income, EPS doesn't quite reflect the health of the business, and thus, it's not the best parameter to evaluate a company's stock.

Finally, the P/E ratio is calculated as the current price of the company's stock divided by its recently reported EPS (Investopedia). Intuitive Surgical's P/E ratio is calculated as 66.54. One way to think about this is that for every \$1 of earnings in Intuitive Surgical, investors are paying \$66.35, or a multiple of 66.35. In general terms, P/E ratio provides information on whether a company's stock is trading at higher valuations or lower valuations. The lower the P/E ratio, the more "undervalued" a company is viewed in the market's point of view. Like EPS, P/E ratio is at best a proxy for a company's valuation, but it will never fully reveal 100% information about a company's financial health. This is because the P/E ratio depends on the value of EPS, and as we discussed in the above section, EPS changes heavily based on the company's net income for a particular quarter. Figure 3 indicates the financial metrics of Intuitive Surgical.

Previous Close	<b>252.57</b>	Market Cap	<b>87.386B</b>
Open	<b>253.00</b>	Beta (5Y Monthly)	<b>1.29</b>
Bid	<b>0.00 x 1300</b>	PE Ratio (TTM)	<b>66.35</b>
Ask	<b>0.00 x 800</b>	EPS (TTM)	<b>3.76</b>
Day's Range	<b>248.50 - 253.35</b>	Earnings Date	<b>Apr 18, 2023</b>
52 Week Range	<b>180.07 - 308.97</b>	Forward Dividend & Yield	<b>N/A (N/A)</b>
Volume	<b>1,179,536</b>	Ex-Dividend Date	<b>N/A</b>
Avg. Volume	<b>1,703,656</b>	1y Target Est	<b>278.37</b>

Figure 1. Financial Metrics for Intuitive Surgical Stock  
(Source: YahooFinance)

### Intuitive Surgical Price Projections

Both the income statement and the balance sheet can help determine the future price projection for a company's stock. In this exercise, we will use the information from the 2020 through 2023 revenue and expense report to calculate the projected stock price in 2027. First, we will assume a linear growth for both products and services revenue. We used the 2020 data as the "y-intercept" value and calculated the slope of these values by subtracting the 2020 values from 2022 values, divided by 2 years. Both of these represent the model equation that would enable the projected product and services revenue for 2027. In our example, the projected product revenue is \$9.078 billion dollars and service revenue is \$1.775 billion dollars for 2027. The total projected net revenue by 2027 would be \$10.853 billion dollars.



Next, we need to calculate the expenses. Unlike revenue however, it would be difficult to obtain a model equation because expenses are variable costs. During some years, the company is expected to spend more money on products vs. services, as well as operating expenses. Instead, we can utilize the profit margin function to help determine the overall expenses. For example, let's assume that by 2027, Intuitive Surgical is expected to retain 45% profit margin. This means that the remaining 55% of the net product and services revenue corresponds to the expenses associated with those products and services. For instance, if the 2027 expected product revenue is calculated as \$9.078 billion dollars, the product expense would correspond to  $\$9.078 * 0.55 = \$4.993$  billion dollars. Same calculation is applicable for services expenses. For simplicity, we will assume a fixed operating expense in 2027 at \$3 billion dollars, which brings the net income down to approximately \$1.844 billion dollars.

Of course, just like how normal individuals are required to pay federal and state taxes, corporations are no exception. For another simplicity, we will assume a 21% corporate tax rate for both combined federal and state taxes. After subtracting the taxes, we have achieved the bottom line net income post-taxes at \$1.488 billion dollars.

We are now ready to calculate the current EPS (Earnings Per Share). We can achieve this by dividing the current net income (post-taxes) by the current outstanding shares, which is approximately 351 million issued shares. This brings our EPS to \$4.24. And finally, we can use this EPS to calculate the future price projection by multiplying by the forward P/E ratio. Financial analysts often provide the future P/E ratio, which is around 50.38 for Intuitive Surgical. The product of  $\$4.24 * 50.38$  corresponds to around \$213.59/share.

Of course, this is a disappointing price projection for Intuitive Surgical because the current price of the stock as of April 2023 trades around \$290/share. However, keep in mind that this is only a price projection using conservative numbers. Depending on the investor's thesis, we can alter any components of the price projection sheet to evaluate the corrected future price. For example, perhaps a linear growth model isn't the most accurate model—perhaps the model should follow more of a parabolic curve. Or perhaps the profit margin can be adjusted so that the company isn't contributing too much towards product and service expenses. Or perhaps the company has found ways to increase efficiency and does not have a lot of operating expenses. Or perhaps the company has moved location to another state or country with less tax obligations and therefore, the net income post-taxes aren't too burdensome. The figures below show a conservative price target vs. a bullish price target (See adjustments).

	2027 Estimates	Model Equation (X=0, 2020)	
<b>Revenue</b>			
Products	9078.5	$Y = 777.7X + 3634.6$	Slope: $(5198 - 3634.6)/2$ years = 777.7
Services	1775.2	$Y = 150.2X + 723.8$	Slope: $(1024.2 - 723.8)/2$ years = 150.2
<b>Total Net Revenue</b>	<b>10853.7</b>		
<b>Expenses</b>			
		Expense Margin	Profit Margin
Product	4993.175	0.55	0.45
Service	976.36	0.55	0.45
Operating Expenses	3000		
<b>Total Expenses</b>	<b>8969.535</b>		
		Tax Rate	
Net Income	1884.165	0.21	
Taxes	395.67465		
<b>Net Income after Taxes</b>	<b>1488.49035</b>		
Net Income after Taxes (In millions)	\$ 1,488,490,350.00		
<b>Total Shares Outstanding</b>	351,100,000		
EPS	\$ 4.24		
Current Price	\$290		
P/E Ratio	68.40420564		
Forward P/E Ratio	50.38		
Target Price in 2027	\$ 213.59		

Table 5. Conservative Price Target for Intuitive Surgical in 2027

	2027 Estimates	Model Equation (X=0, 2020)	
<b>Revenue</b>			
Products	9078.5	$Y = 777.7X + 3634.6$	Slope: $(5198 - 3634.6)/2$ years = 777.7
Services	1775.2	$Y = 150.2X + 723.8$	Slope: $(1024.2 - 723.8)/2$ years = 150.2
<b>Total Net Revenue</b>	<b>10853.7</b>		
<b>Expenses</b>			
		Expense Margin	Profit Margin
Product	3177.475	0.35	0.45
Service	621.32	0.35	0.45
Operating Expenses	2000		
<b>Total Expenses</b>	<b>5798.795</b>		
		Tax Rate	
Net Income	5054.905	0.21	
Taxes	1061.53005		
<b>Net Income after Taxes</b>	<b>3993.37495</b>		
Net Income after Taxes (In millions)	\$ 3,993,374,950.00		
<b>Total Shares Outstanding</b>	351,100,000		
EPS	\$ 11.37		
Current Price	\$290		
P/E Ratio	25.49697969		
Forward P/E Ratio	50.38		
Target Price in 2027	\$ 573.02		

Table 6. Bullish Price Target for Intuitive Surgical in 2027

In the bullish price projection, we have adjusted the expense margin from 55% to 35%, and reduced the operating expense from \$3 billion dollars to \$2 billion dollars. After applying these changes, we can notice that the future price target has risen to \$573.02/share, while applying the same forward P/E ratio. An average of these two scenarios yields a stock price of ~\$375/share which makes the company an attractive investment at the current price levels.

## **Conclusion**

Intuitive Surgical has a strong business model with solid financial fundamentals. Intuitive Surgical's revenue model is based on the da Vinci System with its business model being centered around the sales of disposable surgical accessories. Some risk factors faced by Intuitive Surgical include competition within other robotic surgical manufacturers, technological advancements, and economic risks. While Intuitive Surgical's income statement provides insight into their growth with a gross income growth of about 6.28%, its balance sheet indicates Intuitive Surgical's overall sound financial health. From the income statement it can be determined that Intuitive Surgical has a strong profitability with an average net profit margin of about 30% over the last few years. Extending these projections to the future, we predict a price range for Intuitive Surgical by manipulating the P/E ratio, profit margin, and operating expenses, leading us to a conclusion that it could be an attractive investment at the current price levels based on average projected price.

## Intergroup Discordance: A Review on Artworks from A Social Perspective By Zekai Li

### Abstract

Humanity has always been classified by demographics, values, beliefs, race, and various determinants. Similarly, groups can be defined on a scale as small as a squad or as big as a country. During the interaction between groups, is where conflict would emerge. That is what we call – Intergroup discordance, or in other words, issues that arise when communities start to interact with each other in our society. Though human civilization has always encountered struggles and conflicts that vary between eras throughout history, this review, comprised of 11 historical and modern artworks that span across the long river of history, explores four systematic societal issues - poverty, ethnic inequality, cultural conflict, and revolution, that have persisted till today. Despite evolutionary progress, these daily struggles continue to affect our communities worldwide.

### Keywords

Art history, artworks analysis, art review, social regime, social structure, social class, poverty, ethics, gender inequality, racial discrimination, cultural conflict, and revolution.

### 1 Poverty



Figure 1. Ancient Egypt, *The Famine Stela*, bc. 332-31

Poverty has long plagued human society since ancient Egypt. Around the Ptolemaic Kingdom, recorded on *The Famine Stela* on the Island of Sehel, dated from 332 to 31 BCE, were the inscriptions carved on the rock surface to document a seven-year drought that caused thousands of deaths of Egyptian citizens during which time the river Nile had not flooded the farmlands. Above the forty-two columns of ancient inscriptions, the engraving tells King Djoser's concern towards the severity of this drought as the kingdom's sincere worship of God standing in front of his lines of servants and officials. After all, it was believed to be a natural disaster. Still, King Djoser's insistence on rebuilding the temple of Khnum, known as the god of the source of the Nile, finally ended the seven years of famine towards the end of his reign and is still remarkably remembered today (1).



Figure 2. Gustave Courbet, *Stonebreakers*, 1849

In the 1760s, a style known as realism emerged during the first industrial revolution – when the West had formed a mature society that allowed the capitalists to exploit the lower classes for their benefit. Artists like Courbet started to collectively depict such oppression of the upper class in one of his most symbolic paintings, *Stonebreakers*, showing two construction workers breaking up stones for a new road. Courbet portrays the poor living conditions by letting the peasants wear shabby and worn-off clothes. And the absence of their facial expressions further adds a sense of anonymity to their identity. The lack of an aerial view, such as an open sky or an ample open space, could be seen as a metaphor as if they held no future. Quickly when

more people from the lower hierarchies came back to sense, more conflicts were created between groups, ultimately ending in a revolution.

Now centuries passed, and when civilization, industrialization, and technology have improved our average life expectancy and quality, poverty remains a systematic issue in parts of our world. Countries such as China continue to exploit the now-called “blue collars” (2) in an excruciating capital stylism that only entrenches social hierarchy more persistently, making poverty harder to alleviate.



Figure 3. El Anatsui, *Old Man's Cloth*, 2003

While the rest 6.8 billion of the population has elevated to better living standards, conversely, Africa is home to some of the world's poorest countries, where people struggle to

feed themselves daily. As of 2023, according to the World Bank (3), there will still be as many as 1.2 billion impoverished populations living on less than US\$1.25 a day. El Anatsui, one of Nigeria's most renowned contemporary artists, has dedicated his career to connecting global awareness to his continent. In his contemporary artwork, *Old Man's Cloth*, he chooses liquor bottles to symbolize the history of the Atlantic slave trade started by the Europeans when alcohol was used as a means of exchange. The glowing light from the copper wire is another representation of the colonization of Britain until the late 1950s in his home country – Modern-day Ghana – which used to be called the gold coast. In Anatsui's piece, he links how society was in the past to trigger the audience's reflection on the social structure in modern days.

### **Ethical Inequalities**

Poor social mobility and factors such as colonialism were among the leading causes why racism and gender bias didn't seem to be under the same spotlight as nowadays until the mid-19th century when the first law protecting women's marriage property was signed in New York in 1848 (4). In addition, it was not until 1900 that all states gave women the right to own property



The painting *Free Women of Color with their Children and Servants in a Landscape* would be a perfect example to demonstrate such racial neglect, where the contrast was evident through the position of the light-skinned women in the foreground and dark-skinned people in the back, shadowed by the artificial vignette, as dark as the history of U.S. Slavery. The entire tone has also been deliberately darkened so that only the details of the lighter colored can be seen, including their godly faces, ornate clothing, and jewelry. On the other hand, those with dark skin are left with only their skin tones that once represented the lowest social status, the dress that symbolizes their slavery identities, and nothing else.

Today, major awareness has been brought onto African Americans and women's rights in the US predominately. Many other forms of bias and inequality still impact the communities of immigrants, refugees, and underrepresented minority groups such as Middle East women.



Figure 5. Shirin Neshat, *'Rebellious Silence' Women of Allah*, 1993-97

Modern artwork *Rebellious Silence* continues to address these issues. Quite the opposite of the male gaze used extensively by film directors to suggest how audiences should view female characters through the lens of heterosexual men, Iran-born contemporary artist Shirin Neshat ironically adopted the female gaze to stare back at the media industry, expressing her resentment of the commercial practice that objectifies women. The Western has long portrayed Islamic



women's submission to violence and repression in mainstream media, causing a global misperception. Whereas through Neshat's lens, she has captured the woman with a rather powerful gaze, evoking a sense of determination not to give in. And the way the barrel is positioned within the frame not only reflects the war-torn plight in which Islamic women found themselves, but at the same time, it suggests their willingness to protect and sacrifice for their belief, like the texts that encompass her face further speak of Neshat's honor for the bravery of Islamic women.

*"With an inflicted body, I've come to be with you.  
And on the promised day, we shall rise again."*

– *Allegiance with Wakefulness*, Tahereh Saffarzadeh

### **Cultural Conflicts**

Even though human civilization has become more inclusive, conflicts continue through discrimination, neglect, retaliation, and many other underlying forms. The fundamentals that led people into disagreements were their different pursuits formed under the influence of the land, language, religion, and belief they grew up surrounded by. Before the 21st century, armed forces were the ultimate reconciliation to conflicts. Nevertheless, it is always essential to ponder history and constantly reflect on how to become a better resolver when facing conflicts of interest, let alone many existing artworks that have already spoken history for us.



Figure 6. Philoxenus of Eretria, *Alexander Mosaic*, 100 BCE

*Alexander Mosaic* was a typical example of a collision between two cultures. This art piece shows the two greatest empires at that time, Persian and Greece, fighting against each other. This artwork manifests the details of the battle of Issus, where the two great ancient military leaders Alexander the Great and Darius III, are leading their empires, seeking to conquer each other. The direction that the horses are facing and the equipment scattered on the ground indicate the tragedy of the Persian empire and the victory of the Greek kingdom (5). This is a

prime example of Roman art in the Greek Hellenistic style, and the application of mosaic as a medium indicated that this piece was created for a wealthy Roman elite to exhibit their power and taste.



Figure 7. Diego Velázquez, *The Surrender of Breda* (*La rendición de Breda*), c. 1634-1635

Similarly, *The Surrender of Breda* also depicts the indigenous communities compromising against the invasion of foreign armed threats. The differences in power dynamics between the Spanish conquistadors and the Dutch city of Breda after the Eighty Years' War are apparent as the officer kneels before the Spanish. So are the overwhelmed look on the locals' faces and their shabby clothing and rough weapons compared to the Spanish army's spears, armor, and steeds.



Figure 8. Jaune Quick-to-See Smith, *Trade Canoe: A Western Fantasy*, 2015

Just an ocean across the European continent, American Indian artist Jaune Quick-to-See Smith revealed the conflicts between Native Americans and the European conquistadors in her iconic piece *Trade Canoe: A Western Fantasy*. Smith refers to the brutality imposed on the Indians by the Western conquistadors, for example, by painting a European businessman-looking figure with an eyepatch that only a robber would wear. Many other formations were also painted opposite directions on the same boat representing their unresolved conflicts in the land of America. The rebellious and harsh strokes of red suggest that chaos involving violence and cruelty might have occurred.

Throughout history, many once existed nations have lent a foundation to the now-civilized economies. Undoubtedly, modern civilization couldn't have evolved without the primitive history of humans fighting by force when faced with conflicts and contradictions. But soon, we learned after globalization that only by understanding and appreciating our differences can we resolve a dispute into a situation that harms no parties on this planet earth as more of us are aware now that the eight billion people are closely tied together.

## Revolution

Merging the three fatal issues, when combined simultaneously, poverty, inequalities, and cultural conflicts could lead to a chaotic societal eruption – revolution. That is when the citizens

of one group are no longer satisfied with the rule of their current leadership and tend to form a new norm that often, in successful cases, subverts the mode and function of society.



Figure 9. Delacroix, *Liberty leading the people*, 1830

A famous painting by Delacroix, *Liberty Leading the People*, could demonstrate all the core elements behind a revolution, such as the French flag consisting of white, blue, and red, symbolizing liberty, fraternity, and equality. A female personification of freedom is also shown in the center, and the bare breast symbolizes ideals of classical Greek and Republican Roman culture ruled under a democratic government, featuring the quality of courage and integrity. Some people are dressed in suits and proletariat shabby clothing, symbolizing the same target that people from all social classes are working towards. In the background of the painting, the building in the smoke is the Cathedral of Notre Dame, which symbolizes the end of the monarchy.



Figure 10. Kara Walker, *Darkytown Rebellion*, 1969

Unlike *Liberty Leading the People* or *Berlinguer's funeral*, which depicts a more significant revolutionary movement that overthrew the existing government, *Darky Town Rebellion* shows a revolution in a small town called Darky Town under the considerable context of the abolition of slavery. This installation offers a rebellion in the Southern States of America, where enslaved people fought their enslavers. Walker created a series of art films that aimed to battle against the unfair historical erasure of African Americans. She has also applied silhouettes and psychedelic colors to make the audience more physically involved. That is – the audience themselves would feel as if they were also participating in the rebellion (6)



Figure 11. Funerali di Togliatti, *Renato Guttuso*, 1972

Togliatti (7), the former leader of Italy's communist party for 40 years, had such a magnificent funeral as can be indicated through the acrylic on canvas *Renato Guttuso*. Red is a symbol of communism, as well as features the heroism of Togliatti's life, who was often considered one of the founders of the Italian Republic; they started by leading a few thousand-people communist parties to expand to 2 million people within three years. Besides the unique red, the remaining painting remained monochromatic, with the black and white characters - colors symbolizing Togliatti's death and well-lived life. While some other significant characters were also included, occupying a larger portion on the left side of the artwork, such as Anna Kuliscioff, a renowned revolutionist who advocated for feminism, and Carlo Levi, a painter, writer, activist, and politician.

## Conclusion

As an art review that provides a vision to investigate traces of social issues through artworks of various styles and periods, topics covered in this review, including poverty, ethnic inequalities, cultural conflict, and revolution, have always existed in various forms since the first generation of human civilization. They continue to impact human society today. Nevertheless, they seem inevitable for humans to evolve. Regardless of period and art form, art can undoubtedly trigger our reflection on how we perceive, interpret, and approach ourselves.

The advance of technological developments has improved our living standards substantially, while education simultaneously allows more people to elevate their awareness, and that the problem such as racism could likely be resolved. One day, different countries may unite, and all races start to appreciate the Community of Human Fate instead of fighting for resources. One

day, a civilized society may be formed in every corner of our planet Earth, where all citizens are satisfied with the government that serves their system, and the earth shall be ever peaceful...

And as human develops toward these, as a society constantly upgrades its structure, artwork will continue to be one of the most optimum approaches that provide us with a view of the evolvement. Numerous paintings, sculptures, architecture, and other art forms will set up a steady background for future generations to observe the past as if it is present to them. In this way, people can improve themselves from the long river of history.

### **Acknowledgements**

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# **The Effects of Positive Habit Formation on Self-Assessed Mood in a Group of Individuals.**

## **By Ronit Naik**

### **Abstract**

The word identity was originally derived from the two Latin words *essentitas* meaning being and the word *identidem*, meaning repeatedly. An individual's identity is directly shaped by their “repeated beingness” or their habits (James Clear, 2018). A more exact definition of what habits are: actions performed repetitively in associated contexts without much conscious thought. Many go through life without being remotely aware of how their identity is a direct consequence of their habits. The purpose of this study was to utilize the various habit formation principles and strategies articulated by the current literature surrounding habit formation in a group of individuals while tracking their self-reported mood on a scale of 1-10 in order to discern the effect of positive habit formation on mood. Results indicated that habit formation did not cause a significant change in mood. Participants’ moods stayed largely stagnant over the four-week period.

### **Introduction**

People will often say that they are trying to form better habits like going to the gym more, eating healthier, or daily meditation, but before they can stop themselves they end up slipping back into their old habits such as watching TV, eating unhealthy food, or wasting time on social media. Though these people’s intentions may have been genuine, and for a short time, their actions were in line with their intentions, they likely lacked the proper strategies for forming better habits. Meanwhile, people who are able to form better habits do so by properly implementing the strategies that govern the formation of a habit. Some of these strategies include environmental engineering such as keeping a water bottle in sight with the goal of drinking more water and also by setting implementation intentions to decrease the role of conscious decision-making during the stages of habit formation, which might be seen as a mental commitment made by a participant to say “In this situation, I will perform this action” (Carden and Wood, 2018; van der Weiden et. al, 2020 ). Additionally, research has suggested that self-control doesn’t play a large role in facilitating the formation of a given habit past a certain stage when there is no gratifying alternative (van der Weiden et. al, 2020). Further, the role of ease of access in habit formation has been highlighted, suggesting that making minor changes in accessibility, such as the placement of foods within a salad bar, can heavily influence the choices a person will make, following the “Law of least effort” (Paul Rozin et. al, 2011).

Though all these studies analyze habit formation and the processes involved in habit formation, there is a scant mention of mood and how the formation of positive habits and mood are linked. The current study aims to examine what the relationship between them may be. I expected to see an improvement in the average mood of participants over the four-week period in the participants that felt they had habitualized drinking water regularly. To test this hypothesis, I recruited as many participants as possible in one week from Bridgewater Raritan High School as

well as people who lived in Bridgewater. Over a four-week period, I measured their self-reported habit strength on a scale of 1- 10, their self-assessed mood on a scale of 1-10, and collected data on the amount of water that they are drinking.

This study incorporates environmental engineering by describing to the participants how to manage their environment to help facilitate the formation of a habit ( Lucas Carden and Wendy Wood, 2018 ) and implementation intention principles by explaining to participants what implementation intentions are and how they can help to form habits faster (Thomas L. Webb and Paschal Sheeran, 2009). They are both effective tools in aiding habit formation. However, the study is also designed to give self-control a small role to play in the formation of the habit in question. This is to limit the amount of deliberation that could occur in certain instances. The objective of this paper is to highlight the effects of habit formation on mood in a group of 14 individuals.

### **Methods–Recruitment**

A sample group of 14 individuals was recruited for participation from Bridgewater, New Jersey. Seven of these individuals attend Bridgewater Raritan High School, and the remaining seven are adults over the age of 35 who reside in Bridgewater. The fourteen participants were recruited via e-mail and through one on one approach over the course of seven days. Those who agreed to participate in the study received an email when the study began and were informed weekly with information regarding the study.

### **Habit Strength**

Self-assessed habit strength was tracked through a daily Google form asking participants to assess their habit strength on a scale of 1- 10 (1 being “I drink water when I’m thirsty” and 10 being “I make sure to drink a gallon of water a day”). This metric was tracked over the entire four-week period to ensure that a habit was actually being formed so that a correlation between habit formation and mood could be analyzed.

### **Study Design**

To ensure that participants would follow through with the study, it was designed to be as simple as possible to ensure that habit formation would be easiest. (James Clear, 2018). The field study itself tracked habit strength in the group of individuals and was designed to be as simple as possible.

### **Field Study**

Participants were instructed to drink a certain amount of water every day and to track their water consumption and to have a rough estimate of daily water consumption. They were also instructed to answer a Google form which was sent out daily to collect data on habit strength and water consumption along with general information like age. For the first week of the study participants were instructed to drink one quart per day. The next week called for two quarts of

daily water consumption. The remaining weeks of the study ordered three quarts of water consumption daily. In order to ensure that participants were able to meet their water consumption goals, they were also taught strategies for habit formation along the way such as environmental engineering and context-based implementation. Attached below is a timeline of the field study containing the weekly information on the study.

Dates	Description
26 Apr 2023 - 30 Apr 2023	Field study begins; Participants drink a quarter gallon this week.
01 May 2023 - 07 May 2023	Participants start drinking one a half gallon, and environmental engineering strategies are taught to participants.
08 May 2023 - 14 May 2023	Participants start drinking 3 quarts per day, and environmental engineering strategies are taught to participants.
15 May 2023 - 21 May 2023	Participants continue to drink 3 quarts per day for this period while context based implementation of behaviors is suggested.
22 May 2023 - 26 May 2023	Participants continue to drink 3 quarts per day for this period while advised to implement drinking a proportion of their water during, before, or after an already well defined habit in their routines.

Table 1. Description of the timeline used in the water consumption experiment.

## Results

First, I examined average habit strength over time in order to determine to what extent a habit had been formed. The data reflected an average habit strength of 6.2 at the beginning of the study and an average habit strength of 7.667 toward the end of the study. The data fluctuated between the 6 - 9 range showing no apparent trends. Though the data showed volatile fluctuations, towards the end of the study, a steady strength rating of 7.667 was achieved.

Additionally, I examined average mood over time in order to discern whether or not habit formation had an actual effect on the mood of individuals in the group. Similar to the habit strength, the mood of the participants also fluctuated within the 6 - 8 range. The mood fluctuated frequently, but within the last week of the study, the average mood leveled around the 7.5 - 8 range.

Furthermore, I used the data collected on the participant's age and compared it against the amount of water that they drank in order to understand if age played a role in helping to form a habit.

## Average mood over time

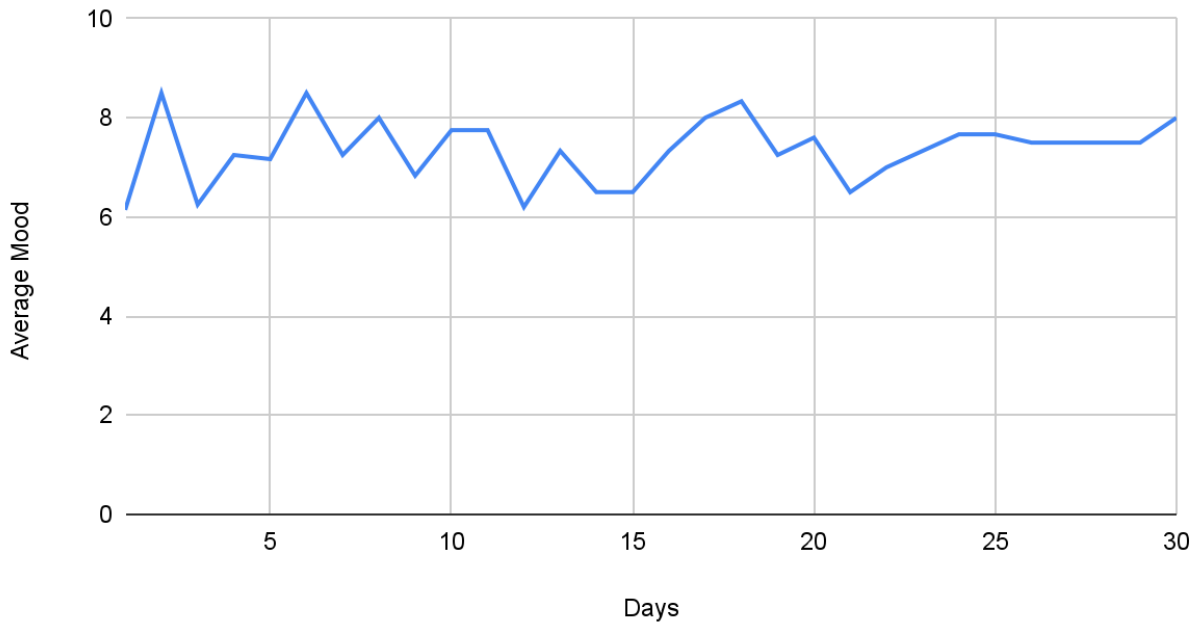


Figure 1. Line graph showing the change in average mood over time.

## Habit Strength Over Time

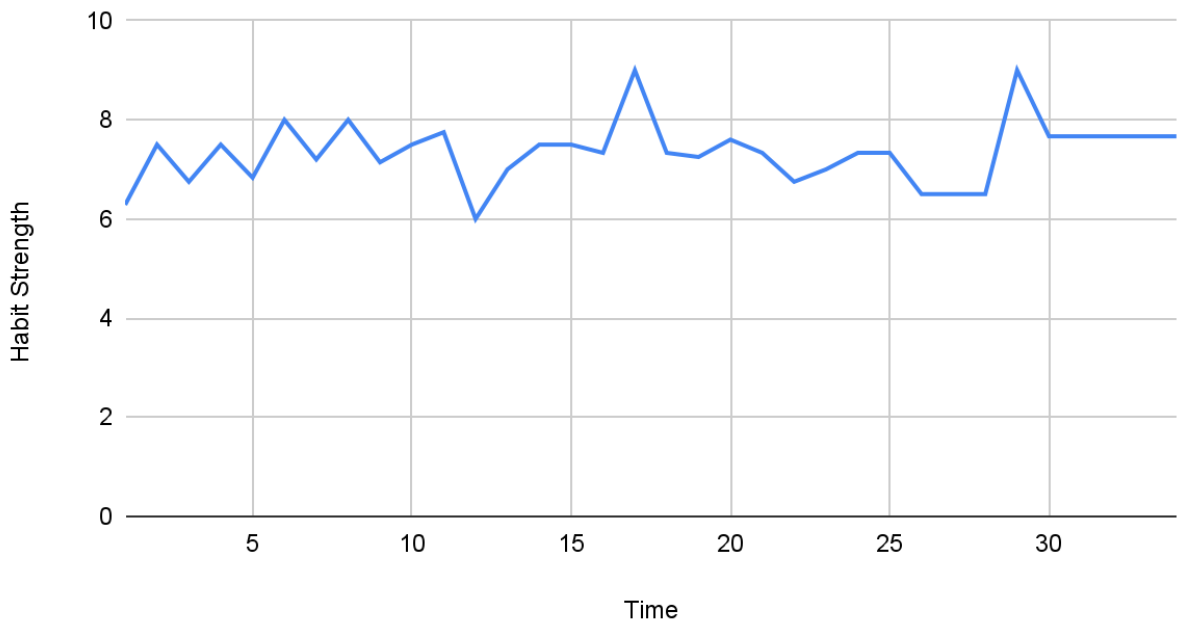


Figure 2. Line graph demonstrating the change in average mood over time.

## **Correlation**

Though the average habit strength and mood both fluctuate profusely among participants the data collected seems to be increasing steadily on both fronts. The data in both sets show similarities in their overall distribution but do not indicate any significant trends in terms of habit formation effects on mood.

## **Discussion**

When making commitments to long-term goals that involve the formation of a new habit, people don't often think about the effect that it will have on their mood. Focusing specifically on self-assessed mood over an extended period helped to determine the effect that forming a positive habit had on mood.

As can be seen, by the graphs, they both indicate no visible trends but do fluctuate a lot. This is possible due to the fact that the study was conducted over a short four-week period that would have needed to be extended in order to see more indicative trends. Research suggests that it can take 59 - 70 days until a new habit becomes automatic (Keller et. al, 2021 ). Additionally, it is possible that the reason there were no visible trends is that the participants had formed a habit within the form itself to enter the same number on the 1 - 10 scale each time that they opened the form. Rather than forming a habit in their daily drinking patterns, they formed a habit surrounding the data that they reported. This would have caused the data collected to remain relatively stagnant over the course of the study.

Though the data does not indicate any significant trends, it does add to the large body of evidence supporting the habit formation strategies that I helped participants to incorporate. As previously mentioned average habit strength fluctuated, however, the range in which it fluctuated was relatively high (the 6 - 8 range). Hence, it can be said that the strategies that I instructed participants to adhere to (those specified by existing research) are also supported by my findings. Additionally, the findings in the experiment performed by Carden and Wood also yielded a negative conclusion, as their data did not support their original hypothesis that habit formation is facilitated by self-control capacity. Their conclusions can be further extended to say that self-control capacity in the pursuit of habit formation does not have an effect on mood either based on my findings (assuming their conclusions are accurate).

Future research consisting of an experiment with the aim to habit formation and its effects on mood that use self-assessed habit strength and self-assessed mood should ensure that they carry the experiment out over a 59 - 70 day period as instructed in (Keller et. al, 2021). This would ensure the highest likelihood of the formation of a habit and would provide unskewed data surrounding participants' moods. Future research looking to discern a relationship between habit formation and mood could also recruit participants that already desire to form a certain habit and then give them strategies to do so and track their mood.

To conclude, this study was the first to track the role of positive habit formation on self-assessed mood in a longitudinal field experiment.

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# Graphene Superconductivity. An Introduction to the Variability of Superconductivity of Graphene By Valeriia Tsoi

## Abstract

Carbon based nanomaterials have been in the center of many researchers' attention because of their possible application and nonstandard physical and chemical properties that could also enable further research in other areas. This paper will discuss conductive properties of graphene in particular to assess the implications of the discoveries of its super- and ultra-conductive properties to the industrial processes and development of quantum computers.

Two phenomenon, 'magic-angle' and embedment of graphene in metals, are generally explained and compared through the bandgap theory and graphene's structure. The main difference between these are the permanence of the conductive properties and the degree of conductivity. While 'magic-angle' makes graphene superconductive under certain angle that can be easily 'switched on and off', the embedment simply increases the conductivity of metals in several times. Both require high quality materials which complicates the scaling of the production.

## 1. Introduction–What is carbon

Overview Carbon is a non-metallic chemical element. There are two stable isotopes of Carbon – Carbon-12 and Carbon-13. Due to carbon formation during star fusion in stars, Carbon-12 is the most abundant isotope and composes 98.93% of Carbon on Earth. Carbon-12 consists of 6 electrons, 6 neutrons, and 6 protons.

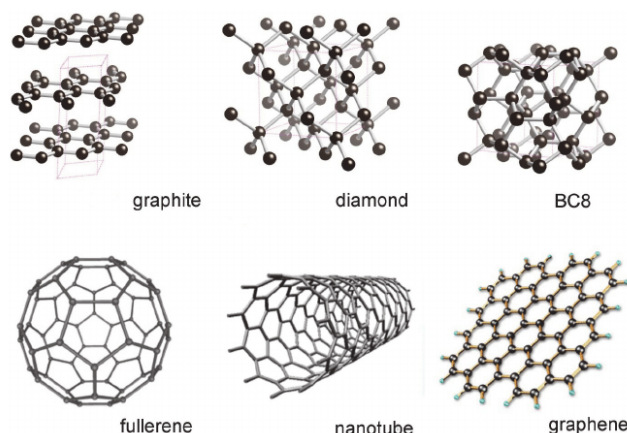
Another stable isotope Carbon-13 accounts for 1.07% in mass. It is used in NMR (nuclear magnetic resonance) spectroscopy. "NMR spectroscopy is a physicochemical analysis technique that is based on the interaction of an externally applied radiofrequency radiation with atomic nuclei. During this interaction, there is a net exchange of energy which leads to a change in an intrinsic property of the atomic nuclei called nuclear spin." (NMR Spectroscopy Principles, Interpreting an NMR Spectrum and Common Problems | Technology Networks) Carbon NMR is less sensitive. While Carbon-12 has a spin number of 0, Carbon-13 has a spin number of  $\frac{1}{2}$ . Therefore, Carbon-13 can resonate in the magnetic field. Carbon NMR is important in Organic Chemistry for molecule structure identification.

There are 14 other known radioactive isotopes, of which the most long-lived isotope is Carbon-14. Carbon-14 is used in radioactive dating to date fossils up to 50,000 years ago. Since carbon dioxide is absorbed by all plants and animals in the form of carbon dioxide. Inside the organism, the radiocarbon decays, but the decayed amount is replenished by the absorbed carbon dioxide once again. After death, however, the organism stops absorbing carbon dioxide, but the decay continues. The amount of the left Carbon-14 allows scientists to calculate the age of the body. (Carbon-14 Dating | Definition, Method, Uses, & Facts | Britannica)

Although carbon is only the 19th in order of abundance in Earth's crust, it produces more compounds than any other element. It is an indispensable element in the environment, and its compounds are included in such natural objects as corals, common minerals, gas, etc.

Key property Carbon is the main element in organic compounds thanks to its electron configuration that allows carbon atoms to form covalent bonds with other carbon atoms. In general, organic compounds are not electrolytes, and, therefore, cannot conduct electricity. However, there are several known allotropes of carbon: diamond, graphite, fullerenes (C<sub>60</sub>, C<sub>540</sub>, C<sub>70</sub>), amorphous carbon, carbon nanotube, and graphene. In the late 2010s, it was discovered that graphene could perform as a conductor under certain conditions or enhance the conductive abilities of the metals.

Figure 1. Carbon allotropes (Carbon | Facts, Uses, & Properties | Britannica)



Fundamental structure Carbon has 2 naturally occurring allotrope forms: graphite and carbon. There are other discovered forms: fullerene (a ball-like arrangement of atoms forming hexagons and pentagons), graphene (a monolayer of graphite), and nanotubes (cylindrical sheets of graphite). They have different properties due to their dissimilar structures.

In this paper, we will focus on solid carbon, since it is the most relevant form, and review why graphene can conduct electricity, unlike most carbon compounds. The findings of magic-angle and metal embedment will be mostly discussed with reference to their application and manufacturing methods.

## Structure

Atomic orbital structure Carbon has  $1s^2 2s^2 2p^4$  electron configuration. Hence, it can form 3 different hybrids:  $sp^3$ ,  $sp^2$ ,  $sp$ .

Graphene structure Graphene has a structure of mono-layer graphite; it is a layer of carbon atoms connected in a hexagonal lattice. Atoms have  $sp^2$  hybridization and form perfect hexagons (in perfect a graphene sheet). Thanks to the angle of  $120^\circ$  and the shortness of bonds (1.42 Å), graphene has an ultimate tensile strength of 130 GPa compared to 0.4 GPa of structural steel. Only three electrons are forming bonds, leaving the fourth valence electron delocalized. This delocalization is the reason behind graphene's conductive properties.

Production. At present, the most common method for producing graphene is the mechanical exfoliation of graphite, which is time-consuming and expensive. The chemical vapor



deposition (CVD) technique has also been developed to synthesize graphene, but it requires expensive equipment and high-temperature conditions, which significantly increase the production cost.

Recently, researchers have offered new synthesis methods for graphene, but they have their remaining challenges (Ho Choi et al.).

### **Superconductivity– Introduction**

Conductivity. Electrical conductivity refers to the degree to which a material can conduct electricity. It depends on factors, like available charge carriers, the valence, and the temperature of the material.

Conductors are used in the production of wires, plugs, lightbulbs, and other electrical devices. Whereas isolators are used in producing switches, disconnectors, or isolating specific areas of the system for repairs. All modern processes depend on them.

### **Regular Conductivity**

In metals, atoms are arranged closely together in a regular pattern, and electrons are charge carriers. Electrons are delocalized and can move chaotically; if they move in the same direction the current is created. Although graphene is not metal, carbon atoms have delocalized electrons that can move once the voltage is applied.

### **Bandgap Theory**

Bandgap theory is a model of how the conductivity of conductors, semiconductors, and insulators can be explained. It can also help us explain why graphene has superconductive properties.

When two atoms form a bond, they form a molecular orbital. Overlapping orbitals separate into two energy quantum states. In solids, atoms combine their electron densities to form continuous bands. In metals, these bands overlap, meaning that any electron can move from valence to the conduction band (see Figure 3). In insulators, there is a bandgap in energy, so for valence electrons, it is very energy-consuming to move to the conduction band. Semiconductors have a smaller band gap, so electrons can overcome Fermi energy and become conductive if energy is applied.

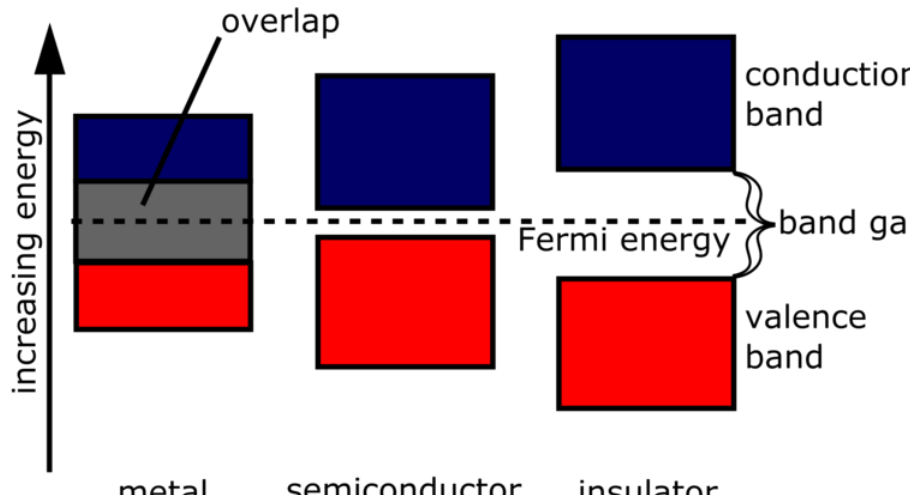


Figure 3. A band gap diagram (Band Gap - Energy Education)

### Superconductivity

Superconductivity is the ability of certain materials to conduct direct current with zero energy losses, i.e., zero resistance when cooled below the critical temperature (for most materials between 0 and 10K). One of the key properties of superconductors is the exclusion of magnetic fields, a phenomenon called the Meissner effect. Therefore, superconductors are mainly used for producing powerful electromagnets.

### Key features of graphene–Insulator/Conductor switch

A recent study (Y. Cao et al.) has demonstrated that graphene can act as both the insulator – a state when the electron flow is completely blocked – and a superconductor – a state when electrons can move with no resistance. The switch between two states is the application of the voltage. Furthermore, the critical temperature is unconventionally high (most known superconductors have critical temperatures close to absolute zero),  $T_c = 1.7$  K.

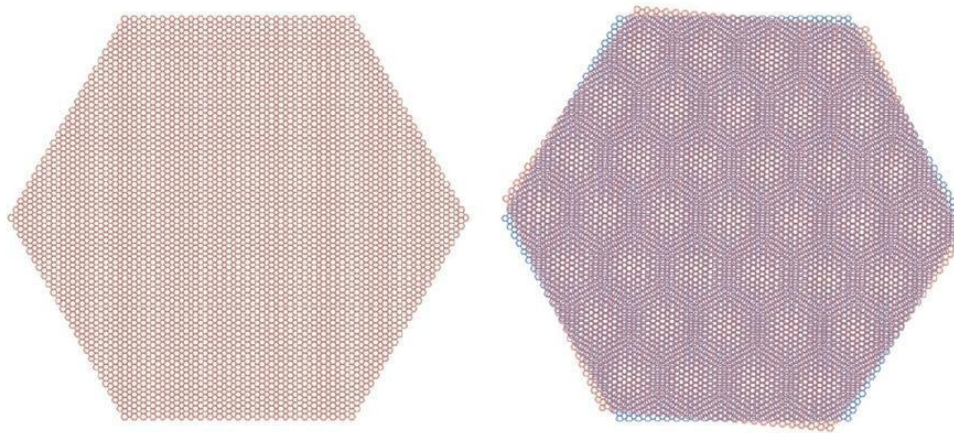


Figure 4. "Superlattice" of two graphene sheets (Insulator or Superconductor? Physicists Find Graphene Is Both | MIT News | Massachusetts Institute of Technology)

According to Jarillo-Herrero, the leader of the team that researched the magic angle of graphene, a superconducting transistor can be extensively used in quantum devices, like MRI scanners for medical imaging, lasers, or masers. (Insulator or Superconductor? Physicists Find Graphene Is Both | MIT News | Massachusetts Institute of Technology)

### **Core mechanism: magic angle**

The structure created by the moiré pattern (interference of two similar patterns with transparent gaps) between two layers of graphene exhibits superconductive properties when the layers are twisted by the “magic angle”.

When two layers of graphene are stacked, their hybridization also results in the “fundamental modifications to the low-energy band structure depending on the stacking order (AA or AB stacking)”. At the twist of the special angles, where Fermi energy reaches zero, the energy bands near charge neutrality become “remarkably flat”, i.e., the orbitals almost do not overlap and become thin. Once the energy bands are flat, the system becomes independent of the momentum and some unexpected irregularities can happen.

### **Embedding Graphene in Metals–Introduction**

Researchers (M. Cao et al.) have suggested embedding the graphene layer in metals to overcome the trade-off between carrier density and carrier mobility and increase the conductivity of the metals (Cu, Al, and Ag).

High-purity copper with fewer grain boundaries exhibits higher conductivity. However, due to its structure, mechanical properties, and production cost, it is harder to apply it.

## Manufacturing

To improve the mechanical and electrically conductive properties, a method to embed a non-metal conductor into a metal-conductor is described as ‘an excellent idea’ by researchers.

Theoretically, introducing 20-30% volume of carbon nanotubes into the metals would increase the conductivity by 100%. However, the mass manufacturing of such an intricate structure is a practical problem. Although graphene has high electron mobility and relatively low electron density thanks to graphene  $sp^2$  hybridization and a single unpaired electron, it is hard to produce it in a macroscopic bulk.

Samples were produced by depositing monolayer graphene on both sides of a commercial Cu foil via the CVD process. The graphene/copper composites are later produced by stacking the and hot-pressing layers of Gr/Cu/Gr foils. This method allows control of the sample thickness by the number of the foils stacked. The CVD process synthesizes high-quality graphene, and hot pressing creates a strong mechanical bond between a monolayer of graphene and a copper foil. However, because there is no method to use the CVD process on a larger scale, the production of such interfaces is also limited despite its low volume percentage.

The result is said to be dependent on the quality of the metal rather than of the graphene (M. Cao et al.), so lower quality and cheaper graphene can be used. Nonetheless, further research into the combinations of different quality metals and graphene would help to identify the most cost-efficient quality of the materials.

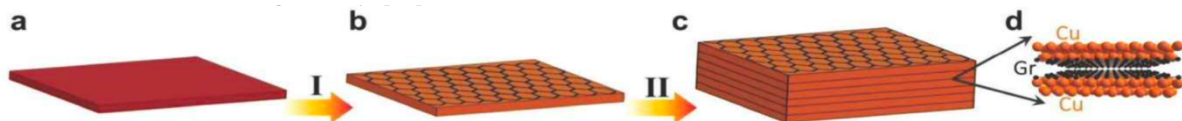


Figure 5. a) pristine Cu foil b) Gr/Cu/Gr foil (CVD Cu) c) Gr/Cu composite d) Cu/Gr/Cu interface (M. Cao et al.)

## Application

Such a system can be used in electrical devices. The cost of production is highly dependent on the production of graphene. Even the development of the lower quality method to produce graphene might not decrease the price because the CVD process also insures the spreading of the monolayer graphene on the metal foil.

## Conclusion

This paper has discussed recent developments in the research of graphene and possible new topics of research including the industrialized method of devices based on graphene’s super- or ultra-conductive properties. While the phenomenon of the magic angle can be used as a ‘switch’ to turn on and off the superconductivity, the embedment of graphene in metals makes them permanently ultra-conductive. Overall, both magic angle and metal embedment can be used

in precise electric devices to expand the limits of contemporary research. Despite the discovered super- and ultrahigh conductive properties, the cost of production is still a problem to address in future research. While some researchers have theorized new possible methods of synthesis, they are to be experimentally tried.

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# Assessing the Impact of India's Digital Initiatives in Schools on Retention Rates By Aanya Iodha

## Introduction

Literacy a person who can both read and write with understanding in any language (Know India, 2020). The percentage of adults over the age of fifteen who are literate is known as the literacy rate. As of 2019 to 2021 data, India's literacy rate is 77.95%, with literate males at 84.4% and literate females at 71.5% (*National Family Health Survey [NFHS-5]*, 2021). This is an improvement from the 2011 Census (conducted every 10 years) that revealed that the literacy rate (measured by the percentage of people over the age of seven) in the country is 74.04%, respectively 82.14% for males and 65.46% for females (Know India, 2020). According to the 2011 Census, Kerala showed the highest literacy rate in India at 93.91%, while Bihar ranked lowest with a rate of 63.82%. However, the overall literacy rate in 2011 improved from the following 2001 literacy rate in India, which stood at 64.80% (Know India, 2020). Despite the upwards trajectory, the disparity between men and women remains, especially in rural areas; the ratio of male-to-female Internet users in Urban India is 57:43, whereas respectively it is 58:42 in Rural India (Kantar, 2021). This can be attributed to the gender discrimination, economic inequality, caste discrimination, and technological barriers that lead to illiteracy in India, as noted by Oxfam's "Determinants of Digital Divide" (Oxfam India, 2022).

Digital initiatives are taking over the classroom as tools for both teaching and learning. According to UDISE+ reports, the government measures schools for their availability of 6 essential yet functional digital initiatives in the classroom: Internet Facility, Desktops/PCs, Integrated Teaching Learning Devices, Projector, Digital Library, and ICT/ICT Labs (*UDISE+ 2021-22 Report*, 2022).

The digital divide, as defined by the OECD, refers to "the gap between individuals, households, businesses and geographic areas at different socio-economic levels with regard to both their opportunities to access information and communication technologies (ICTs) and to their use of the internet for a wide variety of activities" (OECD, 2001). According to the ICUBE 2020 report by IAMAI and Kantar, the number of Indians who accessed the internet was 622 million of the 1.4 billion population in 2020 (Kantar, 2021). Furthermore, a large gender disparity in internet usage is shown in the NFHS-5 report, suggesting that, on average, only 57.1% of the male population and 33.3% of the female population used the internet between 2019 to 2021 (*NFHS-5*, 2021). Reinforced by the NFHS-5 report, the gender gap is worsened for rural households wherein 48.7% of rural males and 24.6% of the rural females qualify as internet-users. Moreover, with the ever-increasing need for digital connectivity during the Covid-19 pandemic, the lack of digitalisation remains a key concern for India's growing population. The Digital Divide amongst different income groups of students is highlighted in the Oxfam Report, which says that "only about 9% of the students who were enrolled in any course had access to a computer with internet" (Oxfam India, 2022). However, the trend goes beyond education to other sectors, like telemedicine, banking, e-commerce, e-governance, which all only

became accessible via the internet during the lockdown (Oxfam India, 2022). The primary reason behind the digital divide stems from the lack of affordability as a result of income differences, and the inability to reap the full benefits of technology due its complexity.

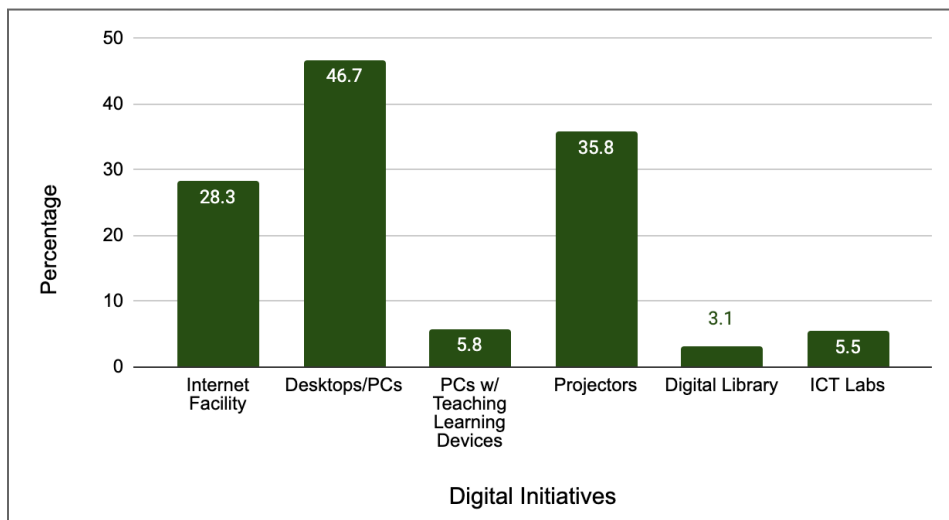
### Retention rate

The retention rate provides the percentage of students enrolled in their current year of education given that they have completed the previous year. This gives an indication of how many students drop out before completing a particular year of education. According to UDISE+ Indian government data from their 2021-22 report, data is presented separately for students in primary (Grades 1-5), elementary (Grades 1-8), secondary (grades 1-10), and higher secondary (Grades 1-12) levels.

### Methodology

The aim of the paper is to Assess the Impact of India’s Digital Initiatives in Schools on Retention Rates. To achieve this, the UDISE+ 2021-2022 report was used to select 6 relevant digital initiatives: Internet Facility, Desktops/PCs, Integrated Teaching Learning Devices, Projector, Digital Library, and ICT/ICT Labs. The availability (in percentage) of each initiative in government schools for 35 States and Union Territories was compared amongst the top 5 and bottom 5 states, with an additional spotlight on Maharashtra. Every state’s percentage of a specific initiative was then correlated to each state’s respective retention rate to yield the degree of correlation. Furthermore, a linear regression was run of all 6 initiatives against the retention rate to determine the coefficients, standard of error, the t value, and the p value to determine which digital initiative is found to be correlated with retention rate. The paper will also analyse existing policy and schemes for relevant digital initiatives to make recommendations, and investigate hurdles faced by states.

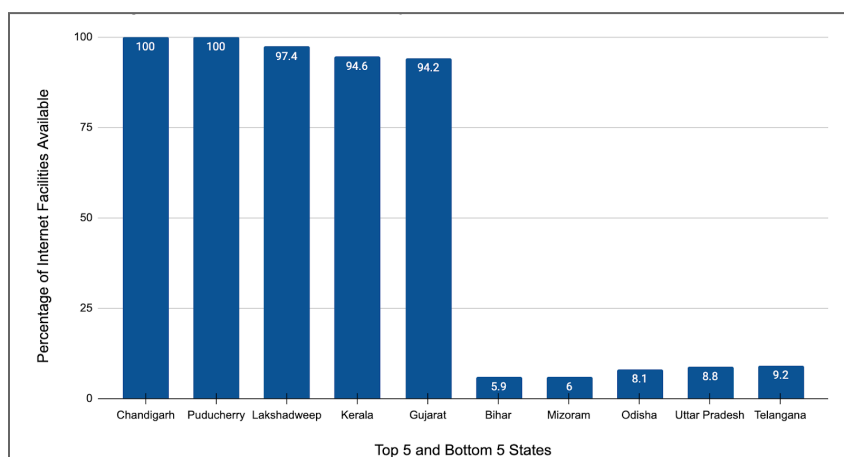
### Results





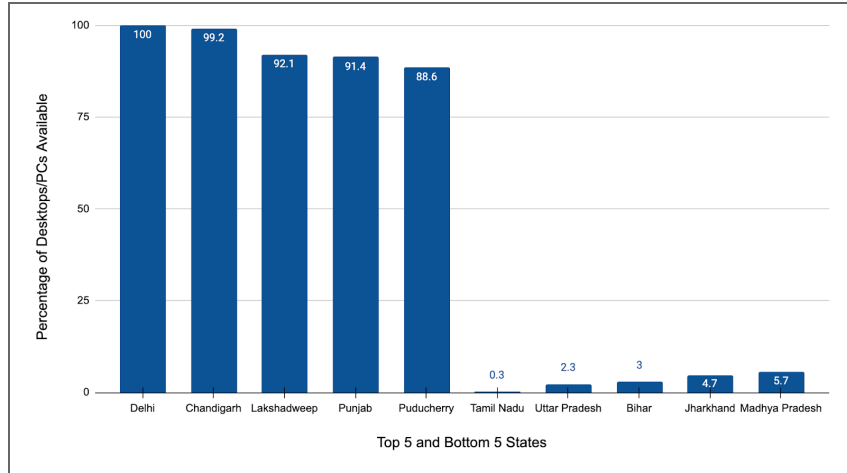
**Figure 1:** Graphical representation of percentage of digital initiatives in Maharashtra

In figure 1, one can see the percentage of digital initiatives installed in Maharashtra as reported in UDISE 2021-22. The average percentage of Internet Facilities across 35 States and Union Territories is 37%, which Maharashtra falls below by 8.7 percentage points. The mean for Desktops/PCs is 33%, which Maharashtra exceeds in performance at 46.7%. For PCs with Teaching Integrated Learning Devices, the mean is 7.4% whilst Maharashtra underperforms at 5.8% availability. The mean for Projectors is 22.9%, which Maharashtra exceeds by 12.9 percentage points. The mean for Digital Libraries is 2% while Maharashtra has 3.1% availability. Finally, the mean for ICT Labs across all states is 31.6%, in which Maharashtra lowly ranks at 5.5%.



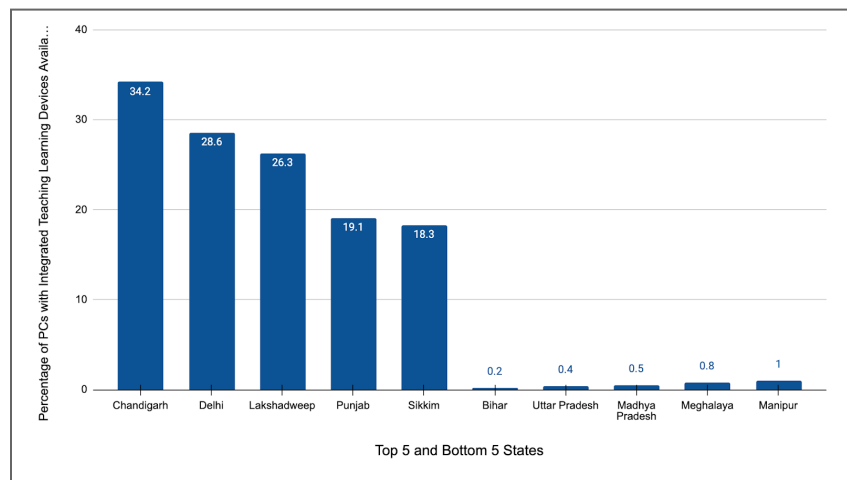
**Figure 2:** Graphical representation of availability of Internet Facilities in top 5 and bottom 5 states in India as reported in UDISE 2021-22

In figure 2, one can see the top 5 states that perform best in the percentage of Internet Facilities available in government schools, and the bottom 5 states that perform worst. Amongst the top 5, Chandigarh and Puducherry both rank at first place with 100% availability, followed by Lakshadweep, Kerala, and Gujarat. The bottom 5 include Telangana, Uttar Pradesh, Odisha, Mizoram, and Bihar with lowest percentage. The average percentage of Internet Facilities available across 35 States and Union Territories is 37%.



**Figure 3:** Graphical representation of availability of Desktops/PCs in top 5 and bottom 5 states in India as reported in UDISE 2021-22

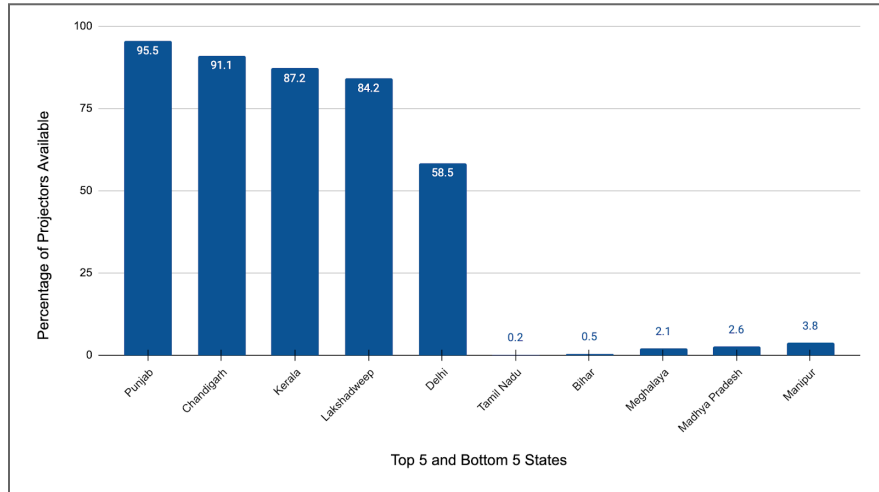
In figure 3, one can see the top 5 states that perform best in the percentage of Desktops/PCs available in government schools, and the bottom 5 states that perform worst. Amongst the top 5, Delhi ranks first with 100%, followed by Chandigarh, Lakshadweep, Punjab, and Puducherry. The bottom 5 include Madhya Pradesh, Jharkhand, Bihar, Uttar Pradesh, and Tamil Nadu with the lowest percentage of 0.3%. The average percentage of Desktops/PCs available across 35 States and Union Territories is 33%.



**Figure 4:** Graphical representation of availability of PCs with Integrated Teaching Learning Devices in top 5 and bottom 5 states in India as reported in UDISE 2021-22

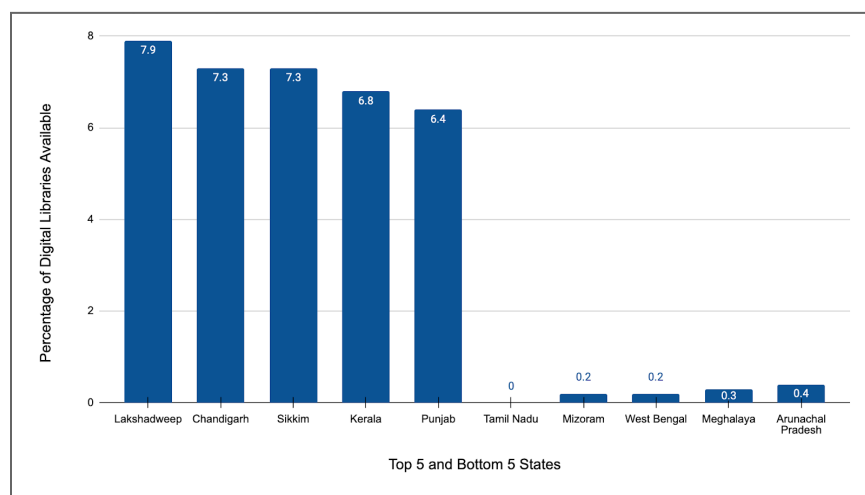
In figure 4, one can see the top 5 states that perform best in the percentage of PCs with Integrated Teaching Learning Devices available in government schools, and the bottom 5 states that perform worst. Amongst the top 5, Chandigarh ranks first with 34.2%, followed by Delhi, Lakshadweep, Punjab, and Sikkim. The bottom 5 include Manipur, Meghalaya, Madhya Pradesh,

Uttar Pradesh, and Bihar with the lowest availability of 0.2%. The average percentage of PCs with Integrated Teaching Learning Devices available across 35 States and Union Territories is 7.4%.



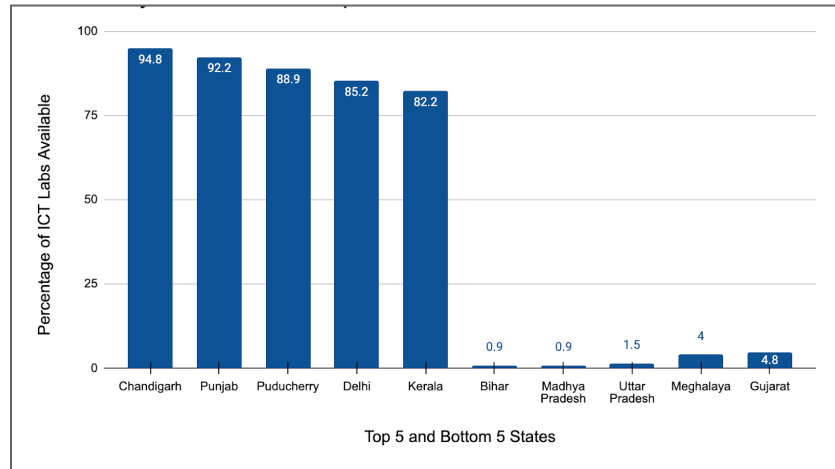
**Figure 5:** Graphical representation of availability of Projectors in top 5 and bottom 5 states in India as reported in UDISE 2021-22

In figure 5, one can see the top 5 states that perform best in the percentage of Projectors available in government schools, and the bottom 5 states that perform worst. Amongst the top 5, Punjab ranks first with 95.5%, followed by Chandigarh, Kerala, Lakshadweep, and Delhi. The bottom 5 include Manipur, Madhya Pradesh, Meghalaya, Bihar, and Tamil Nadu with the lowest availability of 0.2%. The average percentage of Projectors available across 35 States and Union Territories is 22.9%.



**Figure 6:** Graphical representation of availability of Digital Libraries in top 5 and bottom 5 states in India as reported in UDISE 2021-22

In figure 6, one can see the top 5 states that perform best in the percentage of Digital Libraries available in government schools, and the bottom 5 states that perform worst. Amongst the top 5, Lakshadweep ranks first with 7.9%, followed by Chandigarh, Sikkim, Kerala, and Punjab. The bottom 5 include Arunachal Pradesh, Meghalaya, West Bengal, Mizoram, and Tamil Nadu with the lowest availability of 0%. The average percentage of Digital Libraries available across 35 States and Union Territories is 2%.



**Figure 7:** Graphical representation of availability of ICT Labs in top 5 and bottom 5 states in India as reported in UDISE 2021-22

In figure 7, one can see the top 5 states that perform best in the percentage of ICT Labs available in government schools, and the bottom 5 states that perform worst. Amongst the top 5, Chandigarh ranks first with 94.8%, followed by Punjab, Puducherry, Delhi, and Kerala. The bottom 5 include Gujarat, Meghalaya, Uttar Pradesh, and Madhya Pradesh and Bihar which both hold the lowest availability of 0.9%. The average percentage of ICT Labs available across 35 States and Union Territories is 31.6%.

**Table 1:** Correlation analysis between each digital initiative and retention rate ( $N = 35$ )

		Retention Rate
Internet Facilities	Correlation	0.632
	P (2-tailed)	0.000047
Desktops/PCs	Correlation	0.623
	P (2-tailed)	0.000064

PCs with Integrated Teaching Learning Devices	Correlation	0.601
	P (2-tailed)	0.000135
Projectors	Correlation	0.669
	P (2-tailed)	0.000011
Digital Libraries	Correlation	0.523
	P (2-tailed)	0.001276
ICT Labs	Correlation	0.739
	P (2-tailed)	0.00001

Note: statistically significant when  $P < 0.05$

Each of the following digital initiatives—Internet Facilities, Desktops/PCs, PCs with Integrated Teaching Learning Devices, Projectors, Digital Libraries, and ICT Labs—was found to be positively correlated with retention rate. R values between 0.60 to 0.79 classify as having a fairly strong positive correlation, as seen with all digital initiatives besides Digital Libraries, which only has a moderate positive correlation owing to a lower R value of 0.523. For all digital initiatives, the P (2-tailed) value is less than 0.05, therefore proving to be statistically significant to have a correlation with retention rate.

**Table 2:** *Summary of linear regression analysis for digital initiatives on retention rate*

Source	B	SE B	t	p
Internet Facilities	-0.1724	0.2184	-0.7895	0.4362
Desktops/PCs	0.2178	0.1658	1.314	0.1992
PCs w/ Teaching Learning Devices	0.01257	0.6418	0.01959	0.9845
Projectors	0.2296	0.3125	0.7347	0.4684
Digital Libraries	-0.7977	2.479	-0.3218	0.7499
ICT Labs	0.4458	0.1699	2.624	0.01371

R <sup>2</sup>	0.5909
Significance F	0.0001149

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\*P < 0.05      B = coefficients  
                     SE B = standard error

A linear regression analysis was conducted to assess the effect of digital initiatives on retention rate. Five out of six initiatives were found to be statistically insignificant, being Internet Facilities, Desktops/PCs, PCs with Integrated Teaching Learning Devices, Projectors, and Digital Libraries. ICT Labs was found to be statistically significant, due to its P value 0.01371 being less than 0.05. Therefore, no association can be found between digital initiatives and retention rate; however, there is a correlation between ICT Labs and retention rate.

### Discussion

From the graphs reported above (Figure 2 to Figure 7), Bihar appeared in 5 out of the 6 graphs amongst the bottom 5 States with the least percentage of digital initiative available. On the contrary, Chandigarh appeared in all 6 graphs in the top 5 States that rank highest in the respective digital initiative. Furthermore, the greatest percentage of Digital Libraries available in any state is in Lakshadweep with 7.9% availability, which is relatively low compared to other initiatives like Internet Facilities where two states (Chandigarh and Puducherry) both have 100% availability. Finally, Internet Facilities are the most installed initiative across all states judging by the greatest average of 37%, compared to Digital Libraries with the lowest average of 2%. As seen from Table 2, the aforementioned variable found to be associated with retention rate is ICT Labs.

### ICT Labs and Maharashtra

For the digital initiative ICT Labs, Maharashtra happens to underperform by 26.1 percentage points, with a rate of 5.5% compared to the India average of 31.6% across 35 States and Union Territories.

ICT stands for Information and Communication Technology, consisting of a desktop monitor or desktop with a processor, keyboard, and mouse, a projector, a display screen, and an interlinked sound system. However, in 2019, the Ministry of Human Resource Development (MHRD) introduced a new form of technology for classrooms: tablets, laptops, integrated teaching learning devices, notebooks, charging racks, and more under the revised ICT Lab Scheme (*Draft Framework...*, 2018). Therefore, each government school may not pass every checkbox mentioned in the framework by MHRD, but may only have one of the many digital initiatives in their ICT Labs. This means that overall, ICT Labs seem to be the most important initiative that connects the others. The Rashtriya Madhyamik Shiksha Abhiyan [RMSA] is a

scheme under the larger Samagra Shiksha Abhiyan programme to enhance access to secondary education and improve its quality, with ICT Labs remaining a large focus within this (*About Samagra Shiksha*, 2018).

### **Challenges of ICT Labs**

There are a number of barriers with installing completely functional ICT Labs, which Maharashtra may also face owing to its low percentage of instalment. Two of the major problems will briefly be explored below.

#### **Lack of Motivation Owing to Complicated Hardware**

Unstable or lack of electricity, unreliability of equipment, not using up-to-date hardware and softwares, lack of technical support and other resource related issues plague most government schools (Kumar, 2015). Therefore, despite the instalment of ICT Labs, they are usually unused or non-functional.

A 2018 research report by Vikram Singh in schools of Bihar Shows that when asked about how many times the students use ICT Lab in a week, 72.04% students reported that they never use ICT labs. There are still 54.60% of students who don't use ICT Lab irrespective of its existence in the schools (Singh, 2018).

#### **Lack of Competent Computer Teachers in Schools**

A majority of schools either do not have computer teachers or they lack the right kind of knowledge required to operate the ICT lab, according to remarks made by students in Singh's report (Singh, 2018). This lack of skill translates to why teachers are not motivated, and henceforth their students remain unmotivated to learn from ICT labs or understand its merit. As reported by Singh, 93.47% students answered 'no' when asked whether their computer teacher encouraged them to learn computers, compared to 6.52% that said 'yes' (Singh, 2018).

### **Conclusion**

It is clear that ICT Labs remains the most important digital initiative through the work done by MHRD, and thus proven through this report to be the only statistically significant correlated factor to retention rate.

As mentioned in the 'ICT Labs and Maharashtra' section of this paper, the MHRD did a revamp of all its school education programs, including integrating ICT Labs into the RMSA program (RMSA, 2020). The scheme's clear recommendation to tackle the issue of hardware complexity and student motivation is by using tablet-based ICT Lab systems which come with lockable charging racks for the tablets. These racks are not dependent on 24 hour electricity supply and the tablets are also very easy to operate, and thus do not require as much assistance as

PCs/Desktops. Furthermore, another problem with the additional setting up of furniture and blocking a room is eased with Tablet-based instalments of ICT Labs (*Draft Framework...*, 2018).

The revamped guidelines also suggest that a more reliable power supply can be procured through solar power panels. And, when not feasible, generators may be used on a temporary basis (*Draft Framework...*, 2018).

### **Limitations**

This paper relied on UDISE+ data, under the Department of School Education & Literacy, Ministry of Education, which releases annual reports since 2018, extensively reporting on each State and Union Territories education-related statistics, breaking down further through gender, type of school (government, government-aided, private, etc.), and more. This data was used to draw correlations and regressions for retention rate and each digital initiative.

However, despite correlations drawn between each initiative and the retention rate, there are a plethora of other factors that contribute to retention rate, arguably much more than installed digital initiatives. Therefore, the relationship between retention rate and ICT Labs has been found purely on a mathematical basis without considering other factors that are involved in determining a large indicator like retention rate.



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# **Overcoming Limitations of 40 Hertz Stimulation for Treating Alzheimer's Disease**

## **By Grace Ding**

### **Abstract**

Alzheimer's Disease (AD) is a neurodegenerative disease that progressively destroys mental functions and is associated with a buildup of the proteins beta-amyloid and tau within the brain. It is most well known for its severe symptoms such as memory loss, as well as the high prevalence at which it occurs in elderly populations. Currently, one of the only promising treatments available is to provide light and sound stimulation at a frequency of 40 Hz. While this treatment has been shown to improve cognitive function in patients, there are several complications limiting its effectiveness. For example, one such issue is that multiple patients experienced side effects that caused them to prematurely quit the treatment. Another issue is that the device sometimes did not produce visible changes within brain structures which could potentially indicate that the treatment was not effective. Lastly, one study found that over time, patients demonstrated a diminished response to the stimulation. Overcoming these challenges will be necessary to allow 40 Hz therapy to be a much more effective treatment. Some examples of potential strategies to settle these issues include changing dosage, changing the time exposed to treatment, and modifying the device providing the treatment itself. It is also important to determine the reason behind the limitations, as it can lead to a much more educated approach to fixing them. Overall, it is important to resolve these complications as they may impact the effectiveness and reliability of 40 Hz treatment, which can help many people with AD.

### **Introduction**

Currently, Alzheimer's Disease (AD) affects approximately 6.5 million people by impairing their brain functions over time (Anon n.d.). Although there are hundreds, if not thousands, of scientists around the globe researching AD at once, there are currently no effective treatments. However, there are many promising leads, one of which is called 40 Hz treatment, otherwise known as gamma entrainment using sensory stimuli, or GENUS (Alzforum). Summarized, 40 Hz stimulation is when a person's eyes and ears are exposed to light at 40 flashes per second and sound at 40 cycles of a certain wavelength per second. At the moment, organizations focused on this promising treatment have developed devices and are running clinical trials to determine whether or not the stimulations is effective. However, these trials have a number of key flaws: the treatment became less effective over time, one study demonstrated no change in plaque levels, and a plethora of side effects. In this paper, I propose fixing these issues through different methods that currently have not been tested yet.

### **Alzheimer's Disease: an Overview**

Alzheimer's disease (AD) is a common disease that progressively worsens as a person ages. There are four stages of AD, ranging from preclinical to severe as a person's mental state deteriorates. AD is most visibly recognizable an abnormal amount of plaques and tangles, which

are buildups of the proteins beta-amyloid and tau within the brain (Anon n.d.). These buildups usually begin occurring within the preclinical stage. However, it is currently unknown whether these buildups are the cause or an effect of AD. The disease also destroys the neurons throughout the brain as it progresses, starting with the parts of the brain responsible for memory. Microglia, which are immune cells in the brain, also experience a decrease in their clean-up duties due to AD, which in turn allows beta-amyloid to build up. They also release harmful chemicals that further damage the brain (Anon n.d.). It is possible for AD to be familial from mutations in the amyloid precursor protein gene, the presenilin gene, and the presenilin 2 gene (Piaceri et al.). However, most diagnosed AD is sporadic (Piaceri et al.).

#### **40 Hertz Stimulation**

Summarized, 40 Hz therapy is the repeated stimulation of a person's eyes and ears with light and sound at 40 flashes/second. This treatment targets the gamma waves located in the brain. These fast waves are also associated with many important brain functions. It is thought that by using a high frequency of continuous neural oscillations, the brain will also begin producing waves with similar frequencies (Alzforum). These neural oscillations, which are rhythmic electrical impulses, will lead to the same frequencies in parts of the brain and therefore increasing the brain functions (Chen et al.). It may also stimulate microglia to clear out beta-amyloid plaques, although it is unclear whether a decrease in plaques would help a patient (Iaccarino et al.). 40 Hz stimulation also reduces neuroinflammation, which is associated with AD (Anon n.d.). Multiple studies also state that the stimulation increases participants' score on memory tests and other brain functions, leading scientists to believe that 40 Hz treatment causes neuronal connections to strengthen (Alzforum).

#### **Limitations of 40 Hertz Therapy**

There are multiple issues that limit the effectiveness of 40 Hz treatment. In this paper, I will be going into detail about each shortcoming, the studies they are from, and solutions to these issues. However, it is crucial to first acknowledge that all of these issues may be misrepresented by the small amount of studies done up to date. The use of placebos is also important, as it is possible that certain effects reported are due to the imagination.

##### *Limitation #1: Side Effects*

One of the major limitations of 40 Hz treatment is the development of side effects. In two of the studies done so far by Cognito Therapeutics, one of the leading experts in 40 Hz stimulation, tinnitus, dizziness, headaches and worsened hearing loss were noted as side effects (Alzforum). The first study was an open label study called the Flicker study, which involved ten people with mild AD. Five of these people received an hour per day of both visual and audio stimulation for eight weeks, while the other five did only four weeks of stimulation. Both were at the highest intensity tolerable. During this study, two of ten people developed tinnitus, two others

experienced dizziness, while another two began having headaches. Another volunteer's hearing also worsened (Alzforum).

The second study, called the Overture study, was a Phase 2A trial with 76 people with mild to moderate AD (Alzforum). Although two people decided to not participate before the treatment began, the rest of the volunteers wore the Gammasense device, a device designed by Cognito, for an hour daily for six months. 28 people were given a placebo, while 46 were given the 40 Hz treatment. Although it was concluded that the product was safe, more participants on the real treatment experienced tinnitus than those with sham. 28% of each group also dropped out either due to disliking the treatment or experiencing side effects. Overall, the older control group did worse on the memory tests on average, demonstrating the effectiveness of the treatment (Alzforum).

## **Solutions**

In solving this issue, it is important first to note that these symptoms could be due to the placebo effect, especially in the Flicker open label study. With this factor, it will always be unclear whether symptoms are genuinely due to the treatment or a phantom feeling. One possible solution is testing whether a reduced duration/dosing regimen or reduced intensity may help diminish the side effects. Although it may concern some that a reduced duration/intensity will also reduce the positive effects on a patient's brain, it is unknown currently what is the most beneficial amount of exposure, so less intensity/duration may produce better results in the long term. However, these side effects may be affected by factors other than treatment, such as the comfort of the device or the quality of the speakers, so improving the device model itself may be a possible answer. Another solution to side effects may be to co-treat them with medications. For example, Tylenol may reduce headaches (Anon n.d.). Although it is preferred not to use any medicine, it is worth using a small amount of medicine if a person can regain their memory.

### *Limitation #2: No Reduction in Beta-Amyloid Plaque Levels*

Another major limitation within 40 Hz treatment is the lack of reduction in plaque levels. Although it is undetermined whether plaques are a cause or symptom of AD, the lack of change in amount of plaques is concerning as it could mean no changes in physical symptoms as well. Certain studies, such as one done by MIT on mice, state that amyloid loads decreased as well as more microglia were activated during their study (Iaccarino et al.). Within the studies, the research team applied auditory 40 Hz therapy to transgenic 5XFAD mice for a week. They concluded that the treatment reduced the amyloid load in the anterior commissure and the hippocampus of the mice. Tau was also reduced, while microglia were activated. However, multiple other papers concluded that amyloid loads did not change. For example, one study done at Aarhus University Hospital and Newcastle University state that there was no reduction in beta-amyloid levels within the brain, as well as the Flicker study discussed earlier (Ismail et al.).

However, there is an obvious possibility as well that 40 Hz stimulation does not affect plaque levels/microglia and only affects a different aspect of neuron health or brain function. In

other words, even if this treatment does not reduce all effects of Alzheimer's such as plaques, tangles, etc., if 40Hz stimulation can at least improve certain symptoms of Alzheimer's, such as improving brain function, then it would most likely still be worth it and considered successful. This treatment may also affect microglia instead of plaque levels over time which could be proved through longer studies.

### **Solutions**

First, it must be determined whether this result is accurate or not by performing more experiments and increasing the number of patients in the study. 40 Hz treatment could also be paired with another treatment that activates microglia, which could then clear up the excess beta-amyloid. For example, lipopolysaccharide, a key part of the outer membranes of thick-walled, or gram negative, bacteria, is a known activator of microglia (Farhana & Khan). By using lipopolysaccharide alongside 40 Hz treatment, plaques may be reduced at an increased pace through the activated microglia. However, lipopolysaccharide is a highly dangerous toxin, making it an unlikely treatment, but safer chemicals may be used to activate microglia and reduce beta-amyloid.

### *Limitation #3: Desensitization Towards Treatment*

The last and perhaps most significant limitation with 40 Hz treatment is the desensitization towards the treatment over time. Within the Flicker study, it is stated that gamma power within the brain did not change for the first four weeks of treatment, but after eight weeks, the power had weakened (Alzforum). However, the total amount of tau tangles and beta amyloid plaques both did not change as well, leading scientists to believe that the study was too small and short to produce significant and accurate results. No other studies reported this issue, although this could be due to the small total number of studies performed so far. I believe the reduced sensitivity to the treatment is due to the natural inclination towards homeostasis within the human body.

### **Solutions**

My hypothesis is that the brain tries to return to releasing slower waves over time after being used to being exposed to 40 Hz frequencies all the time; however, this must be tested before proven to determine how long it takes for a body to begin adapting to the treatment. It is also important to first determine which homeostasis mechanism, such as hormones or neurons, are causing the brain to adapt and reduce its gamma waves response over time. If the cause is homeostasis, it is possible to increase intensity or duration of exposure over time since by increasing dosage, the body must adapt to the new amounts, similar to certain drugs. Tolerance is built up as a person is exposed to a treatment more often, and by increasing dosage, the stimulation may remain effective. However, the increase in dosage may lead to more side effects, which makes using other medications more effective. There is a possibility that one's body may also adapt to the side effects, but it will take more studies to prove this hypothesis.

Another strategy is to stop the treatment for a certain “reset period” before returning to treatment. During the “reset period”, the brain may have a chance to return to its homeostasis before the treatment and once exposed to the treatment again will react accordingly. However, this solution depends on the amount of time it takes the brain to desensitize in the first place to determine how long the reset period is.

### **Conclusion**

By minimizing the potential risks and issues due to 40 Hz treatment, one can make the therapy much more effective. These solutions can allow for more widely available devices with a smaller percentage of patients unable to use the technology. This treatment may help millions of people all over the globe and may help reduce the symptoms of AD. It is important to allow elderly citizens to enjoy their life without the fear of forgetting those around them, which is why finding a solution to AD is very important and is constantly sought after.

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# **Reflections of Chinese-American Protestors on The Impact of Tiananmen Square on China Today By Natalie Song**

## **Introduction**

On June 4th, 1989, roughly one million Chinese individuals protested against the Chinese Communist Party, fighting for democracy and freedom in their economically, politically, and socially restricted country. However, with the long-term effects of the movement apparent 34 years later, how successful was the Tiananmen Square movement after all?

The primary purpose of this study is to determine how successful the Tiananmen Square protest was in achieving democracy and freedom by asking Chinese-American Tiananmen protestors to reflect on the change in government today. These protestors are important as they are most aware of the injustices of the previous government, they have longitudinal perspectives, and they can quickly determine if similar injustices occur in today's Chinese government.

Although multiple sources have detailed Tiananmen Square protestors' reasons for participation and their reflections on the movement at the time, virtually none have questioned whether these protestors perceive any change in the government today or investigated the long-term impact of these protests on Chinese society over time. Furthermore, no studies in my research have used interviews to do this.

Thus, the study seeks to fill that gap in knowledge by conducting interviews with Tiananmen survivors and asking, "To what extent do Chinese-Americans involved in the Tiananmen Square Protests believe the protests affected the Government today?" It finds that the Chinese government had improved towards but not entirely succeeded in achieving democracy and freedom. Specifically, China expanded the rights to free speech, allowed more Western influence, granted more economic and political freedom, and reduced corruption. However, it still restricts forms of speech, allows more economic than political freedom, and permits corruption. Moreover, whether Tiananmen Square has been entirely successful is deeply polarizing among protestors.

Thus, the impact of the Tiananmen Square movement is more complex than previously thought.

## **Context**

On June 4th, 1989, roughly one million Chinese students, workers, and citizens gathered on university campuses in Beijing and other cities across China to protest against the Communist Chinese Government (Schaffer & Smith, 2004). The movement occurred after the death of Hu Yaobang, the former General Secretary of the Chinese Communist Party. Hu, widely considered a political moderate, was removed from office after refusing to deal with demonstrators harshly. After his death on April 15, 1989, students gathered in Beijing to mourn, calling for his name and reputation to be cleared (Kovalio, 1991). However, the demonstration quickly expanded as citizens urged the government to accelerate economic and political reform, guarantee



constitutional freedoms, fight corruption, adopt a press law, and allow the establishment of privately run newspapers (Nathan, 2001).

They took this opportunity to question their government's shortcomings and demand more rights thanks to foreign influences including Western media and visits from European leaders. Massive direct reporting from China from April to June raised awareness for political freedom, supplying protesters with feelings of anger and inspiration, while the visit from Michael Gorbachev, president of the Soviet Union to China in mid-May 1989, reinforced popular feelings that political reform was imminent (Kovalio, 1991).

Despite the citizens' peaceful motivations and efforts, the government responded to the movement with brute force. Military tanks and soldiers opened fire with assault rifles on unarmed demonstrators (Nathan, 2001). Roughly 1,000 to 2,600 demonstrators died, and the remaining protest leaders were jailed. By the Spring of 1991, 2,578 arrests were confirmed (Mason & Clements, 2002).

### **Aftermath**

However, the 90s and 2000s, the time period after the influences, shed more light on the movement's impact on the Chinese government and China itself. Specific actions taken by the government to support or reject democracy and freedom serve as indicators of the movement's success.

In the 90s, for instance, China faced a major "crisis of confidence" with domestic instability, foreign policy uncertainty, and "a plunge of credibility" after global awareness of the incident (Kim, 1990). As for whether democratic change had been accomplished, it was unclear. While China released hundreds of political prisoners, it also retained other dissenters and used security forces to assault foreign reporters covering the anniversary of the massacre (Kim, 1990). Similarly, it substantially expanded its security state, centering it around addressing social unrest (Wang & Minzner, 2015). Despite these mixed signals, Chinese reformers of the time reportedly believed that genuine political progress and democracy were inevitable, as officials likely became more liberal, educated, and sympathetic (Thurston, 1999). Thus, though Tiananmen hadn't fully succeeded, with dissenters continuing to be jailed and social freedom potentially being reduced due to stricter security states, there remained potential for success as political prisoners were released and officials presumably grew more lenient.

By the 2000s, more than a decade had passed with no demonstrations similar to the number of participants, duration of protests, or the number of cities where demonstrations coincided (Mason & Clements, 2002). Some researchers attribute this to the fact that China doesn't permit the rise of representative institutions that give people a feeling of participation or investment in government and is unwilling to adapt politics to new social realities (Gilboy & Heinbotham, 2001). Others couple this with the fact that China has successfully silenced dissenters by scoring economic and social successes that improved Chinese quality of life: Chinese families could afford a new range of goods as real urban incomes more than doubled, and many Chinese individuals were free to create their own lifestyles, move about the country,

start their own businesses, and express themselves on a wide range of issues (Gilboy & Heinbotham, 2001). This combination of silencing political dissent and increased economic (and even social) benefits could potentially explain China's lack of major demonstrations. More significantly, the improved quality of life contrasted with the lack of representative institutions suggest that the movement was only partially successful in achieving freedom and democracy.

However, today, this success is challenged as The Chinese Communist Party has tirelessly worked to erase the memory of the June 4th, 1989 massacre. The event is known as a "forbidden zone in the press, scholarship, and classroom teaching," as China restricts media and internet commentary about the event (Sarotte, 2012). This restriction has seemingly been successful as a 2019 CBS news source quizzing random Chinese citizens with infamous photos from the massacre revealed that most couldn't even recognize the event (CBS, 2019). Thus, the lack of transparency and knowledge about the fight for democracy questions whether effective changes have been made in the Chinese government at all.

### **Research–Interview Background**

The following conclusions are based on interviews either publicly available through CBS's 2019 interview with Wu'er Kaixi, a Tiananmen survivor, or privately available through first-hand interviews with another Tiananmen protester (named Interviewee #1 for this study). Both interviewees, who are Chinese and live in America, were 21 years old at the time of the protests. Interviewee #1 gained first-hand knowledge of the Chinese government while becoming a government official after graduating, so she details the political reasons for making certain changes after Tiananmen. Additionally, she visits every few years and stays in contact with Chinese relatives/friends through social media, calls, and Chinese television. So while she may not know China as well as when she lived there, she has enough information to talk about and compare it to current China today. However, it is not known whether the same is true for Wu'er, who was expelled from China after the protests. It should also be noted that the CBS interview displayed far less insight into Wu'er's thoughts on how Tiananmen affected the government today compared to the interview with Interviewee #1, so the latter's thoughts were more thoroughly considered for the paper.

### *Thesis*

The primary finding was that the Chinese government had improved towards but not entirely succeeded in achieving democracy and freedom. Specifically, China expanded the rights to free speech, allowed more Western influence, granted more economic and political freedom, and reduced corruption. However, it still restricts forms of speech, allows more economic than political freedom, and permits corruption. Moreover, whether Tiananmen Square has been entirely successful is deeply polarizing among protestors.

### *Free Speech*

Chinese citizens now have more ability to publicly and privately criticize the government. Interviewee #1 explained that “there's much more freedom to express yourself” as “the government today in China has a higher tolerance for this kind of criticism compared to the past.” Whereas, “Before, you were not supposed to criticize the government at home... Now, at least you can speak freely at home...” This supports the finding that Chinese individuals are free to express themselves on a wide range of issues due to economic reforms that expanded personal liberties after Tiananmen (Gilboy & Heginbotham, 2001), but refutes other findings suggesting that Chinese citizens didn't feel they can freely themselves due to their perceived corruption of the government (Sun et al., 2012). However, Interviewee #1 further explains that the “Communist party sees the impact and social instability created by the mass protestors, so they are more careful about their actions/policy procedures.” This aligns with the Communist Chinese Party's mission immediately after Tiananmen to build China “into a more prosperous, democratic, and culturally advanced modern socialist country” and achieve stability and unity (Shi, 1990). Thus, though some citizens may feel they can't freely express their views, this information suggests that they can due to expanded personal liberties, purposely designed by the government to reduce social instability.

However, not all speech is allotted, as the Chinese government still controls Chinese citizens, “media and speech included.” A 2014 study advances this notion as Chinese communications law still controls specific forms of speech to pursue certain objectives and discredit others (Creemers, 2014). But, the “degree of control has loosened, a bit”, as studies also show that the Chinese government has switched from banning to “guiding” news reports (Tai, 2014).

### *Western Culture*

This trend of increased openness is further demonstrated by the increase in Western influence and acceptance in China. For instance, “Before... citizens didn't have access to foreign mediums..like foreign movies, tv, or internet access. Now, citizens have much more access to Western culture, media, internet.” These conclusions align with research demonstrating that Western media has expanded in China Today (Yu, 2009) and support China's position as having one of the world's largest internet populations (Lai & To, 2012). Beyond spreading through media, western influence expanded as the government “allowed thousands of Chinese students to pursue college/higher education in Western countries “ at much higher rates than in previous decades (Broaded, 1993). Specifically, Chinese students bringing Western culture back from studying abroad helped rapidly perpetuate the spread of Western culture into modern Chinese society today (Yu, 2000). Even in terms of work, “Over the past 3 decades, a lot of foreigners work and live in China” while “Lots of Chinese actually work for foreign countries.” This is consistent with record-high numbers in migration to and from China in 2019 (Østbø, 2022). This increase in Western media, education, and work suggests that the Chinese government is much more comfortable with the intermixing of Western and Chinese cultures today.

She attributed this comfortability to the fact that Chinese leaders themselves are educated in Western countries (The Economist, 2023), so China “sees the benefit of investing Western investment/culture in Chinese culture.” This is demonstrated in research suggesting China’s plan to open itself up to and interact with other countries has allowed for more economic and political power (Men, 2020). She further explains “despite (the Chinese government’s) strong desire to control speech and media,” “they can’t go back to several decades ago because of the flow of information, talent, thanks to modern technology, investment from the outside world, and benefits they see from not shutting down China.” This represents broader research suggesting that the sheer number of online resources in China today makes the government incapable of keeping track of online content (Yang, 2009). Thus, the spread of western and foreign influence has become inevitable in Chinese society today.

### *Freedom*

China has given citizens substantially more economic than political freedom. Economic freedom is defined as China’s openness to allowing foreign investment and private enterprises, while political freedom is defined as the ability to participate or be represented in government. Wu'er Kaixi exclaimed that “(the Chinese government is) exchanging our economic freedom with our political freedom” (CBS, 2019), while Interviewee #1 when asked if economic and political freedom were completely achieved, responded, “economic maybe but not political.” This is in agreement with the consensus that while China has allowed dynamic economic progress (by moving towards a free market economy and becoming one of the largest economies and supporters of globalization), its political openness ( in terms of electoral participation, inclusiveness, transparency, responsibility, etc ) is significantly delayed (Wu, 2020). However, Interviewee #1 did admit that “political freedom may have been achieved to a certain degree” as “the government wants to give them enough freedom that it doesn’t impact that sovereignty/management, but not too much freedom to the extent that everyone can easily participate in government.” Thus, while political freedom may have improved very slightly, economic freedom has improved substantially.

### *Corruption*

Corruption, while still apparent, has been substantially reduced (China Corruption Index, 2023). Whereas “in the past...in order to get things done, you have to bribe those in power...(government officials can get a free dinner, get reimbursement.)...., “nowadays, the government arrests officials that committed corruption or implement policies reducing corruption.” For instance, the creation of the anti Unfair Competition Law, the Supervision Law, and the expansion to the Criminal Law of the PRC, all penalized commercial corruption in China after Tiananmen (Briefing, 2022). Despite this improvement, she explained that corruption still exists as it has “been an issue in the government for thousands of years...” Thus, she suggests that although the government has made successful efforts to reduce corruption since Tiananmen, corruption still exists. This supports recent literature revealing how Chinese corruption reform in

the 1990s, which included more than a thousand anti-corruption regulations, laws, and policies in areas of taxation, auditing, procurement, and the recruitment of civil and judicial officials, has decreased corruption cases related to the internal administrative processes, but not corruption cases related to other processes (Ko & Weng, 2012). This trend in corruption reform trends post the 1990s after Tiananmen, suggests that Tiananmen could've contributed to this decrease, but not complete abolishment, of corruption.

### *Tiananmen's effectiveness*

Despite reported improvements in free speech, Western influence, freedom, and corruption, Chinese Americans still disagree about whether Tiananmen Square has successfully affected the government. Whereas Wu'er declared that “we failed miserably,” others like Interviewee #1 argue that it was highly successful. When asked whether Tiananmen Square had changed China and if this change was what the student protestors had envisioned, she responded “Absolutely.” She explained that the difference today is “very noticeable” because of 3 reasons: “After Tiananmen Square, the government allowed more Chinese students to go overseas to study,” “they allowed more foreign investments in China,” and “they allowed Chinese citizens to have access to more Western media.” At the core, she argues, “Thanks to Tiananmen Square, the government started to pay attention to people’s voices” because fundamentally, “the Communist Party doesn’t want to have any social unrest,” aligning with research finding that China has expanded security state centered around addressing social unrest (Wang & Minzner, 2015).

### **Analysis**

While not Chinese American, Jean-Pierre Cabestan, a political science professor at Hong Kong Baptist University and author of *China Tomorrow: Democracy or Dictatorship?*, sheds light on this statement and how Tiananmen Square influenced the Chinese Communist Party Today.

He similarly claims that the Chinese leadership has been adamant about preventing potential political or social protests. However, contrary to Interviewee #1, Cabestan argues that China has increased control over its citizens, claiming that after Tiananmen Square, the Chinese government realized that “it needed to suppress any kind of opposition” to retain its power by “intensifying the party’s control over any kind of NGO and suppressing labor rights organization”. Moreover, the two sources completely disagree as Cabestan suggests that China today is similar to pre-Tiananmen China, as “Tiananmen is not far away,” and “liberal views and ideas have been suppressed” (Trautwein, 2022), whereas Interviewee #1 claims that “there is much more freedom to express yourself today.” Thus, the contrasting sentiments reflect the larger notion that Tiananmen is deeply polarizing in the minds of protestors today.

Although Cabestan’s claims about China’s political control and adamancy on “retaining power” may be true (Gilboy & Heinbotham, 2001), his claims about free speech fail to account for the rapid growth of the internet. Like Interviewee #1 expresses, modern technology has made

it virtually impossible for the government to restrict online messages. Specifically, the internet has provided Chinese citizens with “unprecedented” opportunities to not only access, but share a diverse range of perspectives/information (Qiang, 2003), which oftentimes include political criticisms (Wu & Fitzgerald, 2020). Thus, the Internet’s platform makes free speech far more accessible than before Tiananmen, undermining Cabestan’s claims that “liberal views and ideas have been suppressed,” and suggesting that pre-Tiananmen China and China today are in fact very different.

Additionally, though some argue that Tiananmen was a failure because certain factors like corruption have worsened over time (Bakken & Wang, 2021), the laws and general perceptions of Chinese citizens prove otherwise. Again, the Chinese government initiated comprehensive administrative reforms post Tiananmen in the 1990s penalizing corruption (Briefing, 2022), and these campaigns have only tightened and expanded since as Xi Jinping launched arguably the most massive and rigorous reform in prosecuting both high-ranking officials and grass roots civil servants (Gong, & Tu). Furthermore, these efforts have proved successful as corruption rates have decreased over the years (China Corruption Index, 2023), and majority of Chinese citizens believe that the Chinese government has done a better job fighting it (Davidson & Ratcliffe, 2020). Thus, though corruption may still exist in the government today (Ko & Weng, 2012), the extent of corruption present has been significantly reduced.

## **Conclusion**

Tiananmen Square will forever be remembered as a movement that brought global and national awareness to the injustices of the Chinese communist government at the time. As up to a million people took to the streets of Beijing, China was forced to reckon with its economic, political, and social issues. However, the thousands of people brutally killed, arrested, or exiled in the process beg the question of whether their efforts were worth it.

This research suggests that the Chinese government is advancing toward democracy and freedom. However, it still restricts forms of speech, prioritizes economic freedom over political freedom, and allows corruption to exist. Furthermore, not all protestors believe that Tiananmen was the success that others believe it was, and there is a possibility that China would have made improvements in Western influence, free speech, and corruption even if Tiananmen never happened. Thus, though the study fulfilled its motive of determining how successful the protest was, it can not give a definitive answer on the true success of Tiananmen due to the differing opinions and outside factors. Although limitations don’t allow for further, more in-depth exploration of this topic, future studies can interview more protestors to get a more accurate representation of how the movement impacted the Chinese government today.

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## **Pushkin, Glinka, and Gogol: Clarity and Deception in Nineteenth Century Russian Narratives By Kelly Lingquan Kong**

Built from seized swamps, exploited peasants, and vision of Russia's novel window to the West, the list of symbolisms behind St. Petersburg is likely inexhaustible. From its establishment in 1703, the city has served as a silent reminder of how chaos and enlightenment co-exists within facades shrouded by order and extravagance, an image upheld taxingly by the state and honored by its people. Yet, the "honor" here is baffling. With annual floods coupled by man-made grandeur, at-the-doorstep restraints with active rebellions, and strict censorship over flourishing literary circles, St. Petersburg seemed like the very definition of an involuntary and self-induced identity crisis. This characteristic inevitably developed beyond the city experiment itself, extending to its founders (the autocracy), and its subjects (the people). As reality vacillated between concrete presence and imagined fantasies, one's relationship with truth became pivotal to determining how to live while bound by their system and setting. St. Petersburg's individuals were no longer solely defined by ranks, ethnicity, or background, but also one's state of clarity, denial, or ignorance towards reality. As reflected in various depictions of the city, Pushkin, Glinka, and Gogol's works demonstrated the role in which mutual and self-deception within the ruler and the ruled—born out of the autocracy's need for unblemished power and the generation's need for self-preservation—played in the continuation of the Russian autocracy.

The depiction of St. Petersburg in *The Bronze Horseman* demonstrated a concealed, yet bursting yearning for release, mixed with fears for failed rebellions; both sentiments elucidated the people's need for deception towards oneself when challenged by the power of the autocracy, the masses, and the individual. The story began more than one hundred years prior to the poem's publication. Inspired by his travels through the West, the young Peter I was rashly ambitious, motivated by what he saw as an essential need for Russia to catch up to the European standard (Barker and Grant 253). His subsequent Westernization in Russia was met up by complicated effects with varied attitudes; the old ways of life were seemingly reversed, yet an intensified air of suppressive traditions lurked beneath (Hosking 195). St. Petersburg was no exception. Tsar Peter created the glorious European replica as a replacement capital, one born from foreign designers and grueling labor of Russian serfs and criminals. The city became the short-cut towards witnessing Western progression, especially among the nobility. It was built for Russia, in Russia, yet its uniquely assertive objectives deemed it inevitably out-of-place—an enigma of widespread contrast and contradiction (Barker and Grant 289). When confronted with deprivation and hardship, how long can the allure of mystery last? In 1824, nature's force uncovered the vulnerability of this realized dream. Here begins our "sombre tale" of glory with Alexander Pushkin. There was much exalted exposition in the introduction of *The Bronze Horseman* until the blend of reverence and condescension towards Russia's past penetrated the tone: "So our young capital's aurora / Puts ancient Moscow in the shade, / Just as a new tsaritsa's aura / Must make the empress-mother fade" (Pushkin). Pushkin was born into a noble family of Moscow and became attracted by St. Petersburg for its vibrant intellectual scene. Yet,

in a poem centered around a tragedy of the novel city, he chose to highlight how St. Petersburg's glamor swept the old Moscow aside, deeming it subordinate. The text not only invalidated the old autocracy's legacy in a blatant manner, but also a segment of the author's personal past. Under Nicholas I's strict censorship, this opening felt like strategic flattery, a trivialization of the old to uplift the new St. Petersburg splendor that the text portrayed in its sugar-coated introduction. It not only reflects the autocracy's inclination to deprecate their own predecessors to deem new creations untouchable (this stands in parallel with Peter's reforms), but also the Pushkin's rich understanding of such a necessity. The undertone accentuated how the "present good" is solely the post-reform government's accomplishment, and regarded past power as outdated—"shade" and "fade" made its past glory musty and unenlightened. It also offered the chance to scapegoat former rulers for present faults. This tendency became even clearer when in the text, Tsar Alexander I decidedly blamed God's actions for the flood (Pushkin). The pattern ensues. When one has run out of reasons or people to blame, only the dead or divinity can be held responsible. The reflected normalized absurdity was implicit. It required an artful blend of glorification for the present and belittlement of the past to get through watchful eyes—a reciprocated deception *with* hints of foresight that created a seemingly exclusive relationship between the intelligentsia and the autocracy. On a more personal level, Pushkin's decision to put down Moscow reflected a point of contention with his own identity in such a city. St. Petersburg was supposed to be the land of the open, built to be freer than landlocked Moscow. Under such a contradiction between impression and reality, suffocation from censorship may have been exacerbated under this layer of hope. Perhaps it takes a bit of extra resignation and self-deception to stay put. To deny a slice of the personal past wasn't necessarily validating the present, but it certainly could have alleviated hopelessness within facades of progression.

Pushkin's first descriptions of the Neva River waves also included a series of choices filled with artful intricacies: "And may the Finnish waves now cast / Aside hate born of long subjection, / And not with Futile insurrection / Disturb great Peter's ageless sleep!" *The Bronze Horseman* was a Russian narrative in that contested with Russian realities in all the abstractions, nuances, and duplicities the term "Russian" beared at the time. Yet, Pushkin made the decision to label the waves "Finnish"—a foreign power previously depicted as the victim to Peter's army. It's a fascinating choice to cast such a destructive force as an outsider. Above the irony of how Peter I drew the wave in himself by seizing others' land, Pushkin's decision made the text seem outwardly patriotic against a foreign force. Beyond this, the river also silently assumed the role of both the destroyer and the victim, symbolizing the power of the Russian masses. The lines ostensibly expressed disdain towards the waves' teeming desire for insurrection, yet also acknowledged their gloom from "long subjection." When warning the waves against disturbing Peter's slumber, the poem deemed Peter both as an austere, immortal figure of power, but also the subject of "hate," and thus the figure imposing subjugation. The waves were then portrayed with immense destructive desire and potential, but were also inevitably temporary: "The river turned back to the sea— / Proud of its insubordination, / And after vicious molestation / Abandoning its prey." Unable to disturb Peter the Great, who symbolized the Russian state, the

floods receded from the city after its furious attack. What drew them back? We can look at the results in St. Petersburg. The city was no longer the realized dream of a reformer, but the creation beaten down by the people's plunder. St. Petersburg became just another vehicle for the state's authority and a punch bag for the people's rage. But only Yevgeny returned to remember the "fierce despair" of the waves and witnessed "darkness" from Peter's lofty authority. It drove him mad; he became disillusioned by clarity. The majority returned to "routine" with "cold unconcern" and dealt with their loss with an air of peace in the city that felt almost fabricated, like they had been washed over by voluntary amnesia. The gift of indifference, however strained or feigned, is sanity, driven by the instinct for self-preservation amid extreme deprivation. It is a twisted form of mental *strada*—the painful muddling of reality and myth in exchange for survival. The clarity within the struggle is short-termed; life must go on. Pushkin thus illustrated how willing obscuration of reality is omnipresent under the Russian autocracy, deeming it as an instinctive coping mechanism that transcends social boundaries.

Parallel to the mutual and self-deception among the Russian masses portrayed in Pushkin's work, the irony of patriotism in Glinka's *A Life for the Tsar* reflects Nicholas I's forced rationalization in his unrealistic aims towards achieving national uniformity. In articulating his particular obsession towards military parades, Tsar Nicholas I stated: "'Here'—in the army'—'There is order [...] there is a strict, unconditional legality, no impertinent claims to know all the answers, no contradiction, all things flow logically one from the other; no one commands before he has himself learned to obey ... everybody serves'" (Birmingham 39). The statement exhibited Nicholas I's explicit wish for a specific type of social revamp: reinforcement of rigid consistency and mindless obedience. While his need for such societal attributes primarily reflected a desperate obsession with control (as opposed to seeking flexible route towards his determination for national stability), it moreover revealed the autocracy's struggle with lack of consistency (in social norms, levels of knowledge, etc.) across the societal ladders—a legacy of class divisions and serfdom that revealed the limitations of centralized powers. Underneath the tedious military marches that Nicholas applauded was a last-resort solution to have mechanical repetition/indoctrination create order and unification. The lyrics of Glinka's opera reflected this very notion: "Glory to you, our Russian land! / May our beloved native country / Forever and always be strong!" (Glinka). The piece expressed such sustained enthusiasm and devotion to one's land, people, and warriors, yet never explicitly stating what praising Russia meant after a century of tumultuous Westernization—a process that quietly strained art to further divide, not to meld differences. How could one spread common passion for their country when its identity was ambiguous in the first place? After Peter's reforms, the elite became incongruous with the masses and became "foreigners at home" (Hosking 17), creating a rift in the perception of "Russianness"—there was no common glory, nor was there a shared suffering that Western-influenced art was able to unify; five-sixth of the Russian population were still in peasantry by the 1850s (Kort 67). The attempt at such an art reflected the autocracy's quiet hope for "sameness" to present stability. Nicholas's predecessor, Alexander I, experimented with shifts towards freer institutions; the hostile Decembrist revolt concluded his era, resulting in Nicholas's

personal concerns of such uprisings (Hosking 203). He projected his concerns onto rules governing conformity and censorship—a heavy-handed tactic on an intricate problem. This complication is reflected in the opera. It is a peasant’s heroic tale with a title that honors a Tsar, a Russian folk story constructed in Western forms (Figs 32), and a commemoration of peasant soldiers primed in the splendid Petropolis. The values, priorities, and the “Russian experience” between the opera’s audience and subjects simply did not line up—they even lacked a common enemy. The opera thus became a reflection of internal self-rationalization hovering over the fragility of the autocracy, highlighting moments where even the centralized state muffled their relationship with reason/reality towards governing their citizens.

Extending beyond the personal, public, and autocratic deceptions that Pushkin and Glinka illustrated, Gogol crafted a character residing in St. Petersburg that portrayed the symptoms of a twisted relationship with reality while living under the Russian autocracy. In *Diary of a Madman*, Poprishchin’s awareness of the nobility’s corruption and his concurrent obsession with status elevation sent him down a spiral of madness—an ending that is both a criticism of the rank system, as well as an exploration into how one’s relationship with clarity affects their destiny. Poprishchin’s complaints about the arbitrary power within the Table of Ranks was incessant from the start. He characterized the treasurer by his lack of empathy and generosity, and felt deeply agitated at how his personal income is controlled by a “grey-haired devil”(Gogol 23). Moreover, in the first descriptions of the Director, Poprishchin commented: “...and after that he will fleece the petitioners so that they will be happy to escape with their shirts on their backs.” Through this, the character revealed the level of corruption and exploitation in the highest regarded figure in his department, clearly sensing traces of the Director’s abuse of power. Furthermore, he proclaimed how the power of fashionable clothings leads to an automatic rise in status, thereby recognizing the role pretense plays in maintaining power through the autocracy: “let me wear a cravat like yours, and you wouldn’t be good enough to clean my shows for me. Poverty—ah, that is the trouble!” There is an exceptional sense of clarity about the nature of societal status under the autocracy that preceded his descension into madness. This clarity is alienating, and madness is a frequent byproduct of alienation. However, Gogol did not stop Poprishchin’s characterization where it limits his madness purely as a criticism of the system. Despite his comprehension of the system’s flaws, Poprishchin wrestled between insecurities when facing the nobility and nonetheless held intense yearnings for a rise in social standings. In front of the director’s daughter, a noble woman, he characterized her as a near-ethereal canary while belittling himself to be worthy of decapitation. Conversely, in a fit of rage against the Chief of Selection, he proclaimed that he is an undervalued gentleman: “There is no reason why I should not rise in the service too.” His demand for dignity is accompanied by a fervent romanticization of authority; his sense of self-worth and need for validation stems from the very people he detests the most. By sending this flawed figure into delusion, Gogol not only showcased the power truth can play upon an individual, but also how a person’s relationship with his clarity can affect his fate’s outcome. Even after illustrating Poprishchin’s acknowledgement of the deceptions and pretenses within the system, Gogol allowed the character to continue pursuing

ranks—inducing envy, exasperation, and ultimately insanity. The madness not only resounded disapproval and lamentation towards the system, but also towards Poprishchin's personal choices in establishing his relationship with the truth he got to observe and conceptualize. Until delusion took over, he existed amidst the in-between of the autocracy's facade and his personal revelations. This ultimately induces a sense of hopelessness that rang through Gogol's story—an unworkable decision between chosen obscurity that preserves sanity, freed reality that causes banishment, or the common middle that leads to madness.

Through Pushkin, Glinka, and Gogol's exploration of truth and fantasy, we are able to observe the various ways in which deception and clarity both proved to be a curse, a gift, an utilized tactic, or even a coping mechanism under the Russian autocracy. There isn't an ultimate blame on deception itself for an autocracy's continuation. Deceit is a consequence for the inability to present truth—a vicious cycle of falsehood stemming from systems' and livelihoods' need for survival. But just as Pushkin, even under threats of censorship and banishment, pursued to tell reality through codes, readers today must be reminded not to overlook the present privilege of having knowledge and diverse perspectives at our disposal. The truth never departs, but just as Poprishchin demonstrated, it is just as permanent to the world as it is fragile to our senses. Amidst a reality still tainted by brutality, propaganda, divisiveness, and censorship, may we remember the value of these narratives that teaches us about the prevalence and violence of deception, nearly two centuries later.

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## **Breaking Through Barriers: Neurodiversity and Employment on the Spectrum By Elizabeth Varano**

### **Abstract**

For the vast majority of people, employment is an essential and highly rewarding aspect of life. Unfortunately, certain groups have more employment opportunities than others, due to the need to be educated, experienced, and equipped with neurotypical interpersonal skills. Thus, for individuals with Autism Spectrum Disorder (ASD), finding employment is a difficult task, as this population often lacks college education, extensive work experience, and stereotypical interpersonal abilities. Although individuals with ASD may have deficits in these areas, they often possess various skills that allow them to be very successful in the workplace, making it advantageous for employers to hire neurodiverse employees. This paper describes many of the barriers that people with Autism Spectrum Disorder face when seeking employment as well as the unique abilities and talents they can offer to organizations.

### **Introduction**

Work has always been an important part of the human experience. For our early ancestors, work was necessary for individual survival and the provision of basic needs. As the human race evolved, work involved more collaboration and became associated with connection to a larger community. The contemporary view of work is often discussed within the parameters of the employer and employee relationship, where both parties provide benefits to the other. Work provides people with more than just financial security, as there is an intrinsic value to work which yields a sense of purpose and feeling of self-worth. Therefore, those who are not afforded the opportunity to work miss out on the financial, social, and intrapersonal benefits offered by employment. Because people with Autism Spectrum Disorder are a population that is heavily excluded from the workforce, these neurodiverse individuals are missing out on critical growth opportunities, and employers are failing to reap the benefits of hiring these individuals who present unique skill sets.

Autism Spectrum Disorder occurs in individuals all around the world and affects all ethnicities and social backgrounds (Zauderer). Over the past decade, the number of people with ASD worldwide has increased from 10 in every 10,000 people to 62 in every 10,000 people (Organization for Autism Research). This condition is recognized as a spectrum of complex neurodevelopmental disorders which include a range of symptoms and disabilities. Individuals with ASD often behave.

### **Barriers to Individuals With Autism Spectrum Disorder Finding Employment**

Worldwide, 85% of adults with Autism Spectrum Disorder are unemployed (Giannantonio and Hurley-Hanson), as compared to 18.7% of neurotypical adults (Cusack). Although the overwhelming majority of autistic adults are unemployed, they have the same financial and social needs as neurotypical individuals. However, for people with ASD, finding a

job can be a particularly daunting and futile endeavor. Although finding employment is a struggle for all disabled groups, it is especially difficult for individuals with ASD. According to Doctor James Cusack, among all disabled groups, autistic people are the least likely to be employed, when compared to people with other mental, physical, intellectual, and sensory disabilities (Cusack). This is likely due to the medical and emotional comorbidities associated with ASD. For instance, people with autism often suffer from seizure disorders, sleep disturbances, attention-deficit/hyperactivity disorder (ADHD), obsessive-compulsive disorder (OCD), gastrointestinal complications, and bipolar disorder (“Autism Spectrum Disorder”). Because autistic individuals face a myriad of complications associated with mental and physical health challenges, they have to overcome many more obstacles than the majority of people when searching for employment and applying for jobs.

From an early age, people with ASD face educational disadvantages which set them on a path toward financial hardship. The typical track for students after high school consists of pursuing a college education, then entering into full-time employment. However, this track is almost impossible for the average person with autism to follow. In most cases, “two years after [high school] graduation, half of ASD young adults have no paid job experience, technical education, or college [education]” (Arky). Furthermore, seven years after high school, one-third of people with ASD have no paid employment, or secondary education (Arky). Because people with autism often receive very little education or practical training after high school and usually have limited social skills, finding meaningful employment, which provides a living wage, can be extremely challenging. As they struggle to become qualified job candidates, their prospects of becoming financially independent and personally fulfilled are diminished.

Along with health issues and lack of educational and professional training, societal perceptions of ASD individuals perpetuate the problem. For example, people with autism are often viewed through the stereotype of Raymond Babbitt, the main character in the movie *Rain Man*. In addition, in movies, television shows, and commercials, workers are almost always depicted as neurotypical, and neurodivergent individuals are very rarely portrayed as valuable employees on media platforms (Praslova). The lack of diversity depicted in the media regarding preferable workplace candidates contributes to the struggles that autistic people face in finding employment. Companies often mirror this prejudice in an attempt to align their environments with the media. For instance, 50% of managers said they would not hire neurodivergent candidates (Praslova). Further, of the other 50% who said they would hire neurodivergent people, in practice, most do not. Whether this is because of past experiences or stereotypes, autistic individuals are ultimately disadvantaged by this closed-minded approach in the hiring process. Only a small percentage of companies combat this prejudice by hiring people with ASD. The acceptance of this prejudice normalizes discrimination against neurodivergent employees.

Even when employers hire autistic individuals, the work environment is tailored to fit the needs of neurotypical people. This is caused by the lack of awareness surrounding the needs of neurodivergent people. In a typical work environment, it is challenging for the average individual with Autism Spectrum Disorder to successfully work and produce at their highest potential. This



is because “most state and federal agencies are only starting to understand what it means to support autistic adults” (Rudy). Since ASD individuals function rather differently than neurotypical individuals, suitable work conditions for this population look different. For example, autistic individuals may need more frequent breaks from the social demands that come with being in a workplace environment (Oswald). People with ASD often have sensory issues, including a sensitivity to loud noises and bright lights (Cusack). ASD employees may need defined work spaces, which provide quiet and dimly lit atmospheres. While speaking about his experience with autism in a TED Talk, Rutgers student Ethan Lisi said “If autism was seen as a part of a natural human spectrum, then the world could be designed to work better for autistic people” (Lisi). Lisi’s words communicate that autistic individuals feel unrecognized in many aspects of daily life and are aware of how their differences are misunderstood. Because the needs of people with autism are not adequately understood by employers, misconceptions surrounding this developmental disorder are unfairly perpetuated and discrimination against this group is reinforced. Therefore, because the world of work is designed for neurotypical individuals, it is important for companies to provide autistic employees with accommodations that ensure that they have successful tenures at their companies.

### **Financial Burdens Faced by Individuals With Autism Spectrum Disorder**

Families who care for an individual with ASD incur lifelong expenses because people with autism often require ongoing medical attention and therapies. As a result, they accumulate bills and expenses that can become burdensome to the people who care for them. The total annual cost of care for all individuals with autism in the US is estimated at \$137 billion (Giannantonio and Hurley-Hanson). These expenses, added to the average cost of raising a child, result in significant financial burdens for families of autistic individuals. People with ASD generally need special attention, such as speech therapy, occupational therapy, ABA therapy, physical therapy, and various medications which are often very expensive (“What Are The Treatments”). The cost of tutors, therapists, and doctors adds up significantly, and in most cases, parents are responsible for paying these costs, even throughout the adult lives of their autistic children. Unfortunately, if the individual is unemployed, they can not contribute toward their bills and expenses. Therefore, to alleviate the extensive financial burden that autistic individuals incur, it is important for corporations and organizations to prioritize the creation of work environments that include neurodivergent individuals.

### **Social Challenges Amongst Individuals With Autism Spectrum Disorder**

Not only do unemployed neurodivergent individuals rely on their families financially, but emotionally as well. This is due to the mental struggles that are naturally caused by the disability, coupled with the additional complications created by society. For example, self-esteem issues are often created while working at home or not working at all (Giannantonio and Hurley-Hanson). Many people with Autism Spectrum Disorder are aware of their differences and the social expectation to have a job. Because they are often isolated and left out of typical human

experiences, it is very common for this population of people to suffer from self-esteem issues. According to clinical researchers at the National Library of Medicine, “though unemployment has been linked to mental health problems in the general population, this relationship is seldom considered among adults with autism” (Taylor and Pezzimenti). In general, it is common for adults with autism to suffer from depression, which is exacerbated by unemployment. It is common for a frustrated ASD individual to lash out at a parent or other family member, due to the lack of opportunity they experience (Arky). This contributes to the cycle of frustration amongst individuals with autism and can lead to depression and further social isolation.

### **The Autistic Brain Versus Assumptions**

The lack of education surrounding the differences between the autistic brain, and the neurotypical brain, causes false assumptions regarding the abilities of ASD individuals. Although autism is considered a “disability” it is often misrepresented as an intellectual disability. Autism is defined as “a complex developmental condition”, not “an intellectual, learning, or mental health disability” (Praslova). The term “developmental condition” simply means that ASD individuals often develop social, emotional, physical, and cognitive skills later than neurotypical people. This does not mean that all people with ASD will never obtain these skills or even learn them significantly later than neurotypical people. In addition, when doctors and researchers scan the autistic brain, they are not able to see differences that cause ASD symptoms (Rossi). These scans support the premise that the autistic brain is not physically different from a typically developed brain.

### **Benefits of Employment for ASD Individuals**

The workplace environment can provide social, emotional, and financial rewards to ASD individuals. After finishing high school and college, it is very difficult for autistic people to socialize. However, working with others can improve the lives of people with ASD because connections to co-workers can prevent people with autism from experiencing feelings of loneliness and isolation. For example, relationships with colleagues can create lifelong friendships that otherwise would not have been possible for people with autism (Arky). It is very typical for people to make friends at work due to common interests. This remains true for the ASD population, as they can more easily bond with others who share similar interests and goals. In addition to the potential for forging friendships, work environments often provide the opportunity to experience romantic relationships. Over 30% of all workers find their spouses at work (Giannantonio and Hurley-Hanson). Although marriage is less common in the ASD population, these individuals still benefit from forging deeper relationships in the workplace that can carry into their personal lives.

### **Organizational Benefits of Employing Autistic Individuals**

Hiring individuals with autism benefits the employer as well as the employee because people with ASD often have unique talents and skills that can increase a company’s productivity

and have a positive impact on their financial bottom line. When compared to neurotypical individuals, people with ASD demonstrate higher levels of productivity and work ethic. While completing the same task, individuals with autism can be up to 140% more productive than neurotypical workers (Praslova). Higher productivity is significantly beneficial in fields that require tedious work and task oriented jobs. For example, at Bank of America's support center located in Dallas, Texas, all 75 employees have some sort of disability. They spend their days printing, checking, and sorting paperwork. According to manager Duke Roberson, his workers “with high-functioning autism, tend to be aces at catching errors — and they enjoy the repetition” (Noguchi). Jobs that require high attention to detail and work ethic are often good fits for autistic individuals. Companies that focus on disability inclusion have been shown to be twice as likely to have higher levels of shareholder returns and have outperformed other companies (Giannantonio and Hurley-Hanson). By taking the time to find the proper role in the workplace for individuals with autism, companies can outperform their competitors, and therefore enjoy financial benefits.

Hiring individuals with ASD can also decrease organizations’ turnover. In 2021 alone, over 38 million people quit their jobs (Bardsley). This issue is less likely to occur with autistic individuals due to the common ASD trait of loyalty. People with autism seek routine and structure (Howard). The daily schedule that comes with employment is highly fulfilling for people with Autism Spectrum Disorder. The financial aspect of employment is often insignificant to this population of people, as elements such as the routine and schedule are much more intrinsically rewarding. Therefore, once employed, people with Autism Spectrum Disorder are less likely to quit their jobs, as compared to the population at large.

Autistic individuals often possess specific traits and characteristics which are desired by employers. In certain areas of employment, these traits often enable them to perform at higher levels than neurotypical people. In a study done by The University of Exeter in England, the research team conducted 28 interviews with people diagnosed with Autism Spectrum Disorder. They found that people with autism possess certain traits which make them well-suited for various roles and positions, such as recall and memory. Some of the study participants described “their exceptional memory in graphic detail, with one saying it was like a “small tape recorder in my head”” ("Autism Brings Qualities"). Qualities such as memory on par with a tape recorder can be crucial tools in competitive workplace settings. Autistic individuals have also been shown to have a commitment to consistency, creative thinking, high performance in repetitive tasks, and lower turnover rates (Long and Kearon). Additionally, in an attempt to not stand out, people with autism often have to work harder to fit in, causing them to be less likely to slack off (Praslova). In many cases, the differences in which ASD individuals think, function, and respond, make them exceptional employees.

### **Financial Benefits of Hiring Individuals With Autism Spectrum Disorder**

The small decision to hire a person with Autism Spectrum Disorder can benefit federal economies throughout the world. In fact, “Accenture (2018) estimates that the United States’

Gross Domestic Product could increase by \$25 billion dollars if an additional one percent of individuals with disabilities were able to join the United States workforce” (Giannantonio and Hurley-Hanson). By capitalizing on the multitude of skills that people with autism can bring into the workplace, countries around the world can experience economic growth. There are 3.5 million people in the world with ASD (Giannantonio and Hurley-Hanson). Thus, if 1,000 companies throughout the world opened their businesses up to 35 ASD individuals each, the GDPs of all countries could increase by as much as \$25 billion dollars.

### **Employment is Not Suitable For All**

Although many ASD individuals are highly capable of working in various work environments, the workplace is not always a good fit for people with autism. Just like neurotypical people, ASD individuals are all very different, with unique skills and preferences. Society often groups all levels of the spectrum into one category and assumes the capabilities of people with ASD are all very low. However, there are three levels of autism. Level one includes individuals who are highly communicative and skilled, whereas level three consists of those individuals who struggle to communicate with others (Rudy). Therefore, it is unjust for high-functioning autistic individuals to suffer because of the lack of education surrounding the various levels of the spectrum. Although some autistic individuals will not be able to handle higher-level roles, others will perform very well in these areas. Those who are unable to hold high positions can contribute in simpler ways. Overall, individuals with autism possess different skills. Once these skills are identified and properly assigned to a role, individuals with ASD can perform proficiently and excel in workplace settings.

### **Companies with Neurodiverse Staffs**

The shift from a neurotypical staff to a neurodiverse staff can be a drastic change in the workplace environment. However, multiple companies, in various industries ranging from banking companies to technology, have already made the change and have seen very positive results. Microsoft is one of the few companies with a highly inclusive staff. At Microsoft, ASD individuals have been hired in various roles, such as consultants, data scientists, finance analysts, program engineers, and service engineers ("Global Diversity and Inclusion"). The management teams and employees at Microsoft believe that neurodivergent people are highly capable of strengthening the workforce and, therefore, have created programs to include the autistic population in their staff. After being hired at Microsoft, an autistic software engineer intern said, “Thank you and Microsoft for valuing neurodivergent hiring and including me! I feel like the program allowed me to pace myself and hopefully share my strengths" ("Global Diversity and Inclusion"). This intern also shared that they are now able to better navigate their professional life as a neurodivergent individual. Thus, Microsoft implemented programs to allow for a more diverse staff, while also maintaining the productivity and profitability of the company.

JP Morgan Chase is another large company that has made the shift to include neurodivergent people. Bryan Hill, JP Morgan Chase’s Head of the Office of Disability

Inclusion, felt like his company was missing an opportunity by not including disabled people in the staff. He said, “The way I view my job is to remove barriers to enter the workforce and thrive here” (“New Global Head”). JP Morgan Chase has implemented neurodiverse staffs in nine different countries around the world, and they have discovered that once autistic individuals are given the proper role, they have a lot to offer in the workplace. Brian Gill and the rest of the JP Morgan Chase team are planning on recruiting more neurodivergent members in the future.

Various organizations specialize in training businesses about autism and how to navigate working with a person with Autism Spectrum Disorder. For example, Autism Speaks has educated companies such as Microsoft and Walgreens about how to implement the skills held by individuals with autism in their workplaces (Long and Kearon). Employees at Autism Speaks have said, “we know many adults with ASD who are demonstrating their competence in a wide variety of industries and at all ranks within businesses around the world. But for the vast majority, these job opportunities are not being made available to them” (Long and Kearon). Autism Speaks works to educate businesses on how to properly assign ASD individuals to the appropriate roles and how to effectively communicate with them. Organizations such as Autism Speaks have been successful in spreading awareness about autism, and creating workforce scenarios that are advantageous to employers and employees alike.

## **Conclusion**

Since 2020, companies have begun prioritizing diversity, equity, and inclusion in the workplace. The efforts to include people of all races, genders, sexual orientations, ethnicities, and religions have been generally successful. However, as the workforces of many companies are becoming more diversified, one group continues to be excluded from the The Diversity, Equity, and Inclusion Movement. Unfortunately, the autistic community continues to face discrimination in the hiring process. Not only is this not equitable, it is also not profitable. Companies are missing out on the opportunity to tap into a population that can bring a unique set of skills and talents into factories, labs, classrooms, offices, and boardrooms. Companies who want to identify themselves as socially conscious must recognize that they need to adjust some of their business practices in order to accommodate the needs of people with autism. By doing so, companies can break down barriers and improve the quality of life for ASD individuals while capitalizing on the contributions of these individuals to increase efficiency, profitability, and innovation.

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# **The Invisible Factor: Effects Of Ingroup Bias On The Accuracy Of Thin Slice Judgments**

## **By Yuqian Li**

### **Abstract**

The study is dedicated to investigating the extent to which ingroup favoritism influences or modifies the thin slice judgments that individuals rapidly form of other individual's faces. Experiments were conducted with 23 participants encountering 68 unfamiliar faces. The analysis showed a slight positive correlation between the ingroup favoritism shown and the trustworthiness rated, along with a decrease in the accuracy of thin slice judgments under the effects of ingroup favoritism. It is concluded that thin slicing isn't solely based on facial characteristics: they be shaped by knowledge about an individual's group status that isn't readily visible from their face.

### **The Invisible Factor: Ingroup Bias Effects On The Accuracy Of Thin Slice Judgments**

As human beings, it is innate for us to be intuitive in first-time interpersonal judgments. According to a recent study of 2,000 Americans recruited by Dollar Shave Club on the length of time it takes to establish a first impression, it is determined that 69 percent of respondents establish an initial opinion of someone even before speaking with them (Economy, 2020). This first impression is formed through utilizing thin slice judgments. Thin slice judgments are rapid judgments where individuals could make relatively accurate conclusions about others based on exceedingly tiny samples of behavior (Ambady & Rosenthal, 1992).

Observing this phenomenon, researchers have long been interested in the external driving and influencing factors (e.g. facial features, tone of voice) behind such behavior. Thin slices in research are brief video or auditory segments, typically lasting 1 second to 5 minutes, taken from longer streams of activity, from which raters may make better-than-chance accurate assessments about the individual being shown or heard. Such discoveries are supposed to indicate humans' capacity to interpret social information rapidly, automatically, and efficiently, a skill that is likely to have evolutionary relevance. Such survival-related characteristics enable us to decide how to cooperate with another individual and predetermine how we are going to treat them.

Although the external factors influencing the accuracy of thin slice judgments have been widely studied, the internal influencing factors have been neglected. Hence, it can be said that ingroup status will likely serve as an internal influencing factor, disturbing the accuracy of the thin slice judgments made by introducing ingroup favoritism and bias.

### **Intuition and Thin Slice Judgments 1.1**

Researchers like Ambady and Rosenthal focused on the thin slice judgments and their means. Their work clearly revealed how humans form very rapid judgments of other people's faces and how these judgments often show a great deal of consensus, even when only based on a fraction of a second of exposure (i.e. thin slicing). It is suggested that thin slice judgments are



intuitive and efficient, and they can be made accurately even under conditions of distraction. Moreover, such judgments are impeded by tasks that interfere with the intuitive process such as tasks involving deliberation, e.g. reasons analysis tasks.

These judgments are highly responsive to subtle features of a person's face, and they have also been shown to be highly correlated with much more extensive exposure to someone (e.g., an entire semester of exposure is highly correlated with 2 seconds of exposure). While people are frequently unable to disclose the reasons influencing their assessments, researchers have identified forms of information in tiny slices of behavior that are responsible for correct judgments. Visual and auditory information are examples of external assessment metrics. Researchers are especially interested in how people form judgments based on subtle characteristics such as eye contact, fidgeting, open-handed motions, rigid posture, smiling, and so on. For example, teachers who frowned, fidgeted, and gazed down received low ratings for attributes reflecting their confidence, warmth, and optimism, whereas teachers who received high ratings for these traits smiled more, walked about more, and touched their upper torsos more (Ambady & Rosenthal, 1993).

Ambady and Rosenthal discovered that individuals who assessed teachers after viewing thin slices of behavior provided evaluations that were quite similar to those who rated teachers after considerable contact with them. Furthermore, the accuracy of these assessments did not change substantially across individuals who watched the 2-, 5-, and 10-second films (Ambady & Rosenthal, 1993). This highlights the astonishing amount of information transmitted in tiny slices of ordinary activity, as well as the insight it may provide about an individual's characteristics, regardless of how briefly the actions are studied.

Some have suggested these thin slice judgments may be relatively automatic/intuitive (i.e., not easily perturbed by manipulations), and that they can be shaped primarily by emotional experience. For instance, Greater Beck Depression Inventory scores were linked to lower Profile of Nonverbal Sensitivity precision. It is also investigated whether sorrow reduces accuracy by encouraging a more deliberate information-processing approach. As expected, accuracy was higher among individuals in a sad mood who performed the assessment test while also conducting a disorientating cognitive load activity, preventing the individuals from pondering on their judgments.

The question of the length of time taken for an individual to form a first impression of another individual is also an investigated topic in thin slice behavior. More recently, researchers Willis and Todorov (2006) explored the minimum conditions within which individuals draw conclusions based on the facial characteristics of others. The researchers altered the exposure period of unknown faces in five studies, each concentrating on a different characteristic evaluation. Judgments given after a 100-ms exposure were shown to have a strong correlation with judgments made in a lack of time restraints, suggesting that a 100-ms exposure duration was adequate for participants to establish an impression.

## **An Explanation for Thin Slice Behavior 1.2**

The first explanation is based on psychologists McArthur and Baron's (1983) ecological approach to social impression, which asserts that qualities relating to an undesirable or intimidating presence can be rapidly and easily recognized because the ability to detect a threat is critical for survival and adaptive action. As a result, qualities like wrath and power are more easily identified than ones like amusement or duty.

The second theory focuses on the function stereotypes perform in the early stages of constructing an opinion about another individual. Initial judgments formed by thin slicing are frequently affected by stereotypes, and these stereotypes commonly include a minor amount of validity. Berry and McArthur discovered, for example, that people with baby features are judged to be more genuine, naïve, and compassionate (Berry & Zebrowitz-McArthur, 1988). There is also an indication that biological and physical variations are associated with temperament differences. As an illustration, more reserved and restrained adult males have lighter-colored eyes and a thinner, more delicate physique than more outgoing and compelling men. Yet, stereotypes may not be as realistic as they appear since they can be reinforced through a loop of self-fulfilling prophecies in which our action is controlled by our expectations of someone based on the clichés to which they conform. This, in turn, encourages the target individual to adjust their own behavior to meet those standards, creating the appearance that the person's features have always precisely fit the stereotype. Physically beautiful people, for example, could become more sociable and confident merely because they absorb others' opinions that they must be more publicly acceptable and extroverted (Ambady & Rosenthal, 1992).

The final hypothesis contends that thin slicing generates precise assessments merely because they are made quickly (Ambady & Rosenthal, 1992). Being exposed to only a small fragment of behavior reduces the availability of distracting cues like conversing and does not provide the rater with opportunities to reflectively reason why they perceive an individual in a specific way, which may induce them to try to rationalize and modify their immediate intuition. Thin slicing helps raters to concentrate on expressive behavior while removing superfluous information that might lead judgments to deviate away from actuality. However, neither of these hypotheses were thought to completely capture the real cause for the success of thin slicing. Rather, it is indeed probable that they are rarely mutually contradictory and all of them contribute somewhat to thin slicing accuracy.

## **In-Group Favoritism Overview**

In 1906, sociologist William Sumner suggested that mankind is a species that, by definition, forms groups. He did, however, argue that individuals had an intrinsic predisposition to favor their own group above others, stating that "each group nourishes its own pride and vanity, boasts itself superior, exists in their own divinities, and looks with contempt on outsiders" (Sumner, 1907). On a collective level, this is perceived as ingroup-outgroup bias. It is considered ethnocentrism when it occurs in bigger groupings such as clans, ethnic groups, or countries. Ingroup bias is now defined as the propensity to prefer members within one's own group over

individuals from other groups (Taylor & Doria, 1981). This ingroup favoritism has a large influence on how people respond to ingroups/outgroups members and numerous researchers seek to explain the reason behind such phenomenon.

### **Driving Factor Behind Ingroup Favoritism 2.1–Realistic Conflict Theory 2.1.1**

According to realistic conflict theory (or realistic group conflict), rivalry for resources between groups is the basis of in-group prejudice and the consequent unfavorable attitude towards members of the out-group. The most well-known illustration of realistic conflict theory is Muzafer Sherif's Robbers Cave Experiment. 22 eleven-year-old boys from comparable backgrounds were evaluated in a simulated summer camp setting, with investigators masquerading as camp workers. The boys were separated into two equal subgroups and incentivized to connect in order to cultivate an in-group mindset. Following that, the researchers devised a sequence of competitions that pitched the two groups against one another to win a substantial reward. Out-group criticism and hostility ensued. (Sherif et al., 1988). Finally, researchers sought to counteract the boys' antagonism by putting them in settings of mutual reliance, which resulted in considerable concord among the two different groups. After this study, Sherif concluded that when communities struggle for scarce resources, hostile perceptions against out-groups emerge. However, he also proposed that inter-group tensions might be lessened, and good relationships can be formed, but only in the existence of an underlying aim which could only be accomplished with the collaboration of the two groups.

Because our predecessors lived in tiny social circles that regularly clashed with other tribes, it was evolutionarily advantageous for them to see individuals of other social groups as dissimilar and outright dangerous (Brewer & Caporael, 2006; Navarrete, Kurzban, Fessler, & Kirkpatrick, 2004). Differentiating between "us" and "them" by using the social concept most likely helped keep individuals safe and disease-free. As a result, the human brain evolved to be extraordinarily effective at discerning these differences (Mahajan et al., 2011; Phelps et al., 2000; Van Vugt & Schaller, 2008; Zaraté, Stoeberl, MacLin, & Arms-Chavez, 2008).

### **Self-identity and Social-Group Theory 2.1.2**

Yet, it can also be said that the idea of ingroup favoritism is primarily based on the concept of social identity and social group. Social identity is "that part of an individual's self-concept which derives from his knowledge of his membership of a social group (or groups) together with the value and emotional significance attached to that membership" (Tajfel, 1974). These social identities are portrayed as group archetypes that characterize and prescribe ideas, views, feelings, and actions that optimum equilibrium between minimizing in-group distinctions and maximizing intergroup variations (Tajfel, 1974). On the other hand, a social group is a collection of individuals who perceive themselves to be members of the same social category, and therefore, share a social identity (Tajfel and Turner, 1979; Turner et al., 1987; Ellemers et al., 2002; Ellemers and Haslam, 2011; Turner and Reynolds, 2011). Memberships in societal groupings, according to social identity theory, are an important component of self-concept. When

individuals label and evaluate themselves in aspects of a self-inclusive cultural construct (e.g., sex, class, gender), two processes occur: (1) categorization, which cognitively amplifies distinctions between both the in-group and out-group, as well as similarities within members (including the self) on archetypical aspects; and (2) self-enhancement, which, because the self-concept is defined on the basis of group membership, individuals seek behaviorally and cognitively to approve ingroup members over outgroup members.

Based on social identity theory, there exists a continuum between personal and social identity, with variations along this continuum determining the degree to which cohort-related or personal qualities impact an individual's feelings and actions (Tajfel and Turner, 1979). If a specific social identity is a pertinent basis for self-conception, the self will be integrated into the perceived in-group prototype, which can be a collection of perceived in-group standards in which self-perception, opinions, beliefs, thoughts, and habits are established in terms of the group prototype. Thus, social identities ought to have an impact on behavior via the mediating influence of group norms. Individuals are more likely to participate in a certain action if it is consistent with the standards of behaviorally salient group membership, especially if the identification is a prominent source of self-definition. If group membership is not obvious, people's conduct and sentiments should reflect their own unique personal and distinctive features instead of group standards.

Another essential factor of group biases, according to social identity theory, is the desire to enhance one's self-esteem (Billig & Tajfel, 1973). The desire to perceive oneself favorably is diverted onto the community, resulting in an inclination to perceive one's own group favorably and outside groups negatively. That is, individuals will search for any reason, no matter how trivial, to demonstrate to themselves why their cohort is better. Henri Tajfel, a British social psychologist who investigated the psychological basis of in-group/out-group bias, pioneered and extensively studied this phenomenon.

### **The Minimal Group Paradigm 2.2**

As mentioned previously, scholars like Tajfel conducted studies on the minimal group paradigm and the mechanisms of ingroup favoritism investigating ingroup bias under a modern context. The aim of Tajfel's research was to examine whether intergroup discrimination would take place based on being put into different groups with consequent categorization into in groups and out-groups in a situation where people had just met. Tajfel experimented with young school children by sorting them into groups based on their aesthetic preferences and had them allocate points to the two groups (the group they are in and the other group). The research found that the majority of children allocated more points to the ingroup than the outgroup. Hence, Tajfel proposed that categorization and discrimination operate automatically, even when there is not necessarily any prior prejudice (Billig & Tajfel, 1973; Locksley, Ortiz, & Hepburn, 1980). In fact, ingroup favoritism occurs even when the assignment to groups is on the most trivial things like whether people “overestimate” or “underestimate” the number of dots shown on a display, or on the basis of a completely random coin toss (Tajfel et al., 1971).

Despite minor modifications, the conventional minimum group research is divided into two parts. During the first stage, individuals are separated into two groups (e.g., "Group A" and "Group B") random and anonymously, ostensibly based upon minor factors (e.g., preference for paintings or the toss of a coin). The participants were often strangers to each other. The second stage involves participants in a seemingly unrelated resource distribution activity. Throughout this activity, participants must transfer a valued commodity (e.g., money or points) to other participants who can solely be recognized by their reference code and group identity (e.g., "participant number 34 of Group A"). Participants are informed that once the assignment is completed, they would get the exact quantity of the commodity allotted to them by their fellow participants.

While participants demonstrate a large level of equality in their allocations, they also demonstrate a strong propensity to assign greater money or points to in-group individuals than to out-group individuals (Mullen et al., 1992). Notably, maximizing relative in-group benefit (maximum differentiation) happens even when foregoing total in-group benefit ("Vladimir's choice") (Sidanius et al., 2007).

### **The Present Study**

With the mechanism of both thin slice judgment and in-group favoritism widely investigated, the correlation between the two remains a key gap in the study of first impressions and social psychology. Given these findings, one question is how abstract knowledge about the person can shape or change these judgments. Theoretically speaking, thin slice judgments are solely based on the external aspects of an individual, where in-group favoritism is a potential internal influencing factor for the accuracy of thin slice judgments. When an individual has knowledge that someone is part of a particular group or holds certain preferences or espouses certain views, does their status influence another individual's rapid thin slice judgments about them? This is an intriguing subject since people cannot physically perceive another person's group status. If characteristics of the individual's face do not change, and thin slice judgments are automatic/intuitive, then hypothetically speaking, this abstract knowledge of an individual's ingroup status does not influence them. But, on the other hand, researchers have long known that ingroup favoritism has a large influence on how people respond to ingroups/outgroups. This raises the issue of whether ingroup status may impact even split-second decisions like these. As previous researchers have only focused on physical distraction (e.g. sound), it is noteworthy to investigate whether internal distraction and ingroup status will have an impact on thin slice judgments made.

Thus, my goal in the present study is to make individuals form thin slice judgments of faces that vary in their characteristics from very untrustworthy to very trustworthy and to explore how providing information about whether the person is part of one's (minimal) ingroup can shape/change thin slice judgments about their trustworthiness.

As a prediction, there will not be a major change for faces that are seen as extremely trustworthy or extremely untrustworthy regardless of the photograph's ingroup status because intuition will naturally decide the individual is one of the extremes regardless of their ingroup status; hence, not effecting the accuracy of the thin slice judgment. But for the photographs that are more ambivalent in terms of trustworthiness, ingroup favoritism might potentially cause participants to rate photos as slightly more trustworthy (in comparison to the control group) if the photograph is from the same group as them as a result of ingroup favoritism raising the rater's own self-esteem, hence, decreasing the accuracy of the judgment. If the photographs presented are of another group, the participants might rate the photo with lower trustworthiness due to the same reason as above.

If the hypothesis is proved correct, this study will be able to better explain the contributing factors influencing the process of first impression formation. Therefore, this study is dedicated to shedding light on the effects of ingroup bias on the accuracy of thin slice judgments made, especially focusing on the trustworthiness determined for individuals in the photographs when raters are experiencing effects of the ingroup status.

### **Method–Participants**

The participants' age in this study ranged from 16 to 56 with an average age of  $M = 25.26$ ,  $SD = 14.09$ . The participants are located mostly in China with a minority in the USA. There were a total of 23 participants. Eleven participants were assigned to the green team and 12 participants were assigned to the blue team.

### **Stimuli**

In this study, 68 photographs of individuals unfamiliar with the rater in the Chicago Face database (The Chicago face database contains photographs with high racial diversity and high resolution) were utilized; 34 females and 34 males were chosen at random from the database. The photographs chosen were already rated on trustworthiness. In all photos, the shown individuals wore gray T-shirts, and there were certain photos with beards, mustaches, earrings, eyeglasses, or visible makeup as a potential pathway for participants to decide the trustworthiness of the given photograph. The photos chosen were head-shot photographs of individuals with a neutral expression (Willis & Todorov, 2006).

To acquire reliable and generalizable facial inference results, participants were presented with photographs from the Chicago Face Database for 100 ms. Then the photograph disappeared, and the participants were asked to judge the photograph for its trustworthiness. All judgments were made on a 7-point scale ranging from 1 (not at all trustworthy) to 7 (extremely trustworthy). Each individual from both groups encountered all 68 photographs and was asked to make judgments for all the photographs. The only difference made is the shown photograph's ingroup status.

## **Procedure**

Participants first completed a short quiz, then they were randomly placed into one of the two teams: the green team or the blue team. The techniques used in the method are designed to remove "objective" effects from the circumstance (Sherif, 2017). The lack of intergroup position hierarchies, as well as the groupings' triviality and limited social significance, precludes the effect of normative prejudice (Rubin & Hewstone, 2004). In this case, sorting the participants into groups with colors with similar connotations and presenting them with a trivial quiz was used to achieve this aim. Participants were told this experiment is about first impressions and that they should answer as quickly as possible. The protocols beforehand made it clear that the images would be shown for only 100 ms and that the experimenters were particularly interested in participants' immediate reactions, or gut sentiments.

The control group was the trustworthiness rated by the Chicago Face Database. The only difference between the green group and the blue group was the colored thick border along the picture indicating the group to which this individual in the photograph belongs. The group sorting for the photographs were also random. The photo either belonged to the green group or the blue group. As for the control group (Chicago Face Database rating on trustworthiness), the background color for the photograph remained white and no inferences for the group to the presented photo belongs were presented.

Each trial began with a fixation point (+) presented for 500 ms at the center of the screen. Then a photograph containing an unfamiliar face was presented for 100 ms. Immediately afterward, a question appeared in the location of the photograph replacing it and asking the participant to rate how trustworthy this shown individual was. Participants responded using the computer keyboard, pressing either the 1, 2, 3, 4, 5, 6, or 7 keys according to the 7-point scale ranging from 1 (not at all trustworthy) to 7 (extremely trustworthy). The comparison was made between the ratings the control groups gave, the ratings the ingroup of the individual gave and the ratings the out group of the individual gave.

## **Other Information Collected**

At the start of the experiment, the participants were asked to enter their gender and age and at the end they were asked which team they were placed in. To measure the amount of ingroup favoritism shown, a Tajfel-like point allocation task was conducted, and the participants are asked to choose how many points they want to allocate to each team. There was a choice between (Green team: Blue team 200:0, 150:50, 100:100, 50:150, 0:200). This experiment was utilized to show an interesting and evaluative trend between the amount of ingroup favoritism shown and the trustworthiness rated on the thin slicing. The concealment of respondents' personal identities removes the effect of personal preference in the setting of in-group favoritism. The absence of the individual by using the group as a receiver in the process of resource allocation and judgment-making eliminates the effect of direct human self-interest. Because there is no relationship between overall in-group profit and personal gain, an actual rivalry has no influence.

## Results

As shown in Graph 1, the results presented in the study show that there are effects of ingroup favoritism on the trustworthiness rated for the individual, but only among those assigned to the green team. The blue team showed approximately similar estimated marginal means for the level of trustworthiness rated to the ingroup and the outgroup, showing little effect of ingroup favoritism on the trustworthiness determined. Yet, although the green team raters showed effects of ingroup favoritism with a higher estimated marginal mean of for the ingroup (green team) and a lower estimated marginal mean of for the outgroup (blue team), the correlation is heavily skewed by two data points showing extreme effect of ingroup favoritism on their ratings of trustworthiness, leading to a significantly higher estimated marginal mean.

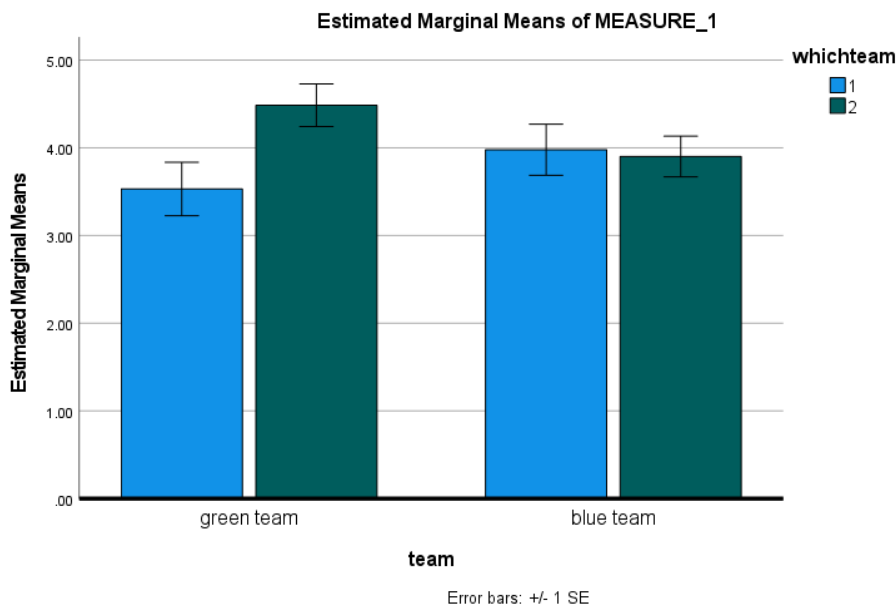


Figure 1. The estimated marginal mean of trustworthiness is rated by individuals from the green team and individuals from the blue team for photographs regarding the photo's ingroup status. (Photographs from team 1 are tinged blue, and photographs from team 2 are tinged green)

To analyze the level of ingroup favoritism shown during the experiment, a Tajfel-like point allocation task was given at the end of the experiment. According to Figure 2, the green team experienced an inclination of allocating more points to the ingroup than the out-group as the mean is 2.82, closer to 1 as expected. The two green groups participants that rated ingroup members as significantly more trustworthy than outgroup members also allocated the all the points to the ingroup in this task, showing a clear effect of ingroup favoritism. This could suggest that the higher the level of ingroup bias, the higher the tendency to rate an ingroup member as more trustworthy, therefore, the less accurate the thin slice judgment. The blue team also experienced a small inclination to allocating more points to the ingroup as the mean is 3.33,



leaning slightly closer to 5. Hence, it can be concluded that there is a trend toward ingroup favoritism during the experiment based on the point allocation task.

	team	N	Mean	Std. Deviation	Std. Error Mean
pointalloc	green team	11	2.82	.603	.182
	blue team	9	3.33	.707	.236

Figure 2. point allocation task (1= 0 points to the blue team, 200 points to the green team, 2=50 points to the blue team, 150 points to the green team, 3=100 for each team, 4= 150 points for the blue team, 50 points to the green team, and 5=200 points to the blue team, 0 points to the green team)

This demonstrated ingroup favoritism is shown to have affected the accuracy of the thin slice judgments made. In figure 3, the ratings given to the green group photographs were higher than the control group for both groups with the green team raters rating the ingroup individuals as even higher, further away from the control group than that of the blue group. As for the blue group photographs, the green team had ratings more consistent with the control group and the blue team had ratings slightly higher than that of the control group. This means that both green team and the blue team decreased the accuracy of the thin slice judgments made for their ingroup members by rating them to be more trustworthy, showing the hypothesized effects of ingroup bias. When both blue and green team raters are asked to rate the photographs without the effects of ingroup favoritism (rating out group members), these raters showed higher levels of thin slice judgment accuracy.

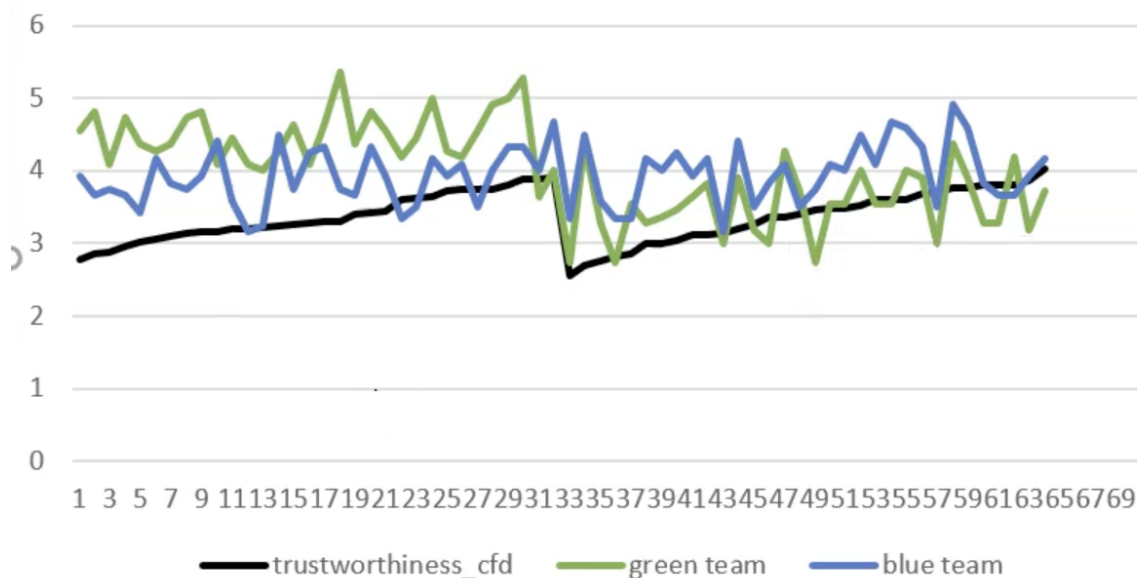


Figure 3. comparing the ratings of the control group and the ratings of the blue group and green group. (The 35<sup>th</sup> face is blue and all faces after that are blue, the 34<sup>th</sup> face is green and all faces

before that are green). The X- axis is the number of faces and the Y-axis is the rated trustworthiness on a 1-7 scale.

As shown in figure 4, the correlation between point allocation and ingroup preference is,  $r(20) = .324, p = .163$ . Although the value is not statistically significant, it still shows a mild to moderate positive relationship. By combining the two experiments conducted, it can be concluded that the extent to which people show a disparity in thin slice judgments in favor of their team is moderately positively correlated with their ingroup favoritism on the point allocation task.

		ingrp_pref	pointalloc
ingrp_pref	Pearson Correlation	1	.324
	Sig. (2-tailed)		.163
	N	23	20
pointalloc	Pearson Correlation	.324	1
	Sig. (2-tailed)	.163	
	N	20	20

Figure 4. correlation between ingroup favoritism presented and the point allocation task

### **Discussion–Limitations**

Despite the correlation shown between ingroup bias and the accuracy of thin slice judgments in the present study, the small sample size places the results under doubt. Due to time constraints, only 23 participants were recruited to complete the experiment. Although the green group in the study presented a correlation between ingroup bias and thin slice judgments on trustworthiness, the correlation is mainly driven by two individuals. This raises the question of whether the two people are outliers in the research or simply good representatives of the phenomena. Hence, more data collection is needed to clarify this uncertainty.

Among the 23 recruited participants, the majority were located in China, placing the results under the uncertainty of whether this is a universal trend. Again, data collection involving a larger variety of participants including different ethnic groups is needed to create stronger reliability. At the same time, the r-value is 0.324 suggesting the between the ingroup bias presented and trustworthiness rated correlation is relatively weak, suggesting that the ingroup bias didn't necessarily have an effect on the ratings give. Henceforth, more evidence is needed to prove the hypothesis true.

As the program is not accessible on the phone, many participants had to complete the random quiz twice, and if they were sorted into different groups by answering with the same response, participants may start to doubt whether the group sorting was actually based on the quiz results. Yet nevertheless, Tajfel's minimal group paradigm suggests that even when individuals are sorted into groups without a clear reason, they still showed ingroup favoritism.

Therefore, this might have only affected the level of ingroup favoritism shown but not whether individuals showed ingroup bias.

When speaking to the participants after the study, some were able to realize the purpose of the study and were deliberately overriding the nonconscious process of ingroup bias and thin slicing, leading to less accurate results. Also, as the mood of the participants were proven to affect the accuracy of their thin slice judgments (Ambady & Gray, 2002), it is unclear to what extent the mood of the participants affected the accuracy of the present experiment, especially when there was no physical interaction with the participants to determine their mood beforehand.

## **Conclusion**

Individuals tended to increase their trust towards an individual after learning that they are part of the ingroup and decreasing their trust after learning an individual is part of the outgroup, hence, decreasing the accuracy of their thin slice judgment. As the level of ingroup favoritism increased, the tendency to judge an ingroup member as more trustworthy and an outgroup member as less trustworthy increased. Overall, the findings suggest that ingroup favoritism is positively correlated with the level of trustworthiness determined in thin slice judgments, and ingroup favoritism can potentially act as an internal influencing factor for the accuracy of thin slice judgments. Based on the results obtained in the study, additional research can arise in areas like investigating the influences of ingroup bias derived from different grouping methods (e.g. religion, ethnicity, gender etc.) on the accuracy of thin slice judgments. Any further implications of this study in areas such as law can help us make more informed choices and decisions, leading to greater justice and equality for all.

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## **Variance in Recognition of Colorectal Cancer Screening Guidelines and Risk Factors Among General Public By Nandini Dasari**

### **Abstract**

Multiple studies have convincingly shown that with regular screening tests and modification of lifestyle factors, the incidence and mortality associated with colorectal cancer (CRC) can be reduced [1]. However, CRC incidence rates in individuals younger than 50 have been increasing by 1-2% since the mid 1990s, highlighting a concerning pattern [2]. Based on these trends, screening guidelines for individuals at average risk for CRC have recently been adjusted, reducing the recommended age to begin screenings from 50 to 45 [3].

This study aims to gauge the general public understanding of CRC, including its associated risk factors and screening guidelines. Through Survey Monkey<sup>®</sup>, an online survey platform, a panel of 500 individuals from the general U.S. population was requested. The survey asked respondents to demonstrate their knowledge of current CRC screening guidelines, types of screening tests, and CRC risk factors. Respondents were also asked to provide insight into their own lifestyle practices which may contribute to increased risk of CRC.

We found that low-income, minority, non-college-educated, and younger-aged individuals had a lower awareness of CRC as compared to their demographic counterparts. Majority of respondents also reported lack of physical activity/elevated BMIs and attributed skipped CRC screenings to misinformation.

### **Introduction**

Colorectal cancer begins when healthy cells in the inner lining of the colon or rectum experience a harmful DNA mutation. These mutated cells may continue to multiply, forming a potentially cancerous growth, or polyp. Over time, cancerous polyps grow into the wall of the colon and rectum, eventually spreading, or metastasizing to other parts of the body through nearby lymph and blood vessels. As cancer metastasizes, it interferes with the regular functions of other organ systems, reducing survival rates dramatically [4,5].

In order to reduce the occurrence of CRC, two courses of action are recommended: 1) treatment and 2) preventative measures. However, treatment options may not always be effective and may have unpleasant side effects for patients. Instead, physicians recommend implementing preventative measures, citing regular screening tests and appropriate lifestyle changes as the most effective way to lower CRC risk [1].

Because most polyps take around 10-15 years to develop into a cancer, regular screenings can ensure that polyps are detected and removed before their cancerous cells spread [1]. There are several different types of CRC screening tests that can be performed, but they can be broadly split into two categories: 1) stool-based tests and 2) visual/structural exams [6]. Each category has its own benefits and limitations and must be performed with varying frequency. In addition, lifestyle changes, such as increasing physical activity, eating a balanced diet, and limiting smoking and alcohol consumption have been shown to reduce risk of CRC [7].

According to the 2018 Colorectal Cancer Screening Guideline released by the American Cancer Society, men and women at average risk of CRC are recommended to get screened regularly between the ages of 45-75, and for some, through the age of 85 [3].

There are several factors that influence the uptake of CRC screening; modifiable and nonmodifiable. Some factors, such as age, race, or family history, are nonmodifiable, while others, such as patient knowledge regarding CRC, are considered modifiable [7]. Studies have shown that by influencing modifiable risk factors, i.e. public awareness of CRC screening guidelines and risk factors, higher participation rates in screening can be achieved. For instance, in one study conducted in Spain with 953 average-risk participants, knowledge of CRC signs and symptoms proved to be the best predictor in having ever taken a screening test [8]. Research also suggests that promoting education efforts among populations who tend to have lower screening rates - for instance, younger-aged and non-college-educated individuals - may help in increasing screening participation [9].

Our study aims to confirm findings from previous studies, identifying the level of awareness of CRC screening guidelines and risk factors among different demographics. Additionally, for eligible individuals who have chosen not to complete screenings, we want to better understand their reasoning. In doing so, we hope to propose a potential solution to increasing screening uptake in the general public.

### **Methods–Participant recruitment & data collection**

With the help of SurveyMonkey®, a paid online survey platform, respondents were randomly recruited. A panel of 500 hundred U.S. residents was requested, and 517 survey responses, including those who partially completed the survey, were received. The panel was balanced according to census data of gender, and age was restricted to individuals 35 and older. All other demographic factors (race, income level, education level, and region of the U.S.) were recorded, but left uncontrolled. All survey responses were received within the span of 7 days.

### **Formulating survey questions**

The online survey was constructed using a conditional logic format, in which questions posed to participants varied depending on their responses to previous questions. All participants were asked to provide their demographic information (race, age, income level, gender, education level, and regional location within the U.S.) and information regarding lifestyle factors (physical activity, BMI, red & processed meat/alcohol consumption, and smoking). All participants were also asked to demonstrate their understanding of current CRC screening guidelines and identify the various CRC risk factors from a list provided. Finally, participants were asked if they had ever completed a CRC screening test. Respondents who answered “yes” were asked to report the date of their last screening test and type of screening test they had completed. Those who answered “no” were asked to supply a reason as to why they had chosen to avoid screenings.

## Statistical analysis

The margin of error (MOE) was established at a confidence level of 90%. U.S. population sizes were based on estimates sourced from government organizations including the Census Bureau and Center for Disease Control. Fig. 1 lists the MOE for various cohorts, and Fig. 2 lists the individual sources of population estimates.

Comparison between two groups of respondents for statistically significant difference was based on Z-score testing at a confidence level of 95%.

Respondents with household income over \$100,000 were identified as ‘High Income’ and those with a household income below the hundred thousand threshold were identified as ‘Mid to Low Income.’ Respondents identifying as non-white (i.e. black/African Americans, Hispanic/Latinos, Asians, American Indian/Alaskan Natives, Native Hawaiian/Pacific Islanders, and “Other”) were considered to be ‘Minorities.’ Respondents who stated that their BMI was over 24.9 were considered obese/overweight and those below the 24.9 threshold were considered to be at a healthy BMI. Fig. 3 details the demographic splits of survey respondents.

Segment	Sample Size	MOE (+/-)
All Respondents	517	4%
Female	269	5%
Male	241	5%
Obese/Overweight	307	5%
Healthy BMI	197	6%
Minorities	139	7%
Whites	377	4%
College	306	5%
No College	210	6%
High Income	165	6%
Mid to Low Income	352	4%
60+	104	8%
45-60	169	6%
44 and Below	239	5%

Fig. 1: MOE for various cohorts of survey participants.

Metric	Measure	Population Size	Source	Website
US Population	333287557		US Census 2022 v1	<a href="https://www.census.gov/quickfacts/fact/table/US/PST045222">https://www.census.gov/quickfacts/fact/table/US/PST045222</a>
% Female	50%		US Census 2022 v2	<a href="https://www.census.gov/quickfacts/fact/table/US/PST045223">https://www.census.gov/quickfacts/fact/table/US/PST045223</a>
% Male	50%		US Census 2022 v3	<a href="https://www.census.gov/quickfacts/fact/table/US/PST045224">https://www.census.gov/quickfacts/fact/table/US/PST045224</a>
% White	76%		US Census 2022 v4	<a href="https://www.census.gov/quickfacts/fact/table/US/PST045225">https://www.census.gov/quickfacts/fact/table/US/PST045225</a>
% Minorities (Non-White)	25%		US Census 2022 v5	<a href="https://www.census.gov/quickfacts/fact/table/US/PST045226">https://www.census.gov/quickfacts/fact/table/US/PST045226</a>
% College Educated	34%		US Census 2022 v6	<a href="https://www.census.gov/quickfacts/fact/table/US/PST045227">https://www.census.gov/quickfacts/fact/table/US/PST045227</a>
% No College	66%		US Census 2022 v7	<a href="https://www.census.gov/quickfacts/fact/table/US/PST045228">https://www.census.gov/quickfacts/fact/table/US/PST045228</a>
% Households w/ income > 100K	34%		Zippia	<a href="https://www.zippia.com/advice/how-many-people-make-over-100k/">https://www.zippia.com/advice/how-many-people-make-over-100k/</a>
Age 60+	23%		US Census ACS Survey	<a href="https://data.census.gov/table?q=United+States&amp;g=010XX00US&amp;tid=ACSDP1Y2021.DP05">https://data.census.gov/table?q=United+States&amp;g=010XX00US&amp;tid=ACSDP1Y2021.DP05</a>
Age 45-60	19%		US Census ACS Survey	<a href="https://data.census.gov/table?q=United+States&amp;g=010XX00US&amp;tid=ACSDP1Y2021.DP05">https://data.census.gov/table?q=United+States&amp;g=010XX00US&amp;tid=ACSDP1Y2021.DP05</a>
Age 44 Below	58%		US Census ACS Survey	<a href="https://data.census.gov/table?q=United+States&amp;g=010XX00US&amp;tid=ACSDP1Y2021.DP05">https://data.census.gov/table?q=United+States&amp;g=010XX00US&amp;tid=ACSDP1Y2021.DP05</a>
% Obese/Overweight	69%		Harvard University	<a href="https://www.hsph.harvard.edu/obesity-prevention-source/obesity-trends-original/obesity-rates-wo/">https://www.hsph.harvard.edu/obesity-prevention-source/obesity-trends-original/obesity-rates-wo/</a>

Fig. 2: Sources of population estimates.



Demographic	% of Respondents	Demographic	% of Respondents
<b>Age</b>		<b>Gender</b>	
35-44 years	47%	Female	52%
45-50 years	17%	Male	47%
51-60 years	16%		
61-76 years	18%		
> 76 years	2%		
<b>Race</b>		<b>Income</b>	
White or Caucasian	73%	Less than \$20,000	9%
Black or African American	8%	\$20,000 to \$34,999	12%
Hispanic or Latino	7%	\$35,000 to \$49,999	14%
Asian or Asian American	9%	\$50,000 to \$74,999	17%
American Indian or Alaska Native	1%	\$75,000 to \$99,999	15%
Native Hawaiian or other Pacific Islander	0%	\$100,000 to \$149,999	16%
Another race	2%	\$150,000 or More	16%
<b>Education</b>		<b>Body Mass Index</b>	
Less than a high school diploma	4%	< 18.5	8%
High school diploma	37%	18.5 - 24.9	32%
Bachelor's degree	35%	25-29.9	31%
Master's degree	17%	> 30	30%
Doctorate	8%		

Fig. 3: Demographic splits of survey respondents.

### Results and Discussion—Certain demographics have lower awareness of CRC risk factors and screening guidelines than others

Our survey responses confirm results presented by previous studies that mid to low-income, minority, non-college-educated, and younger-aged individuals have a poorer understanding of CRC and associated risk factors as compared to their counterparts.

When participants were provided a list of lifestyle factors and asked to select which ones were associated with CRC, factors such as “overweight and obesity,” “lack of regular physical activity,” “unhealthy diet,” “excessive consumption of red or processed meat,” and “family/medical history” were less frequently chosen by the demographics listed above. Data points that demonstrate statistically significant differences in risk factor recognition between cohorts are highlighted in red (Fig. 4-7).

Additionally, when participants were asked if they were aware of the most current screening guidelines for colorectal cancer, low-income, minority, younger aged, and obese/overweight individuals had a lesser awareness of CRC guidelines than their counterparts. Data points that demonstrate statistically significant differences in guideline awareness between cohorts are highlighted in red (Fig. 9).

Interestingly, when comparing the responses of obese/overweight participants versus those who had a healthy BMI, those who were obese/overweight tended to have a greater recognition of 4 out of the 7 risk factors listed. The four risk factors were overweight and obesity, unhealthy diet, family/personal medical history, and lack of regular physical activity.

The difference in recognition of these 4 risk factors is statistically significant, as shown by the data points highlighted in red (Fig. 8). This pattern may suggest that individuals at an unhealthy weight understand that they are at a higher risk for CRC, but are not able or willing to modify their lifestyle practices.

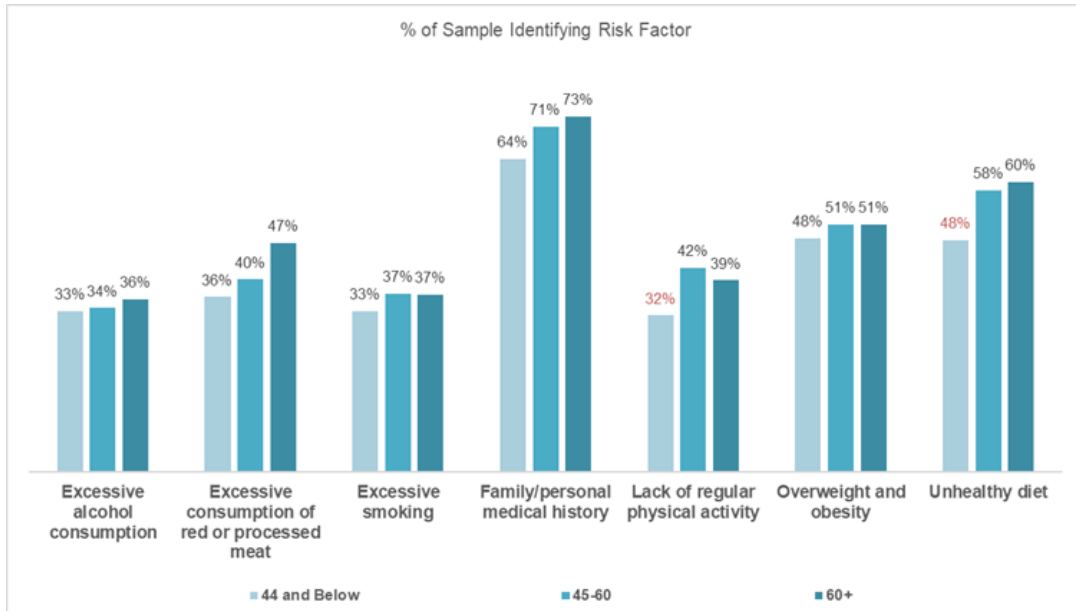


Fig. 4: Identification of CRC risk factors split by age.

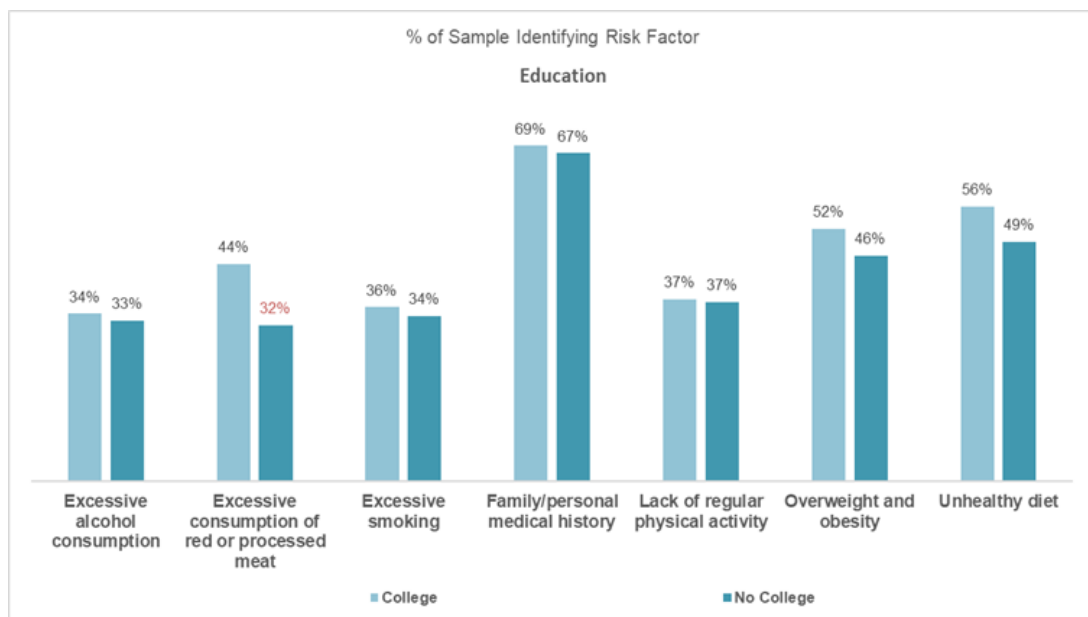


Fig. 5: Identification of CRC risk factors split by education level

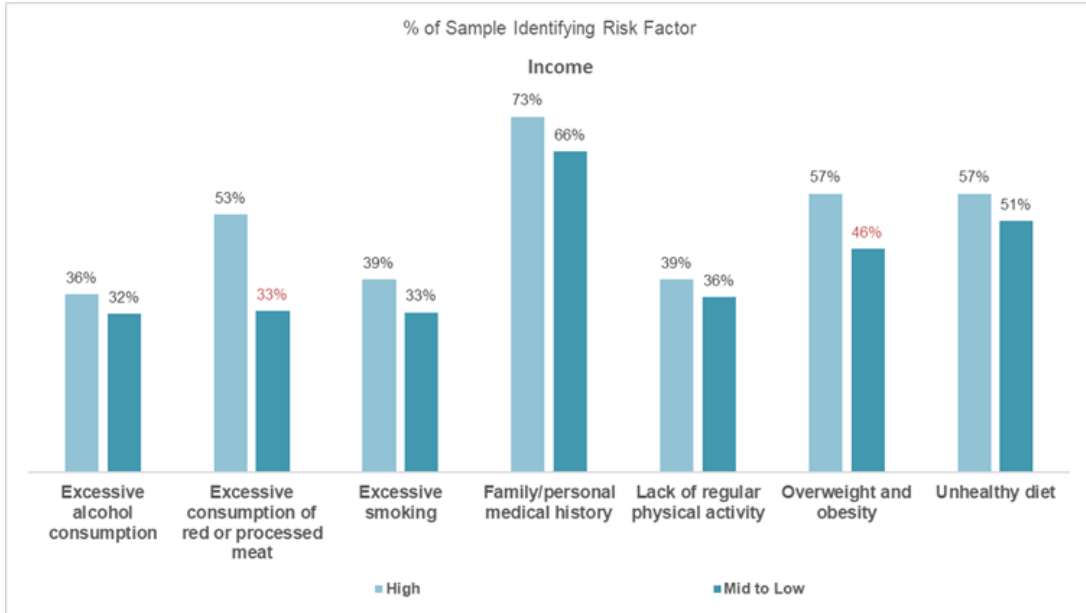


Fig. 6: Identification of CRC risk factors split by income level

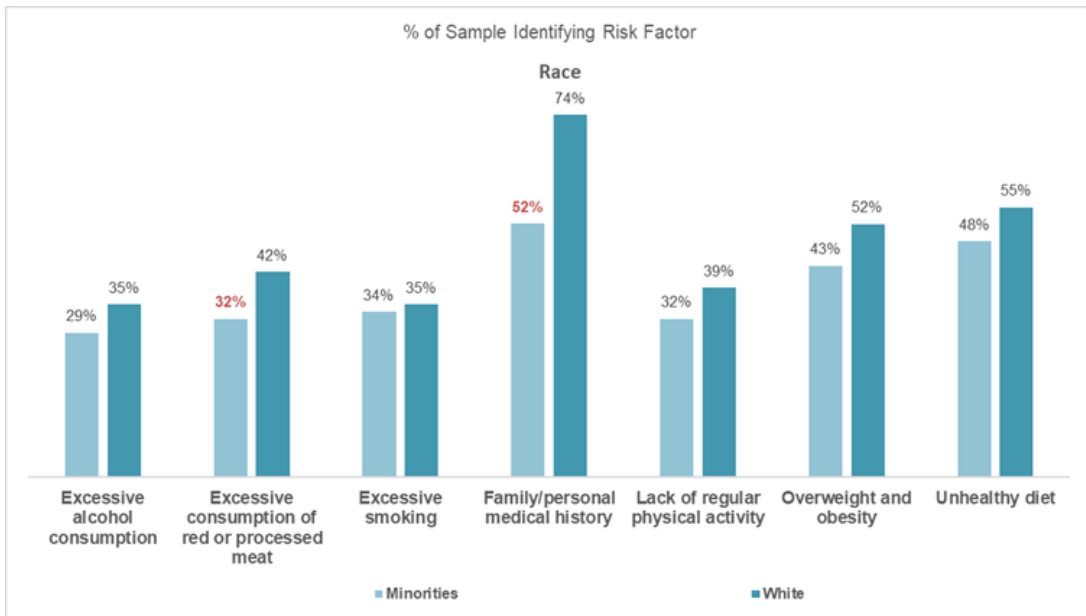


Fig. 7: Identification of CRC risk factors split by race.

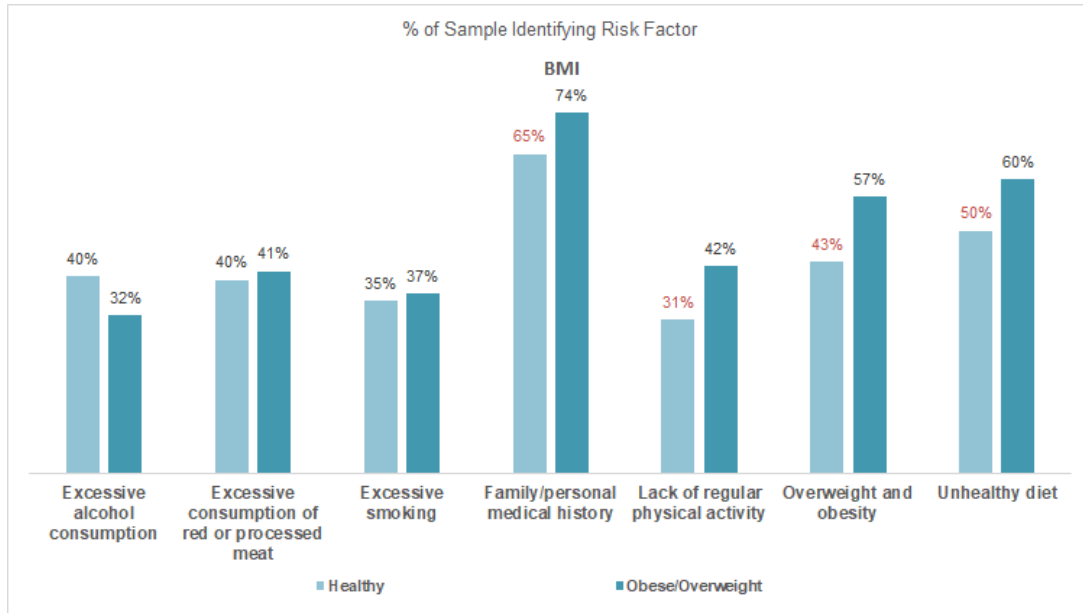


Fig. 8: Identification of CRC risk factors split by BMI.

Demographics	Awareness of CRC Screening Guidelines	
	Yes	No
Female	55%	45%
Male	56%	44%
Obese/Overweight	49%	51%
Healthy BMI	66%	34%
Minorities	43%	57%
Whites	60%	40%
College	61%	39%
No College	47%	53%
High Income	61%	39%
Mid to Low Income	52%	48%
60+	68%	32%
45-60	61%	39%
44 and Below	46%	54%

Fig. 9: Identification of screening guidelines split by demographic cohorts

### Skipped screenings may be associated with a lack of information and/or misunderstanding of CRC

Although the majority of participants insist that they understand CRC screening guidelines, in actuality, they appear to be misinformed. When all participants were asked if they were aware of the most current CRC screening guidelines (as released by the American Cancer Society), the majority (55%) of respondents answered “yes.” Participants who claimed that they were familiar with the screening guidelines were then presented a follow up question, asking that

they select the age at which people of average risk for CRC are recommended to begin screenings. Out of those who answered the follow up question, 31% answered the correct age (45 years), and 69% answered with an incorrect age. Fig. 10 displays the status of guideline awareness among all participants.

Additionally, when participants who were not planning on completing a CRC screening test were asked the reason for their decision, a significant portion of the participants (42%) responded that they “[were] not aware of/advised by [their] physician to consider or begin screenings” (Fig. 11). An additional 21% of participants responded that they didn’t think CRC screenings were necessary, as the participant “[had] no prior or existing medical conditions” (Fig. 11).

Therefore, a majority (64%) of participants who were not planning on completing a CRC screening test had refused to do so based on a lack of information or faulty reasoning. Regardless of current state of health, the 2018 Colorectal Cancer Screening Guideline released by the American Cancer Society advises all individuals to begin screening at least from the age of 45 [3]. (Some individuals who have a family history of CRC or other existing medical conditions may be at a higher risk of CRC and are advised to begin screenings at an earlier age). When participants claim that they should be able to skip CRC screenings because they “have no prior or existing medical conditions,” they cite a reason that is unsupported by prevailing medical research.

A lack of information and/or misunderstanding of CRC can be resolved by primary care physicians, as they may take partial responsibility for educating their patients regarding current CRC screening guidelines.

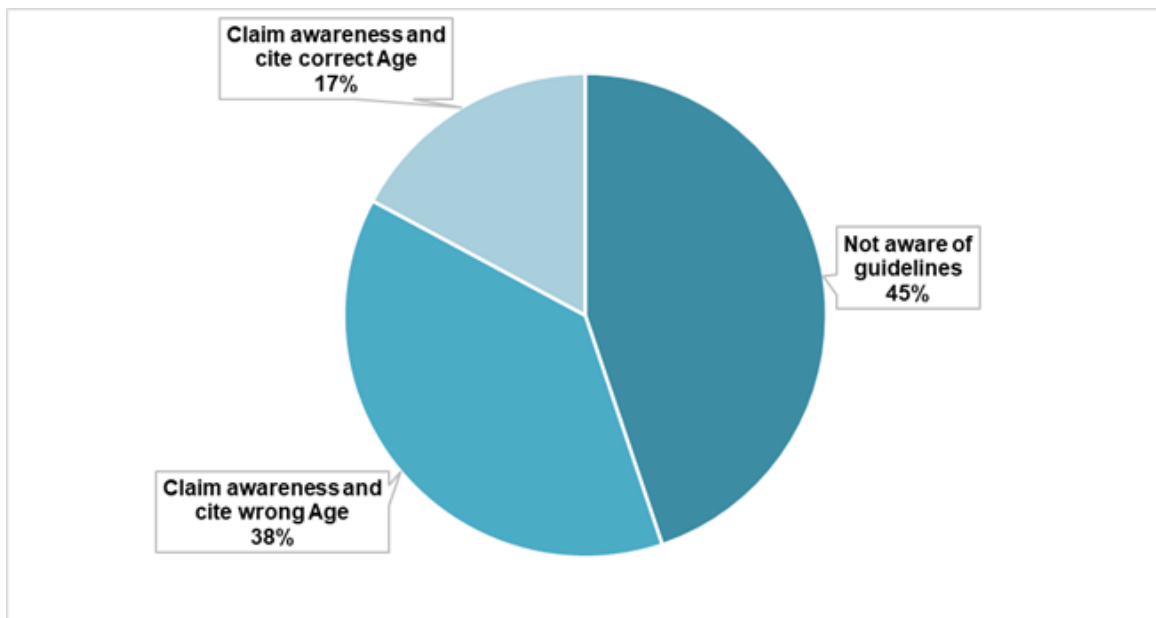


Fig. 10: Status of guideline awareness among all participants

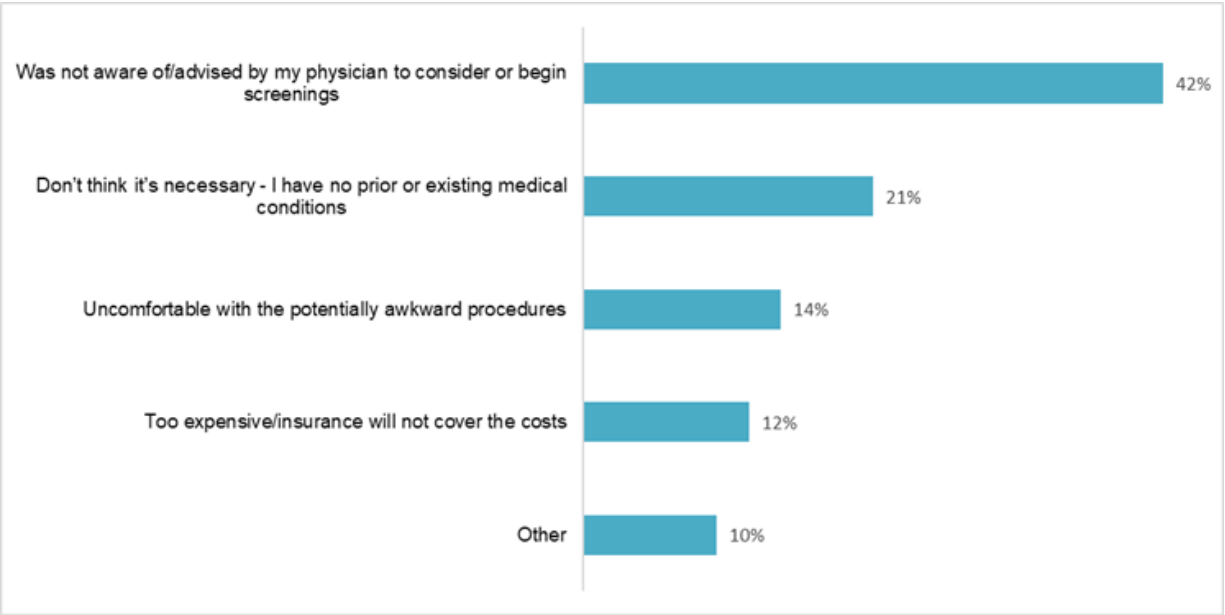


Fig. 11: Reasons cited by respondents who did not complete/plan on completing CRC screenings.

**Majority of Respondents Report Lack of Physical Activity and Elevated BMIs**

In order to better understand the lifestyle of the general public, we asked all participants to report their smoking habits, alcohol consumption, Body Mass Index (BMI), red/processed meat consumption, and amount of weekly physical activity. Analyzing the lifestyle of participants helped us in gaining a general understanding of their risk for CRC. If done in excess, smoking, consuming alcohol or red/processed meat, remaining overweight/obese, and failing to engage in regular physical activity can increase risk for CRC [7].

Out of all participants, 88% are within the recommended guidelines for alcohol consumption (1 drink or less per day for women and 2 drinks or less per day for men) [10]. Though the exact amount of tobacco consumption known to contribute to the development of CRC is unknown, 76% of respondents report that they do not smoke. Additionally, 78% of participants are also within the recommended guidelines for consumption of red/processed meat (3 portions (12-15 oz) or less per week) [11].

Though the majority of participants seem to be meeting the recommended guidelines for alcohol consumption, smoking, and red/processed meat consumption, the majority of participants (83%) are not meeting the recommended guidelines for physical activity (at least 150 minutes of moderate to vigorous physical activity) per week [12]. Similarly, the majority of participants 61% are also overweight or obese (above a BMI of 24.9). Lack of physical activity and remaining overweight or obese are both known risk factors for CRC [7].

The data shows that participants have room for improvement in modifying lifestyle factors to reduce risk for CRC.

## Conclusion

Although not all cases of CRC can be prevented, more than half of all cases can be linked to modifiable risk factors [7]. Maintaining healthy lifestyle habits, such as eating a balanced diet and exercising regularly, can lower an individual's chance of developing CRC [7]. Additionally, completing CRC screening tests in a timely manner can help in catching the cancer at an earlier stage, when it is easier to treat [7].

This study is aimed to test the general public understanding of CRC risk factors and screening guidelines in order to find areas for growth. Our results can be summarized in three main findings:

1) Certain demographics have lesser recognition of CRC screening guidelines and risk factors than others. Mid-to-low income, minority, non-college-educated, and younger-aged individuals have a lesser awareness of CRC risk factors and screening guidelines as compared to their demographic counterparts. Furthermore, when comparing the responses of obese participants versus those who had a healthy BMI, those who were obese tended to have a greater recognition of CRC risk factors. Though the exact reason for these patterns cannot be deduced from our survey data, further research may provide some insight. Conducting similar CRC awareness surveys within the U.S. and restricting survey panels to only one demographic at a time (i.e. only minority respondents or only obese/overweight respondents) can be pursued as a follow-up study. The results of these follow-up surveys may be used by primary care physicians who could target these groups for educational efforts.

2) Most participants seem to be at a lack of knowledge or misinformed regarding CRC screening guidelines. In a follow up study, we may conduct a survey asking respondents within the U.S. which type of educational materials (i.e. social media posts, pamphlets at doctor's office, PSAs, etc.) they find most appealing. Data from this survey could potentially be used to produce public education materials that will reach larger audiences and improve CRC guideline/risk factor awareness.

3) Though the majority of participants are meeting the recommended guidelines for alcohol consumption, smoking, and red meat consumption, the majority of participants are not meeting the recommended guidelines for physical activity or BMI. As a lack of physical activity and remaining obese/overweight are both risk factors for CRC, a follow up study may be conducted to determine the cause of unhealthy weight management among Americans. The follow-up study may also assess any connections between unhealthy weight management and demographic factors, such as race or income.

Overall, there are several drawbacks associated with this study, most notably a skew in age and race of survey respondents. A large percentage of participants, 47%, were within the age range of 35-44, or below screening age for individuals at average risk for CRC. As individuals below screening age typically aren't yet required to schedule screening tests, they may not necessarily be aware of CRC screening guidelines and risk factors. This understandably lower CRC awareness in a large chunk of participants may have interfered with the finding that the majority of participants seem to be at a lack of knowledge and/or misinformed regarding CRC

screening guidelines. Similarly, an overwhelming majority, 73%, of all survey participants were white/Caucasian, leaving only 27% of participants to be classified as minority. Collecting survey responses from a small pool of minority participants may have misrepresented minorities within the general U.S. population, falsely contributing to the finding that minorities have a lower CRC awareness than their white/Caucasian counterparts. Both the skew in race and age of survey participants may be resolved by conducting a follow up survey in which a larger panel is recruited and/or the panel is restricted to only minorities or only individuals of screening age.



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# **Analyzing the Effects of Climate Change (Arable Land and Maximum Temperature) on Regional Migration Using Time Series Regression and Linear Multivariate Regression By Sanjoli Gupta**

## **Abstract**

My research aims to determine the impact of increased temperature and decrease in arable land per person on climate migration in Brazil, Somalia and Pakistan. Understanding the impact of climate change on migration out of rural areas will help cities and countries plan for internal migration. This is of paramount importance since climate migration is a growing issue leading to more migration out of rural areas.

My research applies a moving average time series to forecast future temperature and arable land per person based on past values in different regions of Brazil, Somalia and Pakistan. I then applied multivariate regression to determine the correlation between the rural population percentage, the dependent variable, and arable land per person and increase in maximum temperature, the independent variables, for the whole country.

My ANOVA multivariate regression analysis found a high correlation of decreasing rural population percentage with a decrease in arable land and increase in max temperature. The high correlation is indicated by an  $R^2$  of 0.92 in Somalia, 0.97 in Pakistan, and 0.43 in Brazil. The moving average time series model demonstrated that certain regions were increasing in temperature faster than others and that there would be internal migration out of regions whose climate wasn't fit for farming and sustaining rural populations.

## **Introduction**

By 2050, the IEP predicts that 1 billion people will be displaced due to climate change<sup>1</sup>, which means that these 1 billion people will need to find a new place to stay. With the current lack of resources and overpopulation, it will be difficult to take in the influx of climate migrants without knowing where they will come from, which is why it's important to predict climate migration patterns.

The reason for focusing on temperature increase is because it can cause loss of livelihood, food insecurity, disease, and conditions unfit for human life which are all drivers of climate migration. These conditions will directly impact human survival by causing famine, food insecurity, and conditions where the temperature cannot sustain humans to live in. Drought specifically has been causing issues in the past decades already. Lack of arable, or farmable, land causes food and job insecurity and migration to urban areas in search of stability.

The study will focus on Pakistan, Somalia and Brazil due to their differences in GDP. Having three countries with different GDPs and different levels of development will help assess if the impact of extreme temperatures and decrease in arable land on climate migration varies with income levels. Each country is in a different continent as well helping assess the impact of climate migration in different climates and cultures. The GDP per capita is USD 7507.16 in Brazil, USD 1505.01 in Pakistan and USD 446.98 USD in Somalia<sup>2</sup>. Since the wealthiest

countries drive climate change and have more resources and money to deal with the outfall of climate migration, they will not be the area of focus the study. The focus is on internal migration within countries themselves.

There are some country specific predictions based on past research and patterns. Brazil is a nation with many agribusinesses focusing on producing beef, dairy products and growing soy, the increase in heat has caused extreme drought especially in areas such as the northeast and south. An impact of increasing temperatures is the quicker evaporation of water and drying out of trees. Moreover, reservoirs have had difficulty collecting water: a 2014 drought had the “main reservoirs [reaching] storage levels of only 5% of their 1.3 billion m<sup>3</sup> capacity”<sup>3</sup>. The crops that take 90% of total crop land include soybeans, maize, sugarcane and rice. These crops thrive in rainfed conditions and need water that is present in the southern areas of the country<sup>4</sup>. However, rainfall consists of only 20% of the watering in north central regions and irrigation covers the rest. The Northeast region of Brazil is the driest in the country with less than 700 mm of rain a year<sup>5</sup>. This region includes a fifth of the land in Brazil and twenty five percent of the population. The region “accounts for one-fifth of the nation’s agricultural production, but the industrial and service sectors lag far behind those of the Southeast and South”<sup>6</sup>. The unemployment rate in the Northeast is the highest in the country at 26.3 percent<sup>7</sup>. Water insecurity due to a lack of rain would also help push for this migration<sup>8</sup>.

Somalia is built around movement, with 55% of their population being nomadic<sup>9</sup>. The drought in 2011 led to famine, and the political instability and lack of aid in the area helped exacerbate the issue. Because of drought and semi-arid to arid lands, high temperatures and low rainfall lead to drought. Nomadic pastoralists find themselves moving further in search for good grazing lands for their sheep and goats and, eventually, find themselves crossing borders<sup>10</sup>. The change from the traditional migratory patterns to further ones in search of food can lead to pressure on the carrying capacity of the land since pastoralists move into new areas with environmental stress<sup>10</sup>. Pastoralists are mainly in the north and central regions while agro pastoralism flourishes in the southern and northwest regions. The livestock trade that occurs contributes to 40% of the economy<sup>11</sup>. Somaliland itself is an autonomous region while still in Somalia and there is already a crisis with internally displaced people since there is conflict and violence, drought and lack of employment opportunities<sup>12,13</sup>.

In Pakistan, both heat waves and flooding is now more common and the flooding in 2022 displaced one third of the population. They are projected to have 2 million climate migrants by 2050<sup>14</sup>. Historically, heat waves have been extremely damaging and even increased the mortality rate by 17% in June of 2015 in Karachi<sup>15</sup>. Rainfall has significantly decreased and less than 80% of expected rainfall took place in the spring of 2022<sup>16</sup>. Locust infestations have also occurred multiple times in the past century putting crops and food security at risk<sup>17</sup>. There is an expected population increase to 366 million in 2050 and 487 million in 2100<sup>18</sup>.

A wet bulb temperature is the highest temperature at which sweat can evaporate and the body cooled. According to a research paper on the adaptability to climate change in the face of heat, that temperature doesn’t exceed 31°C and any wet bulb temperature over 35°C leads to

hyperthermia and death<sup>19,20</sup>. However, a study by Penn State proves that the wet bulb threshold is actually much below 35, and may even reach just 31 degrees celsius. If the temperature outside the body is warmer than the internal temperature, the heat from the surrounding environment will infiltrate the cooler body to even out the temperature and it becomes impossible to cool down<sup>21,22</sup>. Sweating can be very effective in a dry environment, but in areas with high humidity, the existing moisture in the air means that sweating doesn't have an impact since the sweat doesn't evaporate off the skin<sup>23</sup>. This means that different places will have different temperatures at which death will become imminent. According to Time, the increasing heat directly relates to increasing heart rate: with every 0.5°C increase in temperature, the body pumps blood at 10 beats more per minute, leading to high blood pressure<sup>24</sup>. This eventually causes fatigue, headache, nausea and vomiting. Seizures and strokes can also take place, and eventually organ failure and death.

If global warming continues and a 4°C increase occurs in the highest near surface temperature and most common range of temperatures, the temperature buffer to reach 35°C shrinks to a fourth of what it was previously. A shift of 8.5°C, the worst case scenario, would result in 35°C becoming a common occurrence.

By 2050, there are projections that there will be one billion climate migrants. Climate migration is a growing problem which can cause overcrowding in mega cities and an influx of people without homes. The change in climate will cause both internal and external migration changing the population density of the land and moving masses of people to areas underprepared for their arrival. Understanding the migration patterns and changes in climate, such as increased temperatures, will help countries better plan for the migration that will occur and ensure they have the infrastructure and employment opportunities necessary to take care of their citizens. Moreover, the issues faced because of climate migration will be unique to each country's demography and lifestyle.

There are a variety of impacts of heat increase. When heat increases, the human body faces a variety of impacts. As heat increases, it becomes near impossible for the human body to continue living. With sustained heat over long periods of time, those over 2-6 hours, the body cannot sweat and use its natural mechanisms to cool down, leading to an increase in body temperature and death. Even with short bursts of heat, the body needs a prolonged time to recover. Famine in both crops and humans becomes more common as temperatures rise. As crops fail due to lack of the correct climate, residents will move within their countries to find new jobs in urban areas and more fertile regions causing a change in the population structure and density throughout the country.

My hypothesis is that the negative changes that come about due to increases in extreme temperatures and decreases in arable land will cause mass migration or displacement internally in countries due to food insecurity, loss of home and loss of livelihood. This will cause major strain on the remaining fertile areas to provide and create overpopulation in urban areas. The focus will be to see how the maximum temperatures will change and how the region should react when it comes to migration based on past migration due to climate issues. I hypothesize that the

decrease in rural population percentage is also being caused by the increase in max temperature and decrease in arable land per person.

I predict that the extreme temperatures and decrease in arable land will create internal migration towards areas with better climate and living conditions and towards urban areas with employment.

For Brazil, as droughts grow more intense and frequent due to increased heat, growing crops and sustaining a livelihood become more difficult leading to migration to the Southeast region which is also more developed. I hypothesize that Somalia's internal migration will be to regions with rainfall and a less dramatic increase in temperature in order to grow more crops. For Pakistan, I predict that there will be climate migration from flooding and drought stricken areas to urban areas and areas with better climate to improve their livelihoods.

Because the information being used in the time series is from past measurements and doesn't use any human or animal experimentation, there is no risk in conducting this experiment. No risk or safety precautions are needed since all the data for the forecasts is coming from the World Bank.

Using information about historical regional max temperatures and arable land per person, the likelihood of migration will be analyzed. The independent variables, on which migration is dependent, are maximum temperature and amount of arable land available per person (in hectares). Migration will be studied by analyzing correlation of rural population percentage with these factors. Decrease in rural population percentage signals those living in rural areas moving to urban areas and redistributing themselves, depicting migration. Since we know where the urban population is centered in the already established regions in countries, we can infer internal migration and the region to which people are migrating.

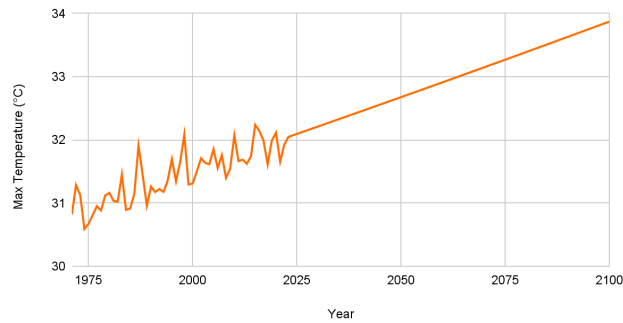
Using the data from the climate portal from the World Bank, the historical max temperature (in °C) and arable land per person (in hectares) for different subunits of Brazil, Pakistan and Somalia were downloaded. The past 50 years of data values, from 1971 to 2021, were modeled using time series to produce a projection of max temperature and arable land per person till 2100. Each country was divided into regions for which temperature increases, arable land decreases and migration could be analyzed. Brazil has 26 states, but is grouped into 5 major regions focusing on their location: North, South, Southeast, Northeast and Central West<sup>25,26</sup>. Somalia has many administrative units but is overall divided into six member states: Somaliland, SouthWest, Puntland, Jubaland, Galmudug and Hirshabelle<sup>27</sup>. The average of the temperatures in each region of each state was taken to create overall average max temperature values for 1971 to 2021. Pakistan has 4 regions, including Sindh, Punjab, Khyber Pakhtunkhwa, and Balochistan and the capital region of Islamabad<sup>28</sup>. Khyber Pakhtunkhwa includes the Federally Administered Tribal Regions as well as the North-Western Frontier, which were kept divided in predictions because of their differences in climate.

To analyze the correlation between the decrease in arable land and increase in temperature on the percent of the population living in rural areas, a linear multivariate regression was used. The rural population percentage data is largely with consistent values and trends being

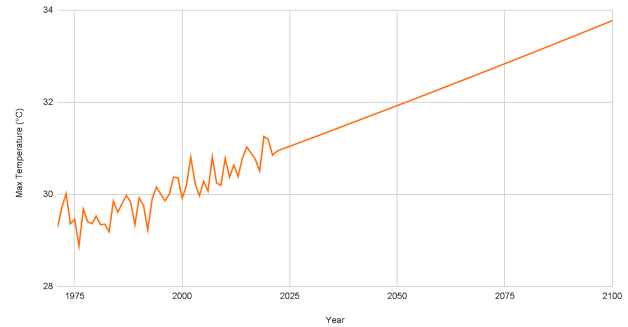
present regardless of the values of the independent variables (max temperature and arable land), and is thus homoscedastic.

## Results and Discussion—Regional Maximum Temperature Analysis

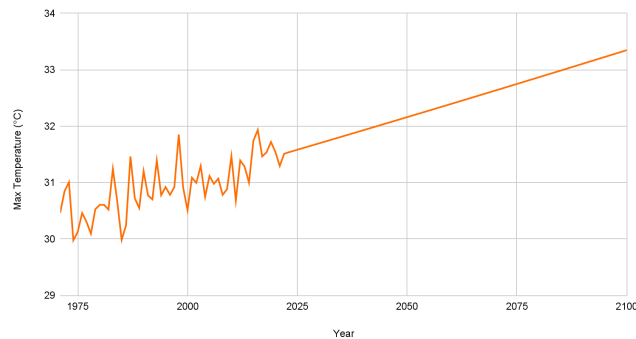
North Brazil



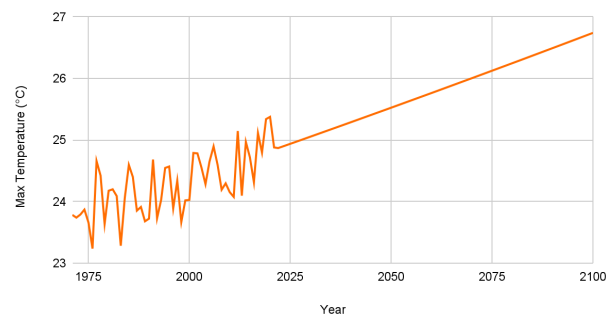
Central West Brazil



North East Brazil



South Brazil



In all the sub areas of Brazil, the time series model predicts a substantial increase in temperature over time. As North Brazil's max temperature increases to 32.67 in 2050, it will be more difficult to continue growing the crops that need water as droughts can occur. The North contains the Amazon rainforest, and as temperatures rise the biodiversity and health of the forest can be compromised. Heat stress on crops can reduce yields and make it difficult to continue farming, leading to those in the North migrating to the relatively cooler South and South East Brazil.

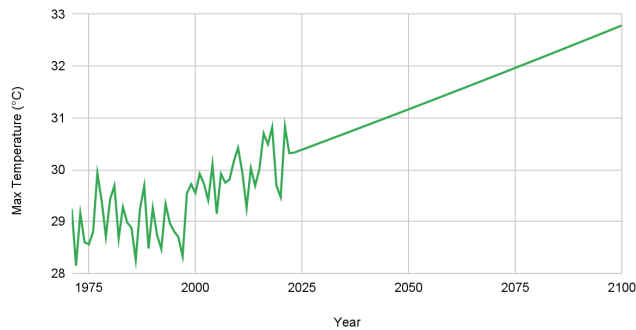
Because of the heat island effect, where the darker surfaces and lack of greenery in cities cause them to be a few degrees warmer than surrounding areas, those living in large cities, such as the megacity San Paolo, will see an increase in temperature above the increase in other areas. There will also be an influx of people whose livelihoods can no longer sustain them causing San Paolo to explode in population and development leaving the North even further behind when it comes to development.

The Central West has heavy farming and the temperature increase will also impact the farming in this region. South and Southeast Brazil temperatures will not rise above 31°C by 2100 while the other three regions will have at least 33°C of heat by 2100 causing mass southward migration. Humidity also means that the high temperatures would make it more difficult for the body to cool down.

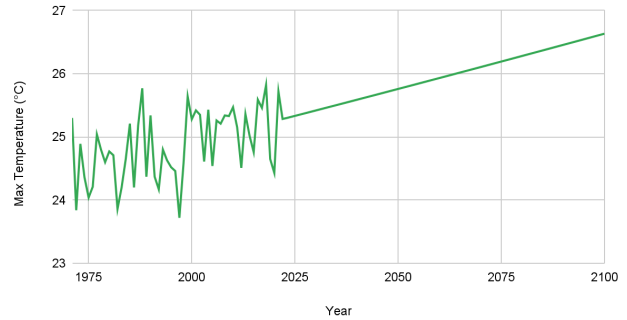
As rainforest in the North is cut down for farming when it becomes harder to farm in other areas, the land desertifies and warming continues with more dark barren land absorbing heat and less greenery. When this land becomes unfarmable or there isn't grass left for cattle, more forest is cut down and people migrate. This can create a positive feedback loop.

## Pakistan

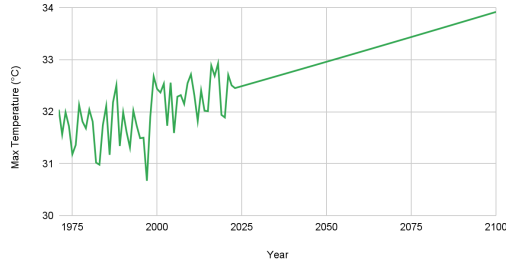
Balochistan Pakistan



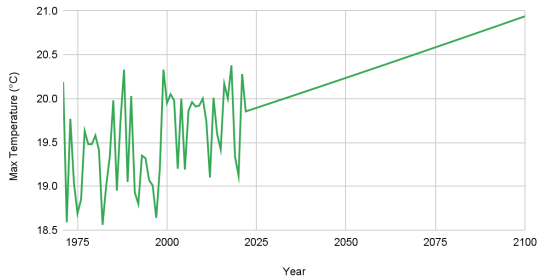
Federally Administered Tribal Areas Pakistan



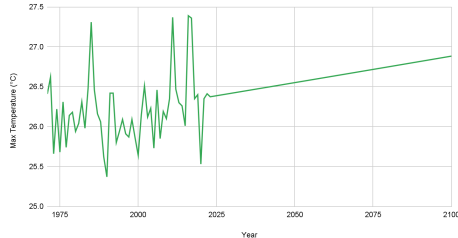
Punjab Pakistan



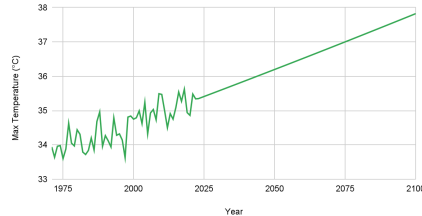
North-West Frontier Pakistan



Islamabad Pakistan



Sindh Pakistan

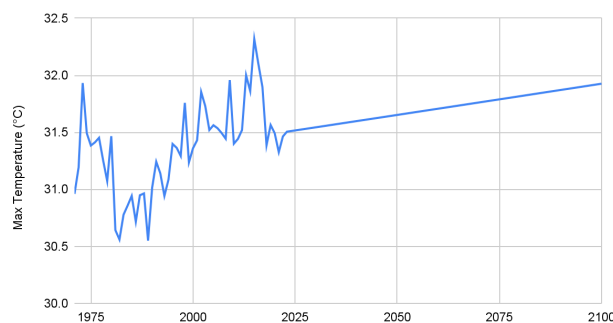


Sindh is already seeing max temperatures above the wet bulb point for humans. In 2021 itself, the temperature was 35.48 °C, which would cause heat strokes and other medical issues to arise for those living in these heat conditions for prolonged periods of time. As the temperature continues to rise to a projected 37.82 °C in 2100, those living in Sindh will be unable to continue living there and will have to leave the region in search of a livable climate. The high humidity means that the body can handle lower temperatures and the high temperatures will be even more stifling. Sindh borders Punjab and Balochistan meaning these two areas will see an influx of millions of people. There are currently 47.85 million people living in Sindh and the influx of this many people into the bordering areas will cause strain on the land. Those who do not have the wealth or resources to move will meet disease and death. Rural and subsistence agriculture are the major livelihoods for people in Sindh, Balochistan and Punjab, so the incoming millions will need more land to grow their food.

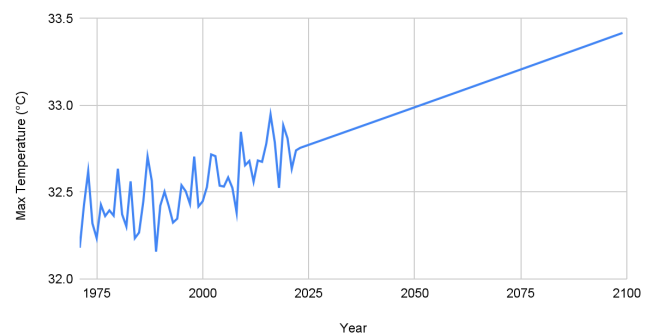
Crop yields will decrease because of heat stress and new pests which thrive in the new conditions. Balochistan is already facing food insecurity due to locust infestations, lack of precipitation and an increase in people and further decrease in yields will cause mass migration<sup>29</sup>. Punjab, which primarily produces wheat, is also seeing an increase in max temperatures which will affect the agriculture of the area. Islamabad, the capital, currently holds around 1 million people and, with the increase in temperature, will not see a mass exodus but an influx of migrants from Balochistan, Sindh and Punjab, but mainly from Sindh because Sindh will become so hot that it is unlivable. The Federally Administered Tribal Areas see an increase in temperature, but will not face life threatening heat. The Pashtuns who live in the semi autonomous region will see more people coming to live there for the better climate. The expected population increase to over 350 million by 2050 and over 450 million by 2100 will not help with the migration and will cause the land to be unable to support the population, with international migration potentially occurring because of the shortage of space. The North-West Frontier already has rugged terrain and the lowest income throughout the country so there might be migration to the area although it would be difficult to sustain.

## Somalia

Somaliland Somalia

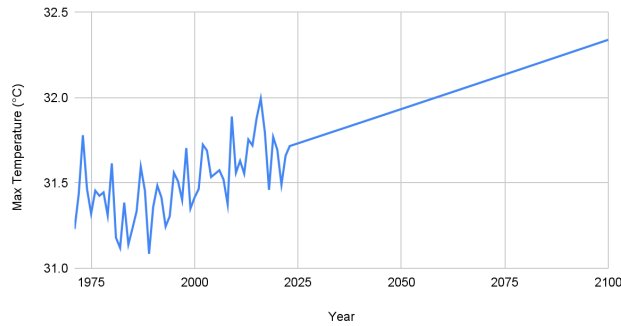


South West Somalia

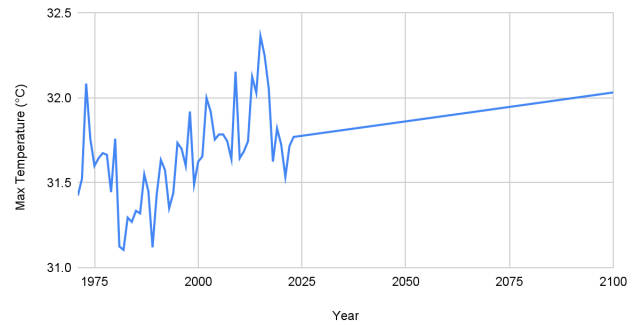




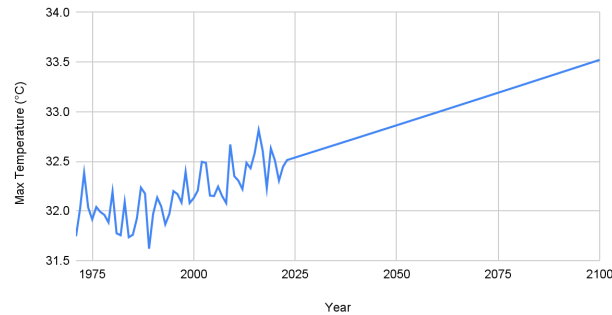
Puntland Somalia



Hirshabelle Somalia



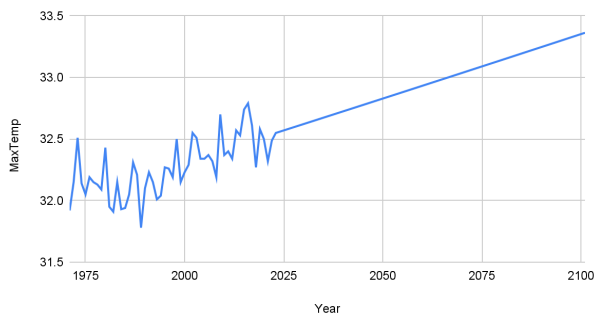
Galmudug Somalia



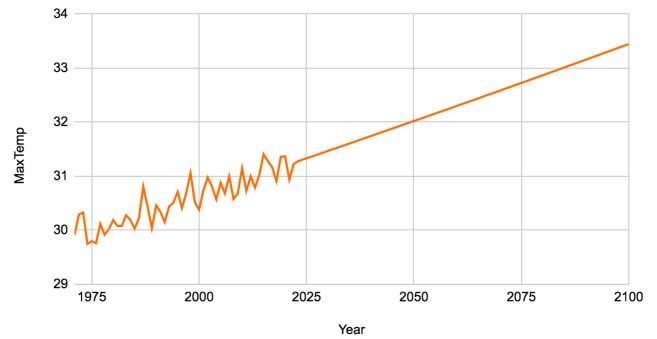
Somalia is seeing an increase in temperatures as well. The nomadic pastoralists in the northern and central regions will become more prominent in both Hirshabelle and Somaliland because of the lower temperatures. Somaliland is the northmost state and Hirshabelle is in the central region. Those who practice agro farming in the northeast and south will move towards the central and northern regions as well due to heat stress caused to their crops and livestock. The northeast region includes Puntland and Mudug, a region in Galmudug while the southern region includes the South West and Jubaland. The highest temperature increase, to 33.52°C in 2100, occurs in Galmudug, where there will be exodus north and to the central parts. This will cause overcrowding in the cooler regions. The humidity will not help with the increased heat. Existing inequalities will be exacerbated with the increase in heat and existing conflict also adds strain to the situation. The current lack of opportunities for employment within Somalia and ways to improve one's socioeconomic status means the international migration is also likely to grow more common in search of areas without drought to sustain one's livelihood and avoid needing to face extremist groups like Al-Shabaab.

## National Maximum Temperature Analysis

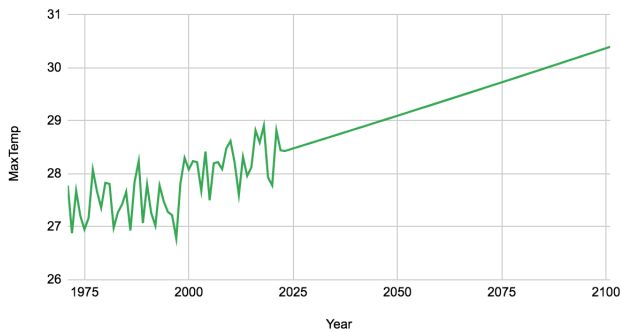
Somalia Max Temperature



Brazil Max Temperature



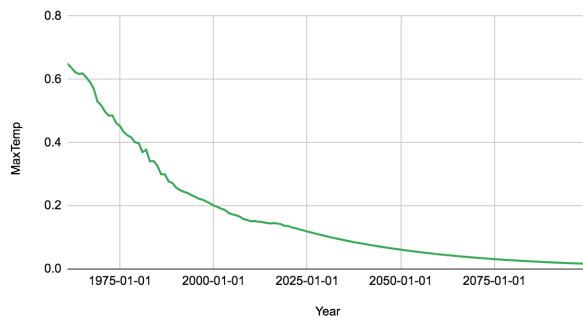
Pakistan Max Temperature



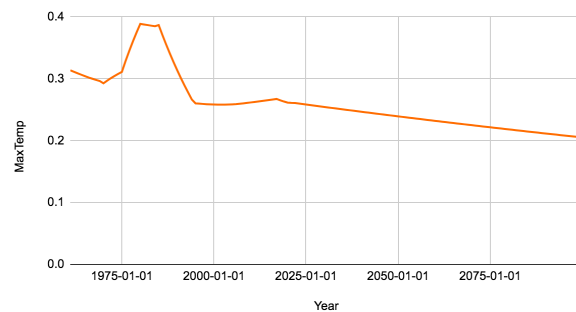
While analyzing overall max temperature for the countries, there were low RMSE values. For Brazil, the RMSE was 0.2136109817. This indicates that the data is accurate and reflects the increase in temperature well. The  $R^2$  was 0.7686198935, meaning that the data is correct 76.86% of the time and will match up with future values. For Pakistan, the RMSE was 0.4202324414, which means that the data is also highly accurate and reflects that the data fits the time series model well. However, the  $R^2$  was 0.4063491705, or 40.63%, meaning that there are more factors affecting the increase in max temperature that haven't been considered. Finally, for Somalia, the RMSE value was 0.1711789202 reflecting the highest accuracy of all three models. The lower the RMSE, the better fit the model was for the data set. Good RMSE values are generally considered to be in between 0.5 and 0.75. The  $R^2$  was 0.4384843454, which indicates that 43% of the variability of the forecasted data for Somalia can be explained by the independent variables of arable land and max temperature.

## Nationale Arable Land (in hectares per person) Decrease Analysis

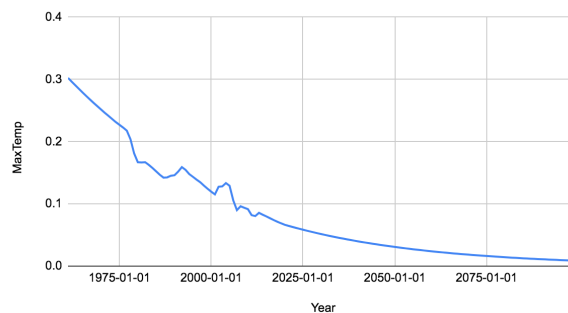
Pakistan Arable Land (hectares per person)



Brazil Arable Land (hectares per person)



Somalia Arable Land (hectares per person)

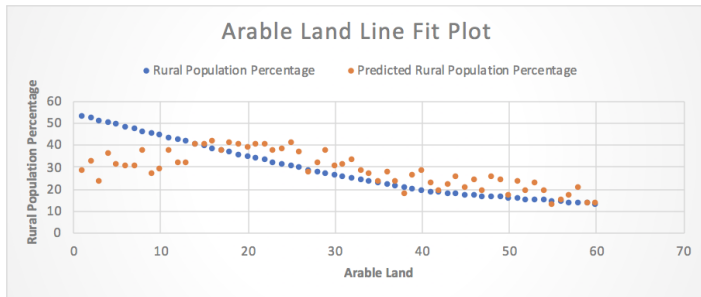
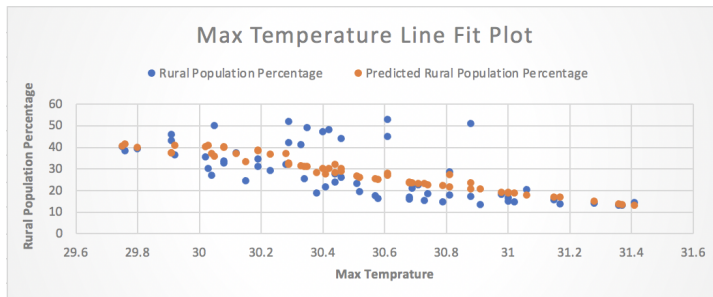


The time series model for Pakistan and Somalia's arable land in hectares per person was polynomial and not linear. For Pakistan, the RMSE was 0.02124419741 and the  $R^2$  was 0.6567034164. Since the low Standard Error, we have strong confidence that Pakistan's per capita arable land can be predicted by past values of per capita arable land. The  $R^2$  of 65.67% shows that there is a high correlation between the predicted and past values. Somalia's RMSE was at 0.01002573816 and the  $R^2$  at 0.8795144484. Brazil's RMSE was at 0.04029126329 and the  $R^2$  0.1119892792. Even though the data fits the model and is highly accurate, there is a bump in Brazil's historical data with a sharp increase, stability and a sharp decrease in arable land per person, which creates a deviation from a trend but overall, the model produces accurate predications.

## Linear Multivariate Regression: Rural Population (Percent of Total Population) Decrease

<i>Regression Statistics</i>	
Multiple R	0.66181399
R Square	0.43799776
Adjusted R Square	0.41827838
Standard Error	9.48890449
Observations	60

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
Intercept	469.919123	121.6010458	3.86443324	0.00028751	226.417229	713.421018	226.417229	713.421018
Max Temperature	-15.034358	3.743852329	-4.0157455	0.00017526	-22.531293	-7.5374233	-22.531293	-7.5374233
Arable Land	57.7535575	37.10067264	1.55667144	0.12508394	-16.539258	132.046373	-16.539258	132.046373

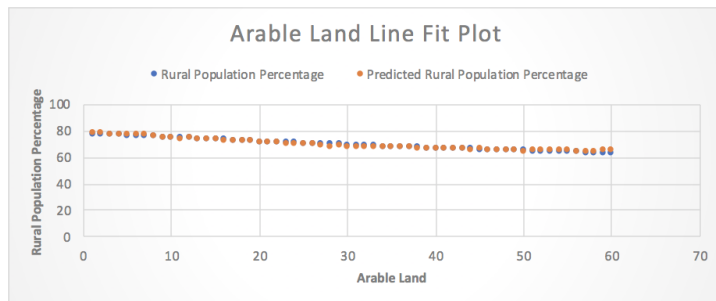
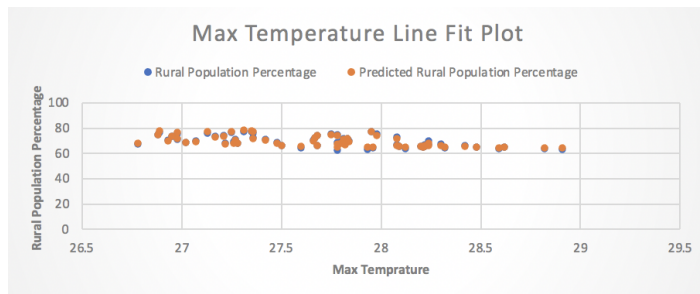


Through this model, 43.79% ( $R^2$ ) of the rural population decrease can be described by decrease in arable land and increase in max temperature. The  $R^2$  value indicates the extent to which there is a correlation between dependent variable (rural population percentage) and independent variables (max temperature and arable land per person). This correlation makes sense because less farmable land and increasing temperatures that harm agriculture will cause those in rural areas to move out. The Standard Error is 9.489 because 60 data points with varying numbers were used for the data from 1961 to 2020 causing the error to increase. There is a clear correlation between increasing temperatures and decreasing arable land with a decrease in the percent of the population living in rural areas. There is heteroskedasticity in the Max Temperature Line Fit Plot, but the Arable Land Line Fit Plot is more homoscedastic in nature. The P value, which measures the statistical significance of the data, is approximately 0.000175 for max temperature, which is well below the 0.05 threshold, indicating the changes in temperature do reflect onto the migration out of rural areas. This model also represents more than just the sample of data used because of the low p value; For arable land, the P value is approximately 0.125, which indicates correlation, but not as strong as with max temperature.

## Pakistan

<i>Regression Statistics</i>	
Multiple R	0.9837331
R Square	0.9677308
Adjusted R Square	0.9665986
Standard Error	0.8017889
Observations	60

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
Intercept	82.848025	6.604610373	12.543969	4.92E-18	69.622521	96.07353	69.6225212	96.0735295
Max Temperature	-0.759933	0.233571353	-3.253538	0.0019185	-1.227652	-0.292215	-1.22765176	-0.2922146
Arable Land	24.944806	0.755893763	33.000412	7.73E-39	23.431155	26.458457	23.4311545	26.4584568



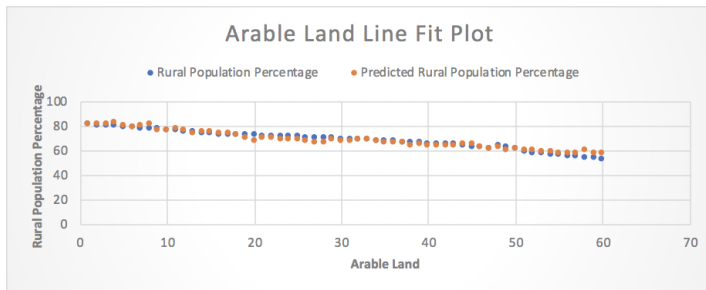
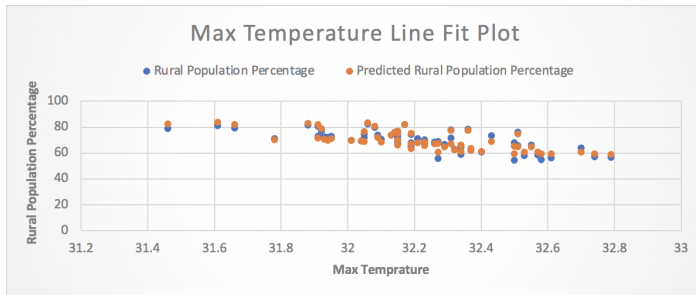
For Pakistan, the  $R^2$  value is 0.96773083. This means that 96.77% of rural population percentage decrease can be explained by an increase in max temperature and decrease in arable land. This is an extremely high value and indicates a very high correlation between the factors and the migration out of rural areas. The Standard Error is 0.8017889 which means that the model fits the data input well. With 60 data values this is a good number, even if it is slightly above the 0.75 threshold. The P value for max temperatures is 0.001918498 which is extremely low. There is high homoscedasticity in both the max temperature and arable land fit plots.

Given the high correlation of rural population percentage with environmental factors (as indicated by  $R^2$  value of 96.77%), migration due to environmental factors is something countries need to begin accounting for in future city planning.

## Somalia

<i>Regression Statistics</i>	
Multiple R	0.957596938
R Square	0.916991895
Adjusted R Square	0.91407933
Standard Error	2.228289714
Observations	60

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
Intercept	212.5453953	45.1564485	4.706866957	1.64892E-05	122.1211669	302.9696237	122.1211669	302.9696237
Max Temperature	-4.901079281	1.384135811	-3.540894788	0.000802483	-7.672763434	-2.129395128	-7.672763434	-2.129395128
Arable Land	92.39742447	5.439570434	16.98616198	5.69381E-24	81.50487256	103.2899764	81.50487256	103.2899764



The  $R^2$  value for Somalia is 0.916991895, which means that 91.69% of the decrease in rural population can be described by increasing max temperatures and a decrease in arable land. This is, similar to Pakistan, a very high value which indicates that the changing climate has a large impact on migration, causing 91.69% of rural population decrease in Somalia to be because of climate driven factors. The Standard Error is approximately 2.2282, which is a good value considering that 60 years of data was used in this calculation. The P value for max temperature is once again very low at 0.000802483 indicating a high statistical significance of the information. Both graphs are homoscedastic in nature, with the max temperature graph being more clumped in one area and the arable land graph more linear. The high  $R^2$  value indicates that max temperature increase and arable land decrease are the main causes of migration out of rural areas.

### Methods:

Time series was used to forecast future temperature and arable land per person based on past values. Using the forecast and an understanding of when people migrate, the migration due to change in climate was predicted more accurately. The use of historical data from the World

Bank regarding rural population change, maximum temperature and arable land per capita ensured the data is credible.

For this time series specifically, Python (Pandas) was used. The first step while writing a Time Series is to check for stationarity, which measures whether there is a steady series of properties throughout the data such as variance or mean. To do this, the Dickey Fuller test was used to establish if the time series is stationary. If the data isn't stationary because of the seasonality (changes between different time periods) and/ or trend, then the series is transformed so that it becomes stationary so that the predictions can create a predictable and accurate pattern. To adjust for the trend, either smoothing, the practice of using the rolling average, or average for the last 12 values, can be used<sup>30</sup>. To remove seasonality, either differencing, which is subtracting a series' value from its value in the preceding time period, can be used. Series decomposition, where both trend and seasonality are represented separately, can be used to remove both trend and seasonality<sup>30</sup>.

The time series equation used is as follows:

$$Y = K + B_0 x_t + B_1 x_{t-1} + B_2 x_{t-2} + B_n x_{t-n}$$

This means that every value uses the preceding values for prediction. The Y value represents the dependent variable being forecasted while the x value represents the independent, or multiple independent, variables being used, and K represents a constant.

After a stationary series is established, we use the AR (autoregressive), MA (moving average) and ARIMA (autoregressive integrated moving average) model predicting the forecasted values. To check if the graph after each step is accurate, the critical values can be compared to the test statistic to find the test statistic that is smaller than the smallest critical value. We finally used the Moving Average time series model because it best fit the data and gave us the lowest RSS (and RMSE) values.

RMSE, or Standard Error, measures how well the model fits the data that is being used.

To calculate the RMSE, the formula  $\sqrt{\frac{\sum(Y_{actual} - Y_{predicted})^2}{Count}}$  was used. As for the R<sup>2</sup>, the

formula to calculate it is  $1 - \frac{\sum(Y_{actual} - Y_{predicted})^2}{\sum(Y_{actual} - Y_{average})^2}$ <sup>31</sup>. R<sup>2</sup> measures the amount of change in the Y

value that can be explained or connected to the change in X values. High R<sup>2</sup> values indicate that the majority of the predicted value can be explained by input values while low R<sup>2</sup> values indicate that other factors that have not been considered are at play.

A few other factors are important to note are heteroscedasticity or homoscedasticity and P values. If a value is heteroskedastic it means that there is high variance of larger values, and a smaller variance with smaller values - in other words, the variance isn't equally distributed across the independent variables. The P value measures how statistically significant a model is and how much weight it holds. Generally, when a P value is lower than 0.05 it is statistically

significant<sup>32</sup>. Scedasticity and P value also inform if the information in the historical data can be used to forecast future values.

This statistic is the most accurate of the models. After finding the most reliable model, the future values till 2100 will be predicted and used to predict migration.

We analyzed and forecasted maximum temperature and arable land for different regions of each country and the whole country respectively. This was followed by study of correlation between rural population percentage with max temperature and arable land for each region. For example, Brazil had separate predictions for the North, Northeast, South, Central West and Southeast regions and the main jobs and economies of each region along with the major changes and impacts were assessed to understand the direction of migration within the country and predict what cities and areas will see an influx and exodus.

## **Conclusion**

The temperatures are increasing all over the world, not in one continent or one nation. This is a global issue with migration increasing due to the changing climate. Just like animals migrate in search of food, humans migrate to find livelihood, food, shelter and stability. When people start flocking to already populous cities, they need to be prepared for the population increase so that the infrastructure and employment options can support the influx of people instead of crumbling under the pressure. Governments need to start charting climate change and it's impact on migration now to ensure they are prepared for the changes climate change will bring.

Climate change has a significant impact on migration, especially out of rural areas. The results presented in the paper support my hypothesis that there is a correlation between climate change and decreasing rural population percentage and migration. This research fits into the larger literature review because it explores the impact of climate change on migration depending on one's economic status and has potential to be further explored to find out what climatic changes have the greatest impact on different countries and what GDP per capita allows people to avoid the impacts of climate change.

This data is significant because understanding the cause of internal migration can help governments and city planners find a solution and plan for the future. When people start flocking to already populous cities, governments need to be prepared for the population increase so that the infrastructure and employment options can support the influx of people instead of crumbling under pressure. For further research, more countries would be analyzed and I'd take a deeper look at the connection between one's socioeconomic class and the pattern it could potentially have (with lower correlation if there is a higher income) depending on the correlation between rural population decrease and max temperature and arable land. Countries with lower GDP per capita, such as Pakistan and Somalia, had a higher correlation between rural population percent decrease and climatic factors while countries with higher GDP per capita such as Brazil had a lower correlation. Studying more countries could help me determine if this trend is applicable more broadly. I would also consider more factors such as change in crop yields and the



likelihood of extreme weather events. I would like to find the threshold at which the GDP per capita is high enough that there is at least 50% correlation (or 0.5  $R^2$ ) between climatic factors.

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# **Literature Review by Zhixuan Jiang: The Effects of Government Policies Used to Promote Economic Growth and Development in China During the Global Financial Crisis and the COVID-19 Pandemic**

## **Abstract**

This review article aims to provide a comprehensive overview and evaluation of the short-term and long-term effectiveness and limitations of government policies, particularly fiscal and monetary policies, implemented to promote economic growth and development in China during the Global Financial Crisis in late 2008 and the ongoing COVID-19 pandemic. The review found that the usage of fiscal policy during the GFC was effective in maintaining China's strong economic growth to sustain the basic living standards of its people in the short term, but the excessive quantity of fiscal injection created ongoing debt problems for local governments. Furthermore, the study also found that the rigorous pandemic control measures to mitigate the impacts of COVID-19 were effective and necessary for China to avoid large mortality due to its dense and aging population. Nonetheless, these measures hindered labour mobility and ceased operations of factories and businesses, which were catastrophic to China's economic growth. In addition, the review found that the control measures reduced the effectiveness of fiscal and monetary policies implemented during the pandemic to facilitate growth as individuals were physically restricted from consuming while businesses were forced to shut down. Together with previous debt accumulations during the GFC, China's economic growth slowed down significantly in 2023, evident as second-quarter growth was at 0.8%.

## **Introduction**

Economic growth refers to the increase in a nation's productive capacity, measured through real GDP growth, whereas economic development is a broad measure of welfare in a nation that includes indicators of health, education, and environmental quality, as well as material living standards (Dixon and O'Mahony 410). Between 1952 and 1977, China's economy transformed from an agricultural economy to an industrialised economy as industrial output as a percentage of GDP increased from 23% to 50%, leading to a spectacular annual average growth rate of 11.3% (Rong), which was common in emerging economies that began the process of industrialisation. However, the reward of economic growth was not distributed evenly among the economy during this time under a planned and centralised system. The growth in personal income was less than the growth in national income, leading to more than 50% of the population living in absolute poverty by the end of 1978.

However, China's economy proliferated after Deng Xiao Ping became the Chairman of the Chinese Communist Party in December 1978, expanding at an average annual GDP rate of 10% ("About China"). President Deng accentuated the importance of the free-market price mechanism in allocating resources and price determination to promote economic growth and development. He implemented several structural reforms such as the Household Responsibility System, Open Door Policy, and taxation reforms to encourage the formation of rural enterprises

and private businesses, incentivise foreign capital to flow into the Chinese market and invest in education and infrastructure to improve the efficiency of the workforce (Hu and Khan 1).

Those policies transformed a planned economy into a socialist market economy (a market economy with a predominance of public-owned enterprises), which positively improved economic growth and development as China is the second largest economy in the world in 2023, with a GDP of roughly USD 18 trillion. China also lifted approximately 800 million people of its population from the extreme poverty line over 40 years (“Lifting 800 Million People Out of Poverty”).

### **Measurements and Instruments**

Gross domestic product (GDP) is the standard measure of the value added created by producing goods and services in a country during a specific period (“Gross Domestic Product”), which is a reliable indication of the short-term effectiveness of macroeconomic policies implemented by the government to smooth out fluctuations in the business cycle. On the other hand, the Human Development Index (HDI) is a measure of economic development devised by the United Nations Development Program. It takes into account life expectancy at birth, levels of educational attainment, and material living standards as measured by gross national income per capita (Dixon and O’Mahony 412).

### **The Global Financial Crisis**

The Global Financial Crisis (GFC) between 2008 and 2009 spread widely from the United States to many globalised and developed nations, leading to a widespread recession. The GFC was triggered by the falling house prices in the US coupled with an increase in defaults on loan repayments due to the overextension of mortgages to weak borrowers (Uhlig). This excessive lending fuelled an asset bubble that reduced demand for a type of financial security called mortgage-backed securities (MBS). The bubble eventually popped and plunged the price of MBS and consequently the net worth of MBS holders. As many international financial institutions (many were US firms) invested heavily in MBS due to their supposedly safe AAA ratings, the decline of MBS prices significantly reduced their revenues, which could lead to insolvency. This was seen in the fourth largest investing bank, Lehman Brothers. Consequently, the collapse of financial institutions destabilised the financial market as households and businesses began to withdraw their savings from banks and were less willing to spend or invest. This reduced economic activity and led to the recession.

The impact of GFC on the Chinese economy was notable and subversive as China’s reliance on trade grown significantly since the beginning of the 21st century after it joined the World Trade Organisation in 2001. The slump in demand for Chinese exports due to the recession reduced export earnings by an average rate of 22.0% between January and July 2009. However, the Chinese government’s rigorous control over private investment outflows mitigated the loss on Chinese private investments in the US security market, ultimately preventing more formidable impacts incurred by the economy. Furthermore, the GFC resulted in more significant

uncertainty and instability about the price of USD. As China was the largest holder of US Treasury bonds at roughly \$6 trillion in August 2008, a potential depreciation of the USD would increase the loss on those bonds. For instance, Premier Wen Jiabao told reporters in Beijing on 13 March 2009: “We have lent huge amounts of money to the United States. Of course, we are concerned about the safety of our assets” (Parameswaran). Overall, China’s GDP shrunk by 5.1% from the beginning of 2008 to 6.4% in the fourth quarter – the lowest GDP growth since the 2000s.

In response to the impact of GFC on the Chinese economy. The Chinese government implemented a 4 trillion yuan (\$586 billion) fiscal stimulus package on 9th November 2008 titled the ‘Chinese economic stimulus plan’ to support the economy through the GFC and avoid a hard landing. The stimulus package comprised 1.18 trillion yuan from the central government plus local government funding and bank credit, which amounted to 12.5% of China's GDP in 2008 and encompassed ten measures to facilitate economic growth:

Accelerate the construction of affordable housing projects (approximately 400 billion yuan). Accelerate the construction of infrastructure in rural areas (approximately 370 billion yuan). Accelerate the construction of major infrastructure such as railways, highways and airports (approximately 1.5 trillion yuan). Accelerate the development of healthcare and cultural education (approximately 150 billion yuan). Strengthen ecologically sustainable development (approximately 210 billion yuan). Accelerate independent innovation and structural adjustment (approximately 370 billion yuan). Accelerate post-disaster reconstruction in earthquake-stricken areas (approximately 1 trillion yuan). Improve the income of urban and rural residents. Implement the reform of the value-added tax, encouraging enterprise technology transformation and alleviating the burden of enterprise by 120 billion yuan. Increase financial support for financial growth. Local government funding surpassed expectations. The real stimulus grew to an estimated 27% of the GDP, with an injection of 19% alone in 2009 (Wong 2).

The 4 trillion-yuan expansionary fiscal package successfully boosted employment in secondary industries consisting of manufacturing and construction, which prevented the potential rise in cyclical unemployment due to economic downturns. China’s unemployment level only peaked at 4.3% from March to December 2009 compared to the 10% unemployment rate in the US in October 2009 (“United States Unemployment Rate”). Ultimately, this fiscal injection of funds into the economy created a ripple effect on national income, also known as the simple multiplier effect. China’s Gross National Income increased by 1.31 trillion PPP in 2010. This was evident when China’s GNI per capita increased at an average of 872.5 PPP between 2009 to 2013 – the highest rate since the 2000s. Consequently, higher incomes led to higher consumption and investments, which successfully improved the material standards of the Chinese population. Furthermore, the construction of basic transport infrastructures such as highways and airports could improve labour mobility and resolve supply constraints, resulting in greater efficiency and productivity. This would theoretically improve workers’ wage outcomes as they are often indexed to productivity, leading to higher income and better living standards. Hence, the fiscal stimulus partly facilitated China’s increase in HDI from 0.672 in 2008 to 0.717 in 2013 (“Human

Development Index”). Moreover, the policy led to greater consumption, thus contributing to higher aggregate demand to facilitate economic growth. In addition, substantial expansionary investment incentives reassured investors' confidence, which led to sizeable private investment inflows. This was evident in a growth of 33.4% in total investment during the first nine months of 2009 - a 6.4% improvement from year to year. Consequently, China experienced a robust V-shape rebound coming out of the GFC. GDP growth in the third quarter of 2009 was 2.6% above the 8% target and 12.2% in the second quarter of 2010 (“China sets 8% target for 2010 economic growth”) - the highest since the beginning of 2008.

However, according to the research conducted by the Chicago Booth Review in 2017, the fiscal stimulus package substantially increased the level of local government debt in the long term as it rose from 1.2 trillion (5.8 per cent of GDP) to 12.5 trillion yuan (22 per cent of GDP) between 2006 and 2013 (Huang et al). Many enterprises struggled to service their loan (Gill). Similarly, rapid growth in infrastructure development, such as new housing and toll highways, could outstrip its demand and lead to overproduction, ramping up the risk of defaults in the long term, especially during cyclical downturns in economic activity when demands for these goods plunge significantly. This was seen during 2022 when rigorous pandemic measures slumped demands for newly-built highways and dwellings, which accrued enormous debt – ones which developers and local governments could no longer repay (“China’s local-debt crisis is about to get nasty”).

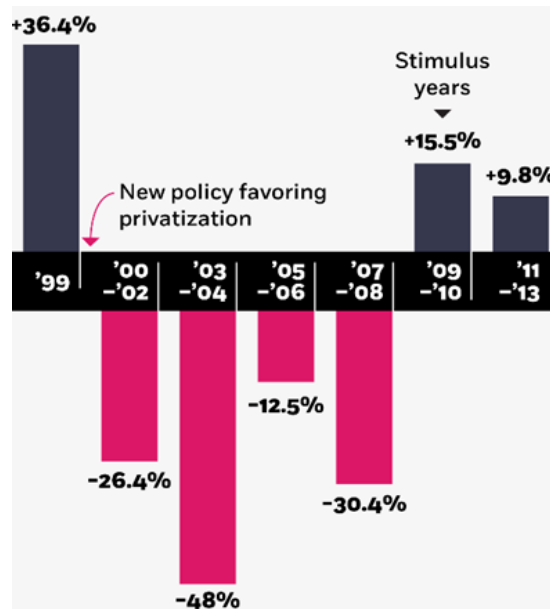


Figure 1: Loans for China’s state-owned companies. Percentage difference in the level of new loans vs. private companies, as a share of revenues. Cong and Ponticelli, 2007

Additionally, Figure 1 synthesised the findings of Chicago’s Booth’s Lin Willian Cong and Jacopo Ponticelli. They found that the difference in level of loans to state-owned companies vs. private companies increased by 45.9% between 2009 and 2010, suggesting that most of China’s stimulus money went to state-controlled companies that were less productive than



privately owned businesses, which were the main drivers of economic growth before the GFC. The large number of bank credits associated with the package were also disproportionately allocated to public-owned companies, which potentially crowded out private firms to participate in the growth initiatives as they faced higher borrowing costs, resulting in a shift in economic activity from the private sector to the public sector. This was reinforced by a research study conducted by Yi Huang, Marco Pagano, and Ugo Panizza, who found that investment in private manufacturing firms was significantly lower in cities with an enormous issuance of local government debt. Consequently, the fiscal injection constrained China's future growth and prosperity, evident when its growth slowed between 2010 and 2019. Furthermore, the 4 trillion fiscal policy fuelled inflationary pressures in the domestic economy as the policy boosted GNI per capita at an average rate of 17.51% between 2009 to 2012 -- the highest rate in history. Consequently, this led to higher consumption, which resulted in demand outstripping supply, thereby leading to demand-pull inflation. By mid-2009, observers started to worry about the side effects of the policy as inflation began to ramp up. Consumer Price Index (CPI) rose from 0.6% in November 2009 to 6.5% in July 2011, which reflected a shift in government policy stance as the average interest rate on loans increased to roughly 8% in 2011, which aimed to reduce demand and curb inflation ("China Consumer Price Index")

Overall, the two-year Chinese economic stimulus plan was an effective fiscal policy that supported the Chinese economy during the GFC in the short term despite various criticisms of its long-term unintended consequences. This was because the policy effectively achieved the government's most prioritised objectives of economic growth and unemployment during the GFC, thereby improving the standard of living. Later policies represent a shift in government objectives to price and external stability.

### **The COVID-19 Pandemic**

On the other hand, the new coronavirus resulted in unprecedented physical and economic challenges to humanity. It was first identified in Wuhan, China, in December 2019, swiftly becoming trans-provincial in January 2020. Subsequently, the World Health Organisation (WHO) officially named the new virus '2019-nCoV' on 14th January 2020, also known as COVID-19. Its ability to spread the disease so quickly and silently led WHO to declare a Public Health Emergency of International Concern (PHEIC) on 30th January 2020 ("Coronavirus disease pandemic"). Nonetheless, the virus rapidly spread to the rest of the world, forcing WHO to officially declare COVID-19 as a worldwide pandemic on 11 March 2020.

As a result of the COVID-19 pandemic, China's GDP growth fell by 12.8% in the first quarter of 2020, down from 5.8% in the fourth quarter of 2019 and resulted in a once-in-a-lifetime negative growth of 6.8%. Implementation of province lockdowns and self-isolation policies significantly impacted the service sector of the economy, which accounted for more than 50% of China's GDP. Its growth fell by 2.7% in 2020. Throughout 2020, China's GDP was at 2.2%, which plunged by 3.8%. It was also the slowest growth rate ever. Similarly, consumer confidence fell short from 126.4 points in December 2019 to 118.9 points in January

2020 and plummeted by almost 30 points since the beginning of 2022 due to sluggish property market.

The Chinese central government gradually implemented the 'Dynamic Zero Policy' across provinces following the first lockdown in Wuhan in January 2020 as an epidemic prevention measure to contain the number of confirmed cases and mortality. This measure preserved the basic requirements for human development, which enforced comprehensive measures such as self-quarantine and regular PCR tests to treat localised COVID-19 cases precisely. The minister of the Chinese National Health Commission, Ma Xiao Wei, distinguished the policy from absolutely zero COVID-19 as it aims to cut off the transmission chain quickly to prevent local outbreaks from spreading nationally.

The policy successfully minimised the number of confirmed cases as people without imperative purposes (such as strolling) to leave their homes were compelled to stay, except for receiving the regular PCR test every 48 hours. It effectively lowered the risk of being transmitted. Furthermore, local governments also developed different accessible applications on mobile phones to track the result of PCR tests and recorded potential sources of contagion. Consequently, although China accounted for more than 18% of the world population, it only recorded 9,753,725 confirmed cases as of November 2022 (Before the policy ended), which was significantly lower than most rich world countries such as the USA (96,725,493 cases), the UK (23,989,308 cases) and Australia (10,110,924 cases) with significantly smaller population size. Similarly, death due to COVID-19 in China was at 30,567 in November 2022, whereas the USA recorded a total death of 1,066,874 people ("WHO Coronavirus Disease (COVID-19) Dashboard"). Ultimately, China maintained positive growth in HDI in 2021, while most nations, including ones in the rich world, generally received a decline.

However, many prominent economists described the 'Dynamic COVID-Zero' policy as a double-edged sword (Haenle). The widening lockdowns led to a sharp decline in consumer spending as it plunged from 56% (of GDP) in 2019 to 53.9% in 2021, and negatively impacted economic growth because it restricted labour mobility and forced small- to medium-sized factories and businesses to temporarily shut down to prevent the spread of the disease ("Final consumption expenditure"). Some of them became permanently closed because of unprofitable operations. Consequently, the policy reduced consumer demands for goods and services and distorted domestic and foreign investments, which dampened economic growth. This was evident as China's GDP in March 2020 fell by an unparalleled rate of 9%, whereas urban employment decreased by almost 16%, and the national unemployment rate was exacerbated throughout 2020. Working hours were also impacted heavily. Together, this suggests that total urban hours worked declined by more than 30 per cent between December 2019 and February 2020, while employment in China's service sector began in 2023, 30 million short of where it should be without COVID-19 (Kemp and Spearritt).

Overall, the 'Dynamic COVID-Zero' policy was a necessary and effective policy to contain the pandemic to avoid large mortality and maintain basic living standards in the short to medium term. However, it also suppressed the freedom of individuals, prohibited the human

need to connect, and eroded the fundamental rights of humans. Together with the catastrophic impacts on economic growth and some tragic fire accidents that killed dozens of civilians, it broke the tacit agreement between the government and its citizens, which triggered mass civilian protests against the policy in Shanghai in late 2022, forcing local and central governments to gradually loosen the policy since December 2022.

In response to the slowdown in economic growth, the Chinese central government adopted an expansionary stance on fiscal and monetary policies during the pandemic to facilitate economic growth. Starting in late 2021, the government implemented tax reliefs on corporate income tax (CIT), value-added tax (VAT), and individual income tax (IIT), which effectively provided greater cash flow for employed individuals and small businesses that struggled the most amid slumps in demand and employment due to mandatory lockdowns. This effectively mitigated the stress on small businesses and individuals to counteract the negative economic impacts of the 'Dynamic Zero Policy'. In March 2022, the tax office revealed that China had issued US\$39 billion in tax deferrals to small businesses that month alone. According to the 2022 Government Work Report released in early March, the government has pledged US\$374 billion in tax refunds (Huld).

Furthermore, the People's Bank of China deliberately cut the bank's reserve requirement ratio (RRR) by 0.5% in December 2021, reducing the amount of liquidity banks must withhold against their investments. The reduction in RRR freed up approximately 1.2 trillion yuan (US\$179.6 billion), which provided banks with more money to invest or lend out, thus creating a chain effect on the economy as individuals and businesses could access more funds to facilitate consumption and investment, thereby effectively stimulated the economy.

Consequently, the government had successfully lowered the leakage ( $\text{Leakage} = \text{Saving} + \text{Taxation} + \text{Imports}$ ) in the economy, which provided sufficient quantity of funds to individuals and businesses to survive the economic slowdown. These additional injections of funds could flow partly to workers to encourage them to consume, thus creating a ripple effect on national income, stimulating the economy through higher aggregate demand for goods and services, and generating more job opportunities for the public. The fiscal stimulus and monetary easing positively influenced China's economic growth amidst the global pandemic as GDP recovered quickly to 8.1% in 2021. Therefore, both government policies were essential in promoting China's economic growth and maintaining stability in the business cycle.

However, there were limitations to these policies. A large stimulus package would force the government to run budget deficits that required them to borrow from domestic or overseas markets, which could result in an accumulation of local and foreign debt. In the long term, a higher level of debt may result in government defaults that deteriorate investor's confidence, which could become catastrophic for China as it relied heavily on investments to facilitate growth. According to a recent survey of 2,892 of the vehicles for local governments to borrow from the public by the Rhodium Group, a research firm, only 567 had enough cash on hand to meet their short-term debt obligations. Furthermore, defaults by indebted housing developers and disappointing growth in China's property market (which many local governments relied on for

economic growth) due to the inability of these policies to bolster confidence among prospective house buyers and business investors had put future economic prosperity at risk, which was reflected in the government's 5% growth target for 2023 – a step towards safety rather than ambition (Cheng). Similarly, the effectiveness of the expansionary monetary policies during the pandemic was reduced due to several factors: firstly, frequent lockdowns and harsh quarantine policies hindered and overshadowed the use of monetary easing, distorted consumers' confidence as they became less willing to spend despite the decrease in interest rates that should encourage spending; secondly, the extent to which interest rates were reduced was not enough to encourage consumers and investors to take more loans to facilitate consumption and investments, especially amidst a period when individuals were more careful than ever when it came to how to allocate their income. Ultimately, China's shallow inflation level in 2022 (2.0%) and 2023 (0.00% reported in July 2023) indicated the slowdown in demand for goods and services post-pandemic.

## **Conclusion**

In conclusion, historical government policies have effectively shaped the economic powerhouse that China is today and drastically improved individuals' standard of living. The '4 trillion fiscal policy' implemented during the 2008 Global Financial Crisis effectively avoided an unprecedented recession, which would otherwise be catastrophic for China's economic and political stability. However, the policy resulted in a large debt burden on local government and future generations, and its impacts emerged in 2023. On the other hand, the 'Dynamic Zero Policy' during the COVID-19 pandemic was an effective measure China must take to avoid considerable mortality in order to maintain quality of life. However, the policy's devastating effects on economic growth and ruthless control over individuals' freedom triggered mass protests at the end of 2022. Contrarily, a suite of macroeconomic policies implemented during the pandemic in response to the slowdown in economic growth was effective to a limited extent in achieving its objective as consumers, and businesses were yet to recover from the pandemic. This was common in other countries such as Australia. However, a sluggish economic prospect and a 'confidence trap' remain a challenge to the Chinese policymakers – they may need more hawkish and stimulative macroeconomic policies to reassure investors' confidence to sustain China's position in the geopolitical and technological dead heat between the West.

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# **Can Happiness be Measured: Quantitative and Qualitative Approaches**

## **By Chenzhang Yan**

### **Introduction**

As people continuously pursue a higher quality of life, the state of happiness, addressed by some as an “optimal state of being” (Williamson 2014), has received more attention. Research has shown that happiness makes people healthier both physically and mentally, increasing their life expectancy and granting them a more creative and generous living experience. (De Neve, Jan-Emmanuel and Diener, Ed and Tay, Louis and Xuereb, Cody 2013) Therefore, in order to maximize happiness, it is important to propose a unit to measure happiness-- or, to begin with, discuss whether such measurement exists. If happiness employs a standard measurement, people would be able to evaluate happiness and more importantly, recognize what needs to be done in order to achieve their desired state of living. However, happiness remains a complex concept. On one hand, it can be defined as the state of mind that people seek, which includes satisfaction, pleasure, and a positive emotional state. On the other, it can also be described as the positive feelings people gain when their needs are satisfied. Such different definitions of happiness furnish the word with disparate properties, therefore prompting varying understandings of how happiness can be evaluated. In order to address the intricate nature of the concept, the goal of this essay is to examine two different ways of measuring happiness-- quantitative measurement and qualitative measurement--when happiness is defined differently, manifesting that happiness is measurable but depending on the choice of how it is understood in the first place.

### **The Quantitative Measurement of Happiness**

One of the most renowned definitions of happiness is discussed in Maslow's Need and Goal Satisfaction Theorem. According to Maslow, human needs are divided into four different levels, and happiness is the feeling that occurs when people meet their needs and are satisfied with the result (Maslow, 1943). This definition establishes a positive mathematical correlation between the level of happiness and the level of satisfaction: the higher the level of satisfaction, the higher the level of happiness, thus making the quantitative measurement of happiness possible. According to the Australian Bureau of Statistics, quantitative measurement is based on expressing things in terms of quantity, such as via numbers and ratios (abs.gov). This method is very common in natural science, helping scientists to evaluate experimental data more directly and accurately. Generally, there are two procedures in scientific research: the transformation of data and the representation of data-- both of which are typical examples of quantitative measurement. For instance, the rate of change in population is calculated to represent how fast an animal population grows, and wavelength is measured to represent different types of light. These data are later organized in a chart or a table in order to be presented holistically. However, quantitative measurement is not only utilized in natural science but also in social science. Social science researchers use questionnaires, surveys, and professional statistical skills such as stratified and cluster sampling to analyze data and make conclusions. For example, in order to



measure people's satisfaction level with the refuse classification policy, questionnaires may ask respondents to rate the policy from very poor to excellent on a scale of 0-5. Researchers would later organize the data into bar graphs and pie charts according to the respondents' age and racial groups, and analyze the data according to these visual presentations.

Similar quantitative methods can be found in measuring people's level of satisfaction (therefore, happiness). Conforming to Zadeh's Fuzzy Set theory, which suggests that subjects should be assessed within a certain interval instead of being assumed to be on bipolar ends (apa.org), people's level of satisfaction is often measured via a numerical and descriptive "spectrum" in self-report questionnaires. The likert scale is a typical method that proposes a series of statements and allows respondents to choose a number that best represents their answer. The numbers range on a scale of 0-5, with 0 as do not agree at all, and 5 as totally agree. Such methodology is commonly used in determining people's life satisfaction levels. For example, in a 2019 study that aimed to measure the psychometric properties of the Satisfaction with Life Scale (SWLS) and the Subjective Well-Being Inventory (SWBI) in Korea, an 11-point Likert scale for SWBI (0 for worst and 10 for best) and a 7-point scale for SWLS (1 for strongly disagree and 7 for strongly agree) are created. After taking the mean value from the results of 1,200 Korean respondents, the research unraveled certain parameters that are determinants of the respondents' level of life satisfaction and concluded that both SWLA and SWBI are relatively applicable measurements in the context of Korean society.

Apart from directly employing a numerical Likert scale in the questionnaire, quantitative measurement is also found when satisfaction level is evaluated through a cumulative "scoring" basis. In this methodology, Researchers propose statements that are related to people's feelings of satisfaction. The respondents then score each statement on a scale of 1-5 with 1 strongly disagreeing and 5 strongly agreeing. The scores for each question are then added up into a total score that indicates the respondent's satisfaction level (the higher the total score, the more satisfied the respondent is). An example of this cumulative scoring strategy is seen in Professor Ed Diener's variation of the SWLS (Satisfaction with Life Scale). Diener's questionnaire incorporates life satisfaction-related statements such as "the conditions of my life are excellent" and "If I could live my life over, I would change almost nothing". After the total score is calculated, researchers put the total number into the pre-established scoring benchmarks: for example, 31-35 being the highest- extremely satisfied, and 5-9 being the lowest- extremely dissatisfied.

Another quantitative method that can be utilized to measure the level of happiness is the Comprehensive Membership Model proposed by Yaoyao Wei, Tian Xie, and Yuxiang Hong in 2016. On the whole, this comprehensive method not only combines the Membership Function Fuzzy Set and Satisfaction Scale of Psychology to measure happiness in each need level but also assigns weighting factors to each level by using the Analytical Hierarchy Process (AHP). To start, abstract descriptions for satisfaction levels such as "quite satisfied" and "slightly satisfied" are substituted with precise numerical values by applying the Membership Degree Function. Then, the research incorporates the AHP process to create weight factors that assess the different

need levels in happiness. For example, in comparison to sources of entertainment, the adequacy of food and clothing is considered a larger weighted factor since it is more fundamental to human living. The final results are calculated by multiplying the weight factors and the Membership Degree Function value in each need level and adding them together.

### **The Qualitative Measurement of Happiness**

An alternative definition of happiness lies in Pelin Kesebir and Ed Diener's 2008 article: *In Pursuit of Happiness: Empirical Answers to Philosophical Questions*. According to Kesebir and Diener, happiness is "people's evaluation of their lives and encompasses both cognitive judgments of satisfaction and affective appraisals of moods and emotions" (2008). In other words, happiness is the measurement of people's mental state and emotions that can neither be "separated into component parts" nor "laid end to end like measuring sticks" (Kesebir and Diener, 2008). Therefore, in order to measure happiness under Kesebir and Diener's definition, qualitative measurements need to be considered. Instead of putting emphasis on numerical values, qualitative measurement sheds light on the properties of the matter by establishing descriptive categories of the subject. For example, the color of light can be quantitatively measured as "660 nm in wavelength", but qualitatively described as a "red light" since this term is commonly used to categorize this specific type of light. Humans tend to measure happiness in a similar qualitative manner. For example, "delighted", "happy", and "joyful" are some among an endless collection of vocabulary that humans utilize to describe "happiness", all of which suggest a physiological state that cannot be perfectly delineated. These vocabularies can also be accompanied by quantifiers such as "very", "extremely", or "barely"-- none of which can be put into exact numerical values. The fact that the statement "I am 26% or 87% happy today" appears incomprehensible proves the necessity for happiness to be measured in a descriptive, indefinite, and therefore, qualitative manner.

Currently, one of the most prominent qualitative measurements of happiness is the Steen Happiness Index (SHI). Modeled by M.E.P. Seligman after the Beck Depression Inventory in 2005, The SHI defines a happy life in three aspects: pleasure, engagement, and meaning (psycnet.apa.org). Similar to the SWLS, the SHI aggravates a series of descriptive statements that require people to pick out the one that most accurately describes their current state. The SHI also presents a comparable ranking system, from 1, the most negative response, to 5, the most positive response. However, in contrast to the format of the SWLS, each question in the SHI consists of several qualitative statements, all of which are worded similarly yet convey different meanings. For example, in question 4 of the SHI, the statements range from "Most of the time I am bored" (scored 1 point) to "Most of the time I am fascinated with what I'm doing" (scored 3 points). 10 years later, Seligman enhanced his theory by adding two more elements to the three pre-existing aspects of well-being, attaining what is nowadays known as the five pillars of the PERMA model: "positive emotions", "engagement", "positive relationships", "meaning", and "accomplishment" (Seligman 2011).

In addition to defining happiness as a psychological state or a set of emotions, happiness can be seen as a qualifier of well-being. Well-being is commonly defined as “feeling good” and “functioning effectively” ( <https://alliance.edu.in>). And since one of the components of "feeling good" is happiness, it is arguable that the measurement of well-being can, to a certain extent, indicate the level of happiness. One of the most common qualitative measurements of well-being is hosting an interview. In Happy City Well-being Measurement in 2016, for example, researchers posed neutral, qualitative, and open-ended questions to the respondents such as “ Do you think you have enough well-being? Why?” and “What is your standard for well-being?” After having recorded people's responses, researchers analyzed the qualitative data via a thematic approach (Braun and Clarke, 2006)-- first categorizing the responses based on the self-proposed standards of well-being, and then summarizing a theme for each group. The different themes are ultimately reorganized and recognized as different qualitative methods for measuring well-being. Since happiness is a component of well-being, the level of happiness can be moderately determined through similar standards.

## **Conclusion**

In conclusion, happiness is measurable both quantitatively and qualitatively. Although it is impossible to establish a universal measurement of happiness due to the verifying nature of its definition, recognizing the measurability of happiness would help humans not only evaluate their level of happiness in the current stage but also trace a clear pathway towards an ideally happy life.

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## The Risky Affair of Skin Cancer By Shakti Vijayakuma

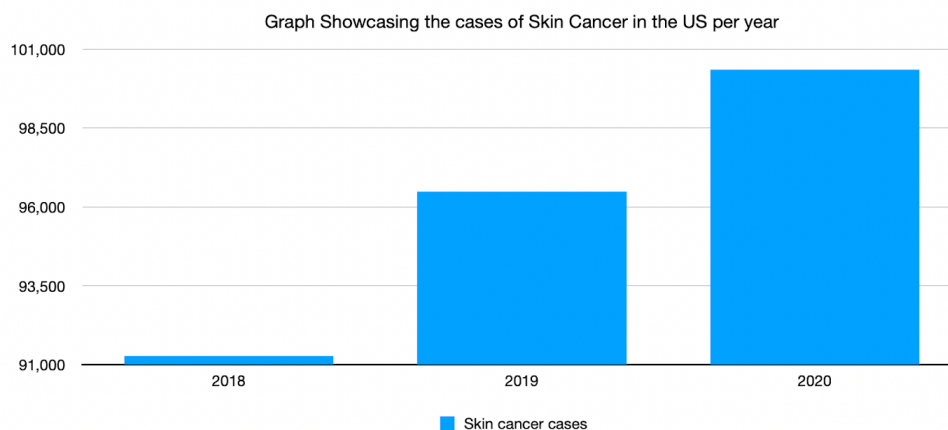
### Abstract

Skin cancer is the predominant form of cancer in the United States of America, facing continual growth; it has been increasing steadily for the past ten years and is anticipated to increase. Early detection of the cancer is critical for successful treatment. This article focuses on the biomarkers that can accurately identify individuals at high risk for skin cancer and gene expression profiling, providing comprehension into the molecular mechanisms fundamental to skin cancer development and progression. Through this article, we will review the current state of knowledge on gene expression and biomarkers in skin cancer, including the role of specific genes and pathways in different subtypes of the disease. We also discuss recent developments in biomarker discovery and validation, including machine learning algorithms and other computational methods to analyze large-scale gene expression data. Finally, we highlight the potential clinical implications of these biomarkers, including their use in risk assessment, early detection, and personalized treatment of skin cancer. This article provides a comprehensive overview of the latest updates of research on gene expression and biomarkers in skin cancer, highlighting the potential of these approaches to develop the diagnosis and treatment of this increasingly common disease.

**Keywords:** Skin cancer, Melanoma, Basal cell carcinoma, Squamous cell carcinoma, Keratinocyte carcinoma

### Introduction

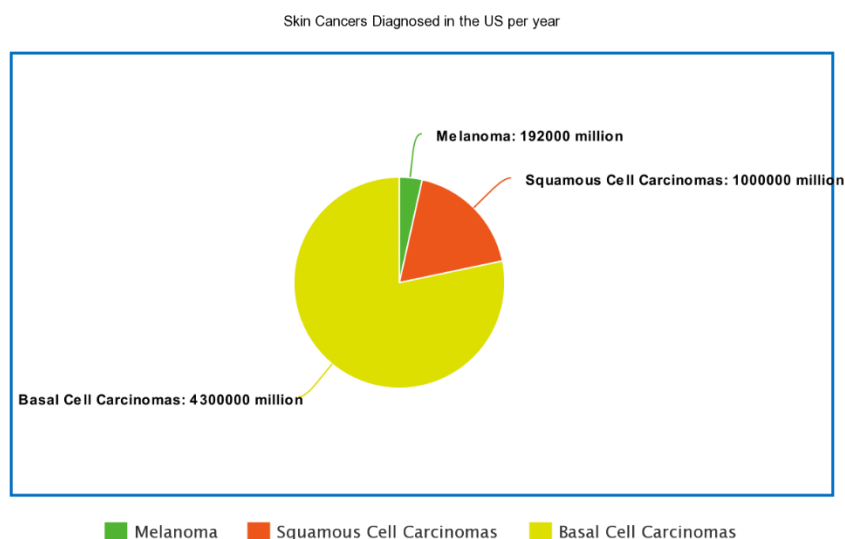
Skin cancer is a prevalent form of cancer that can be classified into various types, including malignant melanoma and non-malignant melanoma [1]. The major basis of skin cancer is prolonged exposure to sunlight and ozone depletion [2]. There has been a significant focus on understanding and combating this disease over the years, which led to numerous clinical studies and publication of research articles (**Figure 1**). This article aims to provide a comprehensive review of skin cancer, covering its detection, diagnosis, prevention, and treatment. Skin cancer is typically described by the abnormal growth of skin cells and is known to primarily develop and amplify on skin that is unprotected from sunlight [3]. Although, this prevalent type of cancer can also manifest in regions of the skin that are not typically vulnerable to sunlight [4]. There are several types of skin cancer, but the most common one is melanoma. Skin cancer is mostly the common type of cancer all over the world, and its incidence has increased over the past few decades [5].



Skin cancer cases per year

	Skin cancer cases
2018	91,270
2019	96,480
2020	100,350

**Figure 1.** Depiction of the diagnosed cases of skin cancer each year in the USA from 2018 to 2020. Data courtesy: Scopus.



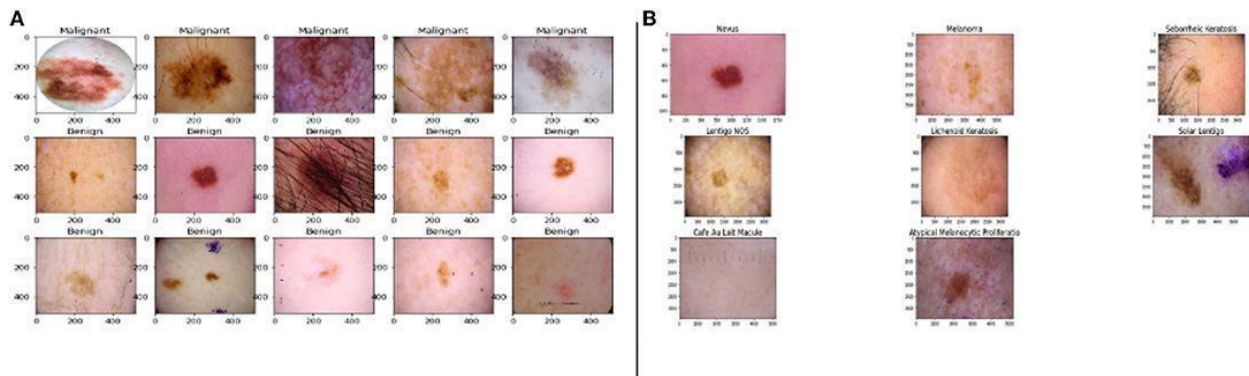
**Figure 2.** Infographic depicting the number of diagnosed types of skin cancers in the USA. Data courtesy: <https://www.skincancer.org/blog/early-detection-starts-with-you/>

Skin cancer is typically considered by the anomalous growth of skin cells and is known to primarily develop and amplify on skin unprotected from the harmful rays of the sun [6]. Although, this prevalent type of cancer can manifest in regions of the skin that are not susceptible to sunlight. There are several types of skin cancer, but the most common one is

melanoma. [7]. Skin cancer is a significant health concern, with a high prevalence in the USA and globally. It is the prevalent form of cancer in the United States, where one in five Americans, on average, can develop skin cancer in their lifetime [8]. **Figure 2** provides an insight into skin cancer in the USA. There exist various forms of skin cancer, including melanoma, basal cell carcinoma (BCC), and squamous cell carcinoma (SCC) [9]. Among them, keratinocyte carcinomas, which encompass BCC and SCC, are the most common cancers in humans, with a higher annual incidence than all other cancers combined [10].

The primary basis of skin cancer is prolonged exposure to ultraviolet (UV) radiation from the sun or any other artificial sources, which is critical in initiating and progressing skin cancer [11]. UV radiation is capable of damaging the DNA in skin cells, which leads to mutations and cancer development. This damage primarily affects the genetic material responsible for controlling cell division and growth [12]. The immune system has a vital role in safeguarding human beings against the development and progression of skin cancer [13]. Immunosurveillance refers to the immune system's constant surveillance and monitoring of our body to detect abnormal or cancerous cells. In the case of skin cancer, this process involves immune cells diligently patrolling the skin, scanning for cellular irregularities or signs of malignancy [14]. When a potentially cancerous cell is detected, the immune system employs a unique mechanism known as antigen presentation. Immune cells, such as dendritic cells, phagocytose the cancerous cells and process their antigens. Recognition of these presented antigens occurs when T lymphocytes, also known as T cells, encounter the antigen-MHC complex [15]. T cells that possess receptors known as T cell receptors (TCRs) that bind to specific antigens, enabling them to recognize and distinguish cancerous cells from healthy ones [16].

Skin cancer encompasses various types (**Figure 3**), each with its unique characteristics and origins. Understanding the distinctions between these types is essential for early detection, accurate diagnosis, and appropriate treatment [17]. Skin cancer can be broadly classified into three major types: basal cell cancer, squamous cell cancer, and melanoma [18]. Basal cell cancer arises from the middle layer of the skin and is more likely to spread if left untreated [19]. Squamous cell cancer, on the other hand, develops from the squamous cells and also poses a risk of spreading [20]. Melanoma is the most aggressive form of skin cancer, arising from the pigment-producing cells called melanocytes [21].



**Figure 3A.** Malignant and Benign stages of skin cancer **B.** Refers to the five major stages of skin cancer. Figure courtesy: reference numbers 22, 23.

Melanoma, a type of skin cancer, demands our attention as a formidable adversary. While it represents a small portion of skin cancer cases, melanoma is responsible for a significant number of skin cancer-related deaths. It is the most aggressive and potentially deadly variant of skin cancer [22]. It originates from melanocytes, which produce pigments in the skin [23]. Melanoma can transpire in any area of the body, including areas not open to the sunlight. Melanoma often manifests as an asymmetrical mole or dark spot with irregular borders [24]. It may exhibit variations in colour, size, and shape. Squamous cell carcinoma (SCC) is the second most prevalent type of skin cancer, comprising around 20% of cases. While it is typically less aggressive than melanoma, SCC can cause significant harm if left untreated [25]. It initiates in the squamous cells located in the upper layers of the epidermis [26]. SCC is primarily linked to cumulative sun exposure over time but can also develop in areas like the mucous membranes or scars and chronic wounds [27]. Basal cell carcinoma accounts for approximately 80% of all cases of skin cancer [28]. It instigates in the basal cells, located in the deepest layer of the epidermis [29]. BCC typically develops in areas habitually out in the sun, such as the face, scalp, neck, and hands. However, it can also occur in non-sun-exposed areas [30]. BCC often appears as a flesh-coloured or pinkish bump or a waxy, pearly nodule. It may have visible blood vessels and occasionally develop a central ulcer or crust [31].

**Table 1.** Table depicting the features of UV-A, UV-B and UV-C

<b>Properties</b>	<b>UV-A</b>	<b>UV-B</b>	<b>UV-C</b>
<b>Wavelength</b>	300-400 nm	300 nm	200 nm
<b>Penetration ability</b>	Penetrate through most transparent substances such as glass or plastic	The glass will absorb intermediate penetration	Weak Penetration
<b>Ozone layer absorption</b>	Passes through the layer	Mostly absorbed by the layer	Completely absorbed by the layer
<b>The extent of reaching Earth's surface</b>	> 98% reaches the Earth's surface	< 2% reaches the Earth's surface	A negligible percentage reaches the Earth's surface



Adopting simple habits and conscious lifestyle choices can significantly reduce your risk of developing skin cancer [32]. UV light is a known culprit when it comes to the development of skin cancer [33]. The sun emits ultraviolet radiation, comprising UV-A, UV-B, and UV-C rays. A detailed analysis of these rays is provided in **Table 1**. While the Earth's atmosphere filters out most UV-C rays, UV-A and UV-B rays penetrate the skin and can cause significant damage [34]. UV radiation damages the DNA within skin cells, disrupting their normal functioning and triggering mutations [35]. Over time, these mutations can accumulate and lead to uncontrolled cell growth, forming cancerous tumours [36]. UV-B rays are particularly harmful as they are more energetic and directly damage the DNA. In contrast, UV-A rays infiltrate deeper and contribute to premature ageing and skin damage [37]. Sunscreen is your best defence against harmful UV rays [38]. Apply a broad-spectrum sunscreen having a sun protection factor (SPF) of 30 or higher, even on hazy days. Remember to generously apply it to all exposed skin areas, including your face, neck, hands, and ears [39]. Prolonged exposure to sunlight and depletion of the ozone layer are significant risk factors for developing skin cancer [40]. Other factors contributing to skin cancer are having a history of sunburns, fair skin complexion, a family history of skin cancer, acquaintance with certain chemicals, and a debilitated immune system [41].

Skin cancer, the most common form all over the world, has increased in incidence over the past few decades [42]. Early detection can successfully treat skin cancer [43]. Various techniques are employed to identify and diagnose skin cancer, including visual inspection, dermoscopy, biopsy, and imaging technologies [44]. Recent advancements in image classification and machine learning are promising to improve the accuracy of skin cancer detection [45]. Preventive measures such as sun protection, including sunscreen, protective clothing, and seeking shade, are vital in reducing the risk of skin cancer [46]. Avoiding artificial ultraviolet light sources, such as sunbeds, is also recommended [47]. Skin cancer treatment depends on various factors, including the type, stage, and location of the cancer [48]. Treatment modalities include surgical excision, cryotherapy, radiation therapy, chemotherapy, immunotherapy, and targeted therapy [49]. Immunotherapy, The treatment choice is determined by healthcare professionals based on individual patient characteristics and the extent of the disease [50].

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## Laser By Aarush Mishra

### Introduction

Right from the toys to supermarkets to movies to medicine, Lasers are everywhere. Lasers have wide ranging applications, and they are there in day to day life. Laser is an acronym for Light Amplification by Stimulated Emission of Radiation. The concept of Laser was given by Einstein in 1916. He suggested that under proper condition atoms could release excess energy as light. Charles Townes developed Maser (Microwave Amplification by Stimulated Emission of Radiation). It had limited applications. But, it gave birth to the idea of Laser. It is said that Towne discussed this concept with Gordon Gould who dwelled upon this idea and developed Laser in 1958. Gould also coined the word 'Laser'. Next few years saw development of many Lasers but with very little practicability. This was aptly described by a young physicist D'Haenens as "a solution looking for a problem". However, over a span of few years, Lasers were used in many industries. Lasers were being used from pointers to probes in space odyssey. (1)

In medical field first laser was used in treating eye ailment in 1963. It was used to photocoagulate the small vessels in retina which could cause blindness. (2) So it has come a long way from science fiction to scientific world. Today Laser is an integral part of medical science. It has many uses in various fields but this paper will limit the discussion about its mechanism and its few applications in plastic surgery. The aim of this paper is to discuss the basics of Laser and its clinical application in medical specialties.

### Material And Methods

This study was conducted over a period of three months at a Laser Surgery centre of a tertiary level hospital. Literature search was made through the internet. Standard text books were read for better understanding of the topic. Interaction was done with the surgeon doing Laser and individual undergoing laser treatment. Written consent was obtained from the individual to use the clinical photographs without disclosing the identity.

### Mechanism of Action

Before going to the details of mechanism of action of Lasers, it is prudent to understand few basic concepts and definitions:

**Light-** Light is defined as the electromagnetic radiation which is visible to the human eye. Light consists of **discrete packets of energy, called photons.**

**Incandescent light** has many wavelengths (non-coherent) and is not parallel.

**Photon-** A photon is a discrete packet of energy associated with light. It has the characteristics of both waves and particles. It travels at the speed of light. It carries energy and momentum. It can be destroyed or created based on when radiation is absorbed or emitted. (3)

**Colour of light-** Light is made up of wavelengths of light, and each wavelength is a particular colour. The colour we see is a result of which wavelengths are reflected back to our eyes. The color of light is determined by the distance between two successive waves. Light consists of seven colours which are Violet, Indigo, Blue, Green, Yellow, Orange and Red. (4)

**Visible spectrum of light-** The visible spectrum for human eyes ranges from wavelengths of 380 to 700 nm. (4)

**Infrared spectrum-** is electromagnetic radiation with wavelengths longer than those of visible light and shorter than radio waves. It is invisible to human eyes. (5)

**Population inversion-** Under normal circumstances, the higher an energy levels are less populated by atoms/electrons. When energy is added to a system more atoms/electrons can reach higher energy levels it is known as population inversion. When they fall back to lower energy levels they release photons. (6)

**Mechanism:** An atom in a resting state has a nucleus and electrons circulating in its orbit. When energy is added electron become excited and reaches to higher orbit. **(Figure 1)** When this electron falls back to resting orbit they release energy called a Photon which has wavelength specific to the atom/molecule. When this photon collides with another atom with electrons in the excited state, that electron comes back to the resting state by releasing another photon of similar wavelength. Now there are two photons in the system, when they hit two more excited electrons more photons are generated, this sequence continues and light energy of specific wavelength is generated. When this process takes place in a Laser tube with mirrors at both the ends with added energy to the system, the majority of the electrons are in the excited state (population inversion) and begin to release photons. When these photons are reflected back and forth between the mirrors, the intensity of the light increases. This phenomenon is known as Light Amplification by the Stimulated Emission of Radiation or LASER. **(Figure 2)** Important properties of Laser are: coherence (all lights are in phase), monochromaticity, directionality (parallel to each other even when travelling for long distances). (7) Lasers have three important components: energy source, laser tube and laser medium (it could be solid, liquid or gas). The commonly used lasers in the medical field are Nd:YAG (Neodymium, Yttrium, Aluminum ,Garnet), Erbium YAG, KTP, Carbon dioxide etc.

### **Laser Interaction With Body**

The laser can have specific target tissues or part of it known as chromophore or it can be nonspecific in nature. Water is the target chromophore for CO<sub>2</sub> laser while Pigment is target chromophore for NdYAG. Hence when laser beam falls on tissue it can specifically target the tissue having specific chromophore for example for hair removal melanin present in the hair follicles is targeted. Oxyhemoglobin is the chromophore targeted for treating abnormality in the vessels. When Laser beams fall on a tissue it can carry out many reactions like coagulation, protein denaturation, vaporization, dessication or welding. Lasers which can nonspecifically destroy the tissues are called ablative lasers for example CO<sub>2</sub> Laser is absorbed by intracellular water which vapourises the tissue as water turns to steam.

### **Lasers In the Medical Field**

**Tattoo Removal:** Q switched YAG Lasers are commonly used for tattoo removal. In tattoo, pigment particles are embedded into the dermal layer of the skin. These pigments are targeted by



the Laser light which are broken down to smaller particles to be eaten away by the blood cells. Dark pigments respond well to the lasers. It generally requires multiple sessions to remove the tattoo. **(Figure 3)**

**Hair Removal:** Hair roots are targeted to permanently decrease the unwanted hair. The target is deep melanin which absorbs light without having any detrimental effects on the surrounding tissues. Diode laser is one of the commonly used lasers for hair reduction. It requires multiple sittings for optimum results.

**Vascular Lesions:** Vascular anomalies and tumors respond well to the Laser treatment. Nd YAG laser is commonly used to treat port wine stains and other abnormalities of arteries and veins.

**Photorejuvenation:** Lasers are also used for photo rejuvenation of the aging face.

### **Laser Safety**

In the modern world where Lasers are being used increasingly, it is imperative to ensure that certain procedures are followed to ensure the operator and patient's safety. Adequate eye protection is of paramount importance. The other protective gears and precautions must be followed as advised in the safety manual of the Laser.

### **Conclusion**

Lasers are based on the sound principles of Physics which have helped the medical fraternity to treat many patients in a big way. Laser tissue interaction is a vast research field which will open new doors for better patient or clientele care in time ahead.

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## **Developing Countries in Solving Climate Change By Emma Crasnitchi**

### **Abstract**

This paper researches the debates surrounding climate change solutions in regard to a country's developmental status. These discourses take much time from finding solutions and should be addressed promptly. This paper begins with a contextual discussion of the conflicts that afflict the current world. It then describes the argument pertaining to the importance of collaboration for the future of civilization. This paper finally moves to form a consensus on how the root of the cause - in this case, climate change - and the ability of a country to pay are two of the most important aspects to consider when answering the question: should developing countries pay less for solutions revolving around global warming?

### **Introduction**

We live during a difficult time - in an epoch of many global problems. There is catastrophic environment pollution, scarce resources for mankind, everyday depletion of oil and natural gas, and global warming. There are complications arising due to the backwardness of underdeveloped countries, possible mass starvation, existing malnutrition, and a staggering development gap between rich and poor countries (causing poverty, hunger, and illiteracy). Today, we cannot live by our own narrow, selfish interests serving our one country: we cannot think that the problems of other countries do not concern us. We are all connected due to globalization. Our economic and political ties refrain us from blaming distance for solving global problems. However, there are many debates surrounding what countries have the role of paying for climate change - a universally threatening issue. Although the prevalence of emissions in developing countries poses a risk to health, food production, and ecosystem quality, and, therefore, exemplifies the importance of all countries participating in finding a solution regardless of which country pays - developing countries should ultimately pay less for climate change solutions because they are less able to alter their landscapes to fit the always-changing world and the negative externalities of pollution are mainly imposed by developed countries, proving that developed countries are not at fault for global warming.

### **Collaboration**

On one hand, the goal of solving climate change should be every country's forefront incentive. Pollution is considered as a negative externality - it imposes an external cost on people who are not directly involved with pollution. To go further, pollution - particularly air and water pollution - is an international externality because its implications cross countries' borders. This means that when working to solve this problem, countries should do so together.

Numerous organizations have formed to help combat climate change, namely the United Nations and AOSIS (Alliance of Small Island States). While the former works to create treaties that directly enact legislation to confront global warming, the latter works to amplify the strength of low-income, coastal countries in negotiations. AOSIS works to spread awareness of the

dangers of climate change because, although these states are not as economically recognized, they experience the same challenges as more developed countries - such as sea-level rise, greenhouse gas emissions, and environmental degradation. Both these organizations aim to work united with various countries, rendering solutions viable for every country, regardless of its “status” of development.

According to recent research conducted by the World Bank, 216 million people will be forced to migrate due to climate change, and crop yields will be substantially reduced. This proves that all countries need to work together because no country is immune to the consequences of global warming. In fact, World Bank states, “The challenge for developing countries is they no longer have an opportunity to develop first in a high carbon-intensive way and then clean up and decarbonize later. They need support today to make investments now to slow a changing climate and enable billions to live safer, more prosperous, inclusive, and sustainable lives.” Collaboration is vital now.

In an effort to foster collaboration, the U.N. created the International Paris Agreement in which each of the 194 countries is required to submit a continuously updated climate change action plan called the “National Determined Contribution” (NDC). Together, these countries encourage each other to work towards a better future. In 2023, the Global Stocktake will show what the participating countries have achieved so far. When all countries work together, without focusing as much on the question of who should pay less, much can be achieved regarding climate change action. In fact, advocates for whole-world, collective solutions remind society of the efficiency of this cooperation, arguing that the ideas of “who pays less” should not be the world’s forefront factor when considering climate change.

## **Ownership**

On the other hand, many other politicians and economist push forth that, whilst working together, developing countries should essentially pay less because they are not as responsible for climate change as developed countries. They believe that money and the duty of paying is an important facet to consider, as it rightfully acknowledges fault and the countries’ ability to provide adequate financial support. It is important to note that when developed countries spend a portion of their budgets to aid foreign countries, they are improving business alliances and partnerships. There are mutual benefits rooted in both developing countries and developed countries. The primary objective of this foreign assistance is to promote international security by strengthening economic stability.

However, since climate change is mostly a result of industrialization and mechanization, developed countries are primarily at fault. For this, regardless of whether there are benefits for developed countries, these countries should pay for climate change solutions. Due to the Industrial Revolution, which began around 1760, the world was changed. Although living standards and population increased, pollution as a result of factories and the exhaustion of national resources also multiplied. Machinery replaced human labor. Coal and steam power replaced wood. Later innovations such as the internal combustion engine and fossil fuel as a

source of energy also contributed to the emission of carbon dioxide. With all, developed countries – particularly those that have infrastructure, a diverse economy (with a large service sector), and high per capita income - are more culpable for global inequity. Therefore, these developed countries and established institutions should work to adopt measures and policies to combat climate change.

Most developing countries, particularly coastal states, are already struggling with climate change because of extreme weather events that shift climatic zones and fewer natural resources available for strong infrastructure. Along with responding to frequent humanitarian crises as a result of extreme natural disasters and the destabilization of states because of resource competition, these countries' security, as well as economic productivity, will be affected if such a large number of emissions will continue to be utilized. Citizens will begin to migrate to escape sea level rise or desertification, which will, unfortunately, do little to help the health of the citizens in these developing countries. Change is crucial.

Envirodevonomics - which is a field of economics that focuses on how effective environment legislation is and how well natural resources are salvaged - scopes into how the financial status of citizens affects their relative consumption and efforts to reduce pollution. Firstly, because developing countries' citizens have lower incomes, they focus more on living needs - such as food - rather than efforts to reduce pollution. The environment is considered to be a public good - something that is available to everyone. This idea may postpone efforts to help reduce contamination in the ecosystem because it puts consumption needs in perspective. Therefore, it is countries that have the financial resources that should help pay for climate change solutions because the developing countries have many other issues plaguing their "action schedules." Their citizens do not have the abilities to spend money and focus on climate change. Secondly, it is the developed countries' job to help the world reduce emissions because global economic inequality grew substantially under the Industrial Revolution, which introduced factories and railways, and, therefore, emissions into society. In fact, an analysis of the New York Times found that 23 industrialized countries contributed to 50% of the world's emissions. This means that industrialized countries are mostly responsible for the emissions, and therefore, global warming. They should be held accountable - the exploitation of underdeveloped countries should end and investments should focus more on environmental standards (and humanitarian relief). It is clear that developing countries are "paying" for climate change, in the sense that they are the prime victims. It is the developed countries' jobs to assist these countries because they are the source of the majority of emissions. They need to "clean up their mess."

## **Conclusion**

Yes, from one standpoint, the question of solving climate change is not who should pay less: countries should come together to combat this problem together, otherwise, there will not be a world for posterity to live in. However, ownership of this problem should be considered when forming a consensus on who should mainly finance solutions for climate change. Because of the prevalence of politics and debates over the economics of this issue, climate change is becoming

less of an environmental concern, and more of an efficiency-based, humanitarian one. Climate change needs to be addressed promptly to aid all aspects of today's world, with developing countries being less economically burdened to help solve this issue because they are already tasked with living with the consequences.

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# **Evaluating Carbon Sequestration Techniques to Mitigate Climate Change by Naina Tallak and Jo Machesky**

## **Abstract**

The increase in atmospheric carbon dioxide concentration due to increased carbon emissions increases global temperatures and has devastating ecological impacts. A goal set by the COP21 Paris Agreement was to limit global warming by 2 degrees celsius. Due to current concentrations of greenhouse gases in the atmosphere, it is necessary to not only reduce current emissions, but also implement carbon sequestration techniques which absorb the carbon already present in the atmosphere by carbon sinks, like the ocean and terrestrial land. Our oceans and land absorb about half of all CO<sub>2</sub> in the atmosphere each year and there is still research that is working towards making these more efficient carbon sinks long term without negatively impacting the chemical workings of the environment.

Proposed techniques, such as utilizing macroalgae or ocean fertilization, for carbon sequestration have unknown environmental risks. A framework which considered storage capacity, expense, environmental impact, scalability, and location was developed to analyze the risks and benefits of enhancing carbon sequestration through bioengineered solutions in the terrestrial and oceanic carbon sinks. Solutions considered include adding alkaline mixtures to the ocean to resist acidification or enhancing carbon dioxide storage capacity through cover crops on land. Other proposed methods include manipulating bacteria to increase the production of carbonic anhydrase, an enzyme that catalyzes the reaction between magnesium and carbon to increase carbon sequestration. After identifying the most beneficial solutions for increasing carbon sequestration with minimal negative environmental impacts and the largest carbon sink, this project explored not only the ecological impacts, storage capabilities, and expense, but also the likelihood of implementing these techniques into the ocean and on land.

## **Introduction**

The continual increase in atmospheric carbon is disturbing the balance of the global climate, leading to extreme conditions like tropical storms or wildfires that impact people worldwide. Burning of fossil fuels and land use changes are some of the leading sources for these increased levels. Carbon sequestration is necessary to mitigate climate change and includes various techniques to manage these rapidly increasing levels long-term and preserve environmental conditions worldwide. One of the main natural carbon capture methods is the ocean's ability to absorb carbon dioxide from the atmosphere. Many carbon capture techniques, such as adding a new chemical into the ocean that reacts with carbon dioxide to produce a harmless output or growing a plant that captures greenhouse gasses, are associated with negative environmental and economic impacts. Solely focusing on reducing anthropogenic emissions will require a longer timeline, so it is necessary to focus on both negative emissions as well as reducing anthropogenic emissions to see significant change and meet goals set by the Conference of the Parties Paris Agreement in 2015.

Scientists are studying various carbon sequestration techniques: cover crops, recalcitrant dissolved organic carbon, limestone, ocean alkalinity enhancement, macroalgae, seaweed cultivation, and ocean fertilization. Making sure that the changes to the ocean to increase carbon sequestration efficiency are ethical, economically beneficial, and environmentally friendly are challenges that scientists have to consider seriously. With the many techniques to consider, the challenge comes down to evaluating which is the most beneficial with the least drawbacks before implementation.

## **Overview of Carbon Sequestration Techniques**

Most articles and papers focus on carbon sequestration techniques ranging from terrestrial to oceanic and fall into categories like direct air carbon capture and storage, removing existing CO<sub>2</sub> from the atmosphere, or bioenergy with carbon capture and storage, storing carbon released from biomass-based processes (19). Many frame their argument around the economic impacts of certain carbon sequestration methods, the need for newer, cheaper technology, and techniques with the least environmental impact. Additionally, some focus on avoiding only the worst effects of climate change as it is an urgent issue where a perfect solution with no drawbacks will take time to discover. Furthermore, scientists consider each method's potential to store large amounts of carbon as these techniques must be efficient enough to meet the Paris Agreement goals by 2050 (2). This paper will focus on the efficiency of each carbon sequestration technique in the amount of carbon (Gt yr<sup>-1</sup>) it can store and its potential environmental impact. First, we narrowed down these methods by considering their carbon storage capacities, expenses, and selecting those with higher potential storage capacities. Then, we compared the advantages and disadvantages of the methods that were proven most promising in the previous step. With this evaluation, we could assess the most beneficial techniques to implement throughout the world to combat the climate crisis. As climate change is an urgent issue, the expenses of these techniques will not be a primary focus. However, they will still be considered, as governments need to implement the most effective method to solve this global issue. Carbon sequestration methods, both on land and in the ocean, will first be introduced briefly and later analyzed throughout the paper.

### *1. Cover Crops*

The ability of soil to uptake carbon depends on various factors like land management practices, crop rotations, the quantity of carbon inputs, climatic conditions, and soil texture. Cover crops like wheat, radish, and rye are fit for carbon sequestration as they feed soil organisms that benefit soil carbon levels. However, farmers planting cover crops need economic profit, which depends on the main crop grown and limits the scope of cover crops to experiment with. Experiments with cover crops also require many years to see the effects. In addition, there still is a need for an appropriate cover crop species that increases the profitability for the growers. The carbon market is an example of meeting this profitability for farmers. Companies and farmers work together to offset the carbon emissions in the world through the carbon market. Companies looking to reduce carbon emissions from their factories or for other reasons can

purchase carbon credits (5). This allows farmers to be paid to plant cover crops that absorb the carbon in the atmosphere and incentivizes them to shift their agricultural practices into a more eco-friendly system. However, the success of cover crops as a method of carbon sequestration depends excessively on humans for it to be efficient and feasible.

### 2. *Recalcitrant Dissolved Organic Carbon*

Another method of carbon sequestration is through the mediated production of recalcitrant dissolved organic carbon (RDOC) in the microbial carbon pump (MCP). This would focus on converting organic carbon into RDOC to produce less carbon and more bicarbonate and  $N_2$ , improving ocean alkalinity (20). Alkalinity can also be enhanced by dissolving certain silicate-containing minerals like magnesium olivine ( $Mg_2SiO_4$ ) or iron olivine ( $Fe_2SiO_4$ ) which increase carbon sequestration. The environmental conditions would need to remain relatively unchanged for RDOC to remain recalcitrant or non-decomposing to store carbon and age. This would rely on humans to maintain or possibly decrease anthropogenic emissions to control the global climate.

### 3. *Limestone*

Some research indicates that carbon dioxide can be converted into limestone using seawater as a method of carbon capture. Limestone is composed of magnesium and calcium carbonates, and there is naturally occurring magnesium and calcium in the ocean, which then reacts with carbon dioxide to form limestone. Carbonic anhydrase, an enzyme found in bacteria, can be used as a catalyst to speed up this naturally slow chemical reaction. Photosynthetic bacteria in the ocean with sufficient food can be grown in labs and manipulated to produce carbonic anhydrase through biochemical processes (7). However, limestone production would require large amounts of energy and harm ecosystems if it's produced in excess.

### 4. *Ocean Alkalinity Enhancement*

Ocean alkalinity enhancement is a high-confidence capture method that has the potential to store significant amounts of carbon, managing the global temperature. This method involves implementing different alkali metals to manage pH levels in the ocean. Unlike other methods that directly absorb carbon dioxide, ocean alkalinity enhancement supports the ocean's ecosystems as it regulates the ocean acidity when the ocean absorbs carbon dioxide. Ocean alkalinity enhancement doesn't require its own land, nutrients, or freshwater as it works directly in the ocean. It can also be beneficial for sustainable development goals and would serve as a buffer for pH levels to protect ecosystems from ocean acidification. This method would be most effective and beneficial in areas similar to the Black Sea with high surface alkalinity and some of the most extensive blooms of calcifying phytoplankton suited to low  $CO_2$  concentrations (3). Additionally, calcifiers would benefit from the effects of ocean alkalinity enhancement as  $CaCO_3$  would precipitate and allow energy for organisms to grow and undergo metabolic processes. The  $CaCO_3$  would also speed up the sinking process of the organic carbon in the deep ocean, enhancing the carbon sink. Minerals like olivine ( $Mg_2SiO_4$ ) dissolve in seawater, creating carbonates while decreasing  $CO_2$  concentration (25). Overall, ocean alkalinity enhancement is a feasible technique for carbon sequestration as it would create a "greener ocean" through mineral

fertilization from iron, benefit certain ecosystems, and become an efficient anthropogenic and fossil fuel emission capturing process.

#### 5. *Macroalgae*

Certain biological organisms can contribute to carbon sequestration. Macroalgae, responsible for the most productive vegetated coastal habitat, can be a source of sequestering carbon and exporting it into coastal sediments and the deep ocean. To prove that these macroalgae have the ability to reach the deep ocean while still storing carbon, their eDNA is studied to trace the specific orders of macroalgae that reach different regions of the ocean (23). The eDNA consists of fragments of cell tissue, gametes, and other debris from the organism. Scientists can recognize the migration of macroalgal carbon by tracking the macroalgal DNA in habitats beyond their own. This technique poses some challenges as the diversity between the lineages of macroalgae is so large, and there is insufficient material on macroalgal sequencing in reference libraries. Using metagenomics, the study of genomes in a community of organisms, scientists discovered the relative abundance of macroalgae across the global ocean. Their results concluded that macroalgae can be preserved longer at lower temperature areas and will be more diverse closer to the ocean's surface. Most importantly, they found no difference between the macroalgae found at the shore compared to distances up to 5,000 km away. This showed that macroalgae are able to be exported across the ocean. An explanation for this can be the storm-driven events that move the macroalgae and later allow them to sink to the seafloor. They also discovered that macroalgae could reach depths over 1,000 km, around where carbon can be stored for a long time.

#### 6. *Seaweed Cultivation*

Seaweed cultivation is a carbon sequestration technique that involves growing seaweed, which can store carbon, near the ocean shore and possibly sinking the seaweed into the deep ocean for long-term storage (15). Seaweed has large capacities for carbon storage and higher productivity, unlike other terrestrial plants, making them an optimal carbon sequestration option. The seaweed productivity would additionally depend on the region in which it is grown as the various ecosystems could react differently with the seaweed. However, there are legal obstacles before implementing large seaweed farms in regional waters. For example, some environmental laws prohibit seaweed farms in certain regions for fear of harming the present ecosystem with a dramatic increase in seaweed. There are uncertainties about the environmental impacts associated with the dramatic seaweed increase in the ocean.

#### 7. *Ocean Fertilization*

Ocean fertilization is a carbon sequestration technique that introduces limiting nutrients like iron into the ocean to stimulate phytoplankton growth and increase carbon uptake (18). The nutrient availability causes phytoplankton to produce organic matter through photosynthesis. This organic matter travels to the deep ocean where the organic particles sink in the water, and therefore, carbon will be stored. However, this method possesses uncertainties involving the permanency of storage, nutrient availability, geographical differences, and environmental conditions for optimal efficiency.

## Results

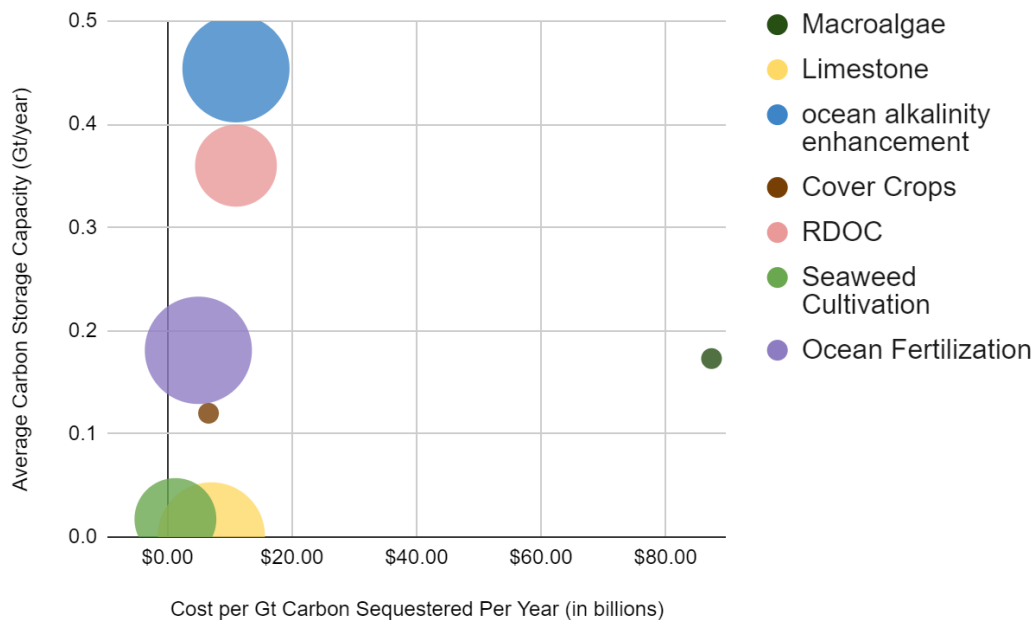


Fig. 1: Comparison of Seven Carbon Sequestration Techniques. The vertical axis indicates the storage capacity for each technique. The horizontal axis indicates the expense for each technique and highlights that macroalgae has the highest expenses overall. The size of the bubbles represents the environmental risk, with the small size equating to low risk and the increase in size equating to high risk. The environmental risk was estimated from the possible harms to surrounding ecosystems, such as chemical imbalances or decreased organism productivity.

With these various methods, some may be beneficial for the environment and store large quantities of carbon while being associated with unrealistically high expenses. To approach this issue, their positive influence as well as the concerns with these methods, will be detailed to evaluate the most beneficial techniques overall. Some convenient techniques that can be easily implemented due to naturally occurring resources present in oceanic ecosystems are the utilization of macroalgae, cover crops, RDOC, and seaweed cultivation. Macroalgae can sink into the deep sea, allowing for long-term storage. Similarly, RDOC can be produced with the Microbial Carbon Pump at any depths in water. Furthermore, the cover crop technique has its own Carbon Market that encourages farmers to plant large scale cover crop farms to supply a method of sequestering carbon.

However, with macroalgae, there are challenges as algae struggle to grow in areas where high levels of carbon can be absorbed. The cover crop market involves contracts that are viable for only short-term agreements, but long-term carbon sequestration is needed to make a substantial change in the world's climate situation. Unfortunately, seaweed cultivation can be detrimental to the surrounding marine ecosystems as the organisms will undergo a dramatic

increase in seaweed, shocking their balanced environment (Fig.1). In some offshore waters, seaweed productivity would decrease with nutrient deficiency.

With ocean alkalinity enhancement, there are various benefits, such as monitoring ocean acidity levels by adding alkaline metals and large-scale capabilities of this method across multiple oceanic regions. However, the expenses of mining metals and the possible dangers posed to marine organisms from changes to pH levels are major concerns that need to be considered when evaluating carbon sequestration methods. Similarly, with the addition of limestone into the ocean, there are unknown effects on certain environments, each varying with the geography, that still need to be investigated (Fig.1). In addition, large amounts of energy and resources to grow photosynthetic bacteria are challenging requirements to meet in the limited time to make significant changes. Regarding ocean fertilization, the iron and other materials added to the ocean pose detrimental impacts to entire ecosystems as phytoplankton, a fundamental part of most oceanic ecosystems, are the main factor of this technique to sequester and sink carbon into the deep ocean (25). Adding in certain nutrients could possibly emit other harmful greenhouse gasses, reversing any benefits from the method (Fig.1).

The average storage capacity of carbon for each technique was analyzed and compared in terms of gigatons sequestered per year. Limestone, seaweed cultivation, cover crops, macroalgae, and ocean fertilization were found to store 0.001 to 0.181 Gt CO<sub>2</sub> yr<sup>-1</sup>—limestone at the lowest, 0.001 Gt C yr<sup>-1</sup> (25), seaweed cultivation at 0.0174 Gt C yr<sup>-1</sup> (15), cover crops at 0.12 ± 0.03 Gt C yr<sup>-1</sup> (24), macroalgae at 0.173 Gt C yr<sup>-1</sup> (21), and ocean fertilization at the highest, 0.181 Gt C yr<sup>-1</sup> (18). However, RDOC and OAE were found to substantially store more carbon compared to the other techniques—RDOC at 0.360 Gt C yr<sup>-1</sup> (20) and OAE at 0.454 Gt C yr<sup>-1</sup> (25). To meet the intended goal of 10 Gt C stored annually to accomplish broader goals set by the Paris Agreement (2), techniques such as RDOC and OAE are promising as they sequester the largest amount of carbon each year of the techniques included in this analysis.

When discussing the expenses of each technique to sequester one gigaton annually, to meet the goal of 10 gigatons of CO<sub>2</sub> removed each year by 2050, these techniques might hold economic concerns. Macroalgae, ocean alkalinity enhancement (OAE), and RDOC are on the higher end of the spectrum for costs per gigaton of CO<sub>2</sub> sequestered; their estimated costs are \$870 billion for macroalgae and \$110 billion for both OAE and RDOC. (34). While seaweed cultivation, ocean fertilization, and cover crops have lower estimated costs per year of \$13 billion(15), \$50 billion (22), and \$66 billion (5), respectively. Although the effectiveness of the method is favored over the expenses as the climate crisis is stressing, the costs of such techniques need to be reasonable for them to be seriously considered by global governments. Techniques such as cover crops, ocean fertilization, and seaweed cultivation are most promising in regards to their costs of implementation—specifically, seaweed cultivation, as it is the least expensive at \$13 billion for 9.58 tonnes of seaweed ha<sup>-1</sup> yr<sup>-1</sup>(15).

## Advantages and Disadvantages of Most Promising Techniques: RDOC, OAE, Seaweed Cultivation, Ocean Fertilization, Cover Crops

### *Environmental Impact:*

Assessing the storage capacities and expenses of the individual techniques, we can see that RDOC and OAE are most beneficial for storage, while seaweed cultivation, ocean fertilization, and cover crops are most beneficial for low expenses. However, when considering the possible detrimental environmental impacts that individual carbon sequestration methods could have, OAE, ocean fertilization, and ocean liming pose serious threats. For example, ocean liming would release 0.786 tonnes of CO<sub>2</sub> back into the atmosphere (14). In addition, both OAE and ocean fertilization shift pH levels with added nutrients and, therefore, disturb natural marine ecosystems nearby. Seaweed cultivation has the lowest expense yet noticeable environmental impact, however, they are not as severe as the techniques prior. The dramatic increase in seaweed could possibly pose threats to marine ecosystems, but more research is needed on the topic. Fortunately, seaweed provides benefits as it creates habitats for certain animal species and is used in medicine and food for humans (15). Cover crops, one of the less expensive methods, are associated with the lowest environmental impact, even supporting nature. The implementation of cover crops leads to an increase in microbial diversity and activity by 22% which makes the microbiome more resilient (24). Overall, both seaweed cultivation and cover crops serve as carbon sequestration methods and benefit the environment and humans, demonstrating their potential for global climate mitigation.



Fig. 2a: Sites of Seaweed Layer Companies Worldwide. Each dot represents a company location where seaweed cultivation would take place.

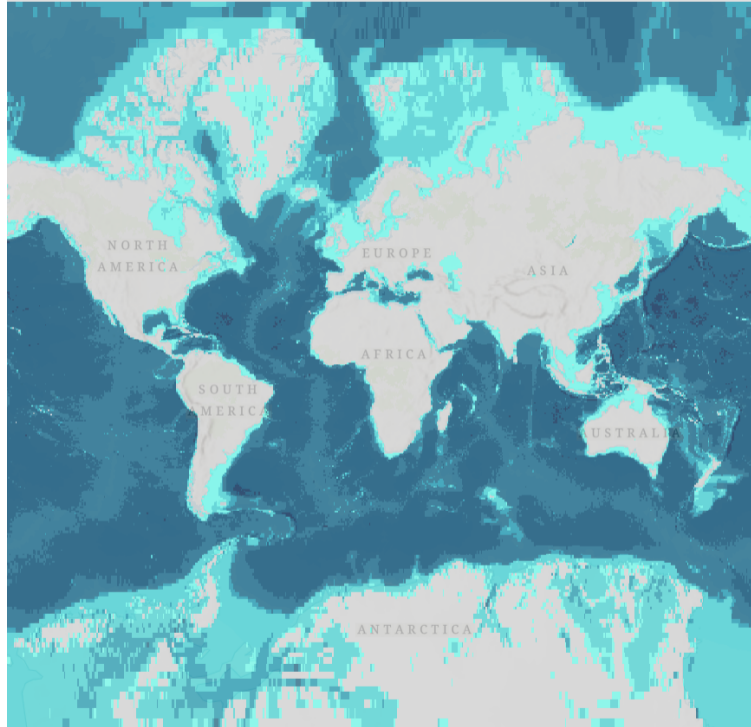


Fig. 2b: Ocean Depth Zones in 2022. The depth zones are represented by the range of colors. As the blue darkens, the depth (meters) increases. The lightest blue near the coasts are less than 200 meters deep where seaweed cultivation, ocean fertilization, and OAE would take place. The darkest blue areas are more than 6000 meters deep where RDOC would sink into the ocean.

*Scalability:*

OAE, ocean liming, and RDOC require large-scale production with mining hundreds of tonnes of minerals for the technique to be effective long term. Additionally, ocean fertilization requires areas as large as the Southern Ocean to be fertilized to sequester about 0.2 Gt of CO<sub>2</sub> (18), too low of an amount and an unrealistically large area required to meet the goal set by the Paris Agreement: 10 Gt of CO<sub>2</sub> sequestered annually by 2050. However, with seaweed cultivation and cover crops, some businesses and industries make a profit from large-scale production. Seaweed farms are largely popular in China and other Southeast Asian regions. Fortunately, seaweed farming is not limited to Southeast Asia but can be incorporated in most coastal waters around Europe (Fig.2a). With large expanses of water, more seaweed can be cultivated for long-term carbon capture and storage. Similarly, cover crops have a unique advantage with their Carbon Market Place, an industry where farmers can plant cover crops for both economic and environmental profit. Farmers are paid by environmental companies to plant cover crops, motivating people to support climate change projects.

*Location:*

The dangers of implementing techniques such as OAE and ocean liming are that the application sites, which are in surface waters, tend to have higher alkalinity and pose potential harm to nearby ecosystems. Although seaweed is harvested on surface coastal waters, most seaweed farms for seaweed cultivation are in oceanic regions that are adapted to the flux of



seaweed, like China (Fig.2a). Continuing to utilize these oceans, which are on the relatively acidic side, seaweed will capture existing and newly released carbon dioxide to meet the global climate goal by 2050. Methods such as RDOC and cover crops are more flexible as RDOC sinks into deep waters for long term storage (Fig.2b), and cover crops can be planted in any farmland worldwide. In 2017, 15.4 million acres of cover crops were planted across the US (32). With high adoption and growth rates, Pennsylvania, Virginia, and Georgia were notably acknowledged for implementing cover crops.

## **Conclusion**

To assess the best methods of carbon sequestration and meet climate goals set by the Paris Agreement of decreasing total global annual emission by 10 Gt CO<sub>2</sub>/yr, this paper evaluated seven different carbon sequestration techniques on their storage capacity and expense—with further analysis on their scalability, environmental impact, and location sites. For the purpose of practicality, the expenses of individual techniques were discussed as governments need to realistically consider the costs of environmental intervention. However, the expenses do not hold a matching significance to storage capacity as the climate crisis is a time-constrained issue. For this reason, ocean fertilization was eliminated despite its low cost, while more expensive methods, such as RDOC were favored for its significantly high storage capacity. In addition to storage capacity and expense, potential environmental impacts were seriously considered as the methods serve to benefit, not harm the environment. With this consideration, OAE, with the largest storage capacity, was eliminated as a potential method as its large-scale production releases unwanted debris into the atmosphere. By analyzing the advantages and drawbacks of these methods, three techniques were identified to have the most potential for real-life application: cover crops, RDOC, and seaweed cultivation. Cover crops and seaweed cultivation have lower storage capacities, so a combination of these two techniques needs to be implemented as they're environmentally and economically beneficial. The Carbon Market Place, which allows large industries to work with farmers and plant cover crops, needs more attention. Aramco, a successful petroleum refinery company in Saudi Arabia, is currently funding a \$5 billion project to build a green-fuel plant and capture and reuse the carbon released into the atmosphere from the Saudi oil fields (11).

Similarly, other influential industries can utilize their resources to support new projects like Aramco or existing networks such as the Carbon Market Place. Like cover crops, seaweed farming can easily be invested across the world and used for various purposes such as medicine and food. Although further research is needed to assess the environmental dangers associated with RDOC and its large-scale production, this carbon sequestration method should work in tandem with other beneficial options, such as cover crops and seaweed cultivation, as RDOC has the potential for large storage capacity to meet Paris Agreement goals. In addition, RDOC is mainly effective in regions that are resilient to changes in pH, so further research is needed to discover a wider range for RDOC incorporation to be significantly beneficial. Current cover crop analysis has been associated with short-term experiments, so researching the effectiveness of

cover crops with long-term experiments is necessary for real-world implementation. More work is needed to invent new technology for large-scale transportation of seaweed into the ocean. All of the three methods will need global participation as each will thrive in specific geographic environments. Further discussion, similar to ones involved for the Paris Agreement, is necessary to begin investing in these carbon sequestration techniques and encourage influential companies to support climate change mitigation.

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# **Acculturation To Los Angeles: A Comparison Between Christian and Muslim Lebanese By Jasmine Wells**

## **Abstract**

The purpose of this research paper is to first evaluate, then compare the degree to which Lebanese Americans living in Los Angeles face acculturative stress and practice acculturation differently based on their religion. My research method combines elements of both qualitative and quantitative research. Two different surveys by Richard Cervantes were used to collect the necessary data: Hispanic Stress Inventory Version 2: Improving the Assessment of Acculturation Stress and Hispanic Stress Inventory Adolescent Version: A Culturally Informed Psychological Assessment. Results revealed that the most commonly reported stressors for both Muslim and Christian Lebanese were from the Discriminatory Stress, Family Stress, and Economic Stress categories. Within the Discriminatory Stress category, Lebanese Muslims displayed significantly higher levels of stress than Lebanese Christians. The implications of my study include bringing awareness to the current mental health struggles of Lebanese Americans originating from acculturative stress

## **Introduction**

The Lebanese Civil War of 1975 provoked an intense wave of Lebanese Immigrants to the United States. As of 2020, there are 310,000 Lebanese Americans living in the United States, making up 0.88% of the American population (US Census Bureau, 2020). The circumstance of their emigration plays a crucial role in the understanding of their traumatic history. Not only were these immigrants forced to leave their country of origin, but they did so in the midst of a catastrophic war. As a result, families were ripped apart, and countless sacrifices were made to prioritize the safe arrival of innocent women and children. “Lebanese immigrants, many of whom had to emigrate under the stressful conditions of the Lebanese war are thus considered to be at greater risk of suffering from psychological problems” (Sayegh 754). Due to a combination of the culture shock caused by the differences between American and Lebanese culture, along with the trauma associated with their arrival, Lebanese Americans are known to face elevated levels of acculturative stress. The level of acculturative stress varies depending on a multitude of factors, such as the religious background of the immigrant. This is indeed the case for the Lebanese community which is made up of two primary religious groups: Christians and Muslims. While there is a misconception that the majority, if not all Middle Easterners are Muslim, this is most definitely not the case for the American Lebanese community, as over 60% are Christian, and 30% are Muslim (Jabbara 99). Even though there has been a significant growth of the Lebanese American population, most studies have focused on either Lebanese acculturation to Canada, or Muslim Arab acculturation to the United States (Hashem 967). No attempts have yet been made to compare the acculturation and levels of acculturative stress between Christian and Muslim Lebanese Americans. The importance of religiosity in measuring acculturative stress and acculturation is highly critical in this case, due to the fact that Christian

and Muslim Lebanese have been physically and socially isolated from one another for hundreds of years (Malley 124). This isolation has caused both groups to form their own unique culture and practices. Thus, in order to fully comprehend the complexity of Lebanese acculturation to the US, it is imperative to look at each religious group separately. The purpose of this research paper is to first evaluate, then compare the degree to which Lebanese Americans living in Los Angeles face acculturative stress and practice acculturation differently based on their religion. As the United States continues to be a melting pot of unique cultures, acculturative stress becomes an increasingly relevant issue for incoming and existing immigrants.

### **Literature Review**

Los Angeles was chosen as the focus area for two major reasons. Firstly, California has the largest Arab population in the US, with 56 out of all 58 counties representing the Arab community (Habaz 43). “Since the late 19th century, Syrian, Egyptian and Lebanese migration, in particular, to Southern California has been increasingly prominent, and intimately connected to and through Latin America, and especially Mexico” (USC Dornsife). Secondly, the city with the largest Lebanese American population is Los Angeles, counting over 31,000 Lebanese, which makes up 10% of all Lebanese in the US (US Census Bureau, 2020). The percent of Lebanese Muslims and Christians living in Los Angeles represents a virtually even split, further making LA an ideal location to perform this research as there will essentially be an equal number of participants from each religious group. Moreover, since little research exists on the acculturation of Arab Americans as a whole, this study will act as a basis for future studies, not only on Lebanese Acculturation, but also many other Middle Eastern ethnic groups.

### **Defining Acculturation and Acculturative Stress**

Establishing a concise and comprehensible definition for acculturation is necessary in order to fully comprehend the fundamental aspects of this paper. One definition of acculturation states: “Acculturation, similar to assimilation, is the process whereby members of immigrant groups come to resemble the cultural majority while abandoning their own” (Jabbara 95). This unique definition considers acculturation and assimilation to be one in the same. In this case, if an immigrant participates in acculturation, they automatically relinquish the culture of their country of origin and fully adopt the culture and values of the host country. A much more commonly used definition, which will be used in this paper, comes from lead psychologist John Berry known for his work in cultural influences on behavior: “Acculturation involves working out how to live with and between two cultures” (Berry, *Critical Acculturation* 364). Berry’s universally accepted definition of acculturation has been expanded throughout the years: “Acculturation is not simply accumulating the cultural norms, behaviors and values of a new, alien culture, yet instead, it is the process of adaptation” (MSU Libraries). The process of acculturation depends on each unique individual, and therefore influences the way they address acculturative stress. This process commences when the immigrant chooses the extent to which they desire to maintain contact with their country of origin and to retain their customs and

traditions along with how they proceed to adapt in the host country – this decision is defined as the bidimensional model of acculturation (Goforth 10). The ways that immigrants choose to acculturate in a host country are called acculturation strategies. The three primary acculturation strategies are assimilation, separation, and integration, with each strategy reflecting the bidimensional model of acculturation. The assimilation strategy consists of the individual deciding to reduce their relationship with their country of origin so that they can build a new relationship with their host culture. The strategy of separation takes place when the individual chooses to fully maintain their culture of origin and resists any interactions or relationship with the host culture. Integration, the final strategy possible, is in effect when the individual opts to continue having a relationship with their culture of origin and simultaneously pursues a relationship with the host culture (MSU Libraries). When encountering a new culture, it has been proven that at least one of these three strategies will be utilized. Accordingly, in 2005, Berry discovered that these strategies could be measured according to five main domains: religion, language, social activities, cultural traditions, and friends (Berry, *Living Successfully* 701) Acculturative stress encapsulates “stressors that are identified as having their source in the process of acculturation” (Berry and Kim 498). Generally, acculturative stress will not occur if the individual is able to deal with the constraints that come with acculturation and is willing to make the behavioral changes that are necessary to fit in with the host culture. Those who cannot or are unwilling to do so will likely experience acculturative stress (MSU Libraries). Acculturative stress can be divided into two subgroups: environmental and family factors. The environmental factors include significant demonstrations of discrimination and racism, and family factors concern disputes within the family relating to values or expectations. Both factors will prove to be indispensable when analyzing the acculturative stress levels of Lebanese Americans.

### **Historical Divide between Muslim and Christian Lebanese**

Lebanese emigration can be divided into two main movements: Pre-Civil War and Post-Civil War. The Pre-Civil War mass emigration occurred when 330,000 Lebanese citizens left Jabal Lubnān (Mount Lebanon) between the 1870s and the 1930s for North America. The Christians in Mount Lebanon were depicted as defenseless victims oppressed by ruthless Muslims within the Ottoman government. This perspective further supported prejudicial Western beliefs that portrayed Muslims as aggressive, dangerous, and destructive (NC State University). It is important to note that these violences were not always one sided; Muslims also faced persecution and were forced to emigrate. According to a 1930s interview with Kassem Haddam, a Lebanese American immigrant, numerous Muslim and Christian families in Mount Lebanon left their homeland for better economic opportunities in the United States. (Smithsonian Institution). While persecution and internal conflict have been on the rise for centuries in Lebanon, they reached a climax at the start of the Civil War in 1975. This miscellaneous violence resulted in the exodus of nearly 1 million Lebanese people to neighboring countries, as well as Canada, France, and the United States. Fifteen years of seemingly never-ending battle resulted in over 200,000



fatalities, and 340,000 injured civilians and soldiers. The primary cause of this war was the exacerbated tensions among Lebanon's Christian and Muslim populations, who for a long time have been physically and socially divided (Perera 14). A fundamental divide between the two religious groups relies on the fact that while the Christian community did not view themselves as Arab and instead related more to the West than to the Arab world, the Muslim community strongly identified as Arab and felt completely disconnected to the West (Malley 122). Unbeknownst to most, leading up to the civil war, in 1973, Lebanon was one of the most developed countries in all of the Middle East (NC State University). However, as of 1991, "Lebanon was considered to be one of the first failed states of the post-World War II era and the term "Lebanonization" officially entered the French lexicon in 1991 as a term denoting the fragmentation of a state as a result of intractable conflict between diverse communities" (Malley 126). As a result of the extensive divide between Muslim and Christian Lebanese, originating deep within Lebanese history, a unique culture specific to each group has formed and evolved over time.

### **The Role of Religiosity in Acculturation and Acculturative Stress**

Lebanese Americans, Christians, and Muslims alike, are more than twice as likely to suffer from PTSD than other Americans (Faragallah 189). Discrimination of Arabs in the United States varies dramatically from the discrimination of other ethnic minorities. Specifically, Americans have preconceived prejudices surrounding the Muslim Arab community following the events of 9/11, believing that they are all "pro-terrorist, anti-Jewish rebels having one goal in mind, to disrupt the peace" (Jabbara 102). According to a Pew Research Center survey, 91% of Muslim Lebanese Americans found that they were subjected to a least some discrimination, compared to only 49% of Christian Lebanese Americans (Pew Research Center). Referring to the acculturation strategies, Muslim Lebanese immigrants mainly practice separation, whereas Christian Lebanese immigrants primarily practice integration. Lebanese American Muslims demonstrated a positive association between religiosity and self-confidence/ ethnic identity; however, those positives were outweighed by the negatives associated with the perceived discrimination. These experiences of intense discrimination also caused higher levels of psychological stress (Hashem, 962). This statement is further validated by various studies done at MSU. Results from these studies showed that the process of integration, defined by co-identity, was associated with a decrease in psychological distress (MSU Libraries). Given the fact that Lebanese American Muslims do not follow the acculturation strategy of integration, it is logical that they would have higher levels of psychological stress than the Lebanese American Christians who follow integration. "pro-terrorist, anti-Jewish rebels having one goal in mind, to disrupt the peace" (Jabbara 102). According to a Pew Research Center survey, 91% of Muslim Lebanese Americans found that they were subjected to a least some discrimination, compared to only 49% of Christian Lebanese Americans (Pew Research Center). Referring to the acculturation strategies, Muslim Lebanese immigrants mainly practice separation, whereas Christian Lebanese immigrants primarily practice integration. Lebanese American Muslims

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## **Conclusion and GAP**

Following a detailed analysis of numerous pieces of literature surrounding the topics of historical and cultural divides, acculturative stress, acculturation, and how these factors impact Lebanese Americans, the GAP of this research paper is the fact that no existing research has yet to evaluate and compare acculturative stress levels experienced by both Christian and Muslim Lebanese Americans, yet alone those living in Los Angeles. A concise evaluation and measurement of acculturation related stressors faced by both Muslim and Christian Lebanese American is the main goal of this research paper, which will ultimately result in an extensive comparison between the two. This research will prove to be significantly important to the Lebanese American community since it will shed light on its unique cultural background and complexity which surpasses the simple notion of religious divide. This paper will also offer an objective perspective on the current treatment and perception of Lebanese Americans in the United States, therefore reducing discrimination against the Lebanese American community.

## **Sample Size**

The sample size from both age groups consisted of a total of 53 participants (26 Muslim and 27 Christian). Within the Muslim respondents, 11 were adolescents and within the Christian respondents, 12 were adolescents. Out of the 26 Muslim respondents, 14 were female, 11 were male, and 1 was nonbinary, and out of the 27 Christian respondents, 12 were female and 15 were male. Among all adult respondents 73% were married or previously married, 22% were single, and 5% preferred not to answer. Finally, 76 % of all adolescent respondents were fully Lebanese, 20% were half, and 4% were less than half.

## **Hypotheses and Rationales**

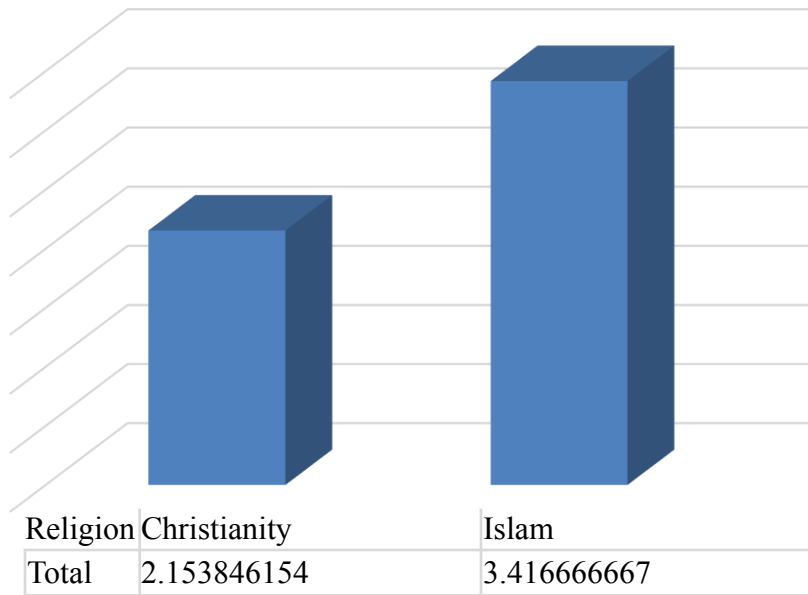
*Hypothesis 1:* Muslim Lebanese Adolescents will demonstrate higher levels of Acculturation Gap Stress than Christian Lebanese Adolescents, evidenced by a higher mean score in the Acculturation Gap Stress category of the modified Hispanic Stress Inventory Adolescent Version. *Rationale 1:* This hypothesis is backed by an ASU study on the psychological stressors of Lebanese American adolescents. The results of the study revealed that within this sample group, Christians displayed higher levels of acculturation gap stress than Muslims (ASU). In addition, since over 70% of all Americans identify as Christian, churches are expected to have a higher level of cultural and ethnic diversity than mosques. As a result, Lebanese Christian adolescents are exposed to an especially diverse religious community which explains their increased levels of Acculturation Gap Stress, relating back to the fact that “being socialized within a different cultural context than their parents, leads to differences in cultural attitudes and values, and subsequent conflict within the family” (Goforth 5). *Hypothesis 2:* Lebanese Muslims will possess considerably higher levels of Discriminatory Stress than Lebanese Christians, evidenced by a higher mean score in the Discriminatory Stress category of the modified Hispanic Stress Inventory Version 2. *Rationale 2:* This hypothesis is supported by a survey conducted by Pew Research Center in 2020. Results revealed that while 91% of Muslim

Lebanese Americans have felt subjected to discrimination, only 49% of Christian Lebanese Americans have (Pew Research Center). These findings can be explained by Americans preconceived prejudices surrounding the Muslim Arab community following the events of 9/11, believing that they are all “pro-terrorist, anti-Jewish rebels having one goal in mind, to disrupt the peace” (Jabbara 102). *Hypothesis 3*: Lebanese Muslims will show higher rates of Social Identity Stress than Christian Lebanese, evidenced by a higher mean score in the Social Identity category of the modified Hispanic Stress Inventory Version 2. *Rationale 3*: This hypothesis is validated by the fact that within Lebanon, the Christian and Muslim populations have been divided for hundreds of years. When it comes to cultural preferences and association, the Christian community has always felt closer to the West than to the Arab world (Malley 122). This greater sense of belonging explains Christians’ lower levels of Social Identity Stress. Since Lebanese Christians are more familiar with American culture, their willingness to adapt is likely to be superior to that of Muslims, who are not as respective to this foreign culture (MSU Libraries).

### **Analysis of Results and Discussion**

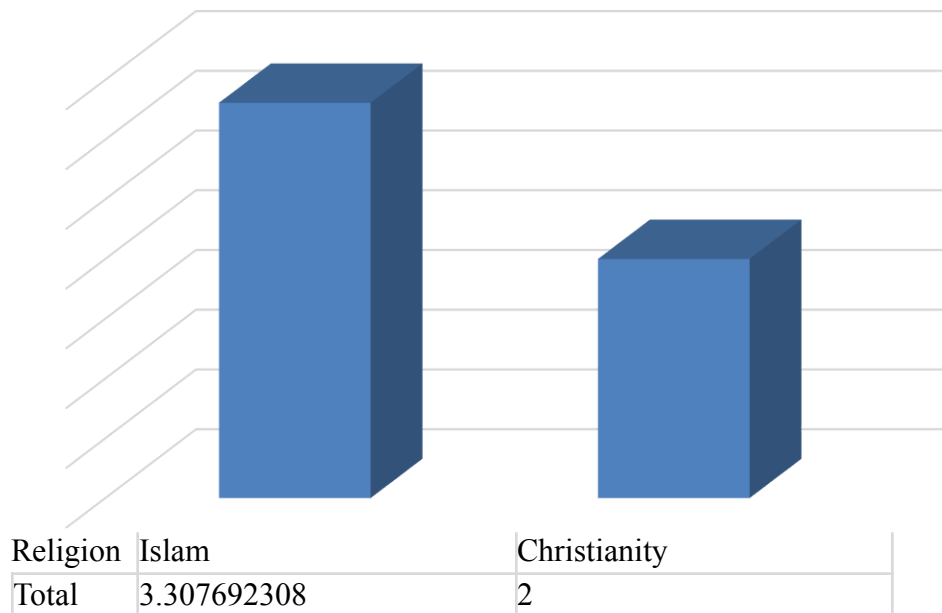
Before undergoing a specific statistical analysis of the degree to which each stressor is reported within the respective religious group, the top ten most frequently reported stressors of each group, regardless of age have been recorded. Stressors are ranked from most frequently reported to least. For both Muslim and Christian Lebanese, five out of the ten frequently reported stressors were from the Discriminatory Stress category, with both groups reporting that they have been discriminated against, have had family members experience discrimination, have been made fun of because of their religious accessories, have felt unaccepted by others because of their Lebanese culture/religion, and have been treated inferior to other Americans because they were Lebanese. Additionally, both groups frequently reported two factors from the Economic stress category, such as feeling stressed about having to economically support family members in Lebanon and having problems finding work post-immigration. Within the Family Stress category, both groups frequently reported having serious arguments with family members still in Lebanon. Nevertheless, whereas Muslim Lebanese participants frequently reported feeling misunderstood by their parents, and that their parents disapproved of their American friends, Christian Lebanese participants did not share the same level of frequency, with both of those stressors not appearing in the Christian Lebanese portion of the top ten most frequently reported stressors. The extent to which participants experienced Discriminatory, Social Identity, and Acculturation Gap Stress is shown respectively in charts 1, 2 and 3 below. The level was measured based on the average degree to which the stressor was experienced, using the Likert scale (1 to 5) to quantify the degree. It is to be noted that while not shown in the charts below, Family-Related Stress and Economic Stress greatly varied depending on the religious affiliation of the participant in a similar manner as did the three previously mentioned above.

*Chart 1: Average Level of Discriminatory Stress (Version 2 survey)*



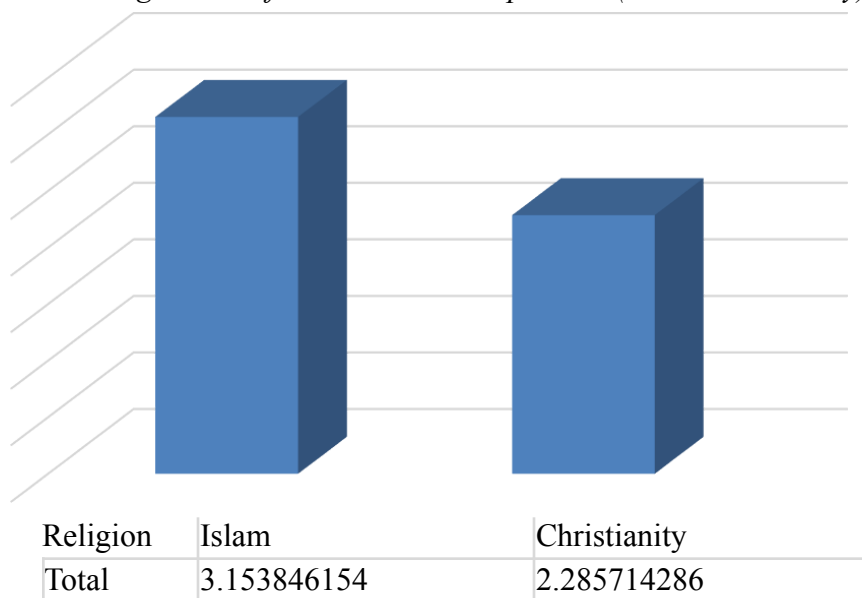
The results of my Version 2 (Adult) survey demonstrated that Lebanese Muslims experience a higher level of Discriminatory Stress than Lebanese Christians, with Muslims on average experiencing a level of around 3.4 and Christians experiencing a level of around 2.2. This thus approving my first hypothesis which stated Muslim Lebanese would experience more Discriminatory Stress than Christian Lebanese.

*Chart 2: Average Level of Social Identity Stress (Version 2 survey)*



Subsequently, my second hypothesis stating Lebanese Muslims would experience more Social Identity Stress than Lebanese Christians was also validated by the results of the Version 2 (Adult) survey. Whereas Muslim participants averaged a level of around 3.3, Christian participants only averaged a level of 2.

*Chart 3: Average Level of Acculturation Gap Stress (Adolescent survey)*



Disappointing my third hypothesis, results of the Adolescent survey revealed that Lebanese Muslim adolescents reported higher levels of Acculturation Gap Stress than Lebanese Christian adolescents. Muslims demonstrated an average level of 3.1, with Christians demonstrating an average level of 2.3.

### **Limitations**

My study contains several limitations which have likely prevented my results from being of the utmost accuracy. First, the sample size of my research group consisted of only 53 participants, which is a little more than half of what Research Gate considers to be the minimum number of participants for an accurate study (Research Gate). In addition, the results may portray some biases due to the fact that all participants were chosen from only two different location, St. Peter Cathedral of Los Angeles, and Masjid Bilal LA Islamic Center. These limitations influenced the credibility of my research and prevented me from assigning concrete conclusions based off my results on the given topic. I recommend that future research studies use a larger sample size totaling a minimum of 100 participants. Furthermore, these future studies should consist of participants originating from diverse geographic, economic, and social backgrounds in order to minimize potential biases.

## **Conclusion and Recommendation**

My study approves 66.66 % of my original hypotheses, with only my third hypothesis that Lebanese Christian adolescents would experience more Acculturation Gap Stress than Lebanese Muslim adolescents being disproved. Based on my research findings, I can conclude that significant differences exist between the acculturation related stressors of Christian Lebanese living in the Los Angeles district and Muslim Lebanese living in the Los Angeles District in all categories of the acculturative stress inventory. My findings have led me to the new understanding that Lebanese Muslims and Christians go through different acculturative stress processes and thus experience different acculturative stressors. Therefore, the two groups' acculturation experiences cannot be regrouped under the same larger Lebanese category when considering my study results. In order to truly confirm these findings, my research would need to be replicated on a much larger scale, because as of now, my findings only indicate a tendency and not conclusive evidence. My research study is significant because it bridges the current gap of research that exist in the category of Lebanese American acculturation, specifically the impact that religious affiliation has on said group's acculturative stress. The implications of my study include bringing awareness to the current mental health struggles derived from acculturative stress that Lebanese Americans go through as a result of their acculturation process. Additionally, my research will help shed light on the unique cultural and religious background of Lebanese immigrants, potentially leading one day to a reunification of the extremely divided Christian and Muslim Lebanese community. Therefore, I recommend that this research be replicated on a larger scale to not only yield more accurate results, but to also increase awareness of this underrepresented community's cultural divide and mental health issues in the US.

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## **On the Relationship Between the Supporting Force on the Front and Back Ends of an Object and its Gravitational Force By Yinlang Ai**

### **Definition of Gravity**

Gravity is a fundamental force in physics that governs the attraction between objects with mass or energy. It is responsible for the phenomenon where objects with mass are pulled towards each other. According to Einstein's theory of general relativity, gravity is the curvature of spacetime caused by the presence of mass and energy. It affects all objects and is proportional to their mass. The strength of gravity decreases with distance, following the inverse square law. Gravity plays a crucial role in shaping the structure of the universe, from the motion of celestial bodies to the formation of galaxies and clusters of galaxies. On Earth, gravity gives weight to objects and determines the trajectory of falling objects.

#### 1.2 The importance of gravity

**Celestial Mechanics** Gravity plays a crucial role in the motion and behavior of celestial bodies such as planets, moons, asteroids, comets, and stars. It governs the orbits of planets around the sun, the moon around the Earth, and satellites around their respective planets. The understanding of gravity has been vital in predicting and explaining the motions of these celestial objects.

**Tides and Ocean Currents:** The gravitational force exerted by the moon and the sun on the Earth's oceans lead to the formation of tides. Tides influence coastal ecosystems, navigation, and certain forms of renewable energy generation. Additionally, gravity contributes to ocean currents, which play a vital role in distributing heat around the planet, affecting climate patterns.

**Atmospheric Circulation:** Gravity also affects the movement of air in the Earth's atmosphere. It influences the vertical stratification of the atmosphere, leading to variations in temperature, pressure, and density at different altitudes. This, in turn, drives atmospheric circulation patterns, including winds and weather systems, playing a critical role in global weather patterns.

**Human Life and Biological Systems:** Gravity is fundamental for life on Earth. The constant downward pull of gravity defines our physical experience and shapes the way our bodies develop and function. From bone density and muscle strength to blood circulation and balance, gravity influences various physiological processes. Without the presence of gravity, human health would be significantly impacted. **Formation of Structure in the Universe:** Gravity is responsible for the formation of large-scale structures in the universe. It plays a crucial role in the clumping together of matter, leading to the formation of galaxies, galaxy clusters, and superclusters. These structures provide insights into the evolution and composition of the universe.

**Time Dilation and General Relativity:** Albert Einstein's theory of general relativity explains that gravity is not just a force but the curvature of spacetime caused by massive objects. Gravity affects the flow of time, leading to time dilation effects near massive objects. This has been proven through various experiments and is essential for accurate GPS navigation and other

scientific measurements.

### 1.3 Application Areas of Gravity

**Space Exploration and Astronomy:** Understanding gravity is essential for space exploration missions, satellite deployment, and spacecraft trajectory calculations. Gravity assists in planning and executing interplanetary missions, orbit insertion, and gravitational assist maneuvers. It also aids astronomers in studying celestial objects and phenomena, including the motion of planets, stars, galaxies, and black holes.

**Transportation and Navigation:** Gravity plays a crucial role in transportation systems, particularly in the aviation and maritime industries. It influences aircraft flight dynamics, enabling safe takeoff, landing, and maneuvering. Gravity-based navigation systems, such as GPS (Global Positioning System), rely on precise measurements of gravitational forces to determine accurate positioning, velocity, and time information.

**Civil Engineering and Architecture:** Gravity is a fundamental consideration in civil engineering and architecture. Structural designs, including bridges, buildings, dams, and roads, must account for gravity loadings to ensure stability and safety. Gravity also affects aspects such as foundation design, slope stability analysis, and the behavior of structures during seismic events.

**Energy Generation:** Gravity-based renewable energy technologies harness the potential energy stored in elevated positions. Hydropower systems utilize gravitational forces to generate electricity by harnessing the energy of falling or flowing water. Similarly, tidal power exploits the gravitational forces exerted by the moon and sun on the Earth's oceans to generate electricity.

**Geophysics and Geodesy:** Gravity is an essential tool in geophysics and geodesy, which study the Earth's physical properties and shape. Gravity surveys help map and measure the distribution of mass beneath the Earth's surface, aiding in geological investigations, resource exploration, and understanding subsurface structures. Gravity data is also utilized in geodetic surveys for precise measurements of elevation, geoid modeling, and establishing reference frames.

**Sports and Recreation:** Gravity influences various sports and recreational activities. Gravity-dependent sports such as skiing, snowboarding, skydiving, and rock climbing rely on the gravitational force for movement, acceleration, and challenge. Roller coasters and amusement park rides utilize gravity to provide thrilling experiences.

### 1.4 Definition of Supporting Force

The force required by the object to maintain its position to the rest irrespective of different forces acting on it is called a support force. Support force does act as a resistive force by resisting the forces acting on the object and helping the objects to withstand those forces.

## 1.5 Importance of Support Force

**Preventing Object Collapse:** Support forces counteract the downward force of gravity, preventing objects from collapsing or falling. Without sufficient support, objects would be prone to tipping over, sinking, or experiencing structural failure, leading to damage or injury.

**Structural Stability:** Support forces are essential for maintaining the stability of structures such as buildings, bridges, and infrastructure. They distribute the load and weight of the structure, ensuring that it remains in equilibrium and can withstand external forces such as wind, earthquakes, or dynamic loads.

**Load-Bearing Capacities:** The concept of support forces is crucial in determining the load-bearing capacities of materials, components, and structures. By analyzing the distribution of support forces, engineers can design structures that can safely carry expected loads without exceeding their strength limits.

**Safety and User Confidence:** Adequate support forces provide a sense of security and confidence for those using or interacting with objects or structures. Knowing that an object or structure is properly supported reduces the risk of accidents, collapses, or unexpected failures, enhancing safety and peace of mind. **Durability and Longevity:** Proper support forces help to minimize stress, strain, and deformation on materials and components. By distributing loads effectively, support forces can prevent premature wear, fatigue, or damage, thereby contributing to the durability and longevity of objects or structures.

**Functional Performance:** Support forces also influence the functional performance of objects or systems. For example, in machinery or mechanical systems, optimal support forces are crucial for smooth operation, minimizing vibrations, and maintaining accurate alignment of moving parts.

**Design Considerations:** Understanding support forces is essential in the design process. Engineers and designers must consider the expected loads, the distribution of support forces, and the selection of appropriate materials and support structures to ensure that the final design meets safety requirements and performance objectives.

## 1.6 Lack of Existing Research on Support and Gravity

For the study of the relationship between support force and gravity, we need to make one thing clear: the study of the relationship between support force and gravity has been deeply explored and widely applied. For example, the stability analysis of structures in the field of construction engineering relies on the principle of the balance between support force and gravity. In addition, the study of mechanical design, mechanical modeling and statics of objects also involves the analysis and calculation of the relationship between support force and gravity. Of course, even when this basic principle is widely used and verified, there are still some special cases or more complex systems that may require further research to gain a deeper understanding of the relationship between support force and gravity. For example, in non-stationary or dynamic situations, such as vibrating, rotating or moving objects, the analysis of support force versus gravity may need to take into account kinetic effects and inertial forces. In addition, for objects

with different shapes, materials, and surface properties, there may be some subtle differences in the support force versus gravity relationship. This involves the consideration of factors such as friction, surface roughness, and contact area. In general, the study of the relationship between support force and gravity has been quite deep and extensive, but there is still room for further research in special cases or in the analysis of more complex systems. Through in-depth experimental and theoretical studies, we can better understand and apply the relationship between support force and gravity.

## **Chapter 2 Rationale: Principle of Levers**

The principle of leverage or the principle of mechanical advantage, is a fundamental concept in physics and engineering. It relates to the ability to magnify or amplify force through the use of a lever or a mechanical system. According to this principle, a small force applied at a certain distance from a pivot point or fulcrum can generate a larger force on the other side of the pivot. This principle relies on the fact that the distance, or lever arm, from the pivot to the point of force application has a significant effect on the resulting force or torque. The principle of levers can be mathematically expressed using the equation:

$$\text{Force} \times \text{Distance} = \text{Force} \times \text{Distance}$$

This equation states that the product of the force and its distance from the pivot on one side of the lever is equal to the product of the force and its distance from the pivot on the other side. This means that if the distance from the pivot on one side is greater than the distance on the other side, a smaller force can generate a larger force.

## **Chapter 3 Experimental Content**

3.1 Experimental materials: Spring Dynamometer Cuboid Cylinder BingDwenDwen Model Car Model Sailboat Model

3.2 Experimental steps: Measuring the force of gravity of each object with its supporting force at each end of the probe and analyzing the data

3.3 Experimental data: Out of the large amount of experimental data, I selected the following five sets of data to develop further analysis

## **Chapter 4 Theoretical Analysis:**

As shown in the figure below When supporting the left end of an object with uneven gravity, the pivot point is O, the power is  $F_1$  and the power arm is  $L_1$ . The resistance is its gravity,  $G$ . The resistance arm is  $L_2$ . According to the principle of levers  $F_1L_1=GL_2$  When supporting the right end of an object with uneven gravity, the pivot point is O, the power is  $F_2$  and the power arm is  $L_1$ . The resistance is its gravity  $G$ . The resistance arm is  $L_1-L_2$ . According to the principle of levers  $F_2L_1=G(L_1-L_2)$

## **AI-Powered Healthcare: Revolutionizing the Present and Pioneering the Future of Medicine; A Comprehensive Study on the prospects and concerns By Saif Ahmed**

**Introduction:** The integration of artificial intelligence (AI) into the healthcare sector has ushered in a transformative era, revolutionizing how medical services are delivered and accessed. AI's integration into healthcare has revolutionized diagnostics, treatment, and patient management. Its data analysis and predictive abilities optimize workflows, enhancing diagnostic accuracy and facilitating personalized medicine. Beyond clinical settings, AI empowers individuals with real-time health insights through wearable devices and health apps, promoting proactive healthcare.

Yet, ethical concerns regarding privacy and bias persist. This research explores AI's impact on healthcare, emphasizing responsible practices to maximize benefits while preserving patient autonomy. The boundless potential of AI in healthcare promises a healthier future, shaping our approach to well-being worldwide. This thesis explores the multifaceted impact of AI on healthcare in the present and investigates its potential to pioneer the future of health, highlighting the profound advancements, ethical considerations, and challenges that arise with its implementation. By examining the use of AI-driven technologies in diagnostics, treatment, and patient empowerment, as well as addressing concerns related to data privacy and algorithmic bias, this thesis aims to illuminate the unprecedented opportunities and responsibilities associated with AI-powered healthcare.

Through a balanced analysis of its benefits and ethical implications, we seek to foster a comprehensive understanding of AI's role in reshaping the healthcare landscape and envision a more efficient, patient-centric, and equitable future of healthcare delivery worldwide. In recent years, the intersection of artificial intelligence (AI) and healthcare has ignited a revolution that is reshaping the medical landscape. AI-powered healthcare is transforming the present by streamlining processes, improving diagnosis and treatment, and empowering patients to take control of their well-being. Furthermore, it promises to pioneer the future of health, offering unprecedented opportunities for advancements in personalized medicine and population health management.

One of the most significant contributions of AI to healthcare lies in its ability to process and analyze vast amounts of medical data quickly and accurately. AI-driven algorithms are increasingly being used to analyze medical images, such as X-rays and MRIs, aiding healthcare professionals in detecting and diagnosing diseases with greater precision and efficiency. These advancements not only lead to faster diagnoses but also improve patient outcomes by catching diseases at earlier stages when treatments are most effective. Moreover, AI-powered predictive models are becoming instrumental in forecasting disease progression and treatment responses. By analyzing patient data, including medical history, genetic information, and lifestyle factors, AI algorithms can identify potential health risks and tailor treatment plans to individual patients. This personalized medicine approach maximizes the effectiveness of treatments while minimizing adverse effects, leading to improved patient care. AI is not only transforming clinical

care but also revolutionizing patient engagement and empowerment. The proliferation of wearable devices and health monitoring applications enables individuals to track their health metrics in real time. AI algorithms analyze this data to provide personalized health insights, enabling users to make informed decisions about their lifestyle choices and preventive care strategies. This democratization of health information empowers individuals to actively participate in their well-being, fostering a culture of initiative-taking healthcare. Artificial intelligence (AI) has found a wide range of applications in the healthcare industry, revolutionizing various aspects of medical care and research.

### **Some of the Notable Applications of AI in Healthcare Include:**

**Medical Imaging Analysis:** AI-powered image recognition algorithms assist in the analysis of medical images such as X-rays, MRIs, CT scans, and pathology slides. These algorithms can detect anomalies, tumors, and other abnormalities with high accuracy, aiding radiologists, and pathologists in making faster and more precise diagnoses.

**Disease Diagnosis and Prediction:** AI models can analyze patient data, including medical records, genetic information, and lifestyle factors, to identify patterns and risk factors associated with various diseases. This predictive analysis helps in early detection and personalized treatment planning.

**Drug Discovery and Development:** AI is used to accelerate drug discovery processes by analyzing vast amounts of genomic and chemical data to identify potential drug candidates. AI models can predict the efficacy and safety of new drugs, potentially reducing the time and cost involved in drug development.

**Personalized Medicine:** AI enables healthcare professionals to tailor treatment plans based on individual patient characteristics, including genetics, demographics, and lifestyle. This approach ensures more effective and targeted treatments, minimizing adverse effects and improving patient outcomes.

**Virtual Health Assistants:** AI-powered virtual health assistants and chatbots provide patients with 24/7 access to medical information and personalized health advice. They can answer queries, schedule appointments, and offer support for self-care management.

**Predictive Analytics:** AI-driven predictive models can forecast patient outcomes and hospital readmissions, enabling healthcare providers to allocate resources efficiently and implement proactive interventions.

**Wearable Devices and Remote Monitoring:** AI algorithms analyze data from wearable devices, such as smartwatches and fitness trackers, to monitor vital signs, activity levels, and overall health. Remote monitoring facilitates early detection of health issues and continuous monitoring of chronic conditions.

**Natural Language Processing (NLP):** AI-powered NLP is used to extract relevant information from medical literature and patient records, aiding medical research, evidence-based decision-making, and clinical documentation.

**Robotics in Surgery:** AI-enabled surgical robots assist surgeons in performing complex

procedures with greater precision, control, and minimally invasive approaches, reducing recovery times, and improving patient outcomes.

**Health Data Analytics:** AI algorithms analyze vast amounts of healthcare data to identify trends, outbreaks, and patterns that can inform public health initiatives and policy decisions. These applications demonstrate the transformative potential of AI in healthcare, making it an indispensable tool for improving patient care, medical research, and the overall efficiency of healthcare system

### **Some of the More Recent Achievements of AI in Healthcare:**

**AI for Early Disease Detection:** AI algorithms have shown promising results in early detection of diseases like cancer, cardiovascular conditions, and neurological disorders. For example, AI-based models have demonstrated high accuracy in detecting diabetic retinopathy from retinal images, enabling early intervention to prevent vision loss.

**Drug Discovery Acceleration:** AI has been utilized to expedite drug discovery processes by analyzing vast datasets and predicting potential drug candidates. AI-driven platforms have identified promising molecules for diseases like COVID-19, significantly reducing the time required for drug development.

**AI in Radiology:** AI algorithms have made significant strides in radiology, assisting radiologists in diagnosing medical images more efficiently and accurately. AI systems have been developed to detect and classify various conditions, including lung nodules, fractures, and brain abnormalities.

**Personalized Treatment Recommendations:** AI is being employed to provide personalized treatment recommendations based on a patient's medical history, genetic makeup, and lifestyle factors. This approach improves treatment outcomes by tailoring interventions to individual patients' needs.

**AI-Enhanced Robotic Surgery:** Surgical robots equipped with AI capabilities have enabled more precise and minimally invasive procedures. Surgeons can benefit from AI assistance during complex surgeries, reducing surgical errors and patient recovery times.

**Predictive Analytics for Patient Outcomes:** AI-driven predictive models analyze patient data to forecast outcomes and readmission risks. This aids healthcare providers in proactively managing patient care and allocating resources efficiently.

**Virtual Health Assistants:** AI-powered virtual health assistants and chatbots have become increasingly common, offering patients personalized health information and assistance. These tools provide accessible and timely support, enhancing patient engagement and self-care management.

**AI for Mental Health Diagnosis and Treatment:** AI applications are emerging in the field of mental health, assisting in the early diagnosis and treatment of conditions like depression and anxiety. AI-powered chatbots have shown potential in offering therapy and support to individuals in need.

**AI-Driven Genome Sequencing:** AI is revolutionizing genomic research by analyzing vast



genomic datasets, identifying disease-related genetic markers, and contributing to advancements in precision medicine.

**Healthcare Data Analytics:** AI tools are being used to analyze electronic health records and healthcare data on a large scale, facilitating population health studies, epidemiological research, and public health initiatives. Despite the tremendous promise of AI-powered healthcare, there are ethical concerns that accompany its integration. Privacy and data security are major concerns, as the collection and analysis of vast amounts of sensitive patient data require robust safeguards. Additionally, concerns about algorithmic bias and the potential for AI to replace human involvement in critical medical decisions need to be addressed carefully.

### **Some of These Concerns Include:**

**Privacy and Data Security:** AI-powered healthcare relies heavily on collecting and analyzing vast amounts of patient data, including sensitive medical records and personal information. If not adequately protected, this data becomes vulnerable to data breaches and unauthorized access, jeopardizing patient privacy and trust in the healthcare system.

**Administrative issues:** Healthcare providers must navigate complex data protection regulations, which can lead to additional administrative burdens. They also need to ensure that patient data is securely stored and transmitted to prevent breaches that may result in legal consequences and damage to their reputation.

**Patient's Trust:** Patients may feel reluctant to share sensitive health information due to concerns about data privacy. This hesitancy could hinder the accuracy and completeness of their medical records, potentially affecting the quality of care they receive.

**Algorithmic Bias:** AI algorithms are trained on historical data, which may reflect existing biases present in healthcare. If not carefully managed, AI systems can perpetuate these biases, leading to unequal access to healthcare services and disparities in treatment recommendations.

**Over-reliance:** Healthcare providers may unknowingly rely on biased AI outputs, potentially leading to incorrect diagnoses or treatment plans for certain patient groups. This could result in suboptimal patient outcomes and undermine the trust between doctors and patients.

**Communal Disparity:** Patients from marginalized communities or underrepresented populations may receive inadequate or inappropriate care due to AI-driven biases. This can lead to disparities in health outcomes, exacerbating existing healthcare inequities.

**Reduced Human Interaction:** As AI becomes more integrated into healthcare, there is a concern that it might lead to reduced human interaction between doctors and patients. Relying solely on AI for certain care aspects might devalue the human touch and personalized care's importance.

**Impact on Doctors:** Healthcare professionals may feel disconnected from their patients and their emotional needs, as AI takes over certain clinical tasks. This could lead to a less fulfilling work environment for doctors.

**Lack of Emotional engagement:** Patients may experience a sense of detachment when interacting with AI-powered systems instead of human healthcare providers. This lack of

emotional connection may hinder patient trust and engagement in their healthcare journey. In conclusion, AI-powered healthcare is revolutionizing the present by enhancing diagnostics, treatment, and patient engagement. Its potential to pioneer the future of health is boundless, with promising advancements in personalized medicine and a more proactive approach to well-being. However, ethical considerations must be at the forefront of this transformation to ensure that AI's benefits are maximized while preserving patient autonomy and privacy. As we navigate the dynamic integration of AI in healthcare, we must strike a balance between embracing innovation and upholding the highest standards of ethical practice, shaping a healthier and more equitable future for healthcare worldwide.

# **The Triple Impact: Exposing the Effects of Fast Fashion on Society, the Economy, and the Environment By Lavanya Gupta**

## **Abstract**

The fast fashion sector has emerged as a prominent entity within the worldwide apparel market, fundamentally transforming the processes of clothing production, consumption and disposal. This review examines the interrelated triple effects of fashion on society, environment and the economy. This is achieved through the process of gathering and evaluating contemporary scholarly research pertaining to the subjects of fast fashion and sweatshops, and subsequently integrating this information into a coherent academic document that offers a comprehensive perspective on the impacts of fast fashion. The pursuit of low prices and rapid production within the industry has resulted in exploitative labour practises and the emergence of a disposable fashion culture which has the significant implications for workers' rights, consumer behaviour and individual wellbeing. From an economic perspective, the phenomenon of fast fashion has contributed to the generation of employment opportunities and facilitated economic expansion in developing nations. However, it has also led to heightened price competition and diminished profit margins for fashion brands. From an environmental perspective, the industry's insatiable demand for resources has resulted in the release of pollutants, greenhouse gas emissions and the generation of the waste, thereby presenting substantial obstacles to the environmental sustainability. The interdependence of these dimensions requires comprehensive solutions that encompass labour rights, consumer behaviour and sustainable practises in order to cultivate a conscientious and fair fashion environment.

*Keywords: Fast fashion, Social, Economic, Environment, Impact.*

## **Introduction**

The emergence of fast fashion has indisputably brought about a significant transformation in the worldwide garment sector, fundamentally altering the processes of clothing production, consumption and disposal. Fast fashion is a phenomenon, distinguished by its expeditious creation and dissemination of fashionable garments at affordable prices (MacCarthy et al., 2010). This industry has gained significant attention from consumer across the globe, resulting in a transformation of their purchasing behaviours and an incessant craving for novel fashion trends (Bhardwaj & Fairhurst, 2010). This phenomenon has undeniably resulted in easily obtainable and constantly evolving fashion options. However, it has also had a significant and frequently disregarded influence on society, the economy and the environment. From a manufacturing standpoint, the fast fashion industry no longer appears to be an ideal process. In order to achieve cost efficiency, companies operating within the fast fashion industry employ inexpensive materials, alongside low-cost labour and affordable real estate, predominantly sourced from developing countries (Joy et al., 2012). The amalgamation of these three fundamental elements of the fast fashion sector establishes the bedrock of the industry, namely the presence of sweatshops. As per the findings of the GAO of US, manufacturing hubs are characterised as

establishments that contravene multiple federal or state labour laws pertaining to minimum wage and overtime, industrial homework, child labour, occupational safety and health, worker's compensation, or industry regulation (Giljum et al., 2014). This definition sheds light on several adverse effects that the fast fashion industry imposes on its workers, such as labouring in unfavourable conditions for meagre remuneration. Furthermore, fast fashion poses a significant threat to the environment due to its contribution to pollution, waste generation, and various other hazards (Anguelov, 2015). On the contrary, the positive impacts of fast fashion are situated on the opposing end of this discourse. One primary advantage of this industry is its ability to enable consumers to stay abreast of fashion trends, which currently undergo frequent changes beyond the traditional seasonal cycles (Niinimäki, 2013). Furthermore, at a more profound level, the fast fashion industry enables individuals and families with lower incomes to acquire a greater quantity of contemporary and fashionable clothing items. As a result of this phenomenon, individuals with limited financial resources are able to adopt fashion trends that are similar to those of their more affluent counterparts, thereby alleviating the effects of social stratification based on attire. Based on the limited enumeration of advantages and disadvantages of fast fashion presented thus far, it appears that fast fashion predominantly engenders adverse consequences for workers while consumers primarily experience positive outcomes. Nevertheless, this assertion does not hold true. This study aims to analyse the advantages and disadvantages of fast fashion for consumers and workers, considering social, economic and environmental factors.

### **Aim and Objective of Review**

This study aims to analyse environmental, social, and economic impacts of the fast fashion industry.

### **Methodology**

The research methodology employed in this study involves the examination of secondary data to facilitate an investigation into the impacts of fast fashion.

### **Social Impacts**

In contemporary times, it is evident that the global presence of artisans and heritage craft industries has experienced a notable decline, primarily attributable to the proliferation of mass production practises and the emergence of second-hand clothing within local markets. We are approaching a critical juncture wherein there exists a potentiality for the loss of ancient and distinctive techniques that have been transmitted across successive generations, unless adequate support is provided. The handcraft trade is relied upon by a significant number of individuals, particularly those residing in rural communities. Based on the findings of the Artisan Alliance at the Aspen Institute (2012), it has been determined that the artisan sector holds the position of the 2<sup>nd</sup> largest employer in developing nations, following agriculture. The annual value exceeds \$32 billion. While certain studies indicate an increasing need for handmade products, the future

trajectory of this sector remains uncertain. In the year 1950, Italy boasted a tailoring workforce exceeding four million individuals, whereas in the present day, this number has dwindled to less than 700,000 (Stearns, 2020).

### **Lack of Diversity, Mental Health Issues, and Negative Body Images**

The realm of fashion has exerted a significant impact on the perception of body image and has played a substantial role in the perpetuation of gender norms across various historical periods (Bhardwaj & Fairhurst, 2010). For a duration exceeding one year, the fashion industry has predominantly employed thin white models for advertising purposes, resulting in a lack of diversity both on catwalks and in fashion magazines. Furthermore, this lack of diversity extends to the boardrooms and offices of fashion businesses, where instances of overtly racist product design and marketing have been observed. Additionally, the industry has demonstrated a limited recognition and valuation of the voices and ideas of individuals belonging to racial minority groups. In the present era, the incessant dissemination of content through social media platforms has engendered a pervasive sense of obligation to conform to specific standards of appearance (Kaiser & Green, 2021). Consequently, advertisers often exploit our vulnerabilities to promote unnecessary commodities, thereby exacerbating the issue of excessive consumption. These concerns can be associated with body dysmorphia, eating disorders, and depression. Furthermore, the industry has historically exhibited a dearth of representation in terms of diverse body shapes, sizes, ages, and gender identities, although there have been recent indications of progress in this regard. The mental well-being of designers and artists is being impacted by the relentless demand for continuous creation, a consequence of the brief lifespan and rapid production of fashion collections (Brooks, 2019).

### **Workplace Conditions and Human Rights**

Despite the presence of international standards, legislations, certification and laws systems aimed at safeguarding human rights and promoting appropriate working conditions, the prevalence of exploitation continues to increase within the fashion industry (Brewer, 2019). Fashion companies continue to engage in the violation of human rights by perpetuating the use of child labour, imposing excessively long working hours, suppressing trade union organisations, offering significantly lower wages, maintaining unsafe and hazardous working conditions, perpetuating gender and racial discrimination, and generally denying access to justice for individuals whose fundamental labour rights are infringed upon in the workplace (De Araujo et al., 2020). These issues are prevalent in various locations such as Bangladesh, Cambodia, Mexico, as well as the United States and Europe (Brooks, 2019).

### **The Child Labour Crisis**

In addition to being enforced on adults who have some control over where they work and the conditions there, the previously specified employment conditions also apply to children. Child labour continues to be prevalent in the apparel industry in developing nations. In Pakistan,

Egypt Bangladesh, and several countries in Central Asia, there is a prevalent practise of employing children in hazardous factories, subjecting them to similar working conditions and extended hours of labour as their adult counterparts (Drennan, 2015). Certain children are compelled to engage in labour within substandard conditions in clandestine factories, as the employment of minors is prohibited in the majority of nations. However, the U.S. Department of Labour has identified 77 countries as non-compliant with international benchmarks as of June 23, 2021 (ILAB, 2021). The appeal of child labour to apparel manufacturing employers lies in the advantageous characteristics of children, such as their small stature, agility, affordability, and compliance. Additionally, children are typically remunerated at rates considerably lower than the already meagre minimum wages (Lambert, 2014). The problem of child labour has persisted for numerous centuries across various nations and sectors, with consistent consequences. In her seminal work titled "The Making of the English Working Class," E.P. Thompson recounts an incident involving a young boy employed in a mill. According to Thompson, the boy was discovered in a state of slumber while standing, having toiled for a gruelling seventeen-hour shift. Subsequently, the mill employers resorted to physical force in order to rouse him from his sleep. The male child refrained from consuming his evening meal subsequent to being transported to his place of residence, and subsequently succumbed to fatigue the following morning, resulting in his demise (Seabrook, 2001). Due to the tender age of these children, the adverse effects of working conditions, abuse, and extended working hours tend to have a more pronounced impact on their physical well-being compared to that experienced by adults. Furthermore, apart from the physical detriment experienced by these children, they also endure psychological distress due to the lack of access to adequate education, as it is presumed that they will remain employed in factories indefinitely (Lambert, 2014). The perpetuation of employing undereducated children for manual labour will lead to a cycle of intergenerational poverty, wherein subsequent generations will face even greater challenges in improving their standard of living. The utilisation of child labour in developing nations, particularly within fast fashion factories, is a widely acknowledged phenomenon among the general population. Numerous entities, including organisations, firms, and consumers, are advocating for a reform in regions where the prevalence of child labour is high. Paradoxically, these regions are also characterised by a lack of enforcement or disregard for existing child labour legislation, thereby impeding the implementation of necessary changes (Lambert, 2014).

### **Problems of Sexism and Abuse**

A significant proportion of the global garment workforce comprises young females who frequently occupy positions with meagre remuneration. In the context of factory settings, it is observed that a higher proportion of men occupy positions of supervisors, managers, and owners. The existing disparity in power dynamics between women and men in certain instances and nations can potentially indicate that women are particularly susceptible to experiencing workplace abuse. Sexual harassment, encompassing unwelcome physical contact, verbal derogation, acts of rape, and mistreatment of pregnant employees, is prevalent within the supply

chain of the industry. Regrettably, as reported by CARE International in 2019, approximately 50% of female workers employed in garment factories in Southeast Asia have encountered incidents of sexual harassment. In June 2019, the International Labour Organisation (ILO) ratified Convention No. 190, a new international legal framework addressing violence and harassment in the workplace. This legislation serves the purpose of offering lucidity and legal safeguards for women and other marginalised individuals, shielding them from instances of violence and sexual harassment within the workplace. However, this provision is exclusively applicable to nations that have officially ratified the Convention. As of now, only a limited number of countries have taken this step.

### **The Effects of Consumer Behaviour on Classism: A Mitigation**

Fast fashion companies play a role in mitigating the enduring consequences of classism in developed nations through their production and marketing of clothing to individuals across different income brackets. This practise fosters a trend where individuals from various social and economic classes wear the same apparel, thereby blurring the distinctions between them. Individuals with a lower socioeconomic status may possess a limited quantity of clothing items and exhibit a slower turnover rate compared to their middle- and upper-class counterparts. However, the advent of fast fashion affords them the chance to don similar styles as their peers, thereby reducing a means by which individuals discriminate against those who deviate from their own social group (von Busch, 2018). The recent movement towards sustainable shopping poses a challenge to the prevailing perception of social classes, albeit through a minor alteration. The impetus to modify consumers' prevailing purchasing behaviours is driven by the adverse consequences associated with the increasing prevalence of fast fashion in the mainstream media. Nevertheless, a primary factor contributing to the prevailing consumer reluctance in purchasing from sustainable brands is the comparatively elevated cost associated with "ethically-made" clothing. The promotion of sustainable consumer behaviour has resulted in a notable inclination among individuals from middle- and upper-class socioeconomic backgrounds to engage in shopping activities at thrift stores and consignment shops. The adoption of this new and costlier trend may have detrimental effects on individuals from working-class backgrounds, as they may encounter difficulties in adhering to it. Moreover, the increasing favourability of thrifting among affluent consumers, as a substitute for purchasing from ethical and sustainable fashion brands, further diminishes the already restricted clothing choices accessible to low-income communities (Nair, 2019).

### **Environmental Impacts**

Determining the precise environmental implications of the fashion industry is challenging, primarily due to the limited scope, reliability, and occasional inconsistencies of existing data. This predicament arises from the absence of a standardised methodology for assessing the industry's environmental footprint. Nevertheless, upon scrutinising the various processes involved in the production, consumption, utilisation, and disposal of our garments, it

becomes apparent that our clothing exacts a substantial toll on our environment. Fossil fuels are essential for various industrial processes, such as illuminating buildings and powering textile machinery. They are also crucial for the production of polyester, a synthetic material derived from petroleum. Additionally, fossil fuels play a vital role in facilitating the transportation of clothing and enabling the global mobility of industry professionals. Furthermore, these fuels provide the necessary energy to operate tumble dryers and washing machines. All of these activities are associated with the generation of substantial amounts of greenhouse gas emissions. In the year 2020, it remains imperative to advocate for a fashion revolution. The fashion industry currently accounts for approximately 10% of global carbon emissions, and if this rate of growth persists, it is projected that by 2050, fashion-related emissions could exceed a quarter of the world's total annual carbon emissions. In the United Kingdom, clothing is identified as the fourth most significant contributor to environmental impact, following housing, transportation, and food. In the United Kingdom, the carbon emissions associated with the clothing sector experienced an increase from 24 million tonnes in 2012 to 26.2 million tonnes in 2016. Conversely, estimates for the European Union indicate a significantly higher figure of 195 million tonnes of carbon emissions generated annually by the clothing industry. In order to provide a contextual framework, it is worth noting that the annual carbon dioxide emissions from a single car amount to approximately 4.6 tonnes. Consequently, the carbon footprint associated with clothing production within the European Union can be equivalently likened to the emissions generated by approximately 42,391,304 cars on an annual basis. Despite the efforts made by certain brands and suppliers to mitigate their carbon emissions, the global community is still striving to limit the increase in average global temperature to 2 degrees Celsius. In order to expedite the process of reversing global emissions, it is imperative for governments to allocate resources towards generating comprehensive and reliable data on the environmental impacts of the fashion industry (Niinimäki et al., 2020; Roy, 2014).

### **Dumping and Recycling**

Our society has developed a tendency to engage in increased clothing consumption, wearing garments for shorter durations, and disposing of them at a faster rate than ever before. According to the Ellen McArthur Foundation (2017), the proportion of textiles clothes that undergo recycling to produce new textiles and clothes is less than 1%. Consequently, a significant majority of discarded clothing items are ultimately disposed of in landfills or subjected to incineration. Fashion waste is typically categorised into two distinct types: The pre-consumer category encompasses scraps and residual materials generated during the production of clothing, as well as unsold or damaged samples and production items. On the other hand, the post-consumer category refers to items that are discarded by consumers after they have been used. According to the Global Fashion Agenda's 2018 report, approximately 25% of resources within the fashion industry are squandered annually due to remnants from garment production. The primary resources that are wasted include incomplete fabrics, cut pieces, remnants of fabric roll, defective fabric fragments, as well as garments that have been



overproduced and subsequently rejected. Typically, garments that have incurred damage and rolls of identifiable fabrics from a particular brand are subjected to incineration as a means of safeguarding intellectual property and mitigating the presence of excess inventory, thereby preventing their sale at significantly reduced prices. According to data from the Environmental Protection Agency, there has been a significant increase of 811% in textile waste from 1960 to 2015. The majority of this waste was ultimately disposed of in landfills. Approximately 10% of the unused textiles are gathered on a global scale for the purpose of reutilization and subsequent exportation to developed markets. According to reports, the influx of used garments to developing nations has been found to have detrimental effects on local textile production and commercial activities. Furthermore, a significant proportion of these garments are deemed unsellable. A study conducted by Ricketts (2020) reveals that approximately 40% of imported apparel ultimately deteriorates in landfills or marine environments. It is worth noting that a substantial portion of these items is composed of synthetic materials that do not possess biodegradable properties. In contemporary times, certain national governments are enacting legislation to compel companies to assume accountability for the waste generated by their merchandise. Additionally, numerous brands and retailers are engaging in the practise of collecting discarded garments from customers. Ultimately, it is imperative to emphasise that the textile employed in garments possesses the capacity for repeated utilisation over an extended period. This phenomenon will consequently lead to a decrease in the necessity to produce clothing from newly manufactured fabrics, thereby facilitating the establishment of a circular system. In the context of a circular system, it remains imperative to utilise chemicals for dyeing and processing textiles, energy for machinery operation, and fuel for transportation purposes. In the present epoch characterised by the excessive production of clothing, it is evident that the concept of circularity alone cannot effectively mitigate the environmental repercussions stemming from the fashion industry's waste generation.

### **Environment, Contamination, Toxins, and Waste Products**

The textile industry is widely recognised as the primary contributor to global water pollution. A significant quantity of water is utilised in agricultural practises for the cultivation of cotton, as well as in the dyeing and processing of fabrics, and in the laundering of garments. Fibre and textile production heavily rely on the utilisation of prominent water basins situated in Vietnam, Pakistan and China. These water basins hold significant importance in ensuring water security within the respective regions, as they serve as primary sources of drinking water for numerous individuals and support the sustenance of local wildlife populations. Based on a study conducted by Maxwell, McAndrew, and Ryan (2015), it has been found that textile treatments and dyeing contribute to approximately 20% of total freshwater pollution. This factor arises due to the failure of suppliers to eliminate hazardous contaminants present in finishing chemicals and textile dyes, resulting in the release of contaminated water into the environment. Numerous prominent companies are actively engaged in the elimination of perilous chemicals from their supply chains due to the potential for severe health complications associated with these toxic

substances. Moreover, during the laundering process of garments composed of synthetic materials, particularly polyester, minute plastic particles are released and subsequently deposited into our aquatic ecosystems, ultimately reaching our oceans, rivers, and lakes. It has been observed that a typical washing cycle has the potential to release approximately 700,000 microfibers from our garments.

### **Biological Diversity and Soil Fertility**

The fashion production process exerts a substantial and detrimental influence on biodiversity, which encompasses the diverse range of animals, plants, habitats, and life forms present on our planet. One of the primary issues pertains to the deforestation of forests for the purpose of cultivating cotton and producing wood-based textiles. According to the Global Fashion Agenda (2017), it is anticipated that the fashion industry will witness a 35% increase in land utilisation for fibre and textile production by the year 2030. This expansion is expected to encompass an additional 115 million hectares, which could potentially be conserved to safeguard biodiversity. It is worth noting that forests, apart from their crucial role in supporting biodiversity, serve as a carbon sink, effectively sequestering carbon that would otherwise be The utilisation of intensive industrial agricultural methods in the production of raw materials and textiles is associated with soil erosion, primarily due to the application of pesticides in cotton cultivation. The utilisation of pesticides is having a detrimental impact on vital insect species that play a crucial role in the pollination of crops and the maintenance of ecosystems, thereby posing a threat to global food security.

### **Safety of Animals**

Fur, cashmere, silk, exotic skins, shearling and leather, are among the animal-derived materials commonly employed in the realm of fashion. The majority of leather originates from India, Bangladesh and China, where animal welfare legislation is relatively lax and the conditions in which animals are kept on farms are often suboptimal. In addition, the absence of traceability and transparency poses a significant challenge in determining the origins of animal materials and the conditions under which they were produced.

### **Economic Impacts**

The fast fashion sector is experiencing ongoing expansion due to the rising demand for affordable and fashionable clothing. Based on a report published by The Business Research Company, the global fast fashion market exhibited a valuation of \$25.09 billion in 2020, which subsequently increased to \$30.58 billion in 2021, reflecting a CAGR of 21.9%. The growth experienced during this period can be attributed to the resumption of normal business operations by numerous companies, as the impact of the COVID-19 pandemic diminished. Nevertheless, according to a report by Globe Newswire (2021), it is anticipated that the market will sustain its growth trajectory, achieving a compound annual growth rate (CAGR) of 7% and reaching a

value of \$39.84 billion by 2025, even in the absence of any additional stimulus from recovering businesses.

### **The Economy of Developed Countries: Job Losses and Economic Impairment**

In her book titled "Fashionopolis: Why What We Wear Matters," Dana Thomas asserts that around 70% of the clothing consumed by Americans was domestically manufactured in the United States. Nevertheless, this paradigm swiftly shifted with the advent of the fast fashion phenomenon. Due to the objective of fast fashion retailers to offer their products at the most competitive prices, numerous companies opted to delegate their manufacturing processes to developing nations, consequently resulting in the reduction of employment opportunities within the United States. The proportion of clothing manufactured in the United States experienced a decline from 56.2% in 1991 to 2.5% in 2012. The decline in question occurred concurrently with the reduction of 1.2 million employment opportunities within the textile and garment sector of the United States between the years 1990 and 2012, as reported by the Bureau of Labour Statistics (Thomas, 2019). This alteration had an impact not only on the American population, but also on other individuals. Indeed, during the 1980s, the United Kingdom textile industry employed more than 1 million individuals, a figure that has since declined to approximately 100,000 in the 2010s. The issue of diminishing employment opportunities in the apparel manufacturing sector resonated across Western Europe and other advanced nations, subsequently leading to economic decline (Thomas, 2019). The relocation of domestic garment manufacturing jobs from developed nations to offshore locations has resulted in adverse trade deficits. According to Thomas (2019), the total value of apparel exports in the United States in 2017 amounted to approximately \$5.7 billion, whereas imports accounted for approximately \$82.6 billion. Additionally, it was reported approximately 92% of Britain's apparel comes from outside imports. Italy was the sole member state within the European Union that successfully avoided negative consequences, as it maintained its unharmed status. This can be attributed to Italy's affiliation with lavish and high-quality goods (Thomas, 2019).

### **Economic Growth and Development in Developing Countries**

The phenomenon of fast fashion, along with its accompanying sweatshops, has exerted a discernible influence on the economies of developing nations, facilitating their progression and evolution towards attaining developed status. According to Benjamin Powell, the presence of fast fashion sweatshops in developing nations plays a crucial role in the process of economic development, ultimately resulting in enhanced standards of living. This phenomenon exhibits similarities to the historical textile mills in the United Kingdom, which, despite their unsafe and inhumane conditions, contributed to the subsequent economic development of the country. Sweatshops are regarded by economists as a crucial component in the process of industrialization, a concept elucidated by Sir Arthur Lewis's "Dual Sector Model." According to this theoretical framework, the movement of individuals with limited skills from conventional agricultural activities to the contemporary manufacturing industry has the potential to augment

productivity, leading to an increase in wages and a decline in poverty levels. China's experience serves as a prime illustration of this transition, wherein a substantial number of individuals migrated from rural regions to urban centres in pursuit of more economically advantageous employment opportunities. Consequently, this phenomenon has resulted in a noteworthy decline in China's poverty rate. Furthermore, the existence of sweatshops in developing countries has additionally contributed to the advancement of infrastructure, as evidenced by China's substantial financial investments in Ethiopia. These investments aim to bolster the country's economic potential by enhancing its transportation, communication, and industrial capabilities. These advancements are perceived as a means to enhance societies and offer prospects for future generations (Canepa, 2016; Powell, 2008; BBC, n.d.; Clark, 2022; Donahue et al., 2018).

### **Interconnected Impact**

The complicated web of fast fashion repercussions is revealed by its threefold influence on society, the economy and the environment. Concerns like worker rights, identity development and overconsumption are all brought to light by the complex web of relationships between labour exploitation, consumer behaviour and mental health that results from this phenomenon. Fast fashions low pricing and rapid manufacturing have benefited the global economy by creating jobs in developing nations and increasing export profits, but at the expense profits but at the expense of fashion businesses through increased. Resource depletion, pollution, and waste production are all on display in the environmental impact, highlighting the critical need for sustainable practises. The fashion industry's social, economic, and environmental impacts are all interconnected, so it's important to find ways to mitigate all three at once in order to foster a more sustainable future.

### **Conclusion**

In conclusion, the multifaceted repercussions of fast fashion on society, the environment and the economy emphasize the pressing necessity for all encompassing and sustainable resolutions. The industry has played a significant role in fostering economic growth and employment opportunities in developing nations. However, it has been associated with the continuation of exploitative labour practises, the promotion of excessive consumption patterns and the degradation of the environment. The interconnectedness of these effects necessitates a collaborative approach, which entails the involvement of various stakeholders such as governmental bodies, fashion corporations, consumers and civil society. Enhancing labour regulations, advocating for conscientious consumer behaviour and adopting sustainable practises are imperative measures in advancing a more responsible and equitable fashion industry. Through the cultivation of consciousness active promotion of transformation and deliberate emphasis on societal and ecological accountability, we can pave the way towards a fashion setting that esteems ethical conducts and the safeguarding of the environment.

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# **The Ethical Business Model: Balancing Ethics and Socioeconomic Realities on Child Labor**

## **By Sihun Park**

### **Abstract**

The ongoing child labor in multinational corporations' supply chains has been an abiding problem for both corporations and child laborers. While the international community recklessly criticizes corporations for these inhumane practices, socioeconomic situations make child labor inevitable in some countries. This essay explores the legal, ethical, and business perspectives of child labor through case studies of Apple Ins. and multinational chocolate companies. After showing the details of how these multinational corporations violated child labor matters, the paper then reviews multiple professional reviews of external perspectives. The study proposes an ethical business model that would effectively balance ethics and morals with the socioeconomic realities of children. The ethical business model aims for a supply operation under a firm international legal body, protecting the human rights of underprivileged children while minimizing the economic risks of both the children and the corporation.

### **Introduction**

Campaigns, education programs, and fundraising advertisements have consistently criticized the ongoing child labor by multinational corporations and its inhumane effects on children. As the international community is expressing its unconditional criticism against child labor, the general public is well aware of how wrong it is to use children as laborers in conjunction with corporations making policies appealing that they are against child labor. Despite the international perspective, the reality is quite different. In countries with particular drawbacks such as poverty, lack of education, and weak legal enforcement<sup>50</sup>, socioeconomic situations make child labor inevitable. In these countries, numerous families rely on child labor for economic stability.

During times when debates rise over whether child labor should be entirely banned when it is the only source of income for some families, policymakers of governments and corporations are seeking an adequate solution to this particular problem. This essay will explore the ethical, legal, and business perspectives on child labor through case studies of multinational corporations' child labor and ultimately propose an ethical business model that would benefit both the corporation and the laborers.

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<sup>50</sup> ECLT Foundation. (2022). Why does child labour happen? Here are some of the root causes.



Figure 1

Apple Inc., the largest technology company best known for the iPhone, was not an exception to the child labor practices.<sup>51</sup> One of Apple's supplier companies, Suyin Electronics, was discovered that they were consistently relying on child labor on multiple occasions. Also, the Apple supplier responsibility team members revealed that the management was loath to cut connections with Suyin due to potential profit losses. According to "The Information," Apple learned in 2013 that Suyin Electronics, a China-based company that made parts for its MacBooks, was employing underage workers. Despite telling Suyin to address the issue or risk losing business, Apple discovered additional workers as young as 14 during an audit just three months later. But rather than immediately cutting ties with Suyin for violating its supply chain ethics policies prohibiting child labor, which Apple claims are the "highest standards," Apple continued relying on the company for over three years<sup>52</sup>. This was a shameful act for a representative multinational corporation to deliver to the public and an action against their own values.

More than just an ethical perspective of the Apple scandal, studies conducted from a legal point of view show some other causes of Apple and other multinational corporations' problematic labor models. The Columbia Undergraduate Law Review states that the absence of a firm international criminal jurisdiction causes corporations to be accountable for such abuses, as current laws primarily rely on nation-states for prosecution rather than a global level. Dimri<sup>53</sup>, in this law review, argues for a new international forum to prosecute corporate human rights violators, especially regarding child labor. He explains the flaw of the current international community's roles, such as the United Nations' Guiding Principles on Business and Human Rights, that they stress the moral responsibility of corporations but do not impose legal liability.

The Law Review shows cases and suggests solutions to these international legal issues. Dimri presents the African Court of Justice and Human Rights as an excellent example of creating an international forum in order to prosecute corporate perpetrators. Due to Africa's indigent legal systems, the African Union added a criminal chamber exceptionally made for the

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<sup>51</sup> Sonnemaker, T. (2020, December 31). Apple knew a supplier was using child labor but took 3 years to fully cut ties, despite the company's promises to hold itself to the "highest standards," report says. Business Insider.

<sup>52</sup> Apple Took Three Years to Cut Ties With Supplier That Used Underage Labor. (n.d.). The Information.

<sup>53</sup> Dimri, A. (2022, January 18). Child Labor and the Human Rights Violations Embedded in Producing Technology. Columbia Undergraduate Law Review.



prosecution of corporate actors. The review honors the African Union for its performance of adequately prosecuting international human rights cases at a domestic level. It encourages more formations of regional international courts that will set critical precedents and regulate domestic courts' approach to multinational corporations. Dimri, however, states that these new modes of enforcement will never be sufficient to solve the ultimate problem, considering multinational corporations are often not directly involved in abusive practices. He shows an example of the lawsuit “Doe 1-13 et al. v. Apple Inc., et al.”<sup>54</sup>,” when the judicial system did not find multinational corporations, such as Apple, Microsoft, Tesla, and Dell, guilty because these companies were not directly operating the child-laboring mines, even though the local mining companies invested in and purchased by the multinational corporations were. The review urges the international court to expand the definition of rights violation to account for the involvement of larger financing networks.

### Case Study 2: Cargill, Nestle, Hershey, et al.



Figure 2

Another legal flaw in multinational corporations' child labor issue is exhibited in the lawsuit “Coubaly et al. v Cargill Inc et al.”<sup>55</sup> This lawsuit was filed by eight formerly enslaved children against numerous multinational chocolate corporations. The formerly enslaved children seek damages for forced labor, compensation for unjust enrichment, negligent supervision, and intentional infliction of emotional distress. The plaintiffs accuse the multinational corporations of aiding and sanctioning the illegal enslavement of thousands of children on cocoa farms in the Ivory Coast, which produces about 45% of the international cocoa supply. The lawsuit claims that the defendants knowingly profited from the illegal work of children, even though they do not own the cocoa farms directly.

However, the United States Supreme Court dismissed this case, saying that this action of human rights violation does not fall under the Judiciary Act of 1789, or the Alien Tort Statute

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<sup>54</sup> UNITED STATES DISTRICT COURT FOR THE DISTRICT OF COLUMBIA. (n.d.). Retrieved July 3, 2023, from [https://www.govinfo.gov/content/pkg/USCOURTS-dcd-1\\_19-cv-03737/pdf/USCOURTS-dcd-1\\_19-cv-03737-0.pdf](https://www.govinfo.gov/content/pkg/USCOURTS-dcd-1_19-cv-03737/pdf/USCOURTS-dcd-1_19-cv-03737-0.pdf)

<sup>55</sup> UNITED STATES DISTRICT COURT FOR THE DISTRICT OF COLUMBIA. (n.d.). Retrieved July 3, 2023, from [https://www.govinfo.gov/content/pkg/USCOURTS-dcd-1\\_21-cv-00386/pdf/USCOURTS-dcd-1\\_21-cv-00386-0.pdf](https://www.govinfo.gov/content/pkg/USCOURTS-dcd-1_21-cv-00386/pdf/USCOURTS-dcd-1_21-cv-00386-0.pdf)

(ATS), because the relevant conduct did not occur on American soil. The multinational chocolate companies only responded with some accentuating their affirmation of combating child labor and eradicating it from their supply chains. This, again, emphasizes the significance of a firm and practical international legal body, like the suggestion of the Columbia Undergraduate Law Review in the previous case study.

### **Why Child Labor Endures**

While child labor is being condemned unconditionally internationally, Bourdillon suggests an idea with quite a different perspective. Bourdillon says that work is a normal part of life and children increasingly participate as they grow up to be responsible social people<sup>56</sup>. In the article that shows the beneficial aspects of child labor, he emphasizes the economic advantages and the necessity of such a form of labor for survival in extreme poverty or crises. Beyond economics, Bourdillon suggests other advantages that children can acquire by working. He studies the psycho-social benefits, such as fostering self-esteem or building enhanced social relationships. The article also questions the idea that formal schooling is the sole education method. Bourdillon states that labor can contribute to a broader form of education by helping children develop their personality, abilities, and professional skills or knowledge. He also shows how work can provide an informal way of schooling through flexible schedule management, work experience opportunities, and community-connected experiential learning.

This article of Bourdillon challenges the predominant bias against child labor by showing the benefits it can provide to children. It also recognizes the significance of the laboring children's safety and educational opportunities. As the article suggests, the focus should be shifted from simply prohibiting child labor to creating conditions where children can engage in work safely and beneficially.

### **The Ethical Business Model**

As stated throughout the case studies and articles, there are both costs and benefits of child labor. It is essential to balance the positives and negatives of child labor in order to create an ethical business model that would benefit both the children and the corporations. The first step for such a business model is a firm and explicit corporate policy or code of conduct. Having a clear and comprehensive policy of what the company values would make the process of not only preventing excessive forms of child labor but also conducting any form of a project as a whole.

In conjunction with a firm corporate policy, the government's robust legal mechanism is also vital to make the most ethical business model. As shown in the two case studies, multinational corporations conduct child labor in countries with weak legal restrictions. However, building a solid legal institution only to prohibit child labor can negatively impact the economic circumstances of children and their families. Thus, it is significant to make the right

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<sup>56</sup> Bourdillon, M. (2017, November 14). Ignoring the benefits of children's work. OpenDemocracy. <https://www.opendemocracy.net/en/beyond-trafficking-and-slavery/ignoring-benefits-of-children-s-work/>

amount of regulation, such as setting maximum labor hours or a clean and safe working environment, that would not disadvantage the working children's economic situation.

Moreover, having a transparent supply chain would contribute to making the multinational corporations more ethical regarding child labor. Even if the government has a strong regulation on child labor and the corporation has an explicit policy, it is the supplying corporates where most of the excessive child labor takes place. And most supply chains are not directly operated by multinational corporates. Having a transparent supply chain, where the general public can view the supply process, would make a flawless and ethical business model for both the children and the corporate.

### **Effects**

The University of Notre Dame conducted a research study on how ethical business operations impact the business's prospects<sup>57</sup>. The research explains that ethical behavior in business includes honesty, fairness, integrity, and understanding of corporate governance and the supply chain. It also demonstrates that unethical behavior has consequences for future business, including heavy fines, expensive lawsuits, and reputational damage. Lastly, it suggests that there are several ways to encourage an ethical workplace culture, including establishing a companywide code of ethics.

The research shows that there are more serious consequences of highly unethical behavior. Businesses that violate ethics and engage in illegal activities can be subject to costly fines and lawsuits. The paper exemplifies the international bank HSBC for being subject to a decade-long enforcement action costing it \$1.92 billion after the federal government determined the institution violated money-laundering laws and sanctions rules.

Research into ethics and business performance has shown the two are linked in some important ways. Data collected by Ethisphere, an organization that tracks the ethical conduct of the world's largest companies, found that the businesses listed on its 2022 list of most ethical companies outperformed an index of similar large-cap companies by 24.6 percent overall.

The researchers conclude with quoting a research by Professor Jiang of Ohio State University Fisher College of Business. "Both high-quality service and low unethical behaviors are important to predicting business unit performance," said Jiang. "This is especially so when the market is very competitive, because then the customers have a lot of options and could ... switch to another product or service provider."

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<sup>57</sup> Peek, S. (2023). A culture of ethical behavior is essential to business success. [online] Business News Daily. Available at: <https://www.businessnewsdaily.com/9424-business-ethical-behavior.html>.

### FIVE-YEAR ETHICS PREMIUM: 24.6%

According to Ethisphere's Ethics Index, the listed 2022 World's Most Ethical Companies honorees outperformed a comparable index of large cap companies by 24.6 percentage points from January 2017 to January 2022.

**ETHISPHERE**  
GOOD SMART BUSINESS PROFIT

\*Selected US Large Cap Index (GTR)



Figure 3

## Conclusion

The continuing child labor in the supply chains of multinational corporates requires comprehensive and ethical business models. While the international community is showing unconditional criticism and raising awareness to the public about the inhumane effects of child labor, the socioeconomic reality of underdeveloped countries makes it challenging to eliminate the labor form completely. The case study of Apple Inc. and multiple chocolate companies reveal a drawback to the legal mechanism on these international laboring matters and urges for a firm international forum that could make the human rights violators accountable.

The ethical business model's prior goal is to build a supply operation under a firm international legal body, protecting the human rights of underprivileged children while minimizing the economic risks to both the children and the corporation. In order to achieve this, it is most significant to accompany a robust government regulation that effectively makes a balance in between prohibiting excessive child labor and considering the economic circumstances of working children.

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## **The Therapeutic Potential of Molecular Overloading and Precursor Molecules on Neurological Conditions By Romir Das**

### **Abstract**

This research aims to analyze and explore the use of molecular overloading and precursor molecules as therapeutic agents in neurological rehabilitation. By delving into the intricate compositional similarities that two core molecules, L-tyrosine and L-phenylalanine, share with dopamine, the neurotransmitter in consideration, this study seeks to probe the intricate benefits the aforementioned molecules can have on motor skill acquisition, motor learning, mood irregularities, cognitive impairment, and sleeping complications. This research endeavors to spark an understanding of an under-researched method for solving severe neurological disorders.

### **Introduction**

The origin of dopamine loss can occur in a plethora of ways. The predominant causes include drug-induced dopamine reduction (through antipsychotic medication), aging, Parkinson's disease, and genetic factors. The occurrence of dopamine loss concerning the three major dopamine locations is the determinant factor for which complications will occur. First, the substantia nigra, a member component of the basal ganglia, resides within the motor cortex. Dopamine reduction occurrence in this area has effects on motor-related qualities, most commonly tremors, movement irregularity, or rigid movements. The second of the three brain locations is the ventral tegmental area (VTA). Dopamine depletion in the VTA implicates cognitive complications. The substantial ones are a loss of interest and enjoyment in rewarding activities, a detriment of attention, working memory, and decision-making, and a heightened risk of a mental health disorder. The final area of severe dopamine depletion is the hypothalamus. The Hypothalamus is a critical aspect of maintaining body regularity. Implications of the depletion of dopamine in this sector will have severe impacts on the body. The predominant issues are as follows: hormone imbalances, disrupted sleeping patterns, and derailed bodily homeostasis. The primary reason why dopamine in its raw element is unable to be inserted into the body is its failure to pass the blood-brain barrier. The blood-brain barrier (BBB) has a selective permeability, preventing the transport of many substances. Dopamine, being a rather large neurotransmitter with a charge, fails to pass the BBB. Its precursor, L-dopa, on the other hand, has been found to effectively pass the BBB, and counteract the effects of dopamine loss. However, L-dopa consequently has many negative effects on the body that will be later discussed in this research, hence two other naturally occurring precursors to both dopamine and L-dopa, L-tyrosine and L-phenylalanine, were investigated to determine their respective potential to be therapeutic alternatives to previously long-standing medications.

### **Molecular Similarities**

The primary quality that sets L-tyrosine and L-phenylalanine apart from other alternatives is the similarity the two amino acids share with L-dopa. The L-tyrosine molecular

makeup is a benzene ring (carbon backbone) with a hydroxyl group (OH), an amino group (NH<sub>2</sub>), and a carboxyl group (COOH) all attached. The derivative substance of L-tyrosine is L-dopa, where both model nearly identical organic chemical structures. The only distinctive variable occurs during the enzymatic process of L-dopa derivation, in which an additional hydroxyl group is added to the benzene ring. Moreover, the forerunner molecule in the derivation of L-tyrosine is L-phenylalanine.

L-Tyrosine and L-phenylalanine also share extreme molecular similarities. The molecular structure properties that L-phenylalanine shares with L-tyrosine include the standard benzene ring (carbon backbone), an amino group, and a carboxyl group. The factor that differentiates the two is the hydroxyl group (OH) on tyrosine is simply a hydrogen atom. The additional oxygen atom that creates the hydroxyl group occurs in the enzymic process of hydroxylation. The following diagram shows the resemblance this family of molecules shares.

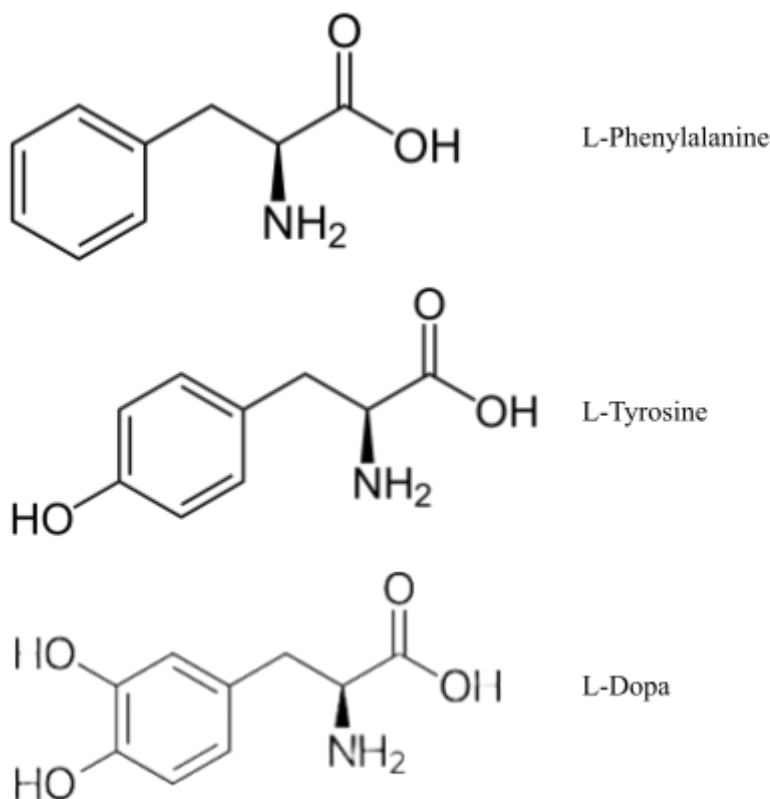


Figure 1: Model molecular makeups for all 3 substances in consideration

### Phenylalanine Hydroxylation Pathway

For L-phenylalanine to be converted into L-tyrosine for bodily utilization, the pathway of phenylalanine hydroxylation must occur. The first step of the pathway is the actual hydroxylation of the L-phenylalanine. For this process to occur, the enzyme, phenylalanine hydroxylase (PAH) must be present. The enzyme adds a hydroxyl group to the L-phenylalanine, creating L-tyrosine. However, in the pathway, there are various cofactors and reaction facilitators involved. The two main ones are tetrahydrobiopterin (BH<sub>4</sub>) and oxygen. Oxygen itself is consumed in the

enzymatic reaction. BH<sub>4</sub>, alternatively, is an external influencing molecule, facilitating the reaction without actually being consumed. BH<sub>4</sub> is recycled in the pathway, making it readily available for further L-tyrosine derivation. A secondary process that occurs within the pathway is the reaction through the dihydrobiopterin-dependent phenylalanine hydroxylase (THA). This reaction adds another hydroxyl (OH) group to the aromatic ring (benzene ring and interconnected groups), which forms 4a-hydroxytetrahydrobiopterin (4a-BH<sub>4</sub>) along with the L-tyrosine. 4a-BH<sub>4</sub> is a crucial co-factor, as it is the molecule that acts as an electron carrier, characterizing enzymes in the entire pathway with reducing power to produce hydroxylation reactions. Through the primary and secondary pathways, L-phenylalanine is converted into L-tyrosine, and all other cofactors and involved molecules are produced, consumed, and recycled.

### **Tyrosine Hydroxylation Pathway**

The process of tyrosine hydroxylation follows a very similar pathway compared to Phenylalanine Hydroxylation, though it is slightly simpler. The main goal of the process is to convert L-tyrosine into L-dopa for dopamine synthesis. The basis of the enzymatic reaction is to attach a hydroxyl group onto the para position (position 4) on the benzene ring of the L-tyrosine molecule. The primary enzyme in the reaction is tyrosine hydroxylase (TH), which catalyzes the L-3,4-dihydroxyphenylalanine (L-dopa) formation. Similar to the Phenylalanine Hydroxylation process, there are cofactors and reaction facilitators involved. Molecular oxygen is consumed in the enzymatic reaction, and Tetrahydrobiopterin (BH<sub>4</sub>) is used to facilitate the reaction. The Tyrosine Hydroxylation Pathway yields the byproducts of water and Dihydrobiopterin. The overall equation of the reaction is: L-Tyrosine + Oxygen + Tetrahydrobiopterin → L-Dopa + Water + Dihydrobiopterin. The L-dopa that is synthesized by both the phenylalanine hydroxylation pathway and the tyrosine hydroxylation pathway is then converted to dopamine through a process known as Decarboxylation, catalyzed by the enzyme Aromatic L-Amino Acid Decarboxylase (AADC). Decarboxylation will not be further elaborated on as it is not directly related to the aims of this research.

### **Why L-Tyrosine and L-Phenylalanine Over L-Dopa**

Though there are a handful of reasons why L-dopa is typically preferred and used over L-phenylalanine and L-tyrosine, such as it being a more direct precursor to dopamine in the biochemical pathway, its efficiency to cross the Blood-Brain Barrier, and its R&D history in the field of therapeutic usage, the research's two main amino acids, L-phenylalanine and L-tyrosine, also have a plethora of factors proving their predominance over L-dopa.

One main factor is the amino acids' expansive impact on multiple neurotransmitters. Though the research's main focus is therapeutic alternatives for dopamine production, L-phenylalanine and L-tyrosine's potential to increase neurotransmitters such as norepinephrine and epinephrine can overall improve neurological functions.



Another factor is the broad amino acid support given by the consumption of these two substances. While levodopa may have a more direct and focused purpose on dopamine production, it's important to also prioritize any other deteriorating parts of the brain that occur due to Parkinson's or other neurological disorders. Two main characteristics of the brain that occur due to dopamine reduction are irregularities in cognitive function and mood regulation, both of which can be substantially improved by the consumption of the aforementioned amino acids.

There are benefits to consuming L-phenylalanine and L-tyrosine rather than levodopa in the field of safer medication and accidental overdosing. While consuming L-dopa may directly boost dopamine levels, L-phenylalanine and L-tyrosine create a pathway of more regulated and natural dopamine production. The amino acid's availability to the body facilitates their conversion into dopamine as needed, without the potential drawbacks of dopamine fluctuations and dysregulation.

L-Dopa has massive risks if levels of dopamine are not properly monitored and balanced. An excess of L-dopa consumption, and subsequently excess dopamine production, can lead to drastic side effects, such as dyskinesias, motor fluctuations, tolerance and reduced effectiveness, psychiatric complications (psychosis), nausea/vomiting/gastrointestinal complications, and cardiovascular concerns. These simpler precursor molecules, L-phenylalanine and L-tyrosine, allow the body to produce dopamine in a safe and balanced pathway, without any of the previously mentioned overproduction side effects.

## **Theory**

To understand the experiment conducted, it's vital to be aware of this research's theory. Levodopa, the primary medication for dopamine production, has specific dosage amounts listed for both new consumers and those who require a heavier dose. Typically, the starting dose is around 300 mg of levodopa per day, with 3 capsules being administered in set and equal intervals throughout the day. Patients who have built a tolerance or require a higher dosage consume up to 8 whole tablets, which total to around 800 mg of levodopa. In these standard tablets, however, the 100 mg of levodopa are combined with 25 mg of Carbidopa. Carbidopa is a dopa decarboxylase inhibitor. Its purpose is to prevent the premature conversion of levodopa into dopamine in exterior parts of the brain. This yields the total quantity of effective medication (not including starches, cellulose, etc.) to about 1000 mg daily.

Pharmaceutical companies typically recommend that L-tyrosine be consumed with a daily cap of around 1500 mg. L-Phenylalanine has various daily dosing amounts, however, it often averages at around 1500 mg. With the amino acid substrates, the daily dosage of effective medication could total up to 3000 mg. This amount is 300% more than the value of the quantities of existing levodopa medications. The central idea of this theory is that higher dosage amounts, up to 300% more, could mitigate lower dopamine conversion rates by using earlier precursor molecules in the biochemical pathways.

Due to levodopa being an extremely close precursor to dopamine derivation, its efficiency in crossing the Blood-Brain Barrier and converting to dopamine through enzymatic processes is relatively high. The main drawback for L-tyrosine and L-phenylalanine individually is their relatively low production yield of dopamine. However, overloading, taking both amino acids concurrently, can eliminate this drawback. Due to the naturally occurring characteristics of both amino acids, concurrent consumption has been deemed safe by both physicians and dietitians. By these means, variable, but equal, quantities of both amino acids together and levodopa can be compared to identify the accuracy of the theory. This theory has been presented to practicing physicians who affirmed its precision.

## **Experiment**

While testing for therapeutic effectiveness, pharmacological properties and concentration are the two main factors to consider. This experiment will gauge concentration as past studies have found levodopa to be superior to the combination of L-phenylalanine and L-tyrosine in terms of pharmacological characteristics such as efficiency and mechanism of action.

In order to test the theory, a ninhydrin reaction test was used to compare the test solution with a market levodopa medication. The ninhydrin test is used to identify substances - in this case, amino acids - in a solution. In a ninhydrin test, a specific substance within a solution can be identified through characteristic colors. Meanwhile, the concentration of this substance can be determined by the intensity of its associated color. For example, serine and threonine produce a green color while asparagine and glutamine produce a blue color. In this procedure, a purple/violet tint to the resulting test will indicate the presence of L-phenylalanine, L-tyrosine, and L-dopa, which all react to form a dark purple/violet hue in high concentrations..

Firstly, a 2% ninhydrin in acetone solution was created for the experiment. 3 test tubes of various contents were used. The first tube was a control group containing only distilled water. The second tube was a solution of one measured dosage (1 of 8 daily) of the experimental combination, which consisted of 187.5 mg of L-phenylalanine and 187.5 mg of L-tyrosine mixed into 37.5 ml of distilled water solvent. The last tube was a solution prepared from the market levodopa medication, which used 125 mg of medication dissolved into 12.5 ml of distilled water. Once all the test tubes were formulated, one ml was extracted from each to be placed into a new, labeled test tube. Four drops of the 2% ninhydrin solution were added to each of the 1 ml solution-containing tubes. These tubes were then collected and submerged in a warm water bath for 5 minutes. After the reaction interval was complete, the tubes were then extracted from the bath and analyzed in cross-reference to visible light spectra to gauge the intensity of the tint. Test tube 1, distilled water, was completely colorless, having had no reaction with the ninhydrin solution. Test tube 2, the experimental solution, radiated a tint with a wavelength of around 425 nm. Test tube 3, the market medication solution, reflected off a hue that showed about a 415 nm wavelength range. Two additional trials with the same procedures were conducted which affirmed the results.

The results from the additional trials are displayed in the graph below. The more violet (intense) tint of the experimental solution compared to the market medication illuminated the idea that the concentration of amino acids in a singular dose of experimental solution is comparatively higher. By principle, in the same quantity of doses of both the experimental solution and the market medication, the experimental solution will contain a higher concentration of effective medication.

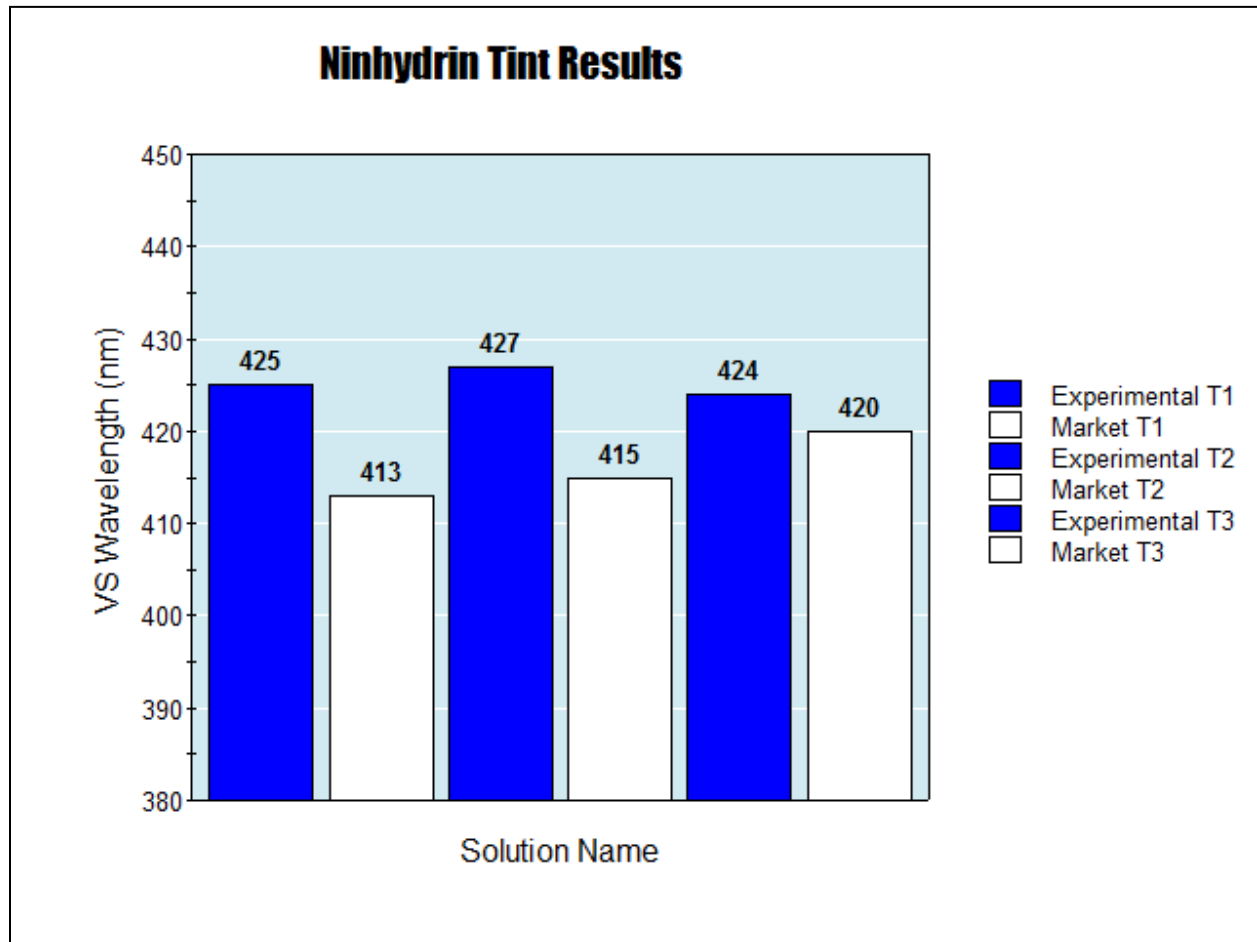


Figure 2: Bar graph representing EM spectrum wavelengths for tints given off from each test tube in all 3 experiments

## Conclusion

This experiment supports the theory that although Levodopa has superior pharmacological characteristics, the experimental solution results in improved concentrations, indicating that it could indeed be a more effective therapeutic. Despite this, there are a handful of factors for potential patients to consider for the experimental medication. Subjective consultation with a dietitian and physician is imperative to complete, prior to medicating with the experimental pharmaceutical. Analytics of enzymology for the individual is crucial to gauging independent enzymatic strength to ensure there is no chance of conversion-related overdosing. A

weaker Tyrosine Hydroxylase enzyme may cause exceeding levels of L-tyrosine in the blood in ratio to both levodopa and L-phenylalanine, which may cause potential side effects. Patients who conduct enzymology reports should evaluate the individual strength of both Tyrosine Hydroxylase and Phenylalanine Hydroxylase to ensure that conversion rates remain similar to one another. Additionally, patients may be faced with the rare condition of tyrosinemia phenylketonuria, in which they are unable to properly metabolize the two amino acids. Patients should conduct a thorough examination of themselves beforehand to prevent any consequential impacts that may be detrimental to their health and well-being.

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# **Gender-Based Biopsychosocial Consequences of Covid-19: Do Men Suffer More Biological Problems Than Women? By Aparajita Manglani**

## **Abstract**

Elderly and patients with already existing diseases like hypertension, diabetes, and obesity have got emphasis amid the COVID-19 pandemic for being more vulnerable to illness or death due to Coronavirus. But it is also evident that men are also more vulnerable to COVID-19 than women. The existing COVID-19 outbreak has constantly affected a lot of countries worldwide. There are both biological and cultural consequences behind the higher risk of COVID-19 for men. They are more likely to have worse outcomes in hospitals and complicated health conditions than women. They also have more harmful habits related to self-care as compared to women.

A lot of psychosocial effects have been observed during the pandemic in women, associated with family, work, childcare, etc. which are intensified because a lot of health workers are female. There are also different direct and indirect effects of gender and sex during outbreaks and they must be taken on a priority basis.

Further studies should pay more systematic focus on gender and sex on existing treatments and vaccinations for COVID-19, whether symptoms are similar for women and men, saving women and their families from infection, and incorporating into surveillance, prevention, and detection mechanisms.

A lot of difference in mortality rate is due to lifestyle factors like higher drinking and smoking levels among men compared to women. Women were reported to be more responsible towards self-care as compared to men during the pandemic. Men had irresponsible attitudes towards preventive measures like keeping masks in public places, staying at home, and washing/sanitizing hands frequently.

**Keywords** – Biomedicine and Health Science; Immunology; COVID-19; morbidity rate; mortality rate; pandemic; biopsychosocial consequences; biological problems

## **Introduction**

The first positive case of COVID-19 was diagnosed in Wuhan, China in December 2019 (Guan et al., 2020). It was initially known as SARS-CoV-2 or novel Coronavirus (n-Cov-2019) by Chinese scientists who isolated patients infected with this virus (Zhu et al., 2020). In February 2020, it was designated as COVID-19 by WHO when they declared it a global health emergency. COVID-19 is listed among the zoonotic coronavirus infections like “Middle East Respiratory Syndrome (MERS)” and SARS (“Zhu et al., 2020”). The  $\beta$ -Coronavirus cluster consists of all “SARS-CoV-2, SARS-CoV, and MERS-CoV diseases (Chen et al., 2020),” even though there is limited information available on the sources of this disease but existing data observed that SARS-CoV-2 combined virus between Coronavirus of unknown source and coronavirus from a bat (Sun et al., 2020).

Snakes are identified as the most common source of COVID-19 when analyzing the virus from different wildlife species (“Sun et al., 2020”). In addition, “Benvenuto et al. (2020)” observed that COVID-19 had a close resemblance to the virus contained in “chrysanthemum-headed bats” in the year 2015, which supported the chance of transmission from bats to humans.

## **Background**

A lot of concerns have been raised by COVID-19 associated with the urgency to deal with the pandemic. There are various biopsychosocial effects of this disease based on gender and sex. Gender defines characteristics that are socially constructed (like social or cultural changes like roles, norms, and relations between men and women, etc.), while sex is naturally determined due to biological changes. The differences between sex and gender are printed in the concepts of healthcare and health (Turabian, 2018a). Both gender and biological characteristics influence vulnerability to disease and health consequences of people along with the use of health services (WHO, 2020; Turabian, 2017a).

Even though men and women are similar in different ways, there are still several behavioral and biological differences between both sexes and genders reflected by the “pathophysiology and epidemiology” of a lot of diseases and common health approaches (“Short et al., 2013; Regitz-Zagrosek, 2012”). There are differences in each organ and tissue system of the body of both sexes (Gupta, 2020). There are gender and sexual differences in “pulmonary, cardiovascular, nephrological, gastroenterological, hepatological, hematological, autoimmune, behavioral, mental, and other aspects”. Gender and sexual differences are observed especially in the frequency of problems related to mental health, such as anxiety, depression, somatic issues, and psychological disturbances.

Women bear significant impacts because of gender, social, and psychosocial issues as they are exposed to more stress in society. It is not easy for them to change their stressful situation and they are also vulnerable to sexual violence (Turabian, 2017b). Gender is an individual “risk factor” after other issues like “age, ethnicity, comorbidities and other biological issues” have been considered. Meanwhile, genetic variants are still there to carry a specific risk among men and women (Regitz-Zagrosek & Seeland, 2013). Sex hormones are assumed to play a vital role in the outcome and pathogenesis of the disease, along with molecular systems related to physiological aspects. Differences related to sex/gender in mortality and morbidity can be controlled partly by genetic factors (Ordovas, 2007). There is still an unclear relationship between economic, genetic, psychosocial, and medical variables (Reyes et al., 2005; Turabian, 2018b).

## **Literature Reviews**

Wu et al. (2020) conducted a cross-sectional, multicenter study and observed that 80% of patients in China who were found positive for COVID-19 showed moderate or mild symptoms

like other respiratory infections. Meanwhile, COVID-19 has also been able to severely affect specific groups like patients with heart disease, diabetes, and obesity and older people and populations (Guan et al., 2020; Faure et al., 2020). There is a lack of proper information on the “epidemiology of COVID-19” but it is evident that men are highly affected by it “(Guan et al., 2020; Onder et al., 2020; Shim et al., 2020)”.

COVID-19 has got limelight because of negligence on men’s health at “national, state, local and global levels (Baker et al., 2020)”. As per the leading body of international government sources which have made sex-disaggregated data public, more men have died of Coronavirus than women in 41 countries out of 47 nations, even though there are no sex differences in several confirmed cases (CDC COVID, 2020), and the overall ratio of “case-fatality of COVID-19” is around 2.4 times larger in men as compared to women (“Sharma et al., 2020; Smith et al., 2020”). “Wang et al (2020)” conducted a large-scale survey on 72,314 confirmed/suspected COVID-19 cases in China, out of which 36.2% cases were women and 63.8% cases were men. There was a 2.8% of case-fatality ratio among men and 1.7% among women. Meng et al. (2020) conducted another study on critically ill subjects in China and found that men with chronic kidney illness, cardiovascular disease, hypertension, and diabetes were found with the highest mortality, while similar patterns were found in US data (“Smith et al., 2020; Richardson et al., 2020; Reeves & Ford, 2020”).

Death rates were higher in Italy among men as compared to women in all age groups as 70% of deaths recorded were male, according to a report on 3200 deaths related to COVID-19 (Sharma et al., 2020). With a “TriNetX Network”, a global health database found that men were more likely to be admitted to a hospital and found with a higher prevalence of diabetes, hypertension, obstructive pulmonary illness, heart failure, coronary heart disease, and nicotine dependence, among 14,712 confirmed female and male patients diagnosed with COVID-19 (Alkhouli et al., 2020). In addition, cumulative odds of survival were very low as compared to women after using “angiotensin receptor blockers (ARBs)” and “angiotensin-converting enzyme inhibitors (ACEIs)” and adjusting for comorbidities and age (Alkhouli et al., 2020).

Around 57% of casualties were reported in men due to COVID-19 in the US by June 2020. Higher mortality was reported among men in all the states of the US, except Massachusetts (Bischof et al., 2020). There has been inconsistency in reporting such data in the US. Only half of the states reported sex as a variable to report morbidity after analyzing 26 states (Bischof et al., 2020). Age was a major indication for “mortality in COVID-19” and a lot of demises reported among adults above 75 years old in the US. There are also differences in death by gender/sex, race, and class exacerbated by already existing health issues like diabetes, obesity, and hypertension (Reeves & Ford, 2020). It is not easy to explore the change in mortality and morbidity of COVID-19 across various sociodemographic profiles, but it is worth noting that ethnicity, gender, sexual orientation, race, and other influences are vital and need care to specific cohorts during the epidemic.



## **Research Gap**

The findings from epidemiological research in different countries showed higher mortality and morbidity of COVID-19 among males as compared to females. Though it is not the right time to determine the cause of the gender gap, this article explores various common factors affecting the morbidity and mortality of men and intervention strategies to prevent such risks.

### **Research Question**

- What are the factors affecting “mortality and morbidity of men during COVID-19”?
- What are the intervention strategies to reduce mortality risk among men during COVID-19?

### **Research Objectives**

- To discuss the factors that affected the mortality and morbidity of men during COVID-19
- To suggest intervention strategies to control mortality risk among men during the pandemic

## **Research Methodology**

To fulfill the above objectives, this study is based on secondary data collected from recent studies published during the post-COVID era about morbidity and mortality of men and women across the world in peer-reviewed journals and gathered from databases like PubMed, ScienceDirect, Google Scholar, etc.

## **Analysis of Study**

### **Factors that Affected Mortality and Morbidity of Men during COVID-19**

Even though there is a difference between both sexes in epidemiological data on mortality rate among the patients found positive with COVID-19, there is a lack of clarity in mechanisms showing differences between men and women in mortality (Sharma et al., 2020; Bischof et al., 2020; Wenham et al., 2020). Since most of the health patterns are caused by a combination of behavioral, biological, and psychosocial aspects, it is important to find out how biological factors related to sex and behavioral and psychosocial factors associated with gender interact to determine health consequences (Griffith, 2016) and to determine mortality associated with COVID-19 (Smith et al., 2020; Reeves & Ford, 2020; Wenham et al., 2020). Biological factors are initially described in this section along with behavioral and psychological factors related to higher risk among men of mortality associated with COVID-19.

## **Biological Factors**

There are differences between both sexes in both “adaptive and innate immune responses”, usually partly associated with sex-related inflammatory responses due to inherited X-chromosomes. The immune-associated genes are highly dense in the X chromosome. Hence, women usually are more immune and adaptive than men (Sharma et al., 2020). This diverse control of immune responses in both sexes plays a vital role with sex hormones and chromosome genes, such as androgens, progesterone, and estrogen. After viral infection, sex-related outcomes

of disease are associated with the sex-reliant generation of steroid hormones, “disease susceptibility genes”, and various copies of X-linked immune response genes (Sharma et al., 2020).

The “SARS-CoV receptor angiotensin-converting enzyme 2 (ACE2)” is used by “Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2)” to break into host cells (Li et al., 2003). In the respiratory epithelial cells, the virus contains the S spike, which is stuck to the ACE2 gene or receptor. The “cellular protease transmembrane protease, serine 2 (TMPRSS2)” in the host cell potentiate the incorporation of the virus (“Hoffman et al., 2020”). The high “case-fatality ratio” and heavy load of illness in COVID-19 patients may be increased partly because of the huge affinity for ACE2, opening the gateway to the virus and multisystem illness in the gut, pulmonary, central nervous, and cardiac systems.

As compared to women, higher amounts of “plasma ACE2 levels” are found in men and there was a higher amount of “plasma ACE2 concentrations” in patients suffering from heart failure than normal in men and it may show higher expression of tissue in ACE2 receptor for COVID-19 infections (Sama et al., 2020). It could show why men are more vulnerable to infection due to COVID-19. Showing which cellular factors COVID-19 uses to enter might give details on therapeutic targets and viral transmission. Further research is still ongoing on the relationship between COVID-19 and ACE2 enzyme and its relation with sex. Even though sex difference in mortality is explained by biological factors, behavioral and psychosocial factors are still important.

### **Behavioral and Psychosocial Factors**

Apart from gender differences in hormones, genes, and immune responses, social, behavioral, and psychological factors also play their part in influencing the progression of “COVID-19 (Baker et al., 2020; Wenham et al., 2020)”. Men easily engage in high-risk behaviors as compared to women, which are responsible for contracting COVID-19 “(Baker et al., 2020; Smith et al., 2020)”. In the first wave of Coronavirus cases in the US, early polls showed gender differences in the severity of the pandemic (McCarthy, 2020). Another study in the US observed that men are known to increase risk of being infected due to negligence of guidelines (Ewig, 2020), and only fewer men have stated to avoid close contact with others or large gatherings than women (Ewig, 2020; White, 2020; Woodyatt & Greene, 2020).

Additionally, when compared to women in the US and other countries, men are likely to have higher COVID-19 mortality and infection-related behaviors than women, such as higher use of alcohol and tobacco “(Baker et al., 2020; Smith et al., 2020; Ewig, 2020; Mellström, 2020)”. Men are also less likely to follow “social distancing rules, practice handwashing, wear masks, and seek medical help than women (Baker et al., 2020; Smith et al., 2020; Ewig, 2020; Garcia et al., 2020)”. It is especially true to focus on men and their response to COVID-19 threats with anger and aggression. With this response, people tend to resist policies to reduce risk and downplay risk, which is problematic when it comes to promoting restrictions like social

distancing (Gupta, 2020). These behaviors tend to lower severity, susceptibility, and perception, which resulted in a decline in preventive practices like handwashing.

There are other factors that may interact with gender and sex like geography and age (Griffith, 2012). For instance, a study was conducted in the US on the association between worry and perceived risk with gender and age. It was observed that older men made the least behavioral changes across gender groups and age, even though they perceived higher risks of infection than their younger counterparts (Barber & Kim, 2021). Another study showed the status of geography or place. When comparing nations with predominantly White or Black populations, the infection was “3 times higher and death toll was 6 times more in nations with a predominantly Black population (Yancy, 2020). In cities with a high population of Black residents living with poor socioeconomic status, there are some problematic narratives blaming people in these areas for having high COVID-19 rates” instead of structures or policies causing such mishaps (Chowkwanyun & Reed, 2020).

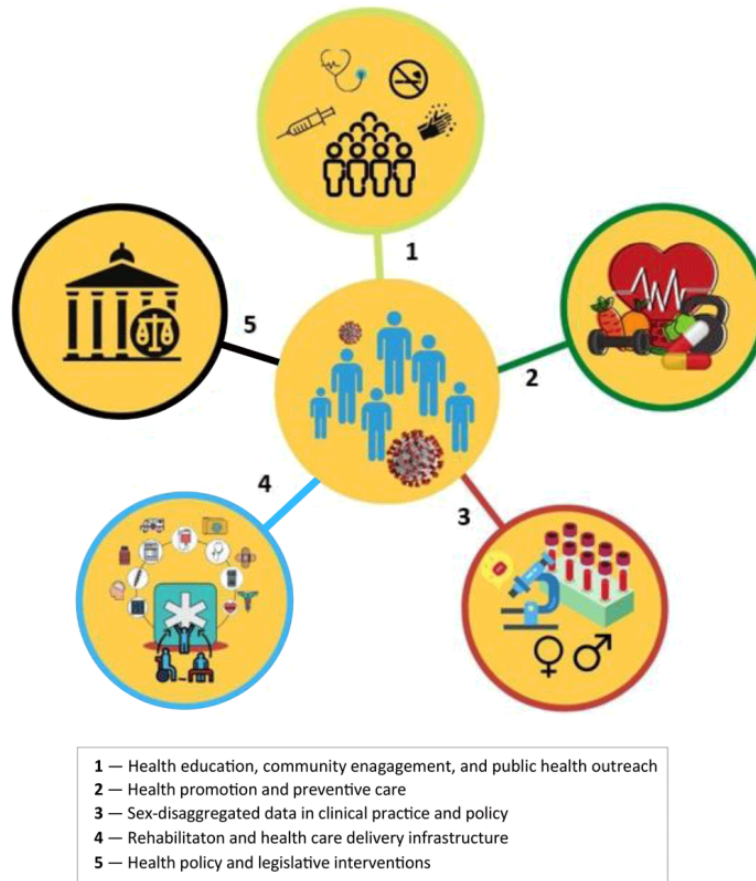
Along with these behavioral and psychological factors, there are changes in occupational risk that takes place between both sexes. In the US, a lot of women are considered to be more essential workers than men, usually due to a vast share of women in healthcare and social workers (Robertson & Gebeloff, 2020). However, underpaid or low-skilled jobs of essential workers like transportation, food processing, warehousing, delivery, manufacturing, and construction are supposed to be related to high mortality risk, wherein men have outnumbered women (Robertson & Gebeloff, 2020).

All in all, a lot of behavioral, psychological, and biological factors can suggest the reason why men were found with higher rates of mortality and morbidity associated with COVID-19 as compared to women. Even though it is significant to regulate factors related to a higher risk of mortality in men due to COVID-19, it is also important to find out ways to mitigate the risks associated with mortality in men. Factors that are responsible to worsen the risk for men are tangled with “ethnicity, race, geography and other proxies for markers of social inequality and marginalization (Smith et al., 2020: Griffith, 2016)”.

### **Intervention Strategies to Control Mortality Risk Among Men During Pandemic**

There are five mitigation strategies to reduce the transmission of the virus and improve tests to reduce the mortality risk for men (Figure 1) -

**Figure 1** – Intervention Strategies to Mitigate COVID-19 Mortality Risk



**Source** – Griffith et al. (2020)

### **Health Education and Public Health Awareness**

Awareness efforts may be effective to encourage people to comply with public health guidelines and to change men's behavior regarding social distancing and hygiene regulations. It is important to explore how the values, goals, and priorities of men affect their choices on whether to avoid or follow COVID-19 guidelines and ignore or focus on potential symptoms in their bodies, when researching psychosocial barriers to health behaviors of men (Griffith et al., 2020). When it comes to self-determination, men should be engaged in a way that they are encouraged to engage in healthy behavior consciously, instead of pressure, shame, or coercion. For instance, some men may like to develop healthy habits to prevent infection or transmission. It is possible not because of their health implications, but by considering the increasing death toll and health risks of their cohorts. It is important for them to be motivated by their reasons to follow guidelines related to COVID-19 transmission when they have pressure to go to work, are fatigued or is inconvenienced by wearing gloves and face masks, and desires to spend some time with family and friends.

## **Preventive Care**

Considering the already existing or underlying conditions like comorbid chronic illnesses like heart disease, cancer, and diabetes, or obesity among men, and cardiometabolic risks, it is important to study men with those conditions responsible to increase the risk of mortality (Griffith et al., 2020). Even though there is a lack of understanding of the higher severity of complications related to COVID-19 in men, initial findings of higher mortality rates related to the above conditions show that researchers have searched for existing treatment plans considering the same.

Garcia et al. (2020) tested a model which determined “ST-Segment Elevation Myocardial Infarction (STEMI)” activations. From “coronary artery occlusion to coronary blood flow restoration, the time showed a huge 38% drop from around the year before January 2019 to March 2020”. The study gathered data from nine “high-volume cardiac catheterization” labs and found that there was a decline in total “STEMI activations” from over 180 per month to merely 138 activations in a month. Hence, patients are likely to stay home due to fear of the virus, although they need emergency care. There is a need to reassure them that even though elective or routine care is stopped by the pandemic, there is still a need to address new signs of stroke and myocardial infarction immediately.

## **Rehabilitation**

There are strategies to avoid complications of Coronavirus, which are important for effective and safe intervention. It is especially important to provide patients with “post-acute care rehab services” to recover from this disease and to prepare new teams to provide treatment to such people (Arora & Fried, 2020). Community health workers should be engaged to improve health outcomes for patients with different chronic health conditions.

## **Sex-based Data in Policy and Clinical Practices**

When it comes to planning clinical tests against conditions related to COVID-19, researchers and clinicians should provide sex-disaggregated data and consider social stressors and behaviors related to gender which might affect treatment options, the efficiency of the drug, and adverse results (Sharma et al., 2020; Springer et al., 2012). Sex differences have long been reported and analyzed and women are always underrepresented in clinical trials and cure for infectious illnesses (Bishof et al., 2020). There is a need to investigate sex differences critically, reflectively, and consistently to meet the need for excellence in COVID-19 treatment.

## **Policymaking and Legal Interventions**

Along with several initiatives to reduce mortality rate and transmission, it is worth considering the possible policy efforts to address the epidemic. Policymakers should have considered gender explicitly as men were dying disproportionately due to COVID-19 (Baker et al., 2020). Disseminating and collecting evidence by sex may be helpful to make the important case to consider the health of men explicitly during the pandemic. In the end, policymakers

should go with an equity-based approach that consists of heterogeneity (Baker et al., 2020; Griffith, 2019). Men who are disadvantaged or marginalized due to their ethnicity, race, incarceration, sexual orientation, etc. are partly vulnerable and it is important to explore overrepresented groups among front-line workers at risk due to underlying conditions.

## **Results**

Along with the factors determining risks, a biopsychosocial approach also considers the places where it is possible to intervene in a health model which consists of both “public health and biomedical interventions” to reduce the death toll. There is a need to ensure that “testing, screening, and quarantine of all potential and confirmed cases, financing, contact tracing, clinical trials, and vaccination” for novel targets don’t vary by sex or any marker of change which is socially meaningful. In addition, it is important to significantly improve investment in the control and prevention of chronic illnesses like diabetes, hypertension, chronic renal disorders, heart diseases, and mental disorders to control the mortality of COVID-19 among men.

There is a lack of specific health care, despite having knowledge of these important differences by sex and gender. The health of women is also a sensitive sign of quality of life and their health is also related to their position in society. Gender and sex differences have been apparent and clinically important for the first time due to the COVID-19 pandemic in this world. It is a different opportunity to increase personalized treatment. Further studies are needed to have more systematic attention to gender and sex in the context of COVID-19.

## **Conclusion**

There are biological changes in men and women in the context of the immune response, which may affect their ability to combat COVID-19 infection. Females are usually more resistant to diseases as compared to men. It is commonly mediated by various factors like a high expression of ACE-2 and sex hormones in men, lifestyle factors like higher levels of drinking and smoking, etc. In addition, more responsible behavior has been observed among women in the prevention of COVID-19 as compared to men. It may help in preventive measures like wearing a face mask, washing hands frequently, and avoiding public gatherings.

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# Alterations of Gene Expression in Preterm Birth: A Screening Study By Siddhi Rajkondawar

## Abstract

Preterm birth is classified by a baby being born 37 weeks or earlier. However, if a baby is born 32 weeks or earlier, they are at a higher risk for death and disabilities. Preterm babies cause more than half of long-term morbidity (suffering from a disease or medical condition) and 75% of prenatal death. Using the Preterm Birth Transcriptomic Database, these genes were screened using a variety of ways. To narrow down these genes, we initially used P-value, then later used FC Value, Val. Fold Change, and Log Fold Change to narrow down the genes. Screening second trimester maternal blood and third trimester maternal blood for significantly regulated genes revealed 42 potential gene candidates. Of these 42 genes, 22 (52.3%) were significantly altered in the third trimester based on p-value less than 0.05. In the end 12 genes were picked for further evaluation. We grouped the genes into 4 major categories: immune system related, metabolism related, clot related, and development related. In summary of the 12 genes screened, TLR4 is our top gene candidate for preterm birth prevention. TLR4 is a part of the TLR (toll-like receptor) family, which plays an important role in pathogen recognition and innate immune activation. This gene and its inhibitor, TAK-242 would serve as a potential causative gene in preclinical mice models and testing of this drug needs to be conducted in various preclinical platforms with the end target of a Phase 1/2 clinical trial.

## Introduction

The number of preterm births per year is estimated to be around 15 million. Preterm birth is classified by a baby being born 37 weeks or earlier.<sup>[1]</sup> However, if a baby is born 32 weeks or earlier, they are at a higher risk for death and disabilities. In 2021, 1 in 10 infants born were affected by preterm birth in the United States. Although, this does differ from other countries as well. Preterm birth rates range from 5% to 18% of all births across 184 countries. To list a few, in the United States, preterm birth rates have risen from 10.1% in 2020 to 10.5% in 2021. (Figure 1) In Europe, preterm births range from 5-10% and in Africa, preterm birth rates were at a high of 14.8% in 2021. Preterm babies cause more than half of long-term morbidity (suffering from a disease or medical condition) and 75% of prenatal death.

Around 30-35% of preterm births are indicated, 40-45% are caused by spontaneous preterm labor, and 25-30% are caused by PPRM; births caused by both spontaneous labor and PPRM are referred to as spontaneous preterm births.<sup>[2]</sup> (Figure 2) Indicated births are when the delivery is medically induced. There could have been an issue with the baby or the mother, requiring an immediate delivery. Spontaneous preterm labor occurs when the mother's contractions have started but their water hasn't broken. Lastly, PPRM birth is when the mother's water breaks and goes into natural labor, however, before 37 weeks. This explains why the United States has a higher preterm birth rate, as induced labor is becoming increasingly common.

Seeing that many babies are typically born at 40 weeks, developmental disabilities and undeveloped systems are more likely to affect prematurely born babies.<sup>[3]</sup> In a press statement, Scott D. Berns, MD, Vice President for chapter programs of the March of Dimes, states that prematurity is a widespread, serious problem in America and that, regrettably, the number of preterm deliveries is increasing each year. “Too many babies are born extremely premature in this country, and the result is that many of them die in the hospital or suffer lifelong consequences, including cerebral palsy, mental retardation, chronic lung disease, blindness, and hearing loss.”

Premature delivery complications can range in severity, however, they are more likely to occur the sooner the baby is born. Extremely preterm is classified as a baby being born 25 weeks or earlier, very preterm is the baby being born less than 32 weeks, moderately preterm is the baby being born between 32-34 weeks, and late preterm is between 34-36 weeks of completed pregnancy. Although complications are not experienced by all premature babies, being born too early can have both short and long term complications. During the first few weeks of a premature infant, short term complications may include breathing problems, temperature control problems, and immune system problems. A premature baby may have trouble breathing due to their underdeveloped respiratory system. Their lungs aren't able to expand and contract normally which can develop respiratory distress syndrome. Premature infants can lose their body heat quickly. They don't have the stored body fat of a full term infant, meaning they are unable to produce enough heat to offset the heat that is lost through their skin. If their body temperature falls too low, hypothermia can occur. Premature babies frequently have weak immune systems, which increases their risk of infection. Sepsis, an infection that spreads to the bloodstream, can be quickly brought on by infection in a premature newborn. In the long term, premature birth can lead to cerebral palsy, dental problems, and vision problems. Cerebral palsy is a movement, muscle tone, or posture condition that can be brought up by an infection, poor blood supply, or trauma to the developing brain of a newborn, either early in pregnancy or while the child is still young. Dental problems can occur to infants that were critically ill. There can be a delay in tooth eruption, tooth discoloration, and improperly aligned teeth. Premature newborns are at risk of developing retinopathy of prematurity, a condition where blood vessels bulge and overgrow in the light-sensitive layer of neurons at the back of the eye (retina). Sometimes the retinal arteries damage the retina over time, forcing it out of position. When the retina pulls away from the back of the eye, the condition is known as retinal detachment, which can impair vision and ultimately blindness if left untreated.<sup>[4]</sup>

There are also some cognitive issues that come along with preterm birth. Many children that were born preterm suffer with mental processes such as attention, problem solving, and memory.<sup>[5]</sup> Studies have found that these cognitive issues start to become noticeable during elementary school. The study discovered that very preterm children (<32 weeks) had more difficulty remembering pairs of simple terms that appeared briefly on a screen, even if only a

moment later. During the study, they also had unique patterns of brain activity on Magnetoencephalography (MEG) than full-term children of the same age. Very preterm children's brains, in particular, showed a decrease in coordinated activity in brain waves in the cortex, the outer layer of the brain. Full-term children, on the other hand, showed an increase in this type of connection when completing the same task.

As stated, the precise reason as to why preterm birth occurs is unknown, nevertheless, there are some known risk factors to preterm birth. These include smoking or drug and alcohol use, being underweight or overweight before pregnancy, having a previous premature delivery, problems with the uterus, placenta, or cervix, and chronic conditions - such as high blood pressure or diabetes.

There are certain things that can be done to help women, especially those who are at a higher risk, these include progesterone supplements and cervical cerclage. Progesterone supplements, which have many uses, can specifically help women who have a history of preterm birth or a short cervix reduce their chances of preterm birth. Cervical Cerclage is a surgical procedure performed during pregnancy in women that have a short cervix. During this procedure, the cervix is stitched together with sutures, which may provide extra support to the uterus. When it is time to give birth, the sutures are removed. This method can be useful because it keeps the cervix closed during pregnancy and can prevent premature birth caused by a weaker cervix.

In this paper, we screened maternal and cord blood to find potential biomarkers related to the risk of preterm birth.

## **Hypothesis**

After research, the gene group with the highest link to preterm birth will be possible candidates for additional exploration. Once a gene group is narrowed down and inhibitors are discovered beside one gene, this gene can be evaluated and potentially used to prevent preterm birth.

## **Methods**

The genes were screened using a variety of ways. To begin, we used P-value to narrow down genes associated with premature birth.<sup>[6]</sup> In statistical analysis, the P-value (probability value) determines statistical significance. (figure) Generally, statistical significance is frequently stated in p-values ranging from 0 to 1. The lower the p-value, the stronger evidence there is, thus the result should be statistically significant. The null hypothesis is the statement you are trying to prove as false when looking for statistical significance. The next method used is the FC or F Value.<sup>[7]</sup> This was monitored when screening genes in the third trimester cord blood. The FC Value (Fold Change) is a type of ratio used in quantitative analysis. It displays the relationship between two variables by stating the ratio of their values. It also shows how many times something has changed in comparison to the original amount. Fold change is useful when searching for increases and decreases in data. Also used to screen genes was the Log Fold

Change and the Val. Fold Change. These values sound very similar yet very different. The Log Fold Change is the log of the Fold Change, the Val. Fold Change is the raw value.

## Results

Screening second trimester maternal blood and third trimester maternal blood for significantly regulated genes revealed 42 potential gene candidates. Of these 42 genes, 22 (52.3%) were significantly altered in the third trimester based on p-value less than 0.05. Secondly, third trimester cord blood was examined using an absolute val. fold change threshold of 2.0. This led to 111 genes being included in the screening. Finally, overlap between third trimester maternal blood and third trimester cord blood was investigated. In the end 12 genes were picked for further evaluation. (Figure 3) We grouped the genes into 4 major categories: immune system related, metabolism related, clot related, and development related.

### Development Related Genes

The H19 gene is a long noncoding RNA gene found in humans and other animals. H19 is involved in the regulation of body weight and cell proliferation. This gene is also involved in the development of various cancers and the regulation of gene expression.<sup>[8]</sup> This gene can also act as tumor suppressor, keeping cells from dividing too fast or in an uncontrolled way. The H19 gene is highly active in numerous tissues before birth and appears to play an important role in early development.<sup>[9]</sup> In our Preterm Birth Transcriptomic Database we used to compare genes, H19 is shown as an upregulated gene.<sup>[10]</sup> A search of PubMed showed no results for a correlation between H19 and preterm birth, however, our research narrows down and concludes that H19 could be a potential candidate for being related to preterm birth.

### Clot Related Genes

There were two narrowed down genes in the clot related category, THBS1 and SERPINI1. THBS1 is a glycoprotein that acts as an adhesive and enables cell-to-cell and cell-to-matrix connections.<sup>[11]</sup> This protein can bind fibrinogen, fibronectin, laminin, collagen types V and VII, and alpha-V/beta-1 integrins. Platelet aggregation, angiogenesis, and cancer have all been linked to this protein. THBS1 was found to be upregulated in preterm births. THBS1 has been studied in the context of preterm births prior and found to be a potential reactor in preterm birth, not just only in humans but in animals as well.<sup>[12]</sup> Additionally, researchers have inhibited THBS1 through use of CD47 antisense antibodies increasing the feasibility of targeting THBS1 to prevent preterm births.

The SERPINI1 gene encodes a protein called neuroserpin, which is a type of serine protease inhibitor.<sup>[13]</sup> Serpins contribute to the regulation of many chemical reactions by inhibiting the activity of specific proteins. Neuroserpin suppresses the action of a tissue plasminogen activator enzyme, which is associated with cell movement, blood clotting, and inflammation. It has been found that a functional SNP in the promoter of the SERPINI1 gene drastically lowered promoter activity in amnion fibroblast cells, increasing the risk of preterm

premature rupture of membranes (PPROM), the major cause of preterm delivery.<sup>[14]</sup> This correlated with our results showing SERPINI1 downregulated in maternal and fetal cord blood. However, targeting of SERPINI has not been pursued in the literature currently and potential off target effects need to be considered.

### **Metabolism Related Genes**

There were three genes narrowed down to being metabolism related, NET1, EPM2A, and ALPL. The NET1 gene is part of the guanine nucleotide exchange factor family.<sup>[15]</sup> This gene is involved in various cancers such as gastric cancer, breast cancer, and glioma. Normally, this gene interacts with RhoA in the cell nucleus and is involved in DNA repair following damage using as exposure to ionizing radiation. In the Preterm Birth Transcriptomic Database, NET1 was found to be downregulated in both 3rd trimester maternal blood and 3rd trimester cord blood. This can represent a vicious cycle between the strong proinflammatory immune signatures (discussed later) and lack of DNA repair promoting additional immune recruitment leading to potential preterm birth.

The ALPL gene codes for an enzyme known as tissue-nonspecific alkaline phosphatase (TNSALP). This enzyme is essential for the formation of bones and teeth.<sup>[16]</sup> It is also found in a variety of other tissues, most significantly in the liver and kidneys. This enzyme functions as a phosphatase, removing clusters of oxygen and phosphorus atoms from other proteins. As stated earlier, ALPL codes for an enzyme abbreviated as TNSALP. TNSALP is required for mineralization, the process in which minerals such as calcium and phosphorus are formed in developing bones and teeth. Mineralization is essential for the production of strong, stiff bones and teeth that can survive eating and grinding. There is a health condition related to the ALPL gene that occurs mainly before birth and early infancy, this condition is known as Hypophosphatasia. Hypophosphatasia is a disorder that affects the development of bones and teeth. The signs and symptoms of hypophosphatasia can occur at any age, from before birth to adulthood. The most severe types of the condition usually appear before birth or in early infancy. Hypophosphatasia weakens and softens the bones, resulting in skeletal deformities similar to rickets, another childhood bone condition.<sup>[17]</sup> Affected infants have short limbs, an irregularly formed chest, and fragile skull bones at birth. Poor feeding, failure to gain weight, respiratory issues, and excessive levels of calcium in the blood, which can lead to repeated vomiting and kidney problems, are all potential complications throughout infancy. In certain circumstances, these problems are fatal.

The EPM2A gene codes for the development of a protein known as laforin.<sup>[18]</sup> Although this protein is found in all cells of the body, it appears to be essential for the survival of neurons in the brain. Laforin has numerous functions within cells, it interacts with other various proteins, including malin, which is produced from the NHLRC1 gene. These proteins are components of complex networks that transmit chemical signals and degrade unnecessary or defective proteins. Additionally, Laforin may also operate as a tumor suppressor protein, which means it prevents cells from growing and dividing uncontrollably. We saw this earlier with the

H19 gene. Laforin and malin play a critical role in the regulation of glycogen, a complex sugar. Glycogen is the body's primary source of stored energy. This sugar is stored in the liver and muscles and is broken down whenever it's needed for fuel. A condition called Glycogen storage disease type IV can be related to preterm birth.<sup>[19]</sup> It's a disorder caused by buildup of glycogen in the body's cells, signs for this condition often develop before birth and many infants are diagnosed at birth. Infants with this condition have very low muscle tone and muscle wasting, these infants unfortunately do not survive past the newborn period due to a weakened heart and muscles used for breathing.

### **Immune Related Genes**

Six pro-inflammatory gene signatures were found to be upregulated in maternal and fetal cord blood including: CLEC4D, TLR4, TREM1, NLRC4, HIF3A, and WDFY3.

Several myeloid related immune genes were upregulated consistent with prior literature showing the importance of myeloid activation in this condition. CLEC4D is involved in cell adhesion, cell-cell signaling, glycoprotein turnover, and roles in inflammation and immune response.<sup>[20]</sup> TLR4 is a part of the TLR (toll-like receptor) family, which plays an important role in pathogen recognition and innate immune activation.<sup>[21]</sup> They identify pathogen-associated molecular patterns (PAMPs) expressed on infectious pathogens and mediate the generation of cytokines required for successful immunity development. Inflammation is the central mechanism of preterm birth, and TLR4 is an important mediator of pro-inflammatory triggers. In preclinical studies, TLR4 has been identified as an interesting medicinal target to protect against preterm birth and prenatal inflammatory damage.<sup>[22]</sup> TREM1 amplifies TLR induced inflammation by increasing the production of inflammatory cytokines.<sup>[23]</sup> TREM1 forms a compound with the adaptor DAP12 and promotes the release of inflammatory cytokines. TREM1 expression is higher in tumor tissues vs non-tumor tissues, most likely due to myeloid cells invading tumors. Higher levels of TREM1 mRNA in tumor tissues correlate with shorter survival times of patients with colon cancer, breast cancer, and pancreatic cancer highlighting the negative prognostic association with this gene. Finally, NLRC4 plays essential roles in the immune response to a wide variety of pathogenic pathogens, tissue injury, and other cellular stimuli.<sup>[24]</sup> Overall, these 4 genes emphasize the clear pro-inflammatory microenvironment present in maternal and fetal cord blood in preterm birth patients.

HIF3A is a protein encoding gene as well. According to our Preterm Birth Transcription Database, the HIF3A gene is upregulated. This gene encodes the alpha-3 subunit of one of several alpha/beta-subunit heterodimeric transcription factors that influence several adaptive responses to low oxygen tension (hypoxia). The transactivation domain found in factors containing the alpha-1 or alpha-2 subunits is missing from the alpha-3 subunit.<sup>[25]</sup> Factors containing the alpha-3 subunit are considered to be negative regulators of hypoxia-inducible gene expression. This gene has many alternatively spliced transcript variants. The hypoxia-inducible factors family, which includes the HIF3A gene, are believed to play a key role in formation of new blood vessels, metabolism, obesity, immunity, and variation in DNA



methylation. A study found that in children, early BMI predicts later HIF3A methylation in blood. New evidence suggests that gestational diabetes and maternal pre-pregnancy BMI have an effect on cord blood methylation at a second HIF3A promoter site.<sup>[26]</sup>

WDFY3 is an upregulated gene. The WDFY3 gene plays a key role in the growth of brain cells. Since this gene is most closely related to the growth of brain cells, many people with a WDFY3 related syndrome have an intellectual disability, autism spectrum disorder, or a speech delay. This gene is not directly related to preterm birth, however, fetuses, infants, and children can all develop a syndrome related to the gene anytime throughout their childhood. This doesn't depend on their parents and whether they have a syndrome related to this gene or not. Most of the time, parents pass on identical copies of the gene to their children. However, the process of copying genes isn't perfect. An alteration in the genetic code might result in physical, developmental, or both problems. A random alteration might occur in the sperm or egg. This new modification to the genetic code is known as a 'de novo' change. The child could be the first in the family to be affected by the gene mutation.<sup>[27]</sup>

## Discussion

The number of preterm births per year is estimated to be around 15 million. Preterm birth is classified by a baby being born 37 weeks or earlier. After screening maternal and fetal cord blood in the Preterm Birth Transcriptomic Database, 12 genes were found to be associated with preterm birth. NET1, EPM2A, and SERPINI1 were the only genes shown as downregulated. WDFY3, ALPL, H19, CLEC4D, TREM1, NLRC4, HIF3A, TLR4 and THBS1, were upregulated compared to healthy controls. (Figure 4)

Interestingly, 4 of the 12 genes (25%) were related to proinflammatory myeloid pathways (TREM1, TLR4, CLEC4D, and NLRC4). All of these genes were upregulated highlighting the potential role of myeloid-dependent inflammation on preterm births. Several genes have been studied in preterm births before however a deeper exploration of the role of genes needs to be conducted. When considering further vetting of these drugs for potential clinical trials, we must consider the presence of drug inhibitors currently on the market that may be repurposed for the treatment of preterm births circumventing certain FDA guidelines and hastening “time to clinic.”

There are inhibitors found for each gene, these inhibitors prevent or slow down the process of the chemical reaction occurring which reduces the activity in a particular area. LP17 was found as a TREM1 inhibitor and TAK-242 was found to be a TLR4 inhibitor.<sup>[28][29]</sup> There are currently no available drugs targeting CLEC4D and NLRC4. There are commercially available TREM1 and TLR4 inhibitors making these an interesting and feasible drug target for preclinical studies. LP17, a TREM1 inhibitor, has only been studied in preclinical murine models and therefore the patient safety of this drug needs to be tested prior to further investigation. However, TAK-242 has been studied in the context of cancer and according to ClinicTrial.gov, 3 clinical trials have been registered using Resatorvid (TAK-242) with good patient tolerance.<sup>[30]</sup> This fact combined with our screening results reveal that inhibition of TLR4 is a strong potential gene target for prevention of preterm births. TAK-242 should be studied in murine preterm birth

models to validate its role in preterm birth and subsequently, given the positive safety profile of the drug, Phase 1/2 clinical trials should be considered.

Limitations of the study include the retrospective nature of the screening process and lack of validation of these targets in in vitro and in vivo assays. Additionally, changes in gene regulation might be secondary to the preterm birth and in fact assisting with prevention and therefore validation of these targets in preclinical platforms is required. Finally, this data was collected and analyzed through the Preterm Birth Transcriptomic Database and there included any limitations and biases present in the primary data.

In summary of the 12 genes screened, TLR4 is our top gene candidate for preterm birth prevention. TLR4 is a part of the TLR (toll-like receptor) family, which plays an important role in pathogen recognition and innate immune activation. This gene and its inhibitor, TAK-242 would serve as a potential causative gene in preclinical mice models and testing of this drug needs to be conducted in various preclinical platforms with the end target of a Phase 1/2 clinical trial.

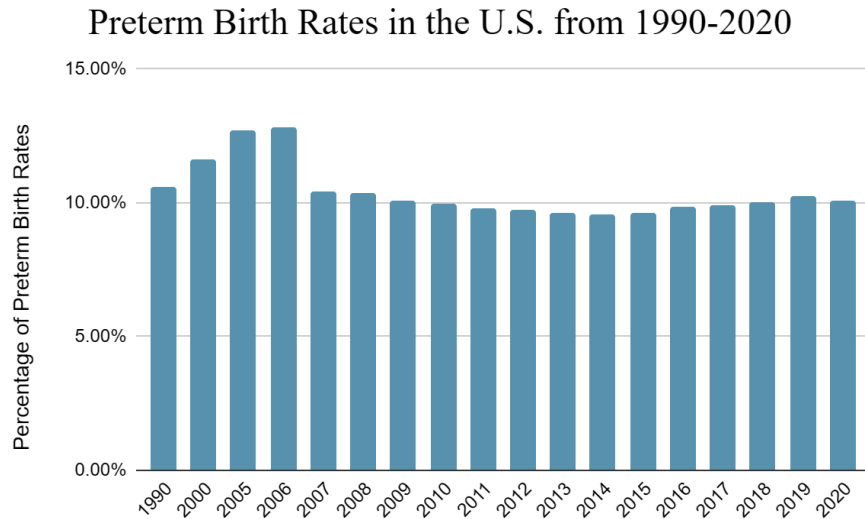


Figure 1 - Timeline of Preterm Birth Rates in the U.S. from 1990-2020

### Preterm Birth Delivery Types

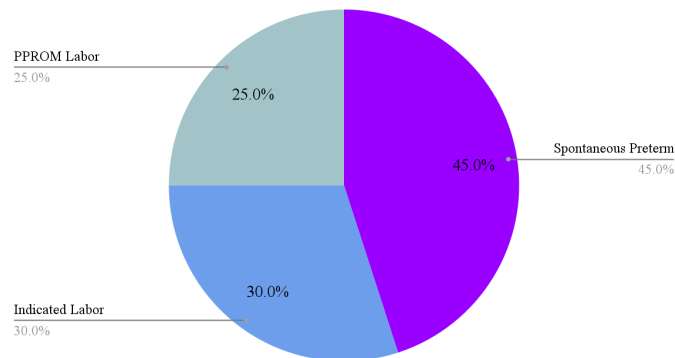


Figure 2 - 3 Different Types of Birth Delivery for Preterm Birth

Downregulated Genes	Upregulated Genes
NET1	WDFY3
SERPIN11	ALPL
EPM2A	H19
	CLEC4D
	TREM1
	NLRC4
	HIF3A
	THBS1

Figure 4 - The list of 12 genes stating whether the gene was Upregulated or Downregulated based on the Preterm Birth Transcriptomic Database

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# Effect of Plant-Derived Enzymes on Gluten Degradation Using ELISA Testing

## By Neil Tivakaran

### Abstract

The current treatment of gluten intolerance is complete avoidance of foods containing gluten. This is an unfavorable option as a gluten-free diet is associated with a potential increased risk of obesity and metabolic syndrome (Ido et al.). Since gluten sensitivity results from the partial breakdown of gluten molecules in the body, enzymes can be utilized to hydrolyze gluten and reduce the severity of the illness. This is especially advantageous as enzymes are naturally occurring in plants, animals, and microorganisms. In this study, four enzymes derived from everyday organic fruits and vegetables were examined to determine their efficacy in degrading gluten proteins. It was hypothesized that the solutions containing the papain enzyme (derived from *Carica papaya*) would break down the highest concentration of gluten proteins when compared to ficin, alpha-amylase, and bromelain (derived from *Ficus carica*, *Glycine max*, and *Ananas comosus*, respectively). Five gluten samples were tested for each enzyme, with gluten samples containing no enzymes serving as control. Gluten proteins from *Triticum aestivum*, *Hordeum vulgare*, and *Secale cereale* were tested for each enzyme in order to evaluate enzyme effectiveness of hydrolyzing gluten from various sources. An enzyme-linked immunosorbent assay (ELISA) was performed to obtain the optical density of the samples, and from these values, the concentration of gluten in parts per million was calculated. The data indicated that the solutions containing papain, ficin, and bromelain obtained mean concentrations significantly lower than those of the control. From the comparison of enzyme effectiveness across all three types of gluten tested, the papain samples obtained a mean concentration significantly lower than the other enzymes. This result supported the hypothesis and suggested that papain could be utilized in the creation of medication that will allow patients with gluten intolerance to digest gluten.

### Introduction

Gluten intolerance is a condition that affects more than one percent of the population worldwide (Rossi). It encompasses celiac disease and non-celiac gluten sensitivity, with symptoms including diarrhea, abdominal pain, and malabsorption. These symptoms are a result of gluten being only partially degraded by the human digestive system, causing some fragments of gluten to damage the lining of the intestine (Ido et al.). Currently, the most effective treatment for gluten intolerance is a gluten-free diet, which can consequently lack needed vitamins and minerals (Dunaevsky et al.). Enzymes, substances naturally derived from plants, animals, and microorganisms, could aid in the digestive process by hydrolyzing the remaining fragments of gluten in the body. Identifying the optimal enzyme for gluten degradation is necessary for patients with gluten intolerance to combat these symptoms and return to a more complete diet.

## Gluten Proteins

Gluten is a storage protein found in wheat, rye, and barley—some of the most common food staples worldwide. Structural proteins in gluten called prolamins are harmful to those with gluten intolerance. The prolamins in each type of grain are unique in structure. Specifically, the prolamins in wheat (*Triticum aestivum*) are referred to as gliadins and glutenins, secalins in rye (*Secale cereale*), and hordeins in barley (*Hordeum vulgare*). Each of these prolamins contains multiple proteins that can affect patients differently. A study published in *Frontiers in Plant Science* subdivided these gluten proteins into high-molecular-weight proteins, medium-molecular-weight proteins, and low-molecular-weight proteins. These classifications were used to compare wheat, rye, and barley gluten samples and determine the relative number of each protein in the grains. (Lexhaller et al.).

## Enzymes

Enzymes are substances that can alter the speed of chemical reactions. Gluten-degrading enzymes, or glutenases, can be found in bacteria, fungi, plants, and insects. Glutenases are a type of endopeptidase, which breaks down peptide bonds. Endopeptidases are stable and active at the acidic conditions of the small intestine, so these enzymes can hypothetically be utilized to break down gluten present in the body (Rossi). Another class of enzymes is cysteine proteases, which have been shown to effectively hydrolyze wheat gluten (Parameswaran et al.). Since many prolamins are resistant to breakdown by natural digestive peptidases in the body, peptidases from other sources that effectively cleave gluten peptides can be used to treat gluten intolerance (Dunaevsky et al.).

## Experimental Background

A study published in the journal *Clinical and Translational Gastroenterology* selected enzymes to digest a peptide found in wheat gluten. The four enzymes chosen were derived from microorganisms and were utilized together to break down the peptide. The experiment was tested on patients with non-celiac gluten sensitivity (NCGS), and the patients were assigned to consume bread containing gluten each day. Half of the patients were given the enzyme mixture, while the other half were administered a placebo. Using a self-reported survey before and after the experiment, the study concluded that the enzyme mixture was successful in improving gluten intolerance (Ido et al.).

A study performed by M. Messer, C. M. Anderson, and L. Hubbard examined the impact of an organic enzyme on gluten hydrolysis. The experiment tested crude papain, a cysteine endoprotease enzyme prepared from the latex of unripe papaya (*Carica papaya*). Papain was administered to patients with celiac disease, and the study concluded that this enzyme improved the symptoms of celiac disease (Messer et al.). Papain is active in a wide range of conditions and is among the most studied cysteine protease enzymes. This is because papain's molecular structure enables it to cleave the backbone of peptide chains. Three amino acids in papain

(Cysteine-25, Histidine-159, and Asparagine-175) are close in proximity and work together in the active site of the enzyme to hydrolyze protein molecules (Mamboya and Amri).

A following study analyzing the applications of bromelain, an enzyme found in pineapple (*Ananas comosus*), was published in the journal *Applied Microbiology and Biotechnology*. Bromelain is obtained through precipitation and centrifugation of pineapple, and it is a protease within the papain family. As a result, bromelain shares a similar structure and protein degradation mechanism to papain. In baking, bromelain was used to hydrolyze gluten in food products to improve dough relaxation. Additionally, it was incorporated into hypoallergenic flour, better suited for patients allergic to wheat (Arshad et al.).

Enzymes found in organic waste material have also demonstrated gluten degradation potential. In a study published by the journal *Waste Management*, alpha-amylase was produced from the husk and flour of soybean (*Glycine max*). Soybean husk and flour were the waste products remaining from the preparation of soybean oil, and they still contained alpha-amylase. Alpha-amylase is a starch-degrading enzyme generated by almost every living organism, and it is responsible for breaking down the bonds in amylose and amylopectin molecules, which are carbohydrates found in grain products. Alpha-amylase is one of the most important amylolytic industrial enzymes and was produced in the study using solid-state fermentation and purification methods. These methods required soybeans to be fermented with fungi in order to produce alpha-amylase from the bean husks (Melnychuk et al.). Alpha-amylase's ability to break down starches could potentially be extended to hydrolyze other substances such as gluten.

A research article composed in the *International Journal of Biological Macromolecules* evaluated the properties of ficin, a protease extracted from the latex of a fig (*Ficus carica*). Ficin contains several proteases, and it has previously been shown to hydrolyze proteins, such as wheat gliadins. Due to varying fig species and environmental conditions, the applications of ficin are rather expansive. Ficin is active at a wide range of temperatures and pHs and can hydrolyze proteins such as hordeins, the prolamin in barley. The article also described how vegetable proteases are more compatible and functional in humans instead of animal or bacterial proteases, which demonstrates the potential applications of plant-derived enzymes. This indicates that ficin could be capable of hydrolyzing gluten and improving celiac symptoms in people with gluten intolerance (Morellon-Sterling et al.).

### **ELISA Methods Background**

A study published by the scientific journal *Foods* utilized a quantitative test to determine the concentration of gluten in various food products. The study compared different enzyme-linked immunosorbent assay (ELISA) methods to evaluate the accuracy of each substance. An ELISA test is an analytical technique that measures the amount of gluten present in a sample. The two types of this test are sandwich methods and competitive polyclonal methods. In a sandwich ELISA test, two antibodies connect to the antigen in order to determine the concentration of antigen in the sample between the antibodies. In contrast, a competitive ELISA test detects fragments of the antigen spread throughout the sample when calculating the



concentration. The study compared ELISA test kits utilizing both methods and concluded that the kits correctly calculated the true concentration of gluten in each of the samples (Yu et al.).

### **Summary**

The gastrointestinal symptoms associated with chronic gluten intolerance can be debilitating, resulting not only in lifestyle changes but also in additional physician visits and reduced workplace productivity (Ido et al.). Gluten intolerance is a global disease with no ideal treatment beyond complete avoidance of gluten, and this management of the illness can be difficult to maintain. It is crucial that enzymes be studied for their potential to hydrolyze traces of gluten in the body, reducing the severity of symptoms. Enzymes can break down peptide bonds in gluten molecules, which may provide a possible solution to the issue faced by many around the world (Parameswaran et al.). These enzymes from natural sources could be manufactured into future medications, allowing patients with gluten sensitivity to properly digest food and limit symptoms of the disease. Prior studies examining papain, bromelain, alpha-amylase, and ficin suggest that these plant-derived enzymes may contribute to hydrolyzing gluten from wheat, rye, and barley.

### **Methods—Enzyme Solution Preparation**

To synthesize the bromelain enzyme solution, cut pineapple was added into a 500mL glass jar. 4 grams organic cane sugar was added to the jar, and the process was repeated until the entire jar was filled with layers of pineapple and sugar. The jar fermented for twenty-five consecutive days to produce bromelain in the jar. Each day, the jar was manually shaken to completely submerge the cut pineapple in liquid. After the twenty-five days, 15mL of the solution containing bromelain were pipetted into each of three clear tubes. Each tube would be used for one of the three types of gluten protein tested.

To produce the alpha-amylase solution, 10g shelled-soybeans were blended with 250mL deionized water for one minute. The mixture was poured into a tube and vortexed to improve the homogeneity of the mixture. Then, 15mL of the mixture, containing alpha-amylase, was poured into each of three tubes. This process was repeated for papaya to obtain the papain enzyme and for figs to obtain the ficin enzyme.

### **Gluten-Enzyme Complex Preparation**

250mg wheat flour (containing the gluten protein gliadin), 2.5mL extraction buffer, and 7.5mL 80% ethanol were added to one tube each of bromelain, alpha-amylase, papain, and ficin. This process was then repeated with 250mg rye flour (containing the gluten protein secalin) and with 250mg barley flour (containing the gluten protein hordein). Thus, twelve combinations of gluten protein and enzyme were created (each of the four enzymes were tested with three types of gluten). Control samples containing no organic enzymes were also prepared with 250mg of either wheat, rye, or barley flour, 15mL deionized water, 2.5mL extraction buffer, and 7.5mL 80% ethanol.



Figure 1: Papain, ficin, alpha-amylase, and bromelain gluten test solutions (from left to right, respectively)

### ELISA Calibration and Testing

After all experimental and control samples were prepared, an ELISA test with the G-12 antibody was performed. Five standards with known concentrations of gluten protein were tested to calibrate the ELISA microplate reader and improve test accuracy. 100 $\mu$ L of Standard 1 was poured into each of two microwells, and the process was repeated for Standards 2, 3, 4, and 5. 100 $\mu$ L gliadin-bromelain solution was pipetted into each of the next five consecutive microwells. The excess solution from all of the wells were discarded, and each well was washed with 50 $\mu$ L deionized water and 50 $\mu$ L wash buffer solution. The remaining deionized water and wash buffer solution was then discarded. This wash procedure was repeated a total of five times before continuing with the test. Next, 100 $\mu$ L enzyme conjugate was pipetted into each well and incubated at room temperature for 20 minutes. 50 $\mu$ L substrate solution was pipetted into each well and incubated in the dark for 20 minutes at room temperature to enhance the solutions' color change. To stop the reaction between the G-12 antibody and the gluten in each sample, 50 $\mu$ L stop solution was pipetted into each well. This procedure was replicated for the other eleven gluten-enzyme combinations and the three control combinations.

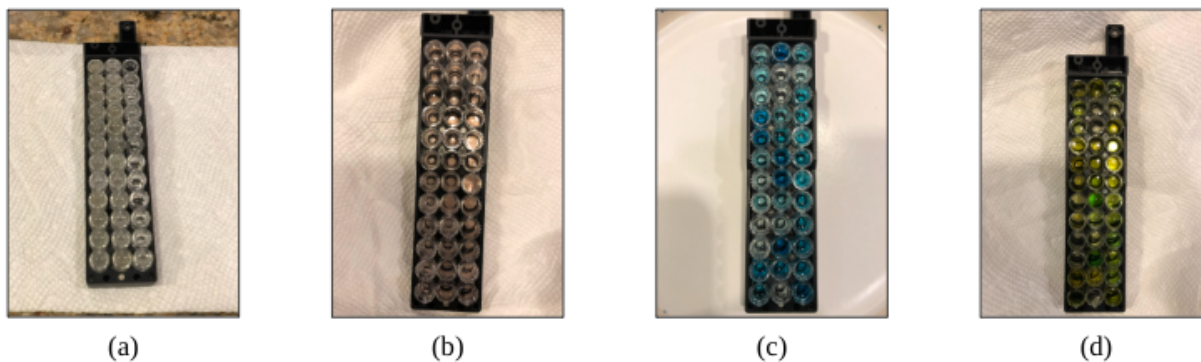


Figure 2: Pipetting Standards 1, 2, 3, 4, 5, and test samples (a), enzyme conjugate solution (b), substrate solution (c), and stop solution (d) into microwells

To obtain the concentration of gluten remaining in each sample, the microwells were inserted into the ELISA microplate reader, which calculated the absorbance (measured in optical

density) for each test sample. The concentration of gluten (in parts per million) was then calculated from the values given by Standards 1, 2, 3, 4, and 5.



Figure 3: ELISA microplate reader with test samples

## Results

The resulting data was compiled into three tables and one graph. Table 1 displayed the range, mean, and standard deviation for each concentration of gluten in the test solutions. The mean values of the papain samples were significantly lower than those of the other test solutions.

Enzyme		Gliadin (ppm)	Secalin (ppm)	Hordein (ppm)
<b>Control</b>	Range	430 - 454	375 - 420	408 - 497
	Mean	447	400	460
	Standard Deviation	9.6	19.3	33.5
<b>Papain</b>	Range	30 - 46	32 - 80	25 - 57
	Mean	40	51	43
	Standard Deviation	6.2	17.9	11.3
<b>Ficin</b>	Range	80 - 173	66 - 83	51 - 81
	Mean	144	77	66
	Standard Deviation	38.2	6.8	13.6
<b>Alpha-Amylase</b>	Range	425 - 451	380 - 451	408 - 478
	Mean	435	415	407
	Standard Deviation	13.3	25.4	34.8
<b>Bromelain</b>	Range	53 - 79	57 - 81	201 - 256
	Mean	69	68	241
	Standard Deviation	12.4	8.8	35.0

Table 1: Range, Mean, and Standard Deviation for Concentrations of Gluten in Test Solutions (ppm)

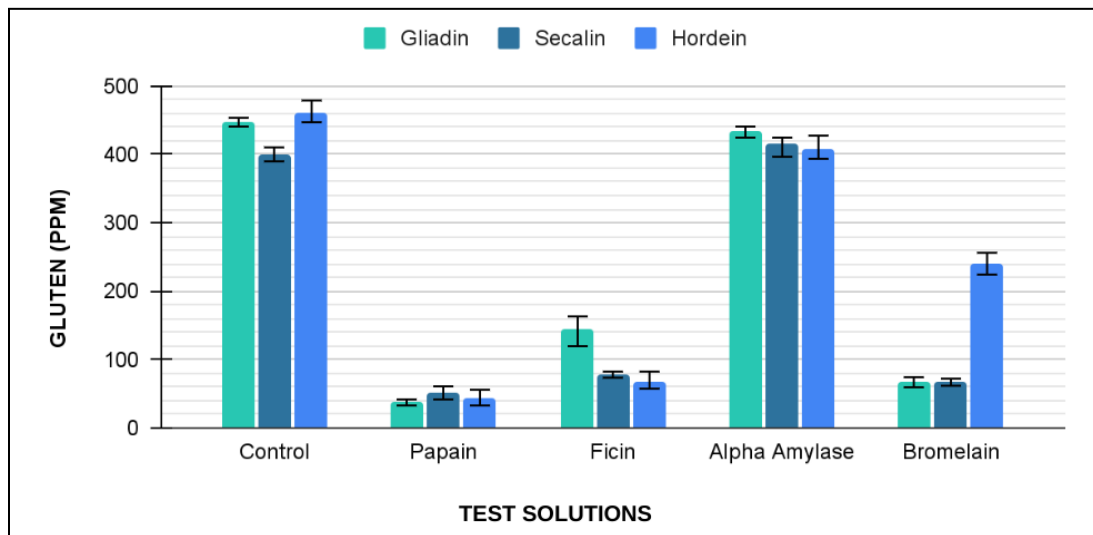
Table 2 displayed the p-values obtained from two-sample t-tests that determined the statistical significance of the decrease in mean concentration between the control and experimental samples. Each concentration value was assumed to be independent, and the

populations were assumed to be approximately normally distributed. The null hypothesis was that the difference between the control and enzyme concentration means was equal to zero, and the alternative hypothesis was that the experimental mean was less than the control mean. With a significance level of  $\alpha = 0.01$ , the p-values for the papain, ficin, and bromelain samples across all gluten types were low enough to reject the null hypothesis and conclude that a significant decrease was observed in comparing the mean concentration of control samples to the enzyme samples. However, the p-values for the alpha-amylase samples across all gluten types were not low enough to reject the null hypothesis, so it cannot be concluded that a significant decrease was observed in comparing the mean concentration of control samples to the alpha-amylase samples.

	<b>Gliadin</b>	<b>Secalin</b>	<b>Hordein</b>
<b>Papain</b>	$1.071 \times 10^{-11}$	$9.896 \times 10^{-10}$	$8.869 \times 10^{-7}$
<b>Ficin</b>	$1.391 \times 10^{-5}$	$1.825 \times 10^{-7}$	$6.132 \times 10^{-7}$
<b>Alpha-Amylase</b>	$7.799 \times 10^{-2}$	$8.246 \times 10^{-1}$	$1.950 \times 10^{-2}$
<b>Bromelain</b>	$2.444 \times 10^{-11}$	$4.495 \times 10^{-8}$	$3.973 \times 10^{-6}$

Table 2: p-Values for Comparison of Enzyme Effectiveness between Control and Enzyme Test Solutions

Graph 1 depicted the mean concentrations in all of the gluten-protein combinations to identify enzyme effectiveness on different types of gluten proteins. Papain, ficin, and bromelain obtained values significantly lower than those of the alpha-amylase and control samples.



Graph 1: Mean Concentration of Gluten Proteins in Test Solutions (ppm)

Table 3 contains the p-values calculated from two-sample t-tests that determined the statistical significance of the difference in mean concentration between the papain, ficin, and bromelain samples. This statistical analysis compares enzyme effectiveness across all three types of gluten proteins tested. Since the alpha-amylase samples were not statistically significant according to Table 2, they were excluded from the investigation. To meet the conditions of the statistical test, each concentration value was assumed to be independent, the populations were assumed to be approximately normally distributed, and the percentages of gluten proteins in the three types of flour used were assumed to be identical. The null hypothesis was that the mean concentration of gluten in the enzyme solutions were equal, and the alternative hypothesis was that the mean concentrations were different. The resulting p-values obtained from these tests were shown in Table 3. The p-value obtained when comparing papain to ficin samples was low enough to reject the null hypothesis and conclude that the mean papain concentration was significantly lower than the mean ficin concentration. The p-value from the comparison of ficin and bromelain samples was not low enough to reject the null hypothesis, so it cannot be concluded that there was a significant difference between these samples. The p-value obtained when comparing bromelain to papain samples was low enough to reject the null hypothesis and conclude that the mean papain concentration was significantly lower than the mean bromelain concentration.

<b>Enzymes</b>	<b>p-Value</b>
<b>Papain and Ficin</b>	$1.456 \times 10^{-4}$
<b>Ficin and Bromelain</b>	$1.207 \times 10^{-1}$
<b>Bromelain and Papain</b>	$1.374 \times 10^{-3}$

Table 3: p-Values for Comparison of Enzyme Effectiveness between Papain, Ficin, and Bromelain Test Solutions

### **Conclusion**

According to Table 1, the gliadin-papain samples obtained the lowest mean concentration of all gliadin solutions, followed by ficin, bromelain, alpha-amylase, and the control, respectively. Additionally, the secalin-papain samples had the lowest mean concentration, followed by bromelain, ficin, control, and alpha-amylase, respectively. Lastly, the mean concentration of hordein-papain solutions was the lowest, followed by ficin, bromelain, alpha-amylase, and control, respectively. The data supported the hypothesis that the papain enzyme solutions would produce the lowest mean concentration of gluten overall.

According to the statistical analysis performed in Table 3, the solutions containing papain were significantly more effective than the ficin, alpha-amylase, and bromelain samples in degrading gluten proteins. Papain, a cysteine protease, is an enzyme that has been previously shown to improve the symptoms of celiac disease and gluten sensitivity (Messer et al.). The three amino acids Cysteine-25, Histidine-159, and Asparagine-175 in papain help to target the backbone of gluten peptide chains, causing proteins to break apart (Mamboya and Amri). This unique molecular structure suggests papain's efficacy in degrading gliadin, secalin, and hordein and may explain the results of the current data.

Both the ficin and bromelain enzymes were able to significantly lower the concentration of gluten in the solutions when compared to the control samples, as shown in Figure 2. Ficin and bromelain are both cysteine proteases with similar molecular structures to papain (Arshad et al.). From Figure 2, the alpha-amylase solutions obtained gluten concentrations that did not significantly differ from those of the control samples and were not effective when degrading gluten proteins. While alpha-amylase is an enzyme known to degrade starch (Melnichuk et al.), it was unable to break down gliadin, secalin, and hordein proteins.

Possible limitations of this study include the number of trials tested for each enzyme. Five samples were tested for each gluten-enzyme combination, but the number of samples could be increased in order to improve the precision of the results. Additionally, the method in which the concentrations of gluten were calculated could be improved. A sandwich ELISA test was conducted in order to obtain the concentration of intact gluten proteins, but utilization of a competitive ELISA analysis may have been more accurate by including the concentration of degraded gluten proteins. Lastly, since the number of proteins in each organic substance tested can vary between plants, further steps could have been taken to account for the differing concentrations of enzymes in each test solution.

## **Recommendations**

Many patients with celiac disease and gluten sensitivity suffer from symptoms including diarrhea, abdominal pain, and malabsorption. From the results of the experiment, the papain enzyme can be utilized to degrade gluten in the body and prevent the onset and severity of the symptoms. Currently, the only effective treatment for gluten intolerance is a gluten-free diet, but medication containing papain or simply the consumption of papaya could potentially be used instead to help alleviate symptoms while still allowing patients to ingest foods with gluten. Further research can be conducted on the design and production of medication with papain as an active ingredient that could be given to patients with gluten intolerance.

An additional area of investigation is to determine the effect of food waste on the breakdown of gluten. The present research examined whether enzymes derived from edible organic substances could be used to degrade gluten proteins; however, further research could be conducted to assess whether peels, skins, and seeds that are often discarded could be repurposed into substances that hydrolyze gluten in the body.

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# **The Relationship of Physical Activity and Executive Functioning Across a Lifespan By Arjun Dhruv**

## **Abstract**

In this research paper we explore the impacts to executive functioning across different age groups based on different physical activities. The paper looks at different tests done for different age groups and highlights the impact on cognitive function, memory and inhibition and concludes that physical activity has a positive effect regardless of the age group. Even moderate amounts of physical activity saw benefits in executive function. Hence the research concludes that physical activity not only benefits physical health but also has a tremendous effect on mental health across all age groups.

## **Introduction**

Physical activity doesn't just have positive impacts on the physical aspect of one's body, but they have also shown to have a positive impact on one's executive functions. Executive functions include processes necessary for the cognitive control of behavior and they have been shown to process better when the body is moving. There are three categories which fall under the executive function umbrella and they are working memory, cognitive flexibility, and inhibition. The first branch of executive function is working memory. Working Memory is one's ability to remember and retain information. However, working memory is only short term and can only retain information temporarily. The second type of executive function is cognitive flexibility. Sometimes known as task switching, cognitive flexibility is the ability to divert one's attention from one task to another, unconsciously. For example, if someone were to participate in one task, and then switch from that one to another one, continuing this, switching at a rapid pace, it would be an example of the utilization of the task switching executive function. The last branch of executive function is inhibition. Inhibition is the ability to control/inhibit automatic or impulsive responses using attention and reasoning, or in other words, the ability to act or not act on an impulse. An example of when one's inhibition levels might be low is when we get distracted by a phone or device while working. This is an example of a lack of inhibition. On the other hand, working hard and diligently without looking up after getting a notification is an example of a strong inhibition or strong ability to reject impulses. It is important to have a balance rather than having an extreme of either behavior.

In order to establish a relationship between cognition and physical activity, it is important to break down the most common physical activity classifications used in academia: chronic or acute and anaerobic or aerobic. Chronic exercise refers to repeated sessions of an aerobic or anaerobic exercise. Acute exercise refers to one session of aerobic or anaerobic exercise. The other part of physical exercise is determining if an exercise is aerobic, requiring oxygen, or anaerobic, without oxygen. The purpose of this paper is to evaluate how aerobic physical activity impacts the executive functioning of people in different stages of life and across different



genders. We hypothesize that aerobic physical activity will positively impact one's executive functioning and cognition, while the person's age will influence this relationship.

## **Children**

Physical activity in small children, or kids under the age of 12 years old, provides consistent executive function benefits. An experiment, by Cooper et al., gave children in this age group a stroop test, a test showing the delay between the stimuli being presented, and reaction time to the stimuli. The subjects completed 10 seconds of running sprints and were given the test 30 minutes before the physical activity, immediately after, and 45 minutes after the activity was completed. Response times on the stroop test were quicker immediately after exercise and 45 minutes after the exercise was complete.<sup>1</sup> Many articles on the positive effects of exercise on the general population are not new, however the positive effects of exercise on children with a varied spectrum of disorders are proving to be really impressive. A study from Liang et al. looked at the effects of exercise on executive functions of children and adolescents with attention deficit/hyperactive disorder(ADHD). In their test they sampled over 300 kids in multiple locations across the globe in clinical settings guided by experienced coaches in that field. Their findings indicated improved overall executive functions of children with ADHD. They even made a recommendation that chronic sessions of exercise interventions with moderate intensity should be incorporated as treatment for children with ADHD to promote executive functions.

Another study, by Hillman et al., looked at how walking on a treadmill affected children's executive functioning. The subjects were given a Flanker test, which tests their choice reaction times. Choice reaction time is when one has to react to a stimulus, but there are other factors involved such as a false stimulus. For example, simple reaction time would refer to the amount of time it takes for a student to press a button after hearing a noise. However, choice reaction time would measure button press timing only when there is the sound of a bell, while consciously ignoring all other noises. The subjects performed this flanker test after walking on a treadmill for 20 minutes. Results displayed a more accurate performance on this test after the single acute bout of treadmill walking. This data indicates that these single acute bouts of physical exercise may maintain stable cognitive health and stable executive functioning abilities over a lifetime.

A narrative review, by Diamond and Lee, also indicated that various activities such as yoga, martial arts and aerobics are more effective at improving executive functioning in 4-12 year olds when compared to cognitive interventions without physical activity.. Children that have poor executive functioning than their peers can particularly benefit from these activities, to close academic gaps later on.<sup>2</sup> In addition, De Greef et al. published a meta-analysis addressing the impact of physical activity on children's executive functioning and attention span to determine effects on academic performance. Of the 17 studies that focused on acute, aerobic, physical exercise, 59% of them found positive findings in at least one of the outcomes. While examining the three branches of executive functioning (inhibition, working memory, cognitive flexibility), the largest difference in functioning after exercise came in the inhibition category.<sup>3</sup> All in all,

meta-analyses suggest that chronic physical activity leads to increased executive functioning in all three subcategories; however, the acute benefits of physical activity on executive functioning tend to be a bit more directed with inhibitory tests revealing the largest cognitive benefits. However, further research is needed to clarify why there is not as many benefits in the other subcategories.

### **Adolescents**

Research suggests that executive functioning is positively impacted by physical activity in adolescents and children. A meta-analysis by Verberg et al. reports that acute physical activity beneficially influences general executive functioning.<sup>4</sup>

Another study done by Cooper et al. featured a stroop test which also focused on subjects inhibitory response to stimuli. 44 adolescents completed high intensity sprints, followed by 50 seconds of a break (walking). The subjects were given the stroop test 30 minutes prior to activity, immediately after the physical activity, and 45 minutes after physical activity. There were two parts to the stroop test, one section featuring simple response time, and the other featuring a complex response time where the subjects would be presented with false stimuli. For the simple reaction time test, the results were the quickest 45 minutes after the exercise, instead of immediately after, or prior to the physical activity. However, the complex reaction time test displayed better results immediately following the physical activity. Along with the reaction time tests, the subjects were also tested on their visual memory and general cognitive speed. Despite the improvement in reaction time, the results for visual memory and general cognitive speed were unaffected.<sup>1</sup>

One of the largest studies was done by Haverkamp et.al where they looked at the data of over 400+ adolescents and they made the participants take 5 tests which included cardio, muscular fitness and speed-agility tests. They assessed not only cognitive functions but also verified academic achievement by conducting two standardized tests assessing mathematics and language. They concluded that skills related to physical fitness are related to cognitive functions and health-related physical fitness is not. Therefore it can be argued that improved levels of skill-related physical fitness may lead to improved cognitive functioning.

Although children under the age of twelve have a more evident benefit of physical activity on cognitive function, adolescents also have displayed positive outcomes of physical activity. Acute physical activity has been shown to benefit adolescents' cognitive flexibility , However, more adolescent research is needed as findings from alternative studies do not provide the consistent responses of similar studies using children. In particular, researchers suggest that more studies addressing the relationship between chronic physical activity and executive functioning be addressed as multiple studies have reported inconclusive findings. Results indicate that adolescents have improved inhibition from physical activity but inconclusive results when it comes to working memory and cognitive flexibility.

## **Middle Aged Adults**

The effect of physical activity on executive function has also been tested in adults. In a study by Kamijo et al., 40 adults were grouped by physical activity participation and asked to complete a mathematical task with either one set of instructions for a pure task condition or two sets of instructions in a mixed task condition. The mixed task condition required more inhibitory cognition due to the complexity of the tasks. The goal of these tasks was to test their cognitive flexibility and inhibition, and determine if there was any relationship between the physical activity and the performance on the tasks. After the test was complete, results indicated that the physically active group performed better on tasks that required a greater amount of executive control (cognitive flexibility and inhibition) when compared to the groups that are less active.<sup>5</sup> These results display a positive relationship between adults' physical activity levels and inhibition and cognitive flexibility test results.

Lin et al., tested the relationship between physical activity and executive function in university students. 162 subjects with a standard switching task. The subjects physical activity levels, as measured with an accelerometer, was classified based on intensity as light moderate or vigorous. The conclusion of the study determined that there are important cognitive benefits to remaining physically active as the results showed cognitive flexibility tests being associated with moderate to vigorous physical activity.

Another study by Sibley and Beilock, examined the relationship between working memory and physical activity. Participants completed working memory testing, an Operation Span test and a Reading Span Test, before and after light physical activity on a treadmill. Participants with lower baseline scores on working memory tests benefited the most from the physical activity. Based on the studies mentioned above, studies indicate that an adult's executive functioning can be magnified following physical activity. This relationship is influenced by the intensity of physical activity and individual executive functioning differences.<sup>6</sup>

## **Seniors/Older Adults**

The correlation between physical activity and executive function has also been tested in older adults, or seniors. As people grow older, their executive functioning ability declines, especially with diseases such as Parkinsons or Alzheimers Disease. A study done by Tanaka et al., examined the effect of moderate physical activity on seniors that have Parkinsons Disease. 20 participants were assigned into two different groups, a control group and a trained group, which participated in a 6 month aerobic physical activity intervention which was with 60 minute sessions, 3 times a week. Following the 6 month intervention, the subjects were given a Wisconsin Card Sorting Test (WCST), which examined their cognitive flexibility. The results of the post-physical activity test indicated that physical activity contributes to the maintenance of executive function as the treatment group's performance on the WCST improved after the 6 month physical activity compared to the control group who remained the same.<sup>7</sup>

Two correlational studies provide further context to support these claims. Boucard et al. (Insert year) examined whether there was a positive correlation between executive functioning

and physical activity in adults. The subjects completed physical activity questionnaires and an acute cardiovascular fitness assessment called the Rockport Fitness Walking Test. Statistical testing was used to determine if fitness levels correlated with cognitive tests of all the branches of executive function, and they only found a positive relationship in inhibition. The results of this study indicated that out of all adults, physical activity in older adults seemed to benefit inhibition the most.<sup>8</sup> Extending these conclusions, Ebinet et al. (year) tested the relationship between resting heart rate as influenced by physical activity and executive functioning in older adults. The study randomly assigned 24 older men and women aged 65-78 years to aerobic physical activity or a stretching program thrice a week for 12 weeks. Their resting heart rate was tested both before and after the 12 week program, and the subjects' executive functioning was determined using the Wisconsin Sorting Card Test, which examines the participants' cognitive flexibility. At the end of the study, the results displayed that only the subjects that were in the aerobic physical activity group performed better on the Wisconsin Sorting Card Test. These results indicate that aerobic physical activity is important in cognition and executive functioning, especially in older adults.

## **Conclusion**

In conclusion, physical activity has a positive effect on executive functioning and cognition. However, the most significant findings were discovered in young children and older adults, as they displayed the strongest correlation between physical activity and executive functioning. Out of the three branches of executive functioning, the two that had the most positive impact from aerobic physical activity were inhibition and cognitive flexibility. These articles suggest that physical activity benefits cognition as well as reducing the risk of diseases in the future.<sup>7</sup> Only moderate amounts of physical activity are needed to see benefits in executive function. American College of Sports Medicine recommends 150 minutes of moderate-intensity aerobic physical activity per week for all adults<sup>9</sup>. Further research is still required to determine specific physical activity parameters that have positive impacts on executive functioning. However, individuals are still greatly encouraged to participate in any type of physical activity due to the clear benefits not just on physical health, but on mental capabilities as well.

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## **Digital Peer Pressure and Normative Education: Psychological Approach to Adolescents' Substance Abuse By Nobel Zhou**

### **Abstract**

The rising incidence of adolescent substance abuse is a worldwide concern. The purpose of this paper is to identify psychological concepts that could cause that substance abuse. A potential solution will also be postulated. Through the exploration of different quantitative, qualitative, descriptive, and analytical research, the correlation between adolescents' substance abuse and digital peer pressure will be demonstrated. This paper demonstrates that adolescents exhibit multiple behavioral and cognitive patterns: internalization, observational learning, and cognitive dissonance respectively. These psychological concepts all have the potential to increase an adolescent's propensity to abuse substances, especially via the use of social media. To reduce the effect of adolescents' erroneous normative beliefs, the implementation of normative education should be considered as a potential solution. The effectiveness of normative education is illustrated through empirical research highlighting that students who received normative education display less likelihood of substance abuse.

### **Digital Peer Pressure Inspires Adolescent Substance Abuse**

A systemic societal problem can be defined as an issue that "concern(s) or ha(s) impact on an entire system." This essay will explore substance abuse as a systemic problem for adolescents. Substance abuse can be defined as the illicit and/or excessive use of chemical substances, which may cause harm to oneself or others. The widespread use of social media has led to digital peer pressure (a form of normative social influence imposed through online information) that can increase substance abuse. A study conducted by Columbia University shows that frequent users of social media are five times more likely than infrequent users to purchase cigarettes, three times more likely to consume alcohol, and two times more likely to use marijuana (National Center on Addiction and Substance Abuse at Columbia University., 2011). This essay will explore how behavior is influenced by internalization, before considering how cognitive dissonance can influence adolescent's thoughts about substance abuse. Finally, the theory of normative education will be used as a framework for solutions.

### **What are the Effects of Substance Abuse on Adolescents?**

Substance abuse negatively impacts adolescents in a number of ways, which is why understanding what leads to abuse is important. The first to take in account is educational attainment. Empirical research shows that adolescents engaging in substance abuse demonstrate worse educational outcomes than their peers who do not engage in substance use (Lynskey & Hall, 2000). This is substantiated by a meta-analysis which considers 46 papers, highlighting the reliability of results (Townsend et al., 2007). Another impact is on adolescent's mental health, with one study showing rates of depression and anxiety higher in those who abuse substances,

although it is difficult to establish the direction of influence in cross-sectional studies (Valentiner

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et al., 2004). Overall, these findings demonstrate that substance use can have serious deleterious effects on adolescents.

### **Behavior - Internalization and Observational Learning**

High school students' imitation of peers' social media posts can result in risky behaviors such as substance abuse. One way this can happen is through internalization, which is when one unconsciously adopts the views of the group they are in, perhaps to enhance their sense of belonging and conformity to their community. The effect of peers' posts on social media is exemplified by a case study evaluating high school graduates' transition to college freshmen and how their peers on social media led to their future substance use. This research showed that "when adolescents' friends are more supportive of drinking and expect more positive outcomes from it, their own beliefs tend to shift in the same direction" (Ragan, 2014).

Another contributor to adolescent substance abuse is observational learning, which is defined as the "acquisition of information, skills, or behavior through watching the performance of others" (APA Dictionary of Psychology, n.d.). This concept can apply to adolescents' conscious desire for conformity in their friend groups. If they see peers engaging in behaviors that are approved in the friend group, they will mimic this. Research indicates that "youth who perceived that the majority of their friends were drunk had two to three times the odds of engaging in heavy episodic drinking" (Song et al., 2012). Song et al.'s research has shown that intimate friend group plays an important role in promoting adolescents' substance abuse. This also applies to social media, since it is a platform to see friends' substance abuse. It could also apply if teens see celebrities or other role models engage in substance abuse.

According to research, "Almost one-third of the Washington adolescents polled had shared marijuana-related content on social media, primarily memes, pictures, and videos"

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(Willoughby et al., 2020). The popularity of posting substance-related content on social media is becoming a trend among adolescents, which is likely to further foster peer engagement in the same activities. CASA research indicates that "75% of 12-to-17-year-olds would aspire to do the same thing if they see their peers' posts about partying with alcohol and marijuana" (National Center on Addiction and Substance Abuse at Columbia University, 2012) and another study shows that from a total of 876 15-year old adolescents, "both males and females, are at greater risk for having used alcohol themselves when they perceive alcohol use is common by friends" (Beckmeyer et al., 2015).

### **Cognitive - Cognitive Dissonance**

Cognitive Dissonance Theory (CDT), refers to "an unpleasant mental state resulting from



inconsistency between two or more elements in a cognitive system, which is presumed to involve a state of heightened arousal and to have characteristics similar to physiological drives” (APA, n.d.). As a result, cognitive dissonance creates a motivational drive to reduce the dissonance. Cognitive dissonance is applicable here, because whilst adolescents may have beliefs that substance abuse is dangerous or unhealthy, they may also have desires to engage in it due to concepts discussed above. In order to reduce this dissonance, they may disregard views that substance abuse is dangerous, for example by reasoning that adults are over-exaggerating the risks of substance use. Media posts impose strong invisible peer pressure for non-substance users, and the discomfort experienced by the adolescents will force them to adapt their group or community values.

### **Neurobiology: Vulnerability to Media Influence**

High school students between the ages of 14 and 18 are especially vulnerable to the influences of social media due to their immature brain development. Since the prefrontal cortex

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High school students are not fully developed, they rely on the amygdala to make decisions. Research indicates the amygdala “plays [a] important role as a neural substrate mediating or modulating behaviors related to initial drug use to addiction” (Psychopharmacol Bull., 2001), which makes high school students prone to addiction to drugs or other substances. This propensity is demonstrated by a one-year experiment predicting alcohol-related social networking sites and future addiction that found, “exposure to friends' alcohol-related SNS content predicted adolescents' initiation of drinking and heavy episodic drinking” (Nesi. Et al., 2017). The immaturity of an adolescent’s brain decisively leads to their vulnerability to peers and media impact.

### **Solutions - Normative Education and Normative Beliefs**

One potential solution to adolescents’ substance abuse is the implementation of normative education, which provides “content and activities to correct a misconception about the high prevalence of substance use” (Griffin and Botvin, 2010). Most adolescents have misconceptions about the actual rate of substance abuse among their peers, which is usually lower than adolescents perceived. This misconception can be exemplified by the FCD Student Attitudes and Behavior Survey data, whereby 82 percent of students either did not drink, or drank once or less per month, but 45 percent of students disagreed that the majority of students in their school drank in moderation (Butler Center for Research, 2015). Therefore, adolescents may falsely perceive substance abuse as a social norm, which they in turn feel pressure to conform to (Butler Center for Research, 2015). Normative education can effectively prevent and reduce adolescents’ substance by means of eliminating adolescents’ normative beliefs. One strong proof of the effectiveness of normative education comes from the European school-based program for

substance use prevention among adolescents called “Unplugged”, which aims to realign

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Normative beliefs surrounding substance abuse. By employing a randomized control design, they demonstrated that the implementation of normative education led to a decrease in adolescents’ substance abuse compared to the control group (Faggiano et al., 2007). In a follow-up study of the effects on the “Unplugged” program, “fifteen months after the end of the program, the increase in the use of tobacco and cannabis and the frequency of drunkenness episodes was lower among the students exposed to the curriculum compared to the control sample” (Taglianti et al., 2014). These results suggest that the enhancement of normative education positively influenced adolescents in terms of reducing their substance abuse. However, validity might be limited, because the control group received no intervention at all. This may mean that the benefits of the intervention were due to non-specific factors, like the presence of any intervention, rather than normative beliefs specifically.

### **Concluding Remarks**

Digital peer pressure encourages adolescent substance abuse. In terms of adolescent behavior, internalization and observational learning account for adolescents’ propensity to imitate their peers based on their substance-related content posted on social media. Adolescent attempts to reduce cognitive dissonance may play a pivotal role in increasing their use of inappropriate substances. This is exacerbated by the neurological (Placeholder1) changes that adolescents are going through, such as alterations in their amygdala. These changes (and the lack of prefrontal cortex development) generate adolescents’ irrationality in decision-making and vulnerability to media influence. The implementation of normative education is a potential solution to reduce adolescents’ misconceptions about the substance abuse. However, even if one can improve students’ cognitive responses and decision-making ability through normative education, adolescents may still be susceptible to irrational behavior and thoughts due to their

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## **How Has Soccer Impacted Social Capital in the 21st Century? By Irene Zheng**

### **Abstract**

This paper examines the impact that soccer has had on social capital in the 21st Century on players, fans, and facilitators of the sport. There is no doubt that during the time period of this paper, soccer has become the most popular sport in the world. Given the global appeal of soccer, this paper is unable to explore all places where soccer is played, but this paper focuses on specific phenomena in countries such as the USA, Australia, Brazil, the United Kingdom, South Africa, and Kenya. The data used throughout this paper has been collected from original interviews, news articles, and published reports regarding non-profit soccer organizations, immigrant soccer leagues, and community-based empowerment organizations. Specifically, this paper looks at the impacts of Street Soccer USA, the Vencer program, and the Society Empowerment Project (SEP) on individuals. The findings of this paper result in the argument that soccer has increased the social capital of players, fans, and facilitators from various cultures and backgrounds. The findings of this paper show that social capital has increased due to the formulation of new social networks among individuals who engage in soccer, especially in areas where there exists demographic diversity which allows for greater exposure to different ideas.

### **Introduction**

Soccer is a seemingly simple sport where the only factors needed are soccer balls, soccer nets, and players. But, in order to participate in the sport, individuals need access to places to play and adequate equipment. Street Soccer USA (SSUSA) is a non-profit organization that uses soccer to provide a support system to homeless individuals. The organization was founded in 2005 by Lawrence Cann in Charlotte, North Carolina, and has 20 teams as of 2013. SSUSA retains only four full-time staff making volunteers integral to SSUSA. Players range from ages 16 to 64 and come from different contexts of backgrounds. Most volunteers had no experience working with the homeless population prior to volunteering with SSUSA. Many were able to develop a sense of community between volunteers and the homeless participants in each city—an example of bridging social capital. SSUSA is just one example of the numerous soccer programs that have allowed players and facilitators to build social capital.

The central research question of this paper is how has soccer impacted social capital in the 21st Century? The answer to this question lies in the central argument of this paper: soccer has increased the social capital of players, facilitators, and fans of the sport in the 21st Century. While this study does not have room to explore everywhere, it will investigate this phenomenon in the USA, Australia, Brazil, the United Kingdom, South Africa, and Kenya. It's important to note that this study analyzes all levels of engagement in soccer from community-based competitions to global contests.

Before the analysis portion of this paper, this author is going to define and contextualize what social capital is. In the book *Social Capital: A Theory of Social Structure and Action* by Nan Lin, Lin establishes the general definition of social capital that is generally consistent

among scholars who have contributed to this discussion. He defines social capital as “*investment in social relations with expected returns in the marketplace*” where the marketplace that Lin is referring to could be economic, political, labor, or a community (Lin 19). For this research paper, the market that I will be primarily discussing is community - specifically the communities that are impacted by soccer. Lin defines the “expected returns” as the social profits that result from social interactions and networks (19). This means that these interactions and networks are the social relations that form the foundation of social capital. So for example, if a market is a community, then the profits that are established in this market are the positive social relations that result from the social networks in this market, thus resulting in an increase in social capital. Lin equates four explanations for how social capital works - *information*, *influence*, *social credentials*, and *reinforcement* which are factors in the development of social capital (19). When Lin discusses *information*, he is talking about the information that is transported through resources in social networks. Growth in information has the ability to beneficially affect the development of social networks and increase one’s social capital. Second, social relations have the ability to exert *influence* on its agents (19). For example, putting in a good word or utilizing one’s connections can carry weight in the decision-making process. Third, social relationships and networks can be seen as testaments of an individual’s *social credentials*, which in itself is a reflection of an individual’s accessibility to resources through social networks and relations. This inherently puts people who have access to resources that allow them to develop their social networks at a significant advantage in comparison to those who have been negatively affected by their circumstances. Finally, social relations have the power to *reinforce* identity and recognition which are essential for maintaining mental health and entitlement to the resources. If we apply these four factors of social capital to soccer, we can analyze how soccer utilizes these elements, thus resulting in an impact on the social capital of an individual.

### **Section 1: Players**

Melbourne has become home to the biggest Somali community in Australia with the vast majority arriving as refugees after 1991 following the outbreak of the civil war and collapse of the government (Abo). For many, a lack of competency in the English language hindered newly arrived migrants from being able to participate in established Australian social networks (Darcy et al. 323). This is why soccer clubs were frequently the first organizations established by migrant communities. For young Somalis specifically, playing with others from the same cultural or language background, or playing with those who have shared life experiences, for instance, with others who have lived in refugee camps, provides them with a sense of comfort and community in a foreign country (Spaaij 40). By being able to speak in their native tongue and engage in a sport familiar to them, soccer provided an avenue for migrants to prosper, develop social relations, and network with compatriots (Darcy et al. 323). Therefore, these soccer establishments were a vessel where all facets of life could be aided. It is important to note that some migrant communities were becoming increasingly marginalized from mainstream Australia since this was a time when migrants were expected to assimilate into mainstream Australian

society. Despite these challenges, soccer clubs allowed for the establishment of new social networks amongst members of the Somali community in Australia, and in turn, led to the creation of new social relations. Many migrant groups were able to develop new social relations and community networks through soccer, thus establishing greater levels of social capital.

In 2018, a group of 50 men from Melbourne's Somali community took a month-long trip back home to Somalia. The soccer players, ages 20-30, took part in tournaments against local teams in Somalia (Abo). Hussein Horaco, the secretary of the Somali Australian Council of Victoria claimed that the purpose of the trip was to give hope to the young people in Somalia and show the young people in Australia the life of hardship their families had left behind (Abo). Organizers wanted to use this trip to encourage greater social cohesion and facilitate a better understanding between these men who lived totally different lives. Many coaches saw the Australian team mature during this trip, specifically with the way that they interacted with individuals (Abo). They were able to use soccer as a vessel to promote conversations between the two teams and formulate a greater understanding of life in Somalia versus life in Australia, thus creating new social networks which is an indicator of an increase in social capital. This trip also helped Australian players develop a different perspective on life back in Melbourne. Many players realized the privileges they had in Australia regarding facilities, education, and resources in comparison to the players from Somalia. After returning home to Melbourne, players started to take on volunteering roles that they never used to with hopes of "bringing good to society" as a result of their trip (Abo). This means that the information that players gained through interactions built on new social networks influenced players to make a positive change in their own communities, which indicates an increase in social capital.

In a similar fashion though in a very different context, the Vencer program—funded by the Inter-American Development Bank and Partners of the Americas—uses sports as a vehicle to provide communities across Brazil with training and skills that lead to employment opportunities through sport. In 2017, the Vencer program focused on São Remo, a community in the western part of São Paulo, home to some of the lowest rankings in the São Paulo areas in terms of income, education, and health (Diniz). The Vencer program donated new spaces for sports practices aimed to allow young people in the community to develop their skills. Facilitators of the program organized sports activities with the intention that young people spend less time on the streets and more on the court. Therefore, through participation in this program, young people were able to develop a deeper sense of companionship in their community. In addition to providing a space for youth to practice soccer, program coordinators for Vencer aimed to use this space as an opportunity to talk about other things, like work and life skills. Volunteers at Vencer attested that the program facilitated negotiations and helped establish relationships, both institutional as well as personal, among participants and facilitators. Thus, the Vencer program provided youth with a place where they were able to build social relations and social capital. In addition to taking part in sports, participants of the Vencer program were supposed to complete at least 180 hours of practical on-the-job experience through internships showing how an essential part of this program was to assist participants in finding a job. Participants in the Vencer program

are primarily from disadvantaged neighborhoods and face substantial barriers to joining the workforce. Approximately 71% of former participants in the Vencer program were able to complete an internship as a result of this program (Spaaij 26). This means that through participating in the Vencer program, youth were able to engage positively in sports and engage in a professional internship. Therefore, young people were able to develop new social networks by engaging in both activities and increasing their social capital.

Washington DC, the capital of the United States, is a bustling metropolitan area where nearly one-in-four people are migrants (Painter and Price 1631). According to the 2017 US Census Bureau, roughly 22.6% of Washington DC's 6 million residents are immigrants (1631). Adult soccer leagues have existed in the DC area dating back to the 1970s, and these leagues eventually became known as the Washington International Soccer League (WISL), which includes multiple divisions played at relatively high levels (1631). Many of the organized teams were established by migrant communities while others were open to a range of players. In the context of soccer, social capital is fostered on the field through the trust integrated within a soccer team. Teammates depend on communication, cooperation, and trust to allow the team to flourish. These inherent norms of soccer elevate the baseline of trust, even between relative strangers or people from different backgrounds. From 2017-2018, approximately 3,000 people participating in soccer leagues in the Washington DC metropolitan area received the option of participating in a survey and 113 people replied to the survey (1636). This survey consisted of three questions to measure the strength of new social connections: *Do you think soccer has helped you make social connections that you would not have otherwise made? Do you ever socialize with players other than at games? Have these soccer connections ever led to a job or job interview?* The results of this survey showed that roughly 91% reported that they made friends through participation in the league (1637). In addition, 80% answered that their friends from soccer were part of their life outside of soccer, and 63% of respondents socialized with fellow players outside of games (1637). These survey results show that the soccer field was a place where social networks were constructed and a place where people were able to develop social relations through newfound friendships, thus increasing players' social capital. Furthermore, this survey showed that a little under 10% of players got jobs or job interviews through participation in soccer leagues, which shows a direct advantage in the job market as a result of playing soccer (1645). Even though this number seems trivial, it is important to recognize that a professional opportunity would have been a byproduct of participation in the sports league rather than the primary reason people choose to play soccer, thus making this a positive externality of soccer and an increase in the individual's social capital.

Subsequently, this author wanted to analyze the impacts that Lucas Radebe's background had on his renowned soccer career. Radebe is a former professional soccer player from South Africa who played for his national team and Leeds United. Statistically, he is one of the most successful South African soccer players and influenced the country's bid to host the 2010 World Cup. In an interview during the 2010 FIFA World Cup, Radebe, whose soccer talents helped him escape poverty and violence in Soweto, discussed the impacts of South Africa hosting the World



Cup. Radebe acknowledged his privilege of being able to use soccer to better his life and emphasized the importance of helping the community where he came from (Phillips). He worked alongside Ajax CT—a program that runs weekly training sessions in local schools and works with disadvantaged youth—to act as a role model for the next generation of South African soccer players. By engaging in this program, participants are able to utilize the opportunity of working with Radebe to create new social relations and benefit from this soccer program. This allows for an increase in social capital amongst young participants alike as well as having a positive impact on Radebe himself.

## **Section 2: Facilitators and fans**

Street Soccer USA (SSUSA) is a volunteer program aimed at creating a communal theme of community amongst participants and volunteers of the program. Across SSUSA's 20 teams, players age from 16-64. The organization collaborates with local social service providers and the majority of facilitators of this program are volunteers (Borland et al. 21). While it is important to note that SSUSA has had a great impact on participants, this section will focus on the impact it had on volunteers. For the start, soccer is an access point for individuals with a common interest to form a common bond. This allows for the formulation of relationships and communities amongst the players and volunteers alike. Many volunteers of SSUSA had little to no experience working with the homeless population. Volunteers associated a new sense of perspective with working with SSUSA because of the personal stories homeless players shared with them, which heightened volunteers' understanding of the homeless community. Many volunteers claimed that volunteering with SSUSA dismantled their prior beliefs regarding homelessness because being able to work with the homeless allowed for a new understanding of their stories (21). Therefore, volunteering with SSUSA fostered the preconditions for the development of social capital by extending their awareness and understanding regarding homelessness, which helped change volunteers' perspectives about the homeless population altogether. Volunteering with SSUSA allowed for the development of a new sense of community between volunteers and the homeless participants in each city. Volunteers attributed the development of these friendships to the fact that they were not engaging with the homeless population like social workers. Instead, by being at practice and on the sidelines, volunteers and players developed a deeper sense of trust between themselves which meant that players were more likely to open up to volunteers (29). One volunteer even built a strong enough relationship with some of the players that he eventually had a couple live with him (29). Many people attribute positive energy to volunteering for SSUSA because of the joy they receive from playing soccer. Because of this shared happiness, volunteers and players developed positive social relationships between themselves which created new social networks, thus increasing both volunteers' and players' social capital. SSUSA and the Homeless World Cup (HWC) scheduled the 18th occurrence of this tournament to be played at Sacramento State University. This event aims to showcase the power of teamwork and community amongst the participating teams. Players and coaches of teams are able to engage positively with other teams and create social networks, thus increasing their social capital.

In a survey given to the Director of Leisure Services in the United Kingdom, sports development officers and leisure centre managers were asked about the potential benefits of community-based sports development (Long and Sanderson 192). Survey responses indicated that sports were likely to enhance community identity and encourage collective togetherness. Sport and leisure officers claimed that they saw many examples of social integration amongst people who attend sports matches. Many even attributed community cohesion through changing attitudes as a result of sharing a love for a sport or facilitating participation (196). As a result, many fans of sports are able to change their attitudes as a result of the development of social networks through attending sports games, thus resulting in an increase in social capital amongst fans of the sport.

Simultaneously, this increase in social capital is also evident from the FIFA World Cup Qatar 2022. Argentinian fans were not the only ones rooting for the winning team in the finale. They were joined by supporters from Morocco, Senegal, Saudi Arabia, Croatia, Mexico, and even rival Brazil (Rogers). The 2022 World Cup largely altered the fan demographics of popular teams seeing that more visitors than usual attended from Arabic countries. The FIFA World Cup has the ability to bring people together in a variety of ways bonded by their love of soccer. After Argentina's win in the 2022 World Cup, Argentinians were joined by soccer fans from a myriad of countries to celebrate and party. The shared support of the Argentina national team resulted in positive social relations and the development of social networks between people from different countries and backgrounds, resulting in an increase in social capital between individuals of different cultures. Soccer introduces a unique environment for fans because players compete both for their national team and professional club team where players can hail from different, sometimes rival, countries. According to the Social Identity Theory, humans tend to categorize people in group memberships because this provides us with a sense of belonging and raises self-esteem (Dawes and Rubenson). This assists in the creation of new social networks amongst fans of soccer who might share the same national identity or have the same favorite club. Regardless, the Social Identity Theory can be applied to soccer fans as they often tend to categorize people into “Us” and “Them” where the first category refers to people who belong to the same social group and the latter refers to everyone else (Dawes and Rubenson). This shared sense of identity amongst certain soccer fans increases an individual's social capital through the social networks existing in these communities. Referring back to Lin's explanation of the factors of social capital, if we focus on the aspects of *information* and *reinforcement* in the 2022 World Cup, this provides an explanation for the increase in social capital of soccer fans (Lin 19). During the 2022 World Cup, soccer fans were able to acquire new information regarding the sport through social media, news outlets, and interacting with soccer fans from other countries which brings a global aspect of the World Cup. In addition, through rooting for a team or nation in the World Cup, fans are able to reinforce a sense of identity that intersects with the Social Identity Theory and creates a sense of shared identity amongst many fans. These factors serve as explanations as to how the 2022 World Cup led to an increase in a fan's social capital.

In a similar fashion, we can apply the Social Identity Theory to soccer and social capital in the context of college sporting teams. College sports as a whole have the ability to increase social engagement on campus and soccer specifically can be used as a tool for a student's involvement on campus. Fans of college soccer are able to feel more connected with peers, faculty, and alumni because of this shared sense of community amongst them. Furthermore, fans of soccer are able to create meaningful memories related to the sport which has the ability to develop one's self-esteem while creating a sense of unity (Fridley et al. 16). In a study conducted by Kibaek Kim, the primary researcher studied the role of community and social capital for 487 international students enrolled at 25 National College Athletic Association (NCAA) Division I institutions in the form of survey responses (34). The surveys were composed of 48 questions aimed to assess participants' attitudes towards sports-related issues. It included questions about an international student's fan identity towards college sports teams, social capital, and a sense of community (28). While this study analyzed college sports as a whole, many findings can be applied specifically to college soccer. The findings of this study indicated that being a fan of one's college sports teams can significantly affect one's social capital. When international students became fans of their college sports teams, they were more likely to see an increase in their social capital in their new environment (39). The increase in social capital was largely due to the fact that when international students became fans of their college sports teams, they were able to benefit from being in the same community and bonding with other community members on campus. In addition, college acts as a vessel for connecting people from various backgrounds which increases the amount of *information* one gains, thus increasing an individual's social capital. When an international student follows their college's sports teams, specifically, soccer, they're able to foster a sense of community within the campus in addition to developing an acculturation in the U.S. This new creation of social networks can be utilized by international students seeing that they're without friends and family in a new country which in turn can lower stress. College sports, specifically soccer, act as a place where international students can become incorporated in a like-minded community which helps them adapt to a new culture. This, in turn, creates new social networks and fosters new mindsets which increases one's social capital.

### **Section 3: Society Empowerment Project (SEP)**

The Society Empowerment Project (SEP) is a community-based organization located in Kenya focused on empowering youth and promoting community development through sports in the rural towns of Oyugis and Homa Bay County. As part of the research process for this paper, this writer conducted an interview with Festus O. Juma, the founder and executive director of the SEP program. They aim to use sports as a means for peace-building, reducing substance abuse, and reducing stigma around reproductive health issues (Juma). SEP works with community leaders to create soccer events between two teams from different regions. These organizations could utilize existing soccer clubs and soccer development organizations. It is vital that participants in SEP have had previous soccer experiences because if they are not interested in soccer, they will not buy into the ideology of SEP. For example, when striving towards

enhancing peace through soccer, SEP will bring together two teams from different communities. Rather than engage in a game straight away, both teams will take the time to convene beforehand and set their own rules. For example, they create their own boundaries, offside rules, and physical boundaries - such as how aggressive everyone is playing. When both teams start to play, they play without a referee, thus requiring trust between both teams that they're playing fairly. After the first few minutes, mediators stop the game and start asking questions such as, *What challenges did you meet? Did we play the game with fair rules?* The dialogue on and off the field allows for individuals to generate their own home-grown solutions, whereas, if teams used their normal soccer ideology, violence might be instigated. Juma has seen positive results from this approach to soccer. He has seen teams become more peaceful and friendly to each other after games and attributes this to the emphasis on dialogue and communication between players (Juma). At the end of the game, players come together and talk about what they learned and how they can translate this off-the-field. In addition, SEP uses soccer to provide people with no proper focus and a shift in direction. Oftentimes, players have had a positive character development through soccer and have built their self-esteem through involvement in SEP. Through engagement in conversations at SEP, many players have transitioned from being a bystander to being a responsible, social, and supportive person. As a result of participating in SEP, players gain confidence in their own soccer ability and become inspired to develop their skills further. Therefore, their focus is redirected towards soccer which reduces their engagement in gang activities. Juma attributes this to the fact that players often spend a large portion of their afternoon playing soccer which reduces their ability to engage in gang activities and violence. The emphasis on playing a fair game of soccer and holding individuals accountable has deterred youth from abusing substances and drinking so that they can stay healthy and produce better results. This positive benefit of soccer is largely attributed to the social networks and social relations built between players from different communities, thus resulting in an increase in social capital.

In the interview that this author conducted with the director of the SEP organization, Juma emphasized how soccer could be used to end the stigma of reproductive health issues and debunk the myths revolving around menstruation. Juma discussed how in many communities around Homa Bay County where SEP primarily operates, the existing myths regarding menstruation have largely hindered the communities' ability to acknowledge new perspectives regarding these issues. Thus, this places emphasis on the role of using soccer as a vessel for engaging in unique discussions seeing that soccer has a respectable reputation in this community. Juma echoed how SEP strives to use the power of soccer to bring down the barriers, discrimination, and stigma around these existing issues and emphasize the narrative that the menstrual process is biological and healthy. Such existing beliefs regarding menstruation were that menstruating girls could not attend school, church, or go to the garden. SEP attempts to implement these conversations through the small-sided five-by-five or seven-by-seven games that occur during these soccer events. Oftentimes, these events occur on weekends and attendees range from young to middle age kids of all genders. These small-sided matches operate when

organizers split attendees into two teams accordingly: one that supports the myths and one that opposes the myths. After a team scores a goal, all members of both teams convene on the field and talk about the issues. Facilitators often assist these conversations with guidance and attempts to help everyone understand why these myths are not true. At the end of the small-sided games, everyone reconvenes in order to debrief and talk about the topic at hand. It's important to note that the purpose of these games is not to promote biased information, rather, it is to emphasize the importance of engaging in new conversations and opinions regarding orthodox topics. Through promoting conversations regarding reproductive health issues and menstruation, SEP has created growth in the information that is transported through social networks. This newfound increase in information beneficially affected the development of social networks, specifically through conversation, which increases social capital.

## **Conclusion**

The central research question of this paper is how has soccer impacted social capital in the twenty-first century? The answer to this question lies in the central argument of this paper: soccer has increased the social capital of players, facilitators, and fans of the sport in the 21st Century. While this study does not have room to explore everywhere, it will investigate this phenomenon in the USA, Australia, Brazil, the United Kingdom, South Africa, and Kenya. The findings of this paper conclude that soccer has had a positive relationship with social capital and largely resulted in an increase of social capital through the formulation of new social relationships and social networks amongst players, facilitators, and fans of the sport alike. A trend in this paper is that it primarily focuses on grassroots and community-based soccer programs which illuminate the importance of local networks and relationships to foster participation in soccer. As community engagement in soccer grows, social capital is likely to increase as well. This author believes that for the duration that community-based soccer programs exist, social capital will continue to flourish for community members engaged with these programs. It's important to note that since social networks are inherently the foundation of social capital, knowledge is constantly being transferred through such connections. The key here is that oftentimes, knowledge is built upon previous experiences. For many of the players, facilitators, and fans of soccer, this is their first time engaging in community-based soccer events. The soccer programs that this paper focuses on are microcosms of a larger society, and this author believes that it will be insightful to analyze the unity of the microcosm and the macrocosm.

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## **The Effects of India's 1991 Balance of Payments Crisis By Alisha Srivastava**

Although today India can be identified as a nation with one of the fastest growing global economies, this was not always the case (Kotwal, et al.). Before India's liberalization of 1991, the economy faced several problems. Issues such as risks of currency collapse, fiscal profligacy, inflated prices, and a decline in net receipts exacerbated into a final balance of payments crisis that threatened a collapse of the Indian economy (Krishnaswamy and Kanagasabapathy). The incompetent economic regulation during this time can be described through the pejorative "license-permit-quota raj", or a "strict government-ruled economy". In an effort to prevent a calamity such as economic collapse, practices of gradualism through economic reforms were enforced with hope of a revival that would help the economy and the people of India. The balance of payments crisis of India in 1991 led to significant economic reform and growth as well as a drastic change in society and culture.

### **What The 1991 Reforms Consisted Of**

The 1990-91 Indian economy was also threatened by a liquidity crisis that was a combined effect of the collapse of the Soviet Union, the Gulf War, and political uncertainty in the country. The crisis contributed to restricted imports, erosion of international confidence in the Indian economy, and an outflow of deposits of non resident Indians with Indian banks (Kumar). India had a high dependence on both oil and gold imports but continued to have a relatively poor competitiveness in exports, which resulted in a widening of the trade deficit, greater fragility of the external sector, dwindling foreign exchange reserves, threats of sovereign downgrades, and a weakened currency (Krishnaswamy and Kanagasabapathy). The liquidity crisis in addition to the balance of payments crisis forced India to consider implementing both stabilization and structural changes to ensure that crippling financial stability was not reached. In June of 1991, India decided to take a historic step of changing tracks by embarking on a comprehensive reform of the economy to widen and deepen its integration with the world economy as a part of structural adjustment (Kumar).

The Indian government made a systemic shift to a more open economy that abolished state monopoly in all sectors, deregulated the financial system while enhancing the supervisory and regulatory systems, signaled a greater reliance upon market forces and the private sector, and introduced policies that favored privatization as well as foreign direct investments (Sharma). The major areas covered by the reform programs were fiscal deficit reductions, industrial and agricultural policies, infrastructure and financial developments, and social sector growth (Ahluwalia). Sectors such as telecommunications, mining, ports, transports, and banking were opened for private investment rather than staying reserved for state control, which led to positive effects on efficiency changes, technological progresses, total factor productivity, and manufacturing.

Fourteen leading private banks were nationalized in 1969 and six more banks were also taken over by the state in 1980 This was accompanied by a strategy of massive expansion of the



banking network especially into rural unbanked locations, and extensive regulation of interest rates (Kotwal, et al.). In addition, bank deposits were substantially preempted by the state in the form of stiff stipulations on investment in government securities and banking licenses were granted to several private players (Kotwal, et al.).

India focused liberalization policies in both the internal and external sectors in an effort to “render Indian manufacturing more productive and competitive in international markets, as well as to facilitate more effective use of factor inputs” (Saravanakumar and Kim). India’s liberalization of trade policy was also a significant change made during reforms, and caused a dramatic shift in India’s government control of the economy. During the restricted pre-1991 trade system, government approval was necessary for the import of nearly all commodities, and imports of manufactured consumer items were prohibited. Under the new liberalization policies, however, the manufacturing sector reforms “rendered the importation of quality raw materials cheaper and more accessible to domestic firms, started productivity growth, and exposed firms to domestic and international competition” (Saravanakumar and Kim). There was also a changed supervision and regulation of India’s central bank, The Reserve Bank of India, in order to “strengthen prudential requirements, raise minimum capital and capital adequacy ratios, and conform to international standards” (Kumar).

### **Result of the 1991 Reforms on the Indian Economy**

The 1991 economic reforms made for a noticeable change in the inherited structure of economic policy due to their “comprehensive and far reaching nature, irreversible character, and intellectual grounding assumptions about economic behavior” (Nayar). The reforms undertaken covered both the internal and external dimensions of the economy, effectively altering the balance between globalization and nationalism (Krishnaswamy and Kanagasabapathy). India’s economic liberalization produced growth because it provided “domestic firms access to capital equipment embodied with new technologies and better intermediate inputs, and expanded their choice set to act” (Saravanakumar and Kim). John Maynard Keynes, the father of Keynesian economics, commented that India’s economic reforms “have given a sharp boost to economic growth by reawakening latent animal spirits” (Sharma).

Changes set in place by the economic reforms include the rupee being sharply devalued by about 20 percent and made fully convertible on the current account, licensing being abolished for imports and tariff levels getting drastically cut, the abolishing of the entire edifice of industrial licensing, the falling of net invisible accounts, and antitrust legislation amending for expansion and diversification of capacity by large firms. (Nayar). Due to specific economic reforms, robust exports of food and capital goods, garments, engineering tools, and refined petroleum also contributed to India's development (Kotwal, et al.). The economic liberalization provided freedom to invest and enter the market, increased the extent of competition and put pressure on the incumbents to upgrade their technologies through imported machinery with the entry of new firms in a more competitive market (Kumar).

In the pre-1991 policy regime, eighteen important industries, including iron and steel,

heavy plant and machinery, telecommunications and telecom equipment, mineral oils, mining of various ores, air transport services, and electricity generation and distribution, were reserved for the public sector (Kotwal, et al.). The reform process had led to increased access to superior technology in the manufacturing sector through higher foreign participation, as well as greater access to importation of higher quality raw materials and capital equipment. It was therefore concluded that there was a “corresponding increase in efficiency to convert technological processes into productivity growths” (Saravanakumar and Kim).

In addition, the sectors that absorbed new technology after the reforms benefited directly, and the “increased incomes of those employed in the organized sectors spilled into demand for those in the unorganized sectors” (Kotwal, et al.). The strength of a “trickle-down” effect from the technology sector depends on the income elasticity of the relatively unorganized sectors of goods and services (Kotwal, et al.). For example, The parts of the unorganized sector in which the income elasticity is relatively high, such as trade, construction, or transportation, would grow fast and continue to grow as demand would grow.

Substantial progress was also made in phasing out remaining quantitative restrictions on agricultural, textile, and industrial processes (Sharma). Efficient firms drove out inefficient firms, factors got reallocated to more productive use, and the overall productivity of factors in the economy increased due to sector transfers (Kotwal, et al.). Productivity in the industry sector also grew rapidly and attracted labor from agriculture due to the relocation of agriculture to more productive sectors.

Investment licensing was used to impose restrictions on the domestic market, requiring both incumbents and potential newcomers to get central government approval before investing. Additionally, "large" industrial organizations were prohibited from expanding without first obtaining approval. To shield them from competition from large-scale units, several industry categories were "reserved" for production by small-scale units (Kotwal, et. al). Price and distribution controls were often applied to industries such as steel, cement, fertilizers, petroleum, and pharmaceuticals (Kotwal, et. al).

Furthermore, the new structural adjustment program adopted by India had been heavily involved with reforming trade policy regimes. Post-1991, the import licensing system had been dismantled, and all non tariff barriers had been phased out from all the tradable consumer goods, bringing the peak of tariff rated down to a maximum of 50% rather than the previous 355% (Kumar). The progressive decline in the average tariff rates were applicable due to the new trade agreements that had stated tariff rates would be lowered on most commodities. Despite this however, India has been continuing to liberalize trade with South Asia at a faster rate than all trade (Kumar). The trade policy of 1991 was targeted at the breaking down of administrative controls and barriers, which had functioned as obstacles to the free flow of exports and imports, The import licensing system was dismantled and the market was opened to foreigners through the lowering of barriers through investment policies (Saravanakumar and Kim). The trade regime as well as the regulation framework were liberalized, and “import liberalization took over large spectrums of foods. Industrial licensing was abolished for all industries, except for a few,

regardless of levels of investment” (Saravanakumar and Kim). Large foreign controlled companies were also abolished and the domestic capital market was restricted with the liberalization of interest rates (Nayar).

India has made an economic shift from the policies in place pre-1991 and is now emerging with sector reforms as a leader in several areas. Due to the economic reforms, India has had opportunities to prosper, and has “built communication satellites and successfully launched them, one of the best computer softwares in the world, and its telecommunication technology has successfully reached the most remote rural areas and it has a strong army too” (Naidu). The government has given a firm monument to the IMF, The International Monetary Fund, to implement economic reforms and invite foreign capital for investments as well as to open areas of the Indian market for foreign multinational corporations. The adoption of economic policies has made an effort to reduce poverty and unemployment in order to build a modern, democratic, socialist, and forward looking India (Naidu). The corporate sector has also continued to have emerging trends following the reforms. There has been a provoking of significant restructuring and consolidation of the corporate sector, and has caused increased emphasis on quality upgradation, non-price rivalry, and product differentiation (Kumar).

The decades of 1980-2000 were especially prosperous in the course of Indian economic development. The growth rate of the gross domestic product, GDP, which had usually stayed about 3.5 percent, had shot up to 5 percent and continued to increase throughout the 1990s until it reached as high as 9 percent (Kotwal, et al.). Although the improvement in the growth performance seems to have been achieved by “following orthodox manufacturing methods or massive inflows of foreign investment”, this is not the case; it is India’s service sector that has led the charge in the growth of the economy (Kotwal, et al.).

### **Result of the 1991 Reforms on Indian People and Society**

The process of globalization is defined as including the “opening up of world interactions, developing of advanced means of communication, growing importance of multinational corporations, and increasing mobility of persons goods, capital, data, and ideas” (Naidu). It deals with economic, political, social, and religious aspects of any country and allows the ultimate goals of the economic development of the country and the wellbeing of its people to be achieved. Globalization and reforms are not only needed for their own sake, but also “for the sake of India’s people and in the interest of having them both contribute to the growth process and benefit from it” (Saravanakumar and Kim).

The economic reforms benefited many aspects of society, including an improvement in the country’s persistent poverty issue. A study on how India's GDP growth has accompanied poverty declines shows that “the proportion of the population below the poverty line declined from about 44.5 percent in 1983-84 to 27.5 percent in 2004-05” (Kotwal, et. al). Another indicates that “poverty levels have fallen from about 40 percent of the population to roughly 28 percent during the second half of the 1990s. This translates into a net reduction in rural poverty of some 60 million people between 1993 and 2000” (Sharma).

In an effort for globalization to also benefit those who are resourceless and those who make livelihood through traditional production activities, emphasis of education had been put in place. It was suggested that India needs to “educate people about the nature and implications of globalization and its different kinds of impact on different sections of Indian populations and the need to formulate popular strategies to influence state policies” (Naidu). In order to complete this however, there was a need to wipe out illiteracy, develop educational facilities and subject young people to training according to new globalization trends.

In addition to poverty and education, the agricultural labor force has experienced positive changes due to the moving of labor to a sector with higher productivity, which has allowed for a major source of overall growth in the economy through savings, investments, and employment. (Kotwal, et. al).

Due to globalization, transformations occurred, such as nation states to networks, traditions to options, export-led to consumer driven, farms to super cities, labor intensive to high tech, and male dominance to emerging women (Naidu). The changes are not only limited to India, but are instead world trends that impact the whole of Asia, especially the people of India (Naidu). Globalization is considered to be a multi-disciplinary character, and its impact is felt upon every walks of life, from individuals to institutions. It has developed virtually across all areas of human activity, goods, capital, people, knowledge, communications, and weapons despite boundaries to become a fundamentally interconnected global order, marked by intense possibilities and processes (Saravanakumar and Kim).

India’s globalization, through using different interpretations, technological innovations, and employment opportunities, converted people into a “global village”, an experience that is not remote or removed from the lives of the people of India (Naidu). In fact, to many, “it represents a brave new world with no barriers” (Naidu). Through the globalization of the Indian economy, there has been more power given to the Indian people, ranging from communication aspects to travel and tourism (Saravanakumar and Kim).

In 1991, India made the momentous decision to change its policies in order to combat threats to its economy and people. It embarked on a comprehensive reform of the economy to “widen and deepen its integration with the world as a part of structural adjustment” (Kumar). The economic gradualism and policy changes of 1991 were a means to achieve the ultimate goal of both increased economic development for the country and an improved well-being of the Indian people, and allowed India to become one of the “the fastest growing developing countries” (Ahluwalia).

India's economic liberalization initiative had finally conquered the problems that had accompanied the country, despite its divided and gradual implementation. Indian society has undergone a significant transformation as a result of the cultural changes brought about by urbanization and globalization. Government-formulated and -implemented economic policies have also been crucial in determining the levels of income, savings, investments, and employment in society (Naidu). As a result of the numerous new sectors where global developments are happening, India's economy and population may now be more fully integrated.

Along with their effects on the economy, globalization's reform initiatives have also had an impact on people's social and cultural lives in a number of aspects of Indian society. Through the momentum of reform and reviving growth despite crises, India sparked an economic and social revolution that continues its influence today. India's 1991 balance of payments crisis resulted in considerable economic development and reform as well as a fundamental transformation of society and culture.

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## **Innovations and Improvements in American Long-Term Care By Maximilian Dabbous**

### **Abstract**

This paper aims to discuss how long-term health care can be improved for elderly patients in the United States. Since 2004, the cost of long-term care (LTC) has risen on average 3.80% annually (Genworth). While cost rises, the reports of care have remained abysmal. From private in-home memory care to public nursing home care, prices and qualities of elderly care fluctuate greatly. The unique medical insurance and taxing system, as well as many stigmas about the elderly, cause America's uphill battle in providing uniform, enjoyable LTC. This scoping review was conducted from January to June of 2023. It assessed possible innovations and improvements for the LTC sector. To progress, standardization of technology and LTC home staff is crucial. Lastly, payment and care models must be adjusted to accommodate elderly patients receiving LTC.

### **Introduction**

In 2013, there were 48 million senior citizens (those above 65) in the United States (Weiner et al.). This made up approximately 15% of the American population, and projections show that this percentage will rise to 22% by 2040 (Weiner et al.). Though 7% seems like a small increase, in reality that adds approximately 35 million more seniors. Roughly 70% of those people will receive long-term care (LTC), with more than half of them relying on medicaid (Weiner et al.). The government supported health insurance, medicaid, forces people to accept lower quality of care and living standards. Alternatively, 19% of senior Americans rely on expensive out-of-pocket payments which can fluctuate greatly based on Emergency Department (ED) transfer rates and hospitalizations costs (Weiner et al.). This causes insecurity, price volatility, and inaccessible care for seniors. Finally, a miniscule 8% rely on private insurance, which still finds ways to evade covering expensive high-end care (Weiner et al.).

Continuing, the broad LTC sector has trouble defining what suitable and high value care looks like. Based on information from various national surveys across LTC homes, high value care involves trust and communication as well as an effort to personalize care. It is essential that care is holistic and that the best outcome for each individual patient is prioritized. (D'Avena et al.). These standards are often unachievable because of the inequity in insurance firms and medicaid that fund LTC (Weiner et al.). Patients bear the burden of this inequity as certain insurances do not cover centers where high value care is guaranteed.

Furthermore, complex health problems that require more care are often unpredictable. Thus, patients do not pay for this care coverage in advance. For others, even if these issues are predictable, these expenses can often be unaffordable (Reaves and Musemecei). Similar to high-end care, low-end long-term care struggles to keep prices affordable (Weiner et al.). However, this is due to unnecessary prescribing, scanning, and transferring to EDs (ABIM Foundation). This leads this paper to the systemic issue in the LTC sector—a lack of accessible,

up-to-date patient data that would allow care-givers to make better decisions for what patients need, further tailoring their care (Dore).

According to Zhang et al., another issue in the sector of long-term care is that decision makers are sometimes underqualified or out-of-tune with patients (289-290). Additionally, due to the stark difference amongst LTC staff, nurses are often forced to act because there is a need for action not because they are well equipped to treat the patients. This helps to explain the variety of care reported from center to center, and is often a cause for different ED transfer rates (Tchoukat et al.).

Ultimately, there are 4 main barriers preventing high value, affordable long-term health care. The first is a lack of proper technology use. Technology has the ability to monitor patients, enabling more efficient use of staff elsewhere. It can also be revolutionary by properly organizing and distributing data. Mainly, technology can ensure that people's money is being spent efficiently to care for their loved ones (Tak et al. 61).

The second barrier to this high-value care is the personnel problem. Closely linked with the technology issue, the improperly staffed centers in which under qualified people are working in task-oriented, non-personalized manners, remain a major LTC issue (Cacchione 236; Vluggen). A lack of standardization in centers also builds inequity throughout.

The third barrier is a misuse of resources. Often due to improper healthcare, over expenditures of resources (overprescribing, etc.) show how money invested in LTC is often lost and with it, high value care (Cacchione 236). However, the fourth and final barrier is the most overarching barrier that likely controls the rest of the variable barriers.

The last barrier to high-value affordable LTC is payment methods. From those who use medicaid to those using private insurance firms, patients tend to pay inconceivable out-of-pocket fees that strain the LTC resident families (Congressional Research Service). This can often be due to the American medical fee-for-service payment model, in which patients are charged for the number of procedures or examinations they receive (Magill 400). Written by the American College of Physicians, a paper discussing the economic waste of fee-for-service, demonstrates how this payment model can lead to an absorbent amount of medical waste (Ginsburg). To explain, when patients are charged per procedure or examination, health centers are incentivized to offer an increased number of services, irrespective of how these impact patient health or well being (Hughes and Meadows, 2020). To progress, these fees must become covered by insurance, or the health care system must decrease these fees in the cases of LTC (Ginsburg).

## **Methods**

This research was performed utilizing a scoping review framework. All articles used to inform the results were drawn from PubMed using the search terms “‘Long-term Care’ AND innovations AND improvements”. Articles were screened via inclusion and exclusion criteria. To be included, articles needed to be published in English between January 2008 and July 2023. Studies that assessed potential solutions for LTC in the US were included. Any article that was a scoping review, systematic review, focused on solving a specific medical issue (ie. End of Life



Care for Seniors with Terminal Brain Cancer), or non-scholarly were excluded from the search. Data in the selected articles had to demonstrate two of the three following qualities: innovation, feasibility of implementation, and cost-effectiveness. Only peer-reviewed evidence of the highest quality was included. A full list of inclusion and exclusion criteria are represented by Table 1.

Inclusion Material	Exclusion Material
Articles with keywords “Long-term care, innovations, and improvements”	Systematic Reviews
Articles covering innovative technologies for LTC	Scoping Reviews
Personnel improvement related articles	Information published after 2008
Cost of Care related articles	Non-scholarly material

Table 1: Complete Inclusion and Exclusion Criteria

**Results–Literature Search and Study Characteristics:**

The initial query was conducted from January 22nd to June 8th 2023 using the search terms “‘Long-Term Care’ AND innovation AND improvements” in PubMed. The search generated 522 articles. All abstracts were screened, and 40-50 articles were determined relevant for full-text review. After applying inclusion and exclusion criteria, 18 articles were determined to be relevant for this analysis (Figure 1). The selected articles suggest innovations for LTC. All articles were read through an economic lens, searching for innovations that acknowledged the economic barriers. The selected studies were further grouped into categories of technology, personnel, or cost-of-care based on the material they contained. The articles were rated on a 1-5 (5 being the best) scale based on their relevance to the research question.

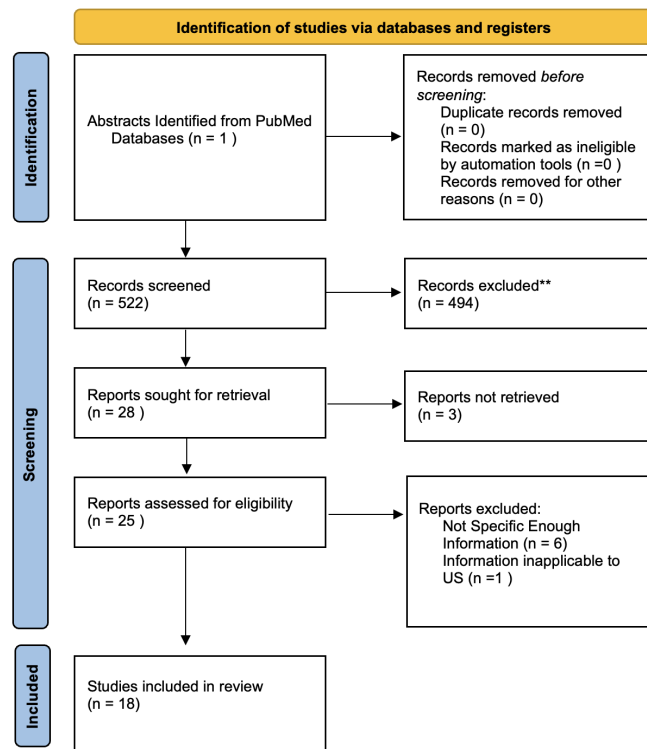


Figure 1: Flowchart of Included Studies

## Technology

Six of the selected 18 articles highlight technological advancements as the most effective way to make positive change in the LTC sector. Prioritizing the effective use of data was a common theme suggested by articles for improving the LTC sector (Dore). For example, keeping chronological, well-updated, and electronic health records (EHRs) of patients improves the possibility for clinical research involving this population. Keeping proper records also helps doctor’s provide patient-centered (Dore). Furthermore, an up to date EHR can ensure evidence-based prescriptions and decrease unnecessary emergency department (ED) visits (Cranley; Dore). All of these are possible because EHRs allow doctors to analyze patients’ histories and decide what is best for each individual.

When EHRs consolidate into a major, secure database, the elderly population—specifically those living in nursing homes—will have a less-likely chance of exclusion from clinical research studies and recruitment into phase 3 and 4 randomized trials (Dore). With stage 3 trials testing if new treatments are preferable, patients have a chance at improved qualities of life. Stage 4 trials look at long-term effects of new drugs. More elderly participants in stage 4 trials could help these drugs become approved for senior patient use. Recently, over 1000 nursing homes have joined the LTC Data Cooperative, a National Aging Institute (NAI) funded group that consolidates and secures the EHRs of the elderly population living in LTC homes (Dore). Many articles stressed the importance of centralizing data; a widespread participation in the LTC Data Cooperative could relieve this stress and improve the future of care.

Another common theme amongst articles was the implementation of physical technologies with hopes of improving care and increasing efficiency (Cranley; Doran et al.; Tak et al. 61). However, the main goal of new technology in LTC is still to improve patients' qualities of life by creating services that enable a person to perform activities of daily life. Rather than taking away the need for human independence, well-made LTC technologies must aim to keep the proper balance between providing aid and preserving autonomy (Tak et al. 62). There is immense potential for technology to benefit patients while receding into their daily living activities (DLA) (Tak et al. 62). Bio sensors demonstrate a compelling innovation with an example of their efficacy in combating pressure ulcers being: "Sensors attached to a mattress to monitor pressure distribution, detect any skin change of a resident and alert staff" (Tak et al. 72). Another complex example was an ADL (AI) helper that can support patients with dementia by providing common daily reminders, taking and reporting vital signs, and retrieving items (Tak et al. 73). A final suggestion for innovative physical technologies was to change the way patients are monitored (Kanyimo). As a result of the COVID-19 epidemic, many LTC homes were forced to remotely monitor patients (Kanyimo). However, it is recommended that this cost-effective innovation could remain common amongst centers (Kanyimo). It's theorized that advanced monitoring systems should begin the emergency protocols as a nurse is called to assess the situation (Kanyimo; Tak et al. 72).

## **Personnel**

Six articles suggested changing personnel in LTC homes was the key to providing proper person-centered care. University of Pennsylvania professor of Geropsychiatric Nursing, Dr. Cacchione shares that the stresses of many mismanaged LTC centers are often borne by the patients. Many articles illustrate this issue by mentioning how unnecessary ED visits and hospitalizations harm the patients of LTC centers more than anything else (Kobewka, 470; Tchoukat et al.). They increase stress of patients and often require prolonged stays and problematic digressions from patients' daily lives (Munene). One way to help decrease these unnecessary visits is by increasing access to same day physician care amongst many LTC centers (Kobewka, 470). A study was conducted involving 161 LTC homes that compared the ED and hospitalization rates of homes that had same-day physician access versus homes that didn't. Of the homes included, only 32 % had same-day physician access (Kobewka, 469). The end results of the study showed that LTC homes with same day physician access had 21% lower hospitalization rates and 14% lower ED rates (Kobewka, 469).

Second, mental illness in elderly patients receiving LTC is an area that necessitates greater attention from staffing. RNs may be expected to handle a mental health care crisis for patients without proper training (Cacchione 236). Essentially, they are being asked to act as geropsychiatric nurses (GPNs)<sup>58</sup> (Cacchione 236). Because RNs are not trained for this and could mismanage care, patients are prescribed antipsychotics, often worsening their condition

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<sup>58</sup> Geropsychiatric nursing can be defined as "the holistic support or the care of older adults and their families as they anticipate and/or experience developmental and cognitive challenges, mental health concerns, and psychiatric/substance misuse disorders across a variety of health and mental health care settings."

(Cacchione 236-237). The FDA warns that prescribing antipsychotics increases risk of death when used to treat behavioral symptoms of distress in elderly adults with dementia (Cacchione 237). In 2012 Louisiana ranked 50th in the US for use of antipsychotics in long term stay residents with an alarming 29.7% of residents being prescribed antipsychotics. (Cacchione 237).

In 2020, eight years after the implementation of GPNs, the percentage of long-term stay residents receiving prescription antipsychotics had dropped to 15.4%, suggesting that evidence-based medicine and nondrug interventions to manage behavioral symptoms of dementia help to decrease unnecessary drug prescription in the LTC sector (Cacchione 238). Another, less traditional approach to dealing with underprepared or overwhelmed nurses is seen in the Netherlands where the SELF program is being implemented. It was coined “SELF” to show the importance of promoting patient autonomy through function-focused care (FFC) (Vluggen). This is a program, directed over seven face to face one to two hour training sessions, in which nurses are educated on behavioral change (Vluggen). They are also taught about preparatory and coping planning, as well as self-efficacy (Vluggen) These are factors that aid in their bringing about behavioral change (Vluggen). The goal is to get nurses to stop working in a task-oriented manner and instead provide patient centered care that promotes independence. Because of their integral role in patients’ lives, nurses are in a position to promote independent behavior and patient functioning in daily activities; however, working in a task-oriented manner, they often do things for the patient unnecessarily (Vluggen). This strips away patients’ independence—and over-time—their functionality (Vluggen). The program is currently being implemented and a process evaluation will occur throughout the experiment to record the project's feasibility (Vluggen).

### **Cost-of-Care**

Six articles implicate the high cost of care as a major obstacle when improving the LTC sector. These articles researched ways to save money and more efficiently fund LTC centers by decreasing or ameliorating transfers. One article recommended a better referral system for ED transfers (Munene). The tool was implemented in 38 LTC centers in Calgary in the Alberta Health System (AHS) (Munene). To test the cost-effectiveness of a referral tool that decreases unnecessary ED transfers, a comparative cost analysis was conducted (Munene). Although the data is still being collected, the analysis of the results will take into account all costs from the hospital to the home.

Another study focuses on decreasing out-of-pocket costs from transfers (Tchoukat et al.). The evaluation was done in Quebec, Canada, and it tested the economic effectiveness of nurse practitioners in different nursing homes over the course of a year (Tchoukat et al.). It calculated how they could decrease spending by helping decrease unnecessary short-term transfers, falls, and pressure ulcers. Given that nurse practitioners can prescribe treatments—unlike registered nurses (RN)—they are more capable of preventing falls, pressure ulcers, and short-term transfers. Thus, they can cut out-of-pocket costs. The end results showed that although the number of falls,

transfers, and pressure ulcers decreased, there remained varying excess costs for all 3 causes of out-of-pocket expenses (Tchoukat et al.).

Rather than focusing on the specifics of one cost, an article written by the Veterans Health Administration considered six possible holistic community care settings (McConnell et al.). The article examines which one was the most cost-effective. Findings showed that the most cost-effective was the medical foster home (MFH) (McConnell et al.). In these homes, monthly savings on out-of-pocket costs ranged from \$145 to \$3314 (McConnell et al.). Since residential nursing fees are eliminated at a MFH, when all out-of-pocket payment is considered, the care is at least cost neutral (McConnell et al.). With lower ED transfer and hospitalization rates, MFH individuals pay \$2645 less per month (McConnell et al.). Additionally, an MFH has fewer ambulatory costs (McConnell et al.). Overall, MFH's ability to slash out-of-pocket costs proves their value to the LTC sector.

## **Discussion**

The results section revealed ways in which affordable high-value care can become accessible in American long term care settings. Technology was able to solve many issues of the LTC sector. Primarily, technology offered a platform where patient EHRs could be updated, concentrated, and made available for physicians (Dore). Secondly, technologies may be wielded for patient monitoring (Kanyimo). These technology solutions mitigate paper work concerns and free time to connect patients with a more involved, creative staff (Tak et al. 1-3).

Furthermore, issues with personnel could be improved by teaching nurses to inspire patient functioning and individuality (Vluggen). Additionally, employing different types of nurses to deal with wide arrays of complex issues in LTC homes allows for better care and less waste of resources (Cacchione 233, 236). This, along with same-day physician access, will help decrease the amount of unnecessary ED transfers and hospitalizations—lowering out-of-pocket expenses (Kobewka, 2019).

Wasted investments remain the main economic issue. The personnel solutions should help to decrease wasted resources and over-prescription, while the technology solutions help ensure the dollars spent are being used efficiently. With a focus on the LTC centers and not on the payment plans, the main economic solution would be to live in centers with the lowest-out-of-pocket costs (McConnell et al.). The Veterans Association laid out the groundwork for a Medical Foster Home which has decreased transfer rates, accessible physicians, and thus, the lowest out-of-pocket costs of the six presented homes (McConnell et al.).

The Commonwealth Fund claims that in 2020, the U.S. spent a collective estimated 361.6 billion dollars on LTC (Horstman et al.). While the US leads the developed world in LTC spending, National Broadcast News highlights how the United States does not see substantial benefit from these investments (Stahl). In fact, a study conducted by the Commonwealth Fund comparing the condition of LTC patients in 11 countries (Australia, Canada, France, Germany, the Netherlands, New Zealand, Norway, Sweden, Switzerland, the United Kingdom) suggested that US patients have some of the worst outcomes (Osborn et al.). It was revealed that US

patients disproportionately faced economic difficulties in covering care, had the second highest rate of out of pocket payments, and nearly one third report “skipping care” to cut costs (Osborn et al.).

A study published from the Massachusetts Institution of Technology Economics Department proposed that the cause for these issues stems from high out-pocket-costs and the inability of medicare to be restructured to meet the cost demands (Brown and Finkelstein 119-120). Thus, the system of LTC in America needs to be restructured and find areas where expenses can be decreased. Fortunately, this research highlights potential economic solutions to improving LTC in the United States. One of the largest challenges to improving LTC centers in the US is the relationship between the health care providers and the insurer. A policy brief from the University of Pittsburgh claims medicare will be able to better sustain care in a fully managed care model rather than a fee-for-service model which can increase costs and disincentivize proper care (University of Pittsburgh Institute of Politics 14). Ultimately, it’s important to show that the new implementations are actually frugal. Though it may cost more to maintain technology, it can prevent many issues that result in short-term transfers (Tak et al. 66). Cost effective results from this research paper, including forming a regimented protocol for short-term transfers, training nurses to promote self sufficient behavior and not work in a task-oriented manner offer ways to resolve issues found in the aforementioned relationship.

A more in depth explanation is offered here: with the economic definition of value being quality over cost. An example of high value care is when quality increases while simultaneously cost decreases. For example, employing geropsychiatric nurses who are equipped to deal with a wide-array of complex issues that they could encounter in a nursing home. They could replace the more expensive nurse practitioners and increase the quality of the care patients receive.

More work on value-centered initiatives must be done to better understand the most effective and efficient ways to improve the LTC health landscape in the United States. Future projects should test different combinations of technology and personnel innovations in controlled environments to elucidate an effective blend of interventions. Health economists and physicians may consider employing miniature randomized controlled trials with different interventions to test hypotheses on increasing value. With promising results, these initiatives should then be brought to scale.

Moreover, success for future work should be monitored in two dimensions: improving quality or decreasing costs. As quality and cost are fundamental to the value equation in healthcare, the most effective solutions would be ones that simultaneously increase quality while reducing cost. The LTC health landscape may also benefit from rigorous economic study, where experts can model different trends in health decisions to see how residents of LTC facilities can take greater ownership over their health and quality of life.

### **Assumptions and Limitations**

There were many strengths to this review. All considered bodies of work were scholarly articles written after 2008. This ensured that the selected articles would present information

relevant to the current system. 522 articles were screened. They were then strategically grouped based on their relevance and information on the topics: technology, personnel, and cost-of-care. These correlate with issues that the U.S. Department of Health and Human Services claim to be essential to solving the many issues of the LTC sector. Lastly, this article was strengthened by including research from international health systems rather than limiting the scope exclusively to the United States.

This review also faced limitations. Firstly, this was a scoping review rather than a systematic review. Additionally, this was a single author review which may make it more vulnerable to implicit biases or human error. This review also only considered sources from PubMed. This along with some articles being blocked further limited the reach of the project. Finally, as a large number of LTC centers are private facilities, their data may not be publicly available for research.

## **Conclusion**

The United States has an increasing population of seniors needing affordable long-term care. This scoping review suggests that technological advancements, personnel changes, a focus on high value-care, and better payment methods will offer the best route to alleviate the LTC crises in America. A focus on standardizing LTC centers with improved technology, physician access, and personnel may be required. Moreover, to make improvements in America's fee-for-service environment, future innovations should focus on high value care. Through targeted solutions, LTC in the United States can achieve greater efficiency, quality, and improved patient outcomes.

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## The HER Family as Therapeutic Targets in Cancer By Max S. Wang

### Abstract

The human epidermal growth factor receptor (HER) family is a group of transmembrane receptor tyrosine kinases (RTKs) responsible for cell proliferation and development. Mutations and overexpression within the HER family gene loci have strong connections with certain cancers and thus HER family has become a paradigm for cancer research and targeted cancer therapies. This paper aims to give an overview of the structures, signaling mechanisms, and abnormalities within the HER family as well as discuss HER-related cancer drugs and drug resistance challenges.

### Introduction

According to GLOBOCAN statistics [1], the most diagnosed cancers worldwide are lung cancer (11.6%), breast cancer (11.6%), prostate cancer (7.1%), and colorectal cancer (6.1%) with leading causes of death by percentage of total deaths being lung cancer (18.4%), colorectal cancer (9.2%), stomach cancer (8.2%), and liver cancer (8.2%). Among lung cancer cases, non-small cell lung cancer (NSCLC) accounts for 80–85% whereas small cell lung cancer (SCLC) accounts for 15–20% [2].

From a histopathological perspective, the majority of common cancers are forms of carcinoma. Carcinoma is a type of cancer that forms within human epithelial tissues (the tissue that lines organs, internal passageways, and the skin) [3]. Carcinoma accounts for 80% to 90% of all cancer diagnoses and appears as malignant neoplasms growing from healthy tissues [3].

The human epidermal growth factor receptor (HER) family proteins and their ligands play key roles in epithelial cell development and are strongly implicated in carcinoma [4-5]. The HER family consists of four closely related transmembrane receptor tyrosine kinases (RTKs): EGFR/ErbB1, HER2/ErbB2, HER3/ErbB3, and HER4/ErbB4, which regulate cellular functions integral to cell proliferation, survival, differentiation, and migration in response to extracellular ligands [6]. The general structure for HER family receptors consists of a unique extracellular domain, a single-span transmembrane helix domain, and a unique intracellular catalytic kinase domain connected to a carboxy-terminal tail (Fig. 1). The ligands of the HER family include 11 peptide growth factors [7]: the epidermal growth factor (EGF), transforming growth factor  $\alpha$  (TGF $\alpha$ ), amphiregulin (AREG), betacellulin (BTC), epigen (EPGN), epiregulin (EREG), heparin-binding EGF-like growth factor (HBEGF), neuregulin 1 (NRG1), neuregulin 2 (NRG2), neuregulin 3 (NRG3) and neuregulin 4 (NRG4). EGF was the second-ever growth factor discovered, following the nerve growth factor (NGF) [8]. The discovery of EGF and NGF earned Stanley Cohen and Rita Levi-Montalcini the 1986 Nobel Prize for Physiology or Medicine.

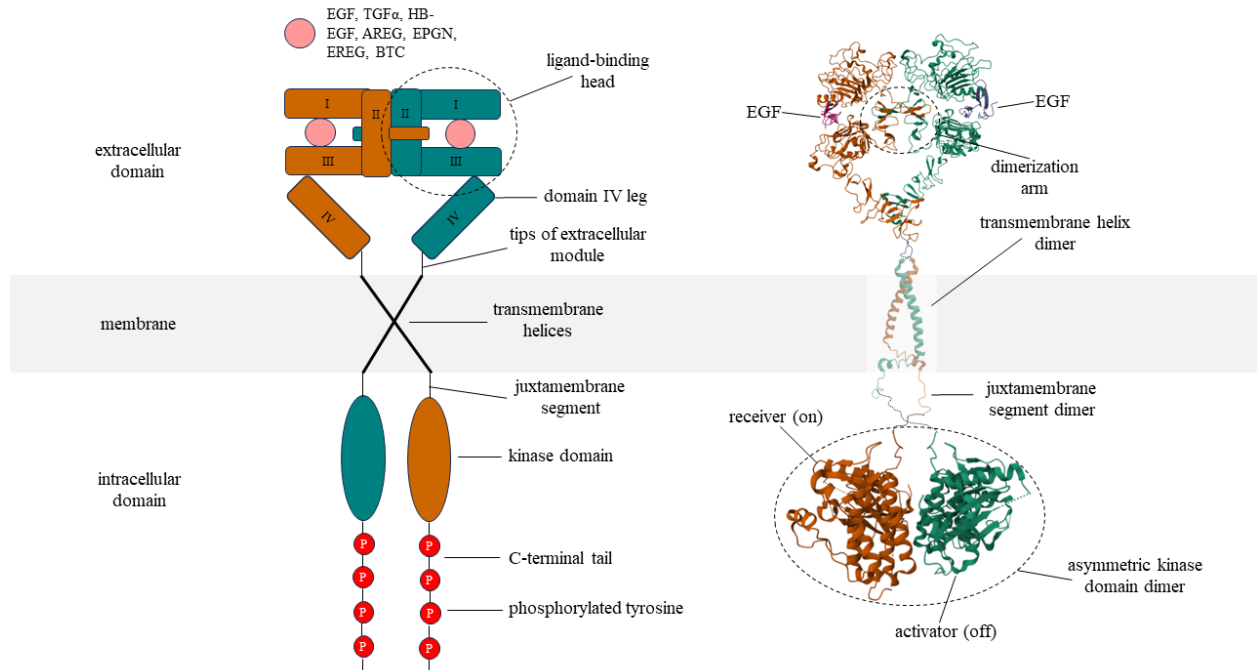


Figure 1. A structural collage of a ligand-bound EGFR dimer. Left, a schematic diagram of ligand-bound dimeric EGFR. Right, crystal structures of EGFR fragments: a dimeric extracellular module bound to EGF (PDB code: 3NJP, [9]), a transmembrane helix dimer (PDB code: 2M20, [10]), and a dimer of kinase domain (PDB code: 3VJO, [11]). The molecular models were downloaded from RCSB PDB [12-13].

HER family molecules are capable of forming dimers with each other, causing transphosphorylation at their intracellular regions. This specific reaction generates the initial signal for the activation of the numerous downstream signaling pathways (Fig. 2). A key mediator of inter-receptor interaction is the dimerization arm in the extracellular domain (Fig. 1, right). All HER proteins with active dimerization arms are capable of forming homodimers with themselves or heterodimers with other receptors. For EGFR, HER3, and HER4, in the absence of a ligand, this dimerization domain is engaged in an intramolecular interaction and is not available for inter-receptor interactions with other HER family molecules. Upon ligand binding, the dimerization arm becomes exposed after a dramatic conformational change which makes dimerization possible [14-15]. Comparatively, HER2 has no ligand and has its dimerization arm constitutively exposed for dimerization [14]. HER3 possesses impaired kinase activity (Fig. 2) and preferably heterodimerizes with HER2 [16].

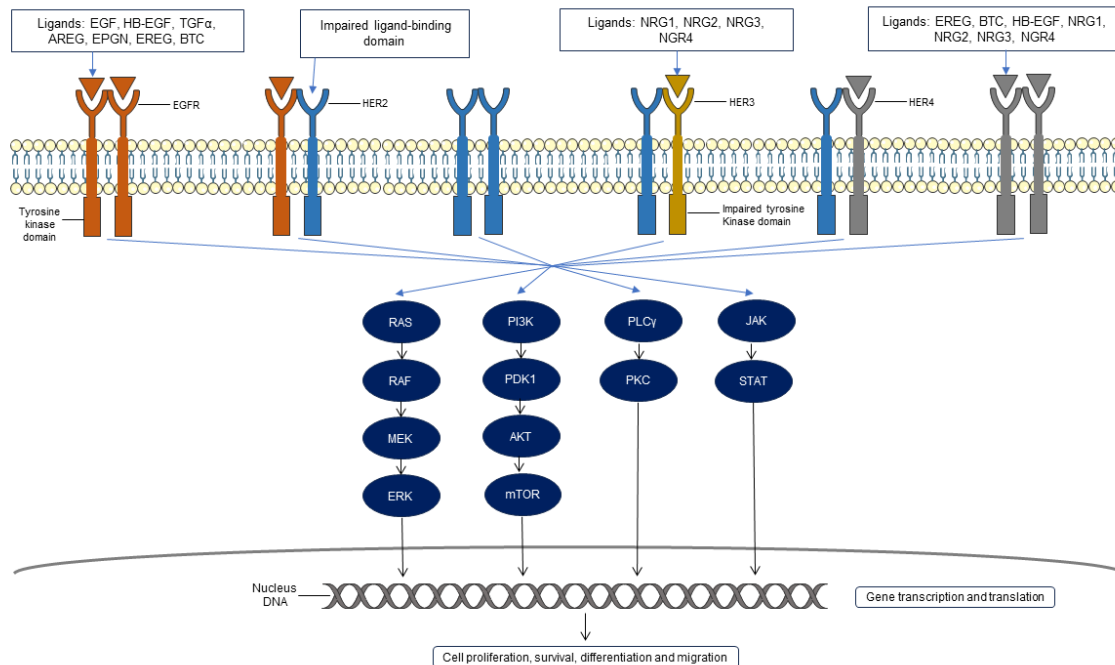


Figure 2. Signaling pathways initiated by HER family members. EGFR, HER2, HER3, and HER4 are denoted in red, blue, yellow, and gray respectively. Note that HER2 does not have a ligand. HER3 has an impaired tyrosine kinase domain and provides little kinase activity. Downstream signaling pathways activated by HER family members overlap and influence each other. Shown in the diagram are RAS/RAF/MEK/ERK, phosphatidylinositol-3 kinase (PI3K)/3-phosphoinositide-dependent protein kinase 1 (PDK1)/AKT (protein kinase B)/mammalian target of rapamycin (mTOR), phospholipase C $\gamma$  (PLC $\gamma$ )/protein kinase C (PKC), and Janus kinase (JAK)/signal transducer and activator of transcription (STAT) pathways, which are important for cell proliferation, survival, differentiation, and migration.

Activation of HER family proteins causes the activation of the signaling pathways RAS/RAF/MER/ERK, PI3K/PDK1/AKT/mTOR, PLC $\gamma$ /PKC, and JAK/STAT [17]. The signaling potency and the selectivity of these pathways are proscribed by the specific dimer pair. A hierarchical relationship governs the signaling potency of HER dimers with heterodimers being more active than homodimers, HER2-containing heterodimers being particularly active, and the HER2-HER3 heterodimer being the most active [18].

### HER Family in Cancer

Mutations and amplifications within the HER family gene loci are commonly observed in human cancers causing gene overexpression and overactive downstream signaling activities. In cancers, these aberrant gene alterations ultimately lead to tumorigenesis, tumor growth, and tumor progression in affected tissues. Below, Table 1 shows a list of alterations related to the HER family, their frequencies, and respective cancers [6, 19-21].

**Table 1. Alterations of genes encoding the HER family in human cancers**

Gene	Alteration	Type of cancer	Frequency
EGFR	kinase domain mutation	NSCLC	10% in US/Europe, 30–50% in East Asia
	gene amplification	breast, head and neck, oesophageal and colorectal cancer, NSCLC	16%, 9%, 7% in colorectal cancer, NSCLC and breast cancer
	Extracellular domain deletion & gene amplification	glioblastoma	40–50%
HER2	kinase domain mutation	NSCLC, breast, gastric, bladder and endometrial cancer	4% in NSCLC
	gene amplification	Breast, gastric and oesophageal cancer	25–30% in breast cancer
HER3	kinase domain mutation	Breast and gastric cancer	10%, 5%, 2% in bladder, colorectal and breast cancer
HER4	kinase domain mutation	NSCLC, melanoma and medulloblastoma	1–2% in East Asia

Some specific HER family gene amplifications are correlated with particular cancers. Notably, HER2 gene amplification is found in 25–30% of breast cancers and EGFR gene amplification is found in 16% of colorectal cancers, 9% of NSCLCs, and 7% of breast cancers.

Focusing on EGFR, mutations in its kinase domain (both point mutations and deletions) are particularly present in 10% of NSCLCs in U.S./Europe and in 30–50% of NSCLCs in East Asia. The exact mutations are generally clustered within exons 18-21 on chromosome 7 (7p11.2) [22], encoding the kinase domain of EGFR. These mutations produce a spectrum of biochemical effects from increased kinase activity to ligand-independent constitutive activity. Destabilization of the autoinhibited conformation of the EGFR intracellular domain has been proposed to explain the constitutive activation of these EGFR mutants [23]. The EGFR mutations in NSCLCs can be classified into distinct subgroups based on their locations on the protein structure, i.e. classical-like mutations, T790M-related mutations, exon 20 loop insertions, and P-loop  $\alpha$ C-helix compressions (PACC) [24]. The classic-like mutations include the common exon 19 deletion and exon 21 L858R point mutation, which account for 32.7% and 23.0% respectively of the mutations. The T790M-related mutations and exon 20 loop insertions account for 13.6% and 9.1% of the mutations respectively. Here, L858R and T790M mutations refer to the amino acid substitution from leucine (L) to arginine (R) at position 858 of exon 21 and the substitution from threonine (T) to methionine (M) at position 790 of exon 20. The remaining 21.6% mutations are related to PACC mutations which alter the orientation of the P-loop or  $\alpha$ C-helix. EGFR amplification and overexpression as a whole is also present in nearly half of glioblastoma cases.

In glioblastoma, amplification is frequently associated with deletion mutations involving the extracellular domain of EGFR, of which one variant, called EGFRvIII, is the most common [25].

Mutations in HER2, HER3, and HER4 are less common than EGFR with the exception of HER3 which is mutated in 10% of bladder cancers [20]. The oncogenic functions of HER3 are largely mediated via its interaction with EGFR or HER2 due to its limited kinase activity. However, upon dimerizing with HER2, the HER2-HER3 heterodimer becomes the most active signaling dimer within the HER family.

As for HER4, its role in tumor development is inconsistent as it appears to function as a tumor suppressor protein and as an oncoprotein, but it has been hypothesized that HER4 homodimers function as tumor suppressors, whereas HER4 heterodimers possess oncogenic activity [26].

### **HER Family Targeted Cancer Drugs and drug resistance**

The HER family proteins, specifically EGFR, are major targets for modern cancer-targeted therapies with a variety of drugs in the current market approved by the U.S. Food and Drug Administration (FDA) coupled with promising clinical results [27-30]. These drugs can be classified as either small-molecule tyrosine kinase inhibitors (TKIs), monoclonal antibodies (mAbs), bispecific antibodies (BsAbs), or antibody-drug conjugates (ADCs). Table 2 has a list of drugs approved by the FDA.

**Table 2. List of the FDA approved therapeutic agents related to the HER family**

Drug name	Brand name	Company	Type	First FDA Approval	Target	Use
Gefitinib	Iressa	AstraZeneca	Small molecule	2003	EGFR	NSCLC with EGFR 19del or L858R
Erlotinib	Tarceva	OSI Pharmaceuticals	Small molecule	2004	EGFR	NSCLC with EGFR 19del or L858R, pancreatic cancer
Lapatinib	Tykerb	GlaxoSmithKline	Small molecule	2007	EGFR, HER2	HER2-positive breast cancer
Afatinib	Gilotrif	Boehringer Ingelheim	Small molecule	2013	EGFR, HER2, HER4	NSCLC with EGFR 19del or L858R, squamous NSCLC
Osimertinib	Tagrisso	AstraZeneca	Small molecule	2015	EGFR	NSCLC with EGFR 19del or L858R or T790M
Neratinib	Nerlynx	Puma Biotechnology	Small molecule	2017	EGFR, HER2, HER4	HER2-positive breast cancer
Dacomitinib	Vizimpro	Pfizer	Small molecule	2018	EGFR, HER2, HER4	NSCLC with EGFR 19del or L858R
Tucatinib	Tukysa	Seattle Genetics	Small molecule	2020	HER2	HER2-positive breast cancer and colorectal cancer
Mobocertinib	Exkivity	Takeda Pharmaceuticals	Small molecule	2021	EGFR	NSCLC with EGFR 20 exon insertion
Vandetanib	Caprelsa	Sanofi	Small molecule	2011	EGFR, VEGFR <sup>1</sup> , RET <sup>2</sup> , BRK <sup>3</sup> , TIE2 <sup>4</sup> , EPH <sup>5</sup> , SFK <sup>6</sup>	Symptomatic or progressive medullary thyroid cancer
Trastuzumab	Herceptin	Genentech	Monoclonal antibody	1998	HER2	HER2-positive breast cancer
Cetuximab	Erbix	Eli Lilly	Monoclonal antibody	2004	EGFR	Metastatic colorectal cancer and head and neck cancer
Panitumumab	Vectibix	Amgen	Monoclonal antibody	2006	EGFR	Metastatic colorectal cancer
Pertuzumab	Perjeta	Genentech	Monoclonal antibody	2012	HER2	HER2-positive breast cancer
Necitumumab	Portrazza	Eli Lilly	Monoclonal antibody	2015	EGFR	Metastatic squamous NSCLC
Margetuximab	Margenza	MacroGenics	Monoclonal antibody	2020	HER2	HER2-positive breast cancer
Anivantamab	Rybrevant	Johnson & Johnson	Bispecific antibody	2021	EGFR, c-MET <sup>7</sup>	Metastatic NSCLC with EGFR 20 exon insertion
Trastuzumab emtansine	Kadcyla	Genentech	Antibody-drug conjugate	2013	HER2	HER2-positive breast cancer
Trastuzumab deruxtecan	Enhertu	AstraZeneca & Daiichi Sankyo	Antibody-drug conjugate	2019	HER2	Breast cancer, gastroesophageal junction cancer, NSCLC

<sup>1</sup>VEGFR: vascular endothelial cell growth factor receptor

<sup>2</sup>RET: Rearranged during transfection, a receptor tyrosine kinase essential for normal tissue development and maturation.

<sup>3</sup>BRK: protein tyrosine kinase 6.

<sup>4</sup>TIE2: a tyrosine kinase receptor that plays a central role in vascular stability.

<sup>5</sup>EPH: members of the erythropoietin-producing hepatoma (EPH) receptor kinases family.

<sup>6</sup>SFK: members of the Src family of tyrosine kinases.

<sup>7</sup>c-MET: hepatocyte growth factor receptor.

For HER-targeted TKIs, they can be grouped into 3 generations due to drug resistance complications. The first-generation TKIs, gefitinib, and erlotinib, have an anilinoquinazoline core backbone structure and bind reversibly to EGFR's intracellular kinase domain in competition with ATP to potently inhibit tyrosine phosphorylating activities and downstream



signaling. In their use in NSCLC patients with metastatic EGFR-mutant tumors, patients have longer overall survival (OS) compared to conventional treatment, however, their effectiveness is not prolonged due to primary and acquired drug resistance [31]. In particular, the T790M mutation in EGFR is suspected to cause first-generation TKI drug resistance with 50% of acquired resistance cases containing the T790M mutation [32]. This acquired resistance is connected to at least 2 molecular mechanisms affected by the T790M mutation [31]. Firstly, the substitution of methionine for threonine at position 790 leads to altered drug binding in the ATP binding site of EGFR. Secondly, the T790M mutation restores the ATP affinity of the L858R mutation, the latter of which increases EGFR activity while decreasing ATP affinity. With the T790M mutation, the ATP affinity of the L858R mutant is increased by more than an order of magnitude, in effect restoring ATP affinity back to the level of wild-type EGFR. This restoration closes the therapeutic window from the diminished ATP affinity of the L858R mutant, which is used by some targeted drugs.

Second-generation TKIs, afatinib and dacomitinib, share the same quinazoline core structure but contain a covalent warhead that causes irreversible binding to the EGFR's kinase domain. This irreversible binding increases the potency but also the toxicity. However, afatinib and dacomitinib also did not overcome the commonly acquired resistance from the T790M mutation.

Third-generation TKIs, osimertinib and olmutinib, were developed to counteract the T790M mutation drug resistance. Third-generation TKIs instead contain a covalent warhead and a pyrimidine core backbone that is structurally distinct from the quinazoline-based structures to optimize selective binding within the catalytic domain that harbors the EGFR T790M mutation [27]. Although third-generation drugs are effective against the T790M mutation, the C797S mutation in NSCLC patients has led to acquired resistance similar to the T790M mutation in earlier generations. Currently, fourth-generation TKIs are under development [33].

As for mAbs, they function by binding to the extracellular domains of HER family proteins to prevent signaling activation. For mAbs targeting EGFR, mAb binding prevents ligand binding, thus reducing kinase activity. For mAbs targeting HER2, since HER2 has no ligand, mAbs instead inhibit dimerization [34]. BsAbs function similarly to mAbs while having two targets. For the BsAb amivantamab, it is capable of binding to the extracellular domains of both EGFR and c-MET simultaneously [30].

An ADC is comprised of a target-specific mAb covalently linked to a cytotoxic drug. Upon binding to targets, the ADC undergoes internalization and releases the cytotoxic drug within cancer cells, resulting in apoptotic cell death [35]. For example, the trastuzumab emtansine (also referred to as T-DM1) is comprised of trastuzumab and the microtubule-targeted agent maytansine (DM1) while trastuzumab-deruxtecan is comprised of trastuzumab and the topoisomerase I inhibitor DXd [35-36].

In addition, antibody-related drugs are capable of leveraging immune responses to maximize efficacy. MAbs targeting HER2, T-DM1, and amivantamab induce

antibody-dependent cellular cytotoxicity (ADCC) which recruits immune cells to kill marked tumor cells [21, 36-37].

Mutations on the extracellular domains of EGFR and HER2 can cause resistance to the mAbs and ADCs due to defects in target binding. Specifically, the EGFR S492R mutation contributes to acquired resistance to cetuximab, and a truncated form of HER2, p95HER2, causes resistance to trastuzumab, pertuzumab, and T-DM1 [21].

Excluding mutations, common resistance mechanisms for HER-targeted drugs also include signaling through alternate RTK pathways and mutational activation of downstream signaling. Alternate RTK pathways may be activated through either non-targeted HER proteins, IGF1R [38], c-MET [39], or AXL [40]. Mutational activation of downstream signaling pathways mainly involves RAS/RAF, PI3K/AKT, and JAK/STAT pathways with mutations bypassing tyrosine kinase activation [21]. Namely, KRAS, NRAS, BRAF, PIK3CA mutations, and PTEN deletions can activate these downstream pathways directly [29]. Therapeutic agents targeting alternative and downstream pathways are under investigation [15-16, 28].

Overall, the underlying molecular mechanisms for drug resistance to HER-targeted therapeutics are varied and complex, presenting significant challenges. Recent research however has provided a promising foundation, but a better understanding of these mechanisms and combination therapy are warranted [21, 34]

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## **An Artist's Political Influence During World War II: Martha Graham and Anti-Fascism** **By Defne Koyluoglu**

### **Abstract**

This study examines the use of Americanism and Americana in two of Martha Graham's ballets, *Appalachian Spring* and *American Document*, to convey messages of anti-fascism during World War II. It, more specifically, also analyzes Graham's storytelling and character depictions to maintain a hopeful and romantic storyline. The research delves into how the two ballets prompt their audiences to confront their own preferences to democracy. The research was based on recordings of the ballets, other published works, such as biographies, on Graham, various newspaper articles, as well as external factors in Graham's life at the time. Utilizing the traditional and hopeful American scene of a pioneer couples' wedding, Graham alludes to themes of anti-fascism and interventionism. Her nuanced representation of these themes enriches our comprehension of contemporary art and modern dance, providing distinct perspectives that challenge societal norms and attitudes toward war. *Appalachian Spring* and *American Document* effectively shed light on crucial aspects of human experiences and societal dynamics.

### **Study**

Pioneering the modern dance world throughout the twentieth century, Martha Graham has become an irreplaceable member of dance history. Her influence on the dance world both visibly in terms of her exploration of dance past classical ballet, as well as dance as a political tool gave her a unique voice. Born on May 11, 1894, Martha Graham founded her dance company and school when she was thirty-two in 1926. As she began exploring the bounds of dance as an expression of emotion, she premiered her first solo *Lamentation* in 1930. *Lamentation* set the scene for Graham's technique by showcasing a dancer who acted to show grief, rather than acting out of grief. The modern costuming, designed by Calvin Klein, of a long tube of fabric across the dancer's body which she stretched and expanded supported the specificity and multidimensionality of symbolism that would continue to show up in Graham's pieces. As her company expanded, so did her casts. *American Document* premiered in 1938 and worked as a "panoramic view of American History presented in the forms of a minstrel show. The work featured familiar folk rhythms, colorful costumes, and readings from American Texts," according to Russel Freedman in *Martha Graham: A Dancer's Life*.<sup>59</sup> *American Document* explored a theatrical side to Graham's style. It opened the door toward incorporating non-dance elements too such as having a narrator read lines from the Declaration of Independence, Abraham Lincoln's Gettysburg Address, Walt Whitman's poetry, the Bible, and other significant documents. Following *American Document*, came *Appalachian Spring*. *Appalachian Spring* takes place in young America. This ballet centered a young Puritan couple in Graham's home state of Pennsylvania. The young pioneer couple's marriage is celebrated throughout the ballet through a cast of Graham, her co-star, Erick Hawkins, a revivalist preacher, seasoned pioneer

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<sup>59</sup> Russel Freedman. *Martha Graham: A Dancer's Life*. New York: Clarion Books. pg. 84. 20 April 1998.

woman, and a chorus of four young girls. *American Document* and *Appalachian Spring* both served to remind the audience of original American values, such as innovation and democratic governmental systems. Themes of Americanism and Americana in both ballets fit right in with the global political scene being that the United States were just leaving the Great Depression and entering into World War II during the time period across both ballets. Graham was heavily influenced by the global political scene and being a famous American artist, incorporated her political opinions into her highly publicized work and actions. This included, but was not limited to, hiring dancers from targeted ethnic groups, such as Pearl Lang and Yuriko, and sharing absolute opinions in regards to War and fascism. Openly anti-fascist herself, Martha Graham sought to evoke anti-fascist and interventionist values in her audiences especially when performing two of her ballets, *American Document* and *Appalachian Spring*.

The time period during which these pieces were premiered is a crucial element of their symbolism. Graham grew up dancing through World War I, and was just starting her twenties when it ended. The United States was battling with whether to interfere with the upcoming World War II in Europe when *American Document* premiered, and the War was close to an end when *Appalachian Spring* made its debut. Across Europe, the Nazi party of Germany was violently imprisoning and exterminating Jewish populations. Although this was not widely known until the latter half of the War. The year after the premiere of *American Document* was the 1939 Nazi invasion of Poland. While Germany and Italy served as the Axis powers in Europe, exploring fascist governmental systems and continuing the War for six brutal years, Japan was the Axis power on the Western side of the United States. Japan bombed Pearl Harbor, in Hawaii, in December of 1941. This attack led to the creation of Japanese Internment camps along the Western coast, and especially centered in California. These camps attempted to rule out the possibility of espionage on the Japanese front of the American military. According to *History.com*, from 1942 to 1945, it was the “policy of the U.S. government that people of Japanese descent, including U.S. citizens, would be incarcerated in isolated camps,” as ordered by the current president, Franklin D. Roosevelt.<sup>60</sup> These internment camps, as well as the intensive racism against Japanese members of American society during and following the War resonated deeply into time-appropriate Western-American life. As a well-known and leading artist in New York, Graham had a privilege here; an audience.

Graham believed there was a unique American signature that she had to explore and define through her work. She claimed, “the American dancer owes a duty to the American audience” and there must be a force that “looks to America to bring forth an art as powerful as the country itself.”<sup>61</sup> These values helped Graham to define life as an American, and what the country meant to her personally. She used her committed dancers to examine modern America, by looking to the past. Her usage of historically accurate costuming and iconic documents allowed her to remind her audience of an idyllic, democratic America. This imagery inspired Graham’s audience with a hope to return to the culture that the promising young America had.

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<sup>60</sup> History.com Editors. *Japanese Internment Camps*. 2009.

<sup>61</sup> Russel Freedman, 75.

By the mid-1930s, she had developed a new technique and way of dancing that included innovative positions, basic technique, and costuming, but had not yet developed certain story themes across pieces such as the fore-coming American and pioneer focused pieces.

As one of the few surviving members of Graham's series of ballets focused in Americanism, some others being *American Provincials* (1934) and *American Lyric* (1937), *American Document* clearly is the bridge between her younger and future ballets. With details such as the cast dressed in colors suggestive of the American flag and the use of the classical structure of a minstrel show, Graham showed her commitment to Americana. While her performance did not include any blackface, there were elements of vaudeville, especially in the theatrical nature of the ballet. Similarly to a standard minstrel show, the ballet began with a sort of 'cake-walk' during which dancers in pairs of two followed a floor pattern around the stage to the back, where they watched their peer dancers do the same. This 'cake-walk' was used to introduce the dancers while an interlocutor greeted and joked with the audience. After this introduction, came the 'olio.' Between skits, musical interludes, and acrobatics the audience was rarely bored. Some of the acrobatic elements here are still pertinent in an average Graham technique class. A common daily exercise across the floor is still acrobatic cartwheels. During this 'olio,' there were also readings from prominent American documents such as the Constitution, Gettysburg Address, and the Bible. These more serious elements contrasted the theatrical and burlesque skits. After the 'olio', came the afterpiece. This end to the show was meant to leave the audience laughing to an almost extreme amount, and allow them to leave greatly amused. Using a greater number of one-liners, the interlocutor vocalized the final 'cake walk.' Graham claimed in an interview in 1989 to have never attended a minstrel show during her life, but at the time, the influence of the culture they supported was too significant to dismiss. While the style of *American Document* did not include elements of minstrel shows such as blackface, classical costuming, or large choruses, it did have heavy influence from ethnicities and races present in America, similarly to the popular *Nutcracker* ballet in the sense that heavy stereotyping was utilized when creating most characters and scenes which included stereotyping Indigenous, certain European, and African-American cultures. The final, and consistent, version of the 'olio' had four sections, the second focused entirely on Indigenous Americans, with no effort toward honoring real elements of Indigenous culture and dance, and the fourth titled *Emancipation* was focused on Black-Americans in American society. This, as well as simply using the structure of a minstrel show, was met with callouts and identified as problematic. Maureen Costonis writes that even while *American Document* was celebrating "the ideals of American democracy, while admitting its faults," it was still a "flagrant example of institutionalized bigotry and repression."<sup>62</sup> Costonis' writing clarifies that *American Document*, while written with intentions of reminding the American audience of democratic views, still wasn't free from the ingrained prejudice present in modern America.

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<sup>62</sup> Maureen Costonis, *Martha Graham's American Document: A Minstrel Show in Modern Dance Dress*. pg 307. 1991.



The press response to *American Document* perfectly matched Graham's intentions behind the ballet. The *Chicago Daily Tribune* described *American Document* as, "as thoroughly American as an Indian Brave," and "as non-controversial as mother or the flag."<sup>63</sup> This article bluntly complimented Graham's work and highlighted the historically American themes present. The *Atlanta Constitution* described *American Document* as "a praise of our rights and a challenge to our own powers to persist as a democracy."<sup>64</sup> The author of that article chose to emphasize the questions asked to the audience by the ballet, such as 'Will our involvement in World War II support or contradict our national democratic values?' The defining American characteristics such as a minstrel show and a reminder of what democracy looks like in America were themes picked up on by these two newspapers. As the audience was reminded of the 'true American democratic values,' an urge within them to share these values globally began to grow, and thus launched Graham's political influence as an artist.

Following *American Document*, and created with the new influence of Erick Hawkins, the *Martha Graham Dance Company's* first male member, came the romantic *Appalachian Spring*. Hawkins' presence, as well as the company's second male member, Merce Cunningham, gave Graham the necessary cast to perform a wedding. As Graham and Hawkins performed their romantic duets and solos, the chorus of four girls all were under the same sense of puppy love for the preacher, played by Cunningham. This piece was premiered toward the end of World War II and reminded Americans that a time where men and women could be reunited was in the near future. Hope was the word to describe *Appalachian Spring*. By using pioneer characters, hopeful for their American futures, Graham inspired her audience to be hopeful for theirs. The optimistic energy of the piece drew a lot of attention, as well as the score by Aaron Copland, a highly respected twentieth century classical composer. Copland followed Graham's energy in his composition. After the ballet's premiere, he said, "I was really putting Martha Graham to music...I wasn't thinking about the Appalachians or even spring...it was a ballet for Martha."<sup>65</sup> While Copland was widely complimented for the score, he credits the inspiration to Graham continually. Copland left the piece with no unique name, and agreed to *Appalachian Spring* for the purposes of it being used in Graham's ballet. While she greatly enjoyed the score, Graham refused to rehearse with the composer present. Copland did not see any of the choreography until the rest of the world saw it with him, when the ballet premiered.

*Appalachian Spring* was reviewed as a significantly more romantic, and new side to the Graham repertoire. With the introduction of Erick Hawkins and Merce Cunningham to the *Martha Graham Dance Company*, came a new response from Graham's audience. The *Chicago Daily Tribune* describes this newer work as "new and with concentrated resonance."<sup>66</sup> The author of that article, Claudia Cassidy, also referred to the piece as "another authentic piece of Graham

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<sup>63</sup> Edward Barry, *Martha Graham Dances a Salute to Democracy: Her 'American Document' Wins Warm Praise*. *Chicago Daily Tribune* 9. 19 March 1939.

<sup>64</sup> *Martha Graham Dances Tonight: To Present 'American Document' at Erlanger*. *The Atlanta Constitution*, 19. 25 February 1939.

<sup>65</sup> NPR.org. *Appalachian Spring*

<sup>66</sup> Claudia Cassidy. *Chicago Daily Tribune*, 21.

Americana.”<sup>67</sup> *Appalachian Spring* marked a significant difference in Graham’s outlook and tools used by Graham to communicate through dance. *Appalachian Spring*’s hopeful nature and Aaron Copland’s accompanying score were both highly praised. Graham alone was still continually praised as a dancer, passing the age of fifty now, and well past the average age for an active dance career.

Erick Hawkins was the first male member of the *Martha Graham Dance Company*, but that detail is the reasoning behind only half of his influence on the Graham technique and repertoire. When he joined the Graham company in 1938, Graham “astonished everyone in the dance world by adding something new-men!”<sup>68</sup> After studying Classics, and specifically Greek Mythology at Harvard University, Hawkins was a ballet dancer traveling with Ballet Caravan, a smaller ballet company. After seeing Caravan performing live, Graham singled Hawkins out backstage to praise his performance and invited him to her studio. A very interested Hawkins agreed and after beginning to take classes there. As well as this, he began teaching basic ballet to Graham’s dancers. In return for his instructional contributions, Hawkins asked Graham for a side role in one of her ballets; as only a walk-on. Graham replied by casting him as a leading role in *American Document* and he debuted in the company in the summer of 1938.<sup>69</sup> As the only male dancer in the ballet, Hawkins was cast in three love duets with Graham, as well as one solo. The only other male character was the interlocutor. Hawkins’ membership of the company, as the only other principal dancer or soloist alongside Graham, gave Graham the ability to explore new themes “of love, jealousy, and sexual passion in her dances.”<sup>70</sup> These new themes added a novel dimension to Graham’s repertoire. While Graham adored him, some other members of the company preferred an all female company, and once Hawkins began to receive the preferential treatment of Graham and had his criticisms invited into rehearsals, four of Graham’s best female dancers left the company. Six years later, in 1944, along with the introduction of Merce Cunningham, Graham premiered *Appalachian Spring* as Bride and Hawkins played her young farmer husband. Graham, who had just turned fifty, had her work reviewed by the *Chicago Daily Tribune* as “ritual and reality, a dance rich in imaginative invention, gracious in design, cumulative in emotional impact.”<sup>71</sup> The playful and charming ballet held a unique position in Graham’s repertoire. *Appalachian Spring* expressed “her growing love for Erick Hawkins...radiant optimism...the promised joys of domestic bliss,” according to Russel Freedman.<sup>72</sup> Hawkins and Graham were married four years after the premiere of *Appalachian Spring* when Hawkins was thirty-nine and Graham fifty-four, although she wrote forty-six on the marriage license. Two years into the stormy and passionate marriage, as Graham began to rely more heavily on Hawkins’ use around the company, teaching classes, holding rehearsals as she choreographed, Graham and Hawkins performed together for the last time. In a heated argument

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<sup>67</sup> Claudia Cassidy. *Chicago Daily Tribune*. 21.

<sup>68</sup> Russel Freedman, 83.

<sup>69</sup> Russel Freedman, 83.

<sup>70</sup> Russel Freedman, 85.

<sup>71</sup> Claudia Cassidy, *ON THE AISLE: Martha Graham and Aaron Copland Good Companions in Superb "Appalachian Spring"*. *Chicago Daily Tribune*, 21. 18 March 1946.

<sup>72</sup> Russel Freedman, 101.

after Graham was injured, Hawkins suggested the company could perform without her. Him pushing Graham to the sideline and becoming her equal, deeply irritated the independent and famous-for-her-originality Graham. This argument sent Hawkins walking away from the marriage, company, and Graham technique all together. Hawkins influence in her future ballets did not end with the end of their marriage though. His significant interest in Greek Mythology inspired Graham's 'Greek-Cycle' -a series of eighteen ballets telling the stories of various Greek myths and allowing Graham to explore psychological theories such as the Freudian Oedipus complex in *Night Journey* (1947).

A main theme across both *Appalachian Spring* and *American Document* was symbols of cultural America, or Americana. As defined by Encyclopaedia Britannica, Americanism is an "attachment or allegiance to the traditions, interests, or ideals of the U.S, the political principles and practices essential to American culture" and Americana is consisted of "materials concerning or characteristic of America, its civilization, or its culture *broadly* : things typical of America."<sup>73</sup> Americanism served as a nationalistic edge in the United States. This did not, however, mirror the level of extreme nationalism in Hitler's Nazi Germany, where nationalistic values were used to control the population. The rise of the consumer economy, directly after World War II, as well as a more clearly defined American culture, led to American culture to have a global impact, and for America to become globally idolized. Within the country and during the war, though, Americanism was used as a tool by anti-fascist and anti-war activists. While Graham was not necessarily anti-war, she was an interventionist, and made this clear in her public comments and actions. Her aim to communicate this through dance only went so far, so Graham translated her iconic dance personality, which included heavy independence, an expectation of true commitment to her that almost led to idolization, and radical personal commitment to her own thoughts, into her press personality.

As a part of her response to the fierce racism against Japanese-Americans, Graham hired Yuriko, a young Japanese-American girl recently released from a World War II Japanese-American internment camp. Graham did not openly speak against racism, but rather, hired dancer's in a sort of 'color-blind' manner; hiring Black-Americans and Asian-Americans long before the forthcoming American civil rights movement. Graham also knew she was a significant leader in the modern dance world, with influence over peer companies and professional artists across America. These artists were not limited to dancers, and included musicians, fashion designers, and poets. In 1936, Graham turned down an invitation to perform at the International Dance Festival in Berlin during the Olympic Games. While the performance opportunity was unmatched in terms of outreach throughout the rest of her career, she refused to perform for the fascist government of Nazi Germany. She protected her dancers and said, "It never entered my mind even for a second to say yes. How could I dance in Nazi Germany?"<sup>74</sup> Since she already knew about the persecution of Jews and other minorities on behalf of the Nazi party, she openly and bluntly refused the offer and mentioned that "part of [her] concert group

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<sup>73</sup> The Editors of Encyclopaedia Britannica. *Americanism*. 2023.

<sup>74</sup> Russel Freedman, 80.

would not be welcomed in Germany.”<sup>75</sup> This directly referenced the Jewish members of the *Martha Graham Dance Company*, such as Pearl Lang. Graham’s refusal to associate with the Nazi party set the tone for all other American dance companies invited. After seeing Graham’s publicly set example, no other American dance companies agreed to perform at the Olympic festival that year. After World War II, Graham learned her name was on the list of those to be ‘taken care of’ when the German Nazis controlled the United States. “I took it as a great compliment,” she said.<sup>76</sup> These are some of the ways Graham used her influence on the dance world and large audience to share her personal values of anti-fascism and anti-Nazi resistance. This, especially accompanied with the level at which her dancers idolized her, had great impact.

Pearl Lang was another member of the *Martha Graham Dance Company* who sparked an audience reply. Lang, who first played Bride in *Appalachian Spring* in 1954, was reviewed by the *New York Times* in 1975 as “sleek in style and sweetly intense” and “probably the artist who most clearly recalled Miss Graham herself.”<sup>77</sup> Lang, being a Jewish woman, danced as a soloist for Graham from 1942 to 1952 and guest artist from 1954 through the last 1970s. Lang and Graham together set the tone for the employment of Jewish women in American dance companies during and around World War II, when Jewish people were targeted by the Nazi party of Germany. She was one of the active members of the *Martha Graham Dance Company* that was referenced when Graham refused to perform for the Olympics in Nazi Germany.

Using her audience and presence in the press, Martha Graham was able to communicate her anti-fascist and interventionist personal beliefs through the use of storytelling, historical documents, and classical American performance structures. Her two ballets *American Document* and *Appalachian Spring* exemplified her use of classical American values such as innovation, democratic governments, and a collection of various racial and ethnic groups. Being that these two pieces were premiered during World War II, when Nazi Germany was dominating Europe and Japan and the United States were in direct conflict on the Western coast of the United States, leading to the incarceration of Japanese-Americans, the use of dance as a political tool was a young and adventurous idea, in the beginning stages of its development. While *American Document* and *Appalachian Spring* each had notable differences in terms of the methods used within them to communicate such values, newspaper review articles and secondary sources made it clear that the same values were pulled from each ballet. *American Document* had historically iconic papers read aloud to the audience in the middle section, nicknamed ‘olio,’ between two comical ‘cake-walk’ scenes. The two ‘cake-walk’ scenes mimicking the set-up of a minstrel show were both appreciated by the audience for their recognizable and humorous natures as well as criticized for overlooking the racist association of such shows and continuing to stereotype racial and ethnic groups in the ballet. In contrast to the theatrical and burlesque nature of *American Document*, *Appalachian Spring* invited an amorous and simple view of what America

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<sup>75</sup> Russel Freedman, 81.

<sup>76</sup> Russel Freedman, 81.

<sup>77</sup> Clive Barnes. *Martha Graham’s ‘Appalachian Spring’: Pearl Lang as Bride*. The New York Times, 72. 14 Dec. 1975.

'should be.' As Erick Hawkins began to leave his eternal mark on the *Martha Graham Dance Company*, *Appalachian Spring* gained attention because of its innovative style and familiar character dynamics to classical pioneer family-dynamics. Graham's invitation of dancers like Yuriko and Pearl Lang also reminded America that the persecution of jewish populations in Germany was a starkly fascist trait in Europe, and did not align well with the recognizable democratic America.

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## **Review on Measurements of Happiness and its Limitations By Borou Dou**

### **Abstract**

Happiness can be referred to as a state of having pleasurable moments and overall satisfaction with one's life. The subjectivity of happiness makes it difficult for psychologists to come up with an absolute definition and criteria for measuring happiness. Nonetheless, psychologists had come up with certain methods capable of collecting data on the level of happiness of individuals. For instance, psychologists had been conducting surveys along with scales to gather numerical data for evaluation. The Satisfaction with Life Scale is a common scale used consisting of 5 questions and a rating scale of numbers 1 to 7 that allows the respondents to rate their level of happiness through self-evaluation of satisfaction and pleasantness of life. Another method utilized is the observation method, where psychologists measure happiness through the evaluation of the expression of moments of happiness on certain platforms. Though, problems regarding the validity and reliability of the measurements arise due to the dependency of the results of these measurements on the respondents' evaluation of their level of happiness. Likely, respondents won't be able to clearly distinguish between expected happiness and actually experienced happiness when ratings themselves using scales. As respondents are required to recall memories to assist with the evaluation of their overall level of happiness, invalidity could lie within the process of memory extraction. The answers of respondents and the ones being observed are also likely to have bias. All of these leads to the production of distorted answers, which makes the data collected invalid and unreliable. Though, as more research is being done, it is optimistic that new methods and approaches would be created to give more accurate measurements of the level of happiness. This review explores the existing methods utilized to measure happiness and addresses the limitations and uncertainties associated with current measurement practices.

### **Introduction**

Happiness is a concept without a universal definition because it means different things to different people. For some, performing on stage is an amusing activity to enjoy, while others might see it as a tormenting experience. Despite the difficulty in precisely defining happiness, there is a consensus among many people that it could refer to a state of contentment and overall satisfaction with one's life (Ackerman, 2019). Psychologists often use the term "subjective well-being" to describe this state of happiness. Subjective well-being is explained as the "scientific term for happiness" (Worthy et al, 2020). More specifically, it encompasses individuals' overall satisfaction with their lives, their experience of positive and negative emotions, as well as their perception of the meaning and purpose in life (Lyubomirsky, 2007). These facets contribute to our understanding of how happiness can be assessed. Although

happiness is subjective and lacks a universally agreed-upon definition, there are methodologies available for measurement. Scales, typically employed through questionnaires and surveys, are commonly utilized for self-evaluation of happiness. Additionally, individuals' mental state can be evaluated through observation. However, it is crucial to consider the reliability and validity of the obtained results.

### Current Methods for Measuring Happiness

One of the primary methods employed by psychologists to assess happiness is through self-reports, wherein subjects are asked to provide responses regarding their level of happiness. Over the years, psychologists have developed various rating scales specifically designed to quantify happiness.

In psychology, scales are utilized as standardized measures for assessing specific psychological variables (Koscielski, 2009). One notable example is the Satisfaction with Life Scale (SWLS), a 5-item scale developed by Ed Diener. The SWLS incorporates five statements, shown in figure 1.

	Strongly Agree	Agree	Slightly Agree	Neither Agree or Disagree	Slightly disagree	Disagree	Strongly Disagree
In most ways my life is close to my ideal	7	6	5	4	3	2	1
The conditions of my life are excellent	7	6	5	4	3	2	1
I am satisfied with my life.	7	6	5	4	3	2	1
So far, I have gotten the important things I want in life.	7	6	5	4	3	2	1
If I could live my life over, I would change almost nothing.	7	6	5	4	3	2	1

Diener, *et al.* (1985) (sum up scores are 31 - 35 Extremely satisfied, 26 - 30 Satisfied, 21 - 25 Slightly satisfied, 20 Neutral , 15 - 19

Fig 1: Five statements in the SWLS (

These statements not only prompt subjects to reflect on past experiences, but may also imply the extent to which individuals perceive their life as meaningful. Respondents are required to rate each statement on a scale of 1 to 7, and the cumulative score reflects the level of life satisfaction, with scores ranging from 31-35 indicating extreme satisfaction and scores from 5 to 9 suggesting extreme dissatisfaction. The numerical value being collected allows psychologists to quantify the degree of happiness experienced by individuals. The universality and nonspecific nature of the 5 statements employed in SWLS allow subjects to assess their life satisfaction according to their own unique standards (Pavot & Diener, 1985). Rather than comparing life satisfaction based on predetermined criteria, the SWLS compares an individual's experienced life to their personal criteria for a satisfying life. Self-rating one's level of happiness is a complex task that involves considering numerous variables. By providing subjects with various choices, researchers aim to calibrate the subject's responses to a specific standard. These choices serve to evaluate and compare their current level of happiness.

In addition to questionnaires, psychologists employ observation as a methodology to assess the level of happiness demonstrated in everyday life. Unlike surveys and questionnaires



that rely on self-reflection, observational methods focus more on capturing moments of happiness presented by individuals (Mogilner et al, 2020). This approach allows psychologists to obtain data on happiness from the perspective of experimental states. Mogilner et al conducted an experiment that involved analyzing blogs posted by individuals online and identifying commonly associated concepts of happiness. By searching for the phrase “I feel...” in users’ blog posts, psychologists were able to gain insights into the instant expression of happiness in daily life (Mogilner et al, 2020). Compared to using questionnaires and surveys which require the respondents to self-reflect, the observation method looks at solid moments being recorded down when the emotional state of happiness is experienced.

While these methods provide psychologists with insights into individual’s happiness levels, significant challenges and limitations persists. Response bias and the potential for misinterpreting questions are prevalent issues in questionnaires and surveys, as they highly rely on participants’ responses (Lindemann, 2022). Moreover, the prevalence of feigned displays of emotions in modern society raises concerns about the authenticity of the information provided, potentially leading to a discrepancy between reported and actual emotional states (Hideg & van Kleef, 2017).

### **The Doubt in Validity and Reliability**

What makes happiness hard to measure is its subjectivity, but what made happiness subjective? Individuals’ standards of happiness vary due to diverse elements such as personal values, social relationships, and the environment. Although psychologists have identified associations between happiness and different factors, applying such generalizations to individual cases becomes imprecise. For instance, psychologists have found a positive correlation between marriage and happiness (Lee & Kawachi, 2019); however, this could be imprecise on the individual level where there are people in marriages that experience domestic abuse and stress, which contradicts happiness. Correlations can provide insights into the overall happiness level within a large sample, reflecting collective sentiments. However, there is no universal standard by which to measure the happiness of each individual. Individuals living in poverty may view happiness as getting enough food and shelter, while those in middle-class or affluent circumstances may perceive such necessities as insignificant (Sintia Radu, 2018). These variations stem from the subjective nature of standards of happiness, as each person possesses their own. Thus, establishing precise benchmarks for happiness proves challenging, as subjectivity renders them inapplicable to every individual. This obstacle necessitates that psychologists strive to overcome in order to attain more accurate data.

As there is no universal standard for measuring happiness, psychologists turn their focus to the comparison between the expected standard and the real level of happiness felt within one subject. Although psychologists don’t need to calibrate standards of happiness, there are still issues with validity and reliability within certain methods. Numerous scales utilized to measure happiness, including the SWLS mentioned before, are grounded in the cognitive theory of happiness. According to this theory, individuals establish their own subjective standard of a

happy life and constantly evaluate their current life circumstances in relation to these internal standards, rather than relying on objective criteria (Veenhoven, 2006). While this approach of comparing one's life against internal standards may appear to address the subjectivity of happiness, it introduces new challenges stemming from the ambiguity of these measurements. One's standard of happiness can be blurred due to the lack of a clear understanding of an ideal standard of happiness. The standards of the surrounding social environment (family and school) could be adopted and internalized by individuals as their own standard of happiness (Ott, 2020). However, due to the fact that people may do this unknowingly, they struggle to make accurate comparisons, resulting in potentially invalid results (Veenhoven, 2006).

The concerns of reliability also lie within the process of human memory retrieval. Self-reports require the subject to recall their past experiences of moments of happiness to assess the level of happiness and life satisfaction. The clearer the memories are, the more valid and reliable the results are; however, memory can fail us many times. Two shortcomings, known as transience and suggestibility, undermine the reliability of memory. Transience suggests that over time the ability to access memory decreases, and suggestibility incorporates wrong information into memory (Murray, 2003). For instance, when individuals are asked about their overall life satisfaction, theoretically, they are expected to recollect all past experiences that contribute to their satisfaction or dissatisfaction. However, there is a likelihood that they may forget certain moments or inadvertently mistake imaginary scenarios as genuine memories.

Another factor that undermines the reliability of happiness measurements is the response bias in subject's answers, which may not accurately reflect their true state of happiness. This applies to most studies in happiness as the reliability and validity of data rely on the subject's evaluation of themselves. A study conducted by Ladder, a career site, revealed that 81% of employees reported faking happiness at work (Montanez, 2020). This finding suggests that faking happiness is a common phenomenon in society. Some psychologists suggest that this behavior may stem from ego-defense and a sense of social desirability. Ego-defense is a mechanism adopted by our subconscious mind to heal our psychological well-being when an individual experiences undesirable events (Parvez, 2021). When subjects are asked to reflect on their level of happiness and satisfaction, they could disregard certain unpleasant memories as a mechanism of self-protection. This could be considered as a form of self-depletion, causing distorted answers to be given. Another cause is the social desirability bias, which occurs when the subjects conceal their true thoughts and instead present themselves as a figure desired by the surrounding society (Nikoloupoulou, 2022). The standard of being happy in surrounding society can be social norms, and it can also be influenced by people the subject is interacting with. For instance, when the interviewer is a well-dressed businessman, the respondent may subconsciously associate happiness with material wealth (Veenhoven, 2014). These factors can introduce bias and potentially distort in the responses, undermining the reliability of the measurements.

## **Future Considerations**

Despite the existing challenges associated with the measurement of happiness, it is imperative to acknowledge the potential for future research and exploration in this field. Given the intricate nature of happiness, psychologists have the opportunity to employ a multifaceted approach by utilizing various methods, such as employing scales that assess different aspects of happiness. This comprehensive approach allows for more genuine responses, and also facilitates a thorough assessment of response validity, helping to mitigate potential biases or inaccurate information. A combination method with neurobiology could also be considered when measuring moments of happiness as the neurological response is something that can be seen and used as a tool to assist in the measurements.

## **Conclusion**

In conclusion, by utilizing different research methodologies, researchers can obtain certain results on the level of happiness. The SWLS measures happiness by enabling respondents to assess their level of happiness according to their own standards, while the observation method measures the level of happiness of individuals based on moments of expression of happiness. However, the subjective nature of happiness among individuals and the lack of a clear understanding of genuine happiness pose significant challenges in obtaining valid and reliable data. Given the absence of an exact definition of happiness, psychologists can enhance the comprehensiveness of their data by exploring different dimensions of happiness. While it may be unrealistic to alter individuals' perceptions of happiness, psychologists can focus on interpreting answers with contextual conditions. Perhaps knowing more about the context and life events of the subjects will allow researchers to better understand the intentions and gain more control of their evaluation of the level of happiness. As technology advances and as psychologists continuously to put in big efforts to investigate the methods of measuring happiness, it is optimistic that there will be methods that are more valid and more reliable.

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# **Can Happiness Be Measured? An Examination of the Notion of Happiness in Asian Family Relationships in the Context of the Movie “Everything Everywhere All at Once” By Alana Sirui Zhou**

## **Abstract**

It critically analyzes the concept of happiness, arguing that its universalization as a construct in experimental psychology is elusive and context-dependent. The Western individualistic paradigm contrasts with the Chinese collectivist view of happiness, where it is considered a collective phenomenon. Family relationships play a crucial role in Chinese culture, and the film "Everything Everywhere All at Once" exemplifies how family dynamics can impact individual happiness. The complexity of happiness hinders its direct measurement, and cultural variations further complicate the matter. The film challenges Western conceptions, highlighting that true happiness in Chinese culture stems from interpersonal relationships and mutual support, rather than material success. In conclusion, understanding happiness in Asian family relationships involves recognizing its collective nature, the significance of family harmony, and respecting cultural diversity in the construction of happiness.

## **Keywords**

Experimental psychology, Everything Everywhere All at Once, Happiness, Individualistic Paradigm, Chinese collectivist, Asian family relationships

## **Introduction**

This paper will develop an analysis of the concept of happiness based on a critique of its use as a construct operationalized in experimental psychology. As a result, it will be stated that how happiness is conceived and thought is elusive and cannot be universalized. This is because it is a multidimensional phenomenon that differs based on cultural context.

In order to logically sustain this critique of the universalization of the meaning of happiness -and therefore its operationalization- it will be developed how happiness is conceived in Chinese culture. In China, happiness is considered a collective phenomenon instead of an individual one, as in the Western paradigm. Having explored the sources of happiness for Chinese families and culture, we will illustrate them with the movie "Everything Everywhere All at Once". This movie shows the dynamics of a Chinese family in the United States regarding happiness.

In this way, the paper proposes to shed new light on the meaning of happiness by leaving aside individualized Western paradigms where all can be measured while shifting toward a cultural relativist perspective.

## **What is Happiness?**

In the academic world of psychology, there are numerous methods and studies that seek to measure and quantify, for example, the stress in people. Similarly, some methods also focus on measuring happiness, although in comparison, they are relatively few (Holder, 2017). This lack of focus on quantifying happiness suggests that happiness is a complex concept to measure in a precise and universally accepted way, which refers to the difficulty in quantifying the phenomenon (Diener, 2012).

The theme of happiness has accompanied philosophy throughout history, and can be sustained as an essentially human concern, fundamentally with respect to how to achieve it. Aristotle argues that happiness is the ultimate goal of human life, and that it is achieved through the practice of virtue, i.e., a practical and individual matter that every human being wishes to attain. However, he also posits that happiness cannot be achieved alone, but depends largely on community and social relations, giving a place to this aspect of happiness in human ensembles. Aristotelian tradition emphasizes individual practice and our individual actions, however the question of happiness has historically taken on a more individual character. The philosophy of Schopenhauer (2003), for example, affirms that happiness is a subjective state that can only be achieved by the individual, not by society as a whole. Happiness is obtained by satisfying one's own desires and needs, which one can achieve only with their own determination.

Throughout the history of philosophy, there have been various theoretical and philosophical positions on happiness, but in psychology, an individual approach to happiness dominates. In Freudian psychoanalysis, for example, happiness is achieved by balancing unconscious drives with external demands (Freud, 1920). The humanistic approach, represented by Maslow (1954) and Rogers (1961), has argued that happiness can be achieved through self-actualization and personal development, primarily through autonomy, self-fulfillment, and self-expression. Individuals and their own abilities are at the center of the humanistic approach. When it comes to more contemporary issues, psychophysiology and neuroscience have played an important role. As Antonio Damasio (1994) noted, happiness is a brain-based emotion, expressing itself in the body, and is associated with satisfying a person's needs and desires. Hence, it is a result of a balance between emotional and cognitive responses, which includes the ability to evaluate one's environment and adapt to it effectively (Damasio, 1994). However, the definition of happiness varies across cultures. The Dalai Lama and Howard C. Cutler (1998), a Western psychiatrist, discuss the keys to finding happiness in life through Buddhist philosophy and Western psychology. The Dalai Lama argues that happiness is achieved through the practice of compassion, meditation, and acceptance of impermanence, placing a strong emphasis on the importance of connecting with others and generosity with others; while Cutler develops the idea of the importance of resilience, self-esteem, and positive attitude, all of these characteristics being relevant to the individual (Dalai Lama & Cutler, 1998). However, these last definitions allow us to argue that the meaning given to happiness and the conditions that result from it are particular to each culture.

In Chinese culture, therefore, a collectivist paradigm about the conditions for achieving happiness and conceiving happiness for its own sake has predominated. An example of this is

Confucianism, one of the main Chinese philosophies, which emphasizes the importance of social relationships and interpersonal harmony as fundamental elements to achieving happiness (Confucius, 2014). For Taoism, happiness is achieved through balance and harmony with nature.

### **Family Relationships In Asian Culture**

These Chinese philosophical approaches, despite their antiquity, continue to permeate the current reality and worldview of that nation: “Chinese culture has been described as a family-like collectivism and the Chinese people as fundamentally socially oriented” (Yang, 1995 cited in Lu & Gilmour, 2004, p. 275). In other words, “for the Chinese, social relationships are perhaps the most salient element of their conception of happiness, as well as the sources of happiness” (Lu & Shih, 1997 cited in Lu & Gilmour, 2004, p. 285).

One theory that allows us to think of the phenomenon of happiness as something collective in Asian cultures is the theory of interdependence. This theory holds that collectivist cultures, such as those of Asia, emphasize the importance of interdependence and connection between people, insofar as it is conceived that individual well-being is closely and directly related to collective well-being (Triandis, 1989). Thus, happiness is achieved through harmony and cooperation in interpersonal relationships and in the community in general.

Thus, interpersonal relationships play a fundamental role in Chinese culture in the attainment of happiness. In this way, the family, as the first and fundamental interpersonal relationship, is key. According to Luo Lu & Jian Bin Shih (1997), it is possible to show that the Western conception of happiness gives greater importance to internal, intrapersonal, or individual satisfaction, while in Chinese culture greater importance is given to external or interpersonal satisfaction. In China, the family is considered an interdependent unit, where each member has an important role to play and must fulfill it responsibly in order to be happy and for the whole to be happy. This is consistent with the results obtained by Xu and Lu (2021), who suggest that the family has a great influence on people's happiness in China, and that this influence varies according to the stage of life in which individuals are, highlighting the relevance of the role played by the family in happiness.

Parenthood has been traditionally associated with happiness in China. According to Confucian values on family, procreation is highly encouraged and even required and is considered an integral part of a good life. Also, procreation is thought of as a family responsibility to be fulfilled as it is a primary way to maintain the lineage (Ma et al., 2019; Zhang & Liu, 2007).

Therefore, it is possible to think that family harmony and loyalty to the family are fundamental values in Chinese culture, so members of these are expected to fulfill certain specific roles and responsibilities. Therefore, family harmony is essential for both collective and individual happiness and emotional well-being, and family conflicts can negatively affect individuals.

### **The Measurement of Happiness**

From the discussion previously made about the significance of happiness in different contexts, it is possible to affirm that, although happiness is a common human experience, it is not



possible to measure it directly as it is a subjective and multidimensional concept, which means that the concept and the experience itself may mean different things to different people and may depend on personal, cultural, and situational factors. Furthermore, the measurement of happiness is further complicated by the lack of a clear consensus on what is being measured and how it should be measured (Diener, 2012). This leads to the conclusion that it is impossible to measure the complex phenomenon of happiness objectively and reliably, which cannot be reduced to a simple quantitative measure (Kahnemann, 1999).

### **The Choice of Happiness: Everything Everywhere All at Once**

The choice of happiness in Asian family relationships is a complex issue that can be approached from various perspectives. Because of the above, the film “Everything Everywhere All at Once” (Kwan & Scheinert, 2022) will be considered to exemplify how family relationships can affect the happiness of individuals, also allowing us to sustain the idea that the concept of happiness is more complex than the Western individualistic view.

It is essential to keep in mind that choosing happiness in Chinese family relationships does not necessarily mean putting individual needs above those of the family, but quite the opposite: it is about finding ways to meet individual needs within the context of the family and the respective harmony. This may involve finding ways of compromise and effective communication to resolve conflicts and achieve shared goals.

In this context, the protagonist of the film “Everything Everywhere All at Once” (Kwan & Scheinert, 2022), Evelyn Wang, is a Chinese immigrant who owns a laundromat in the United States and finds herself in critical debt. This situation has led Evelyn to feel that her life is plagued with failures and has negatively affected both her family and professional situation: her husband is about to ask for a divorce, her daughter wants to move away from her, and her father, with whom she shares a roof, is barely bearable.

The film is an adventure that takes us through different universes and realities, but its true essence lies in the introspective journey the protagonist undertakes through herself. As she faces interdimensional challenges, she reflects on the decisions she has made in her life and how they have influenced her current situation.

In the capitalist society where she lives, success and failure are associated with money and public recognition, rather than with the human quality of interpersonal relations and family. However, Evelyn learns that what really makes life worthwhile are the people we have by our side in good and bad times and that mistakes and failures can help us learn and face our future. Ultimately, happiness in Chinese culture is perceived as a collective state that is achieved through mutual support and understanding among family and community members and cannot be measured in quantitative terms such as wealth or public recognition.

The above example demonstrates how the film “Everything Everywhere All at Once” (Kwan & Scheinert, 2022) approaches the topic of happiness from a perspective that challenges prevailing Western conceptions. In Chinese culture, happiness is perceived as a collective phenomenon and cannot be measured in quantitative terms, such as success and money [western

capitalism]. Through the story of Evelyn and her family, the film shows us that despite failures and difficulties, true happiness is found in interpersonal relationships and mutual support. In addition, the film emphasizes the importance of learning from failures and not judging ourselves so harshly, as these can be valuable opportunities for personal growth and learning. In short, the film invites us to reflect on what is important in life and to value human relationships and personal growth as keys to happiness.

## **Conclusion**

Although happiness in Asian family relationships cannot be measured quantitatively, it can be understood as a collective phenomenon that is closely linked to harmony and well-being. The importance of family relationships in China's tradition is fundamental to understanding how happiness is constructed in this society. The film "Everything Everywhere All at Once" (Kwan & Scheinert, 2022) gives us a deep insight into these dynamics and how family relationships can be a path to happiness.

It is important to note that the position taken in this essay is not that happiness in the Asian context is superior or inferior to other cultures, but rather that it is a different way of understanding it. Therefore, it is crucial to understand cultural diversity and respect the different ways of constructing happiness in the world.

Ultimately, happiness in the context of Asian family relationships is a complex and multifaceted phenomenon based on harmony, collective well-being, and the role of family relationships in people's lives. By exploring this topic, we can gain a deeper understanding of happiness in a specific cultural context, allowing us to better appreciate and respect cultural diversity and the complexity of human life.

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## **Digging Deeper: Eliseo Nevarez Provides Insights On Tackling Ocean Pollution**

### **By Snigdha Arun**

Do you know when you're typing to erase something but your sister keeps writing while you erase? Or when you keep cleaning your room only for your friend to bring more stuff to clutter it. Or it's like pouring water into a cup that already has a hole. Frustrating, right? Not only is it infuriating, but it is also highly inefficient. Similarly, more than 10 million tons of plastic are dumped into our oceans each year, and numerous nonprofits and other organizations work hard to clean up these microplastics<sup>1</sup>.

In an enlightening interview I conducted, Eliseo Nevarez, a marine science educator who graduated with a B.A. in biology from the University of Santa Cruz, shares his first-hand experiences while volunteering in Indonesia. He explains, “You see that in real life, you see an island that's just accumulating all this plastic,[and] it starts to make you feel really uncomfortable, especially when you're working at a place that goes to an island that no one lives on”. “And you pick up all the trash from the beach, and you come back a week later, and the beach is completely covered in trash.”, he added in the interview.

While ocean remediation is much needed and greatly helps the environment, other factors need to be taken into consideration as well, like taping the cup, or in this case understanding the true story of pollutants in the ocean, how it affects us, and how we need to be advocating for change.

The ocean is just a means of disposing of these pollutants, which are just the results of our actions and to truly help the cause, we need to get to the root of it. Eliseo explains that “the ocean at the end of the day is a sink for where everything ends up from, from pollution to single-use plastics, to contaminants to chemicals, they all basically end up in the ocean, because it's a sink.” Therefore, changing what goes in and out of the sink won't change anything because the current condition of the ocean is due to climate change, which is caused by human actions.

Some may be alright with or dismissive of the decline of the ocean's health because they believe there are larger issues at hand regarding climate change. However, according to an article from the UNEP, “while ocean and seas are often overlooked in climate negotiations, research shows they are an essential climate solution, as they store carbon that is driving climate change and provide valuable climate adaptation benefits”<sup>2</sup>. Additionally, Eliseo notes the importance of oceans for humans: “keeping our oceans clean, and healthy is something that not only benefits our planet, but also benefits our health since oceans provide more than 50% of the oxygen we breathe.”

Therefore, it is absolutely critical to treat this with importance. So, Eliseo discusses the importance of knowing the story of pollutants, like plastic: “And that each plastic bottle has a story. So it came from fossil fuels,[which] came from a community living next to these giant

extraction sites that pollute the environment, pollute their water, their soil, their air. And so that's just one starting point of plastic and then it moves on to a refinery where it gets condensed, it gets manipulated into different forms, and here's where it also releases a lot of greenhouse gasses and harmful contaminants to, again, the communities living next to those facilities and those factories. And then we move on to the plastic bottle being in stores where people buy it, they use it, they throw it in the bin or they recycle it.” Understanding the lifecycle of the pollutants that end up in the ocean is a significant step in making the right choices and developing solutions.

However, this isn't the only step; taking responsibility for your actions that contribute to the crisis is the second step for seeing change. Responsibility is also important to create a shift in the narrative: Eliseo explains that "It's the focus and the narrative...it really should be the responsibility of these giant corporations that are making a material and an item that they know very well does not break away, or does not break apart, or doesn't biodegrade in our oceans, which is something that's the biggest problem with plastics, that they just remain on earth for a very long time.”. “Because at the end of the day, they're the ones that cause these problems, and they can't put the pressure on communities to clean up their mess.”, he adds. Meanwhile, responsibility also means changing one's personal way of thinking by being cautious of their own decisions. Instead of believing that a small change doesn't affect anything, every individual should notice that even the smallest step to a better tomorrow is critical.

Finally, the third step to seeing productive change is knowing what the right solutions look like and raising awareness. Creating the right solutions involves knowing who is most affected by the crisis we face. “So when we think about the solutions, the solutions have to be available for everyone at a price that works for everyone. If not, then we're just creating solutions that help the richer, affluent communities, and leave communities that are most affected behind.”, Eliseo explains. Raising awareness entails empathizing with those who may not understand your cause by showing them the criticality of this issue. “Raising awareness,” Eliseo concludes, “ is really looking at the lifecycle of plastic and connecting it back to our health because a lot of the times we focus on the sea turtle, we focus on the dolphin in the ocean, which we all love and are super important for ecosystems and biodiversity. But the problems are also a lot closer to home, and we might not even know it. So I think raising awareness is connecting individuals, communities, and cities directly to how plastic affects their health and their environment.”

Ultimately, Eliseo Nevarez's insights, shared in an interview I conducted, can be valuable in the next steps to help restore our oceans by understanding the underlying problems, taking responsibility, spreading awareness, and choosing the right solutions. Eliseo emphasizes how interconnected our world is and that whether people believe it to be favorable or not, we depend on the health of our oceans just as much as the rest of the organisms on this Earth. So, taking action right away isn't the only necessary task; we must also take the right kind of action. Just like fixing the empty cup requires more than pouring in water, combating ocean pollution requires both holistic and systematic approaches.

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## **Is Happiness Measurable? By Yao Xiao**

### **Introduction**

Humans have long been fascinated by the concept of happiness. The English philosopher John Locke even granted the “careful and constant pursuit of true and solid happiness” as “the highest perfection of intellectual nature” (Locke, 49). Our fascination with happiness has been the driving force for further philosophical inquiries, such as “What is happiness?” and “How happy am I?” These questions have sprouted multiple approaches for measuring happiness, including the proclaimed authentic happiness questionnaires online, and the mass World Happiness Report.

However, such metrics rely on the popular notion that happiness is measurable, which this paper aims to question. This paper will proceed by first examining the nature of happiness followed by a critique of the pitfalls within contemporary systems for quantifying happiness, ultimately shedding light on happiness as a phenomenon that exists outside of measurement.

### **The Nature of Happiness**

Before embarking on this inquiry, the nature of the term “happiness” must be clarified: What is it? What are its origins? What are its characteristics? For the purpose of establishing common grounds with modern studies, this paper adopts the definition of happiness from the discipline of positive psychology, now widely accepted as the defining framework within happiness research, which describes happiness as a positive emotional state (Synder and Lopez)

The fundamental causation of happiness and other emotions is a widely debated field. Many hypotheses on the origin of happiness have been proposed; these myriad possible foundations for happiness have ranged from James-Lange’s physiological explanation to the cognitive Lazarus theories (Cherry). A compromise between competing definitions has brought about one of the most popular theories for the root of emotions, the Schachter Singer’s two-factor theory. This theory suggests that emotions are the result of perceiving a physical response. For example, when one is introduced to a stimulus that would benefit themselves, the nervous system prepares for the action of seizing this beneficial object, and thus causes an increase in heart rate. The person then cognitively labels the increase in heart rate as a physical reaction caused by excitement, or a sense of happiness, and with this knowledge, the person consciously experiences the expected emotions. In practical experiments, Schachter and Singer injected participants with adrenalin to stimulate sympathetic activation, and succeeded in generating both emotions of euphoria and anger from the same physiological action (Schachter and Singer).

Another important aspect regarding the nature of happiness is how it is subject to sensory habituation, which leads to a shift in one’s differential threshold in the perception of happiness.

The phenomenon of habituation to sensory input is well documented in psychosocial studies; this means that responses towards a stimuli recede with repetition. The activations in the cortex of the emotion control center, the amygdala, are found to be significantly higher in younger test subjects, suggesting the cumulative effects of habituation (Wright et al. 2006). It has further been found that habituation for positive emotional stimuli is more pronounced in contrast to fearful stimuli (Wright et al. 2001). From this, the logical inference is that happiness is more easily evoked when one has less experiences. In other words, as one ages, stimuli for happiness, once novel, become repetitive, thus causing a rise in the differential threshold for happiness.

### **Primer of Measurements**

Having clarified the definition of happiness, it is also necessary to determine the meaning of the term “measurement” in order to establish a proper framework for evaluating the concept of happiness. In the social sciences, measurement, as observed by the renowned American social scientists Edward Carmines and Richard Zeller, is “a process of linking abstract concepts to empirical indicants” (Carmines and Zeller, 10). However, to what extent can an indicator represent a theoretical concept?

There are two general properties needed to assess the usefulness of a particular measurement, namely the reliability and the validity of the indicator. The former suggests that the measurement yields similar results upon repeated trials, while the latter is concerned with whether the assessment measures what it intends to measure (Carmines and Zeller).

Reliability and validity are basic considerations of psychosocial measurements, and thus only assessments that score high in both aspects should be taken as proof that happiness is a measurable quantity.

### **Contemporary Assessment of Happiness**

Various websites claim that happiness is measurable, proposing questionnaires, theories, and reports that rely on the supposed measurability of happiness. This section aims to refute the existing measurement models for happiness by evaluating them against the definition of measurement.

A framework to study emotions, published by Anderson and Adolphs in 2014, suggests that valence and arousal are primitive forms of emotions. Under this context, happiness could be distinguished from rage, for example, by its difference in valence; it can also be differentiated from calmness by having higher levels of arousal (Anderson and Adolphs). The valence section of this theory is established upon Darwin’s concept of “Principle of Antithesis,” which holds that emotions come in pairs, such as happiness versus sadness, which provides the emotion-defining scale with a positive and negative axis (Darwin). However, Darwin’s principle was concluded through behavioral observations; for example, a person smiles when happy and frowns when sad. With the underlying behaviors observed in the “Principle of Antithesis” being debatable in their relationship to emotions, the validity of the theory itself is questionable. Contemporary understandings of emotions suggest that one’s behaviors do not truly reflect their emotions; this



has been demonstrated in the aforementioned two-factor theory. Within this understanding, emotions are not the cause of behaviors, but rather the result of them. Hence, the validity of valence is limited in using Darwin's methodology and thus cannot be relied upon as a valid measurement scale.

The other axis in this framework refers to physical arousal to assess the intensity of emotions. Undoubtedly, the reliability for this is satisfactory since it is technologically possible to monitor the excitability of individual neurons using techniques such as optogenetics. However, whether arousal accurately corresponds with emotions remains questionable. Taking the two-factor theory of emotions to be true, cognitive labeling offers a bridge between physical arousal and the creation of emotions. Though it is valid to quantify physical arousal, it is in no way possible to accurately measure the arousal's accompanying cognitive state, as this is highly differentiated between individuals and influenced by events' context and personal experiences. Thus, a framework of measurement based on physical arousal and cognitive valence is unable to fulfill the requirement of high validity and therefore cannot be used with sufficient accuracy to measure happiness.

A more popular and accessible system for the quantification of happiness often appears online as individual assessments, usually in the form of questionnaires. In an effort to control the type of questions presented to respondents, this paper will evaluate the set of authentic happiness quizzes developed by the University of Pennsylvania and their feasibility in measuring the concept of happiness. These assessments are based on rating scales, where respondents are asked to "describe the way you have been feeling for the past week, including today," and to choose from five different levels. The choice box, for example, included statements like: "I am usually in a bad / neutral / good / great / unbelievably good mood" (Seligman). As suggested by the differential threshold of happiness perception, these self-reported questionnaires tend to be volatile in their assessment of happiness, as they are subject to numerous individual factors, including the order and timing of questions, and the recent emotional spectrum of the participant taking the questionnaire. Additionally, since these online questionnaires do not offer any precautions to increase their reliability, the ratees' scores are solely based on the answers given in the questionnaire.

Another widely acknowledged assessment is the World Happiness Report (WHR), which attempts to measure a society's happiness as a whole. The WHR bases its judgement of societal happiness upon subjective life evaluations from individual examinees, using tools such as the Cantril ladder, subjective well-being measurement, and the satisfaction with life scale (Helliwell et al.). Though there have been steps to refine the accuracy of the data, the nature of happiness still prevents the WHR from achieving a highly valid assessment; this is primarily owing to the questionable premise that life satisfaction is equivalent to happiness. The Cantril ladder shows the same result in the span of time of fifty years, yet given the increased differential threshold of happiness over time, the happiness level of people should be higher now than that before for the advancement of convenient technologies and other recent inventions in the last fifty years (Ng). Owing to the improvement in the standards of living during the last fifty years, people born prior

to these improvements would be more moderate in their aspiration for happiness than those born after. If this is the case, then the shift in satisfaction of life standards would mask the potential growth or decline in happiness levels, and thus would not be a valid reflection of happiness.

## **Conclusion**

It is clear that no contemporary assessments have been able to accurately measure happiness. Given the nature of happiness, it will continue to elude quantifiable assessment into the future. Happiness is not a technical problem, but is rather an unmeasurable association between emotions and behaviors; happiness is fluid and subject to sensory habituation.

## **Does it Matter?**

The World Happiness Report found it important to quantify happiness as it would “reflect a worldwide demand for more attention to happiness” and would establish “well-being as a criterion for government policies” (Layard). However, as argued above, contemporary measurement methodologies are faulty, leaving happiness as an unmeasurable aspect of the human experience.

Measurements of happiness are often an obstacle preventing people from recognizing their own emotional state. When one solely relies on reported numbers to reflect their emotional well-being, they are discouraged from spending time inwardly investigating their own emotional state and being their own judge on the current conditions of their happiness. However, the origins of happiness guarantee that there is always a connection between our cognitive labels and one’s own self-awareness: oneself is the only one able to be aware of their state of happiness, and thus perceive minute changes in their differential emotional thresholds. Such emotional awareness has long been honored as a necessary ingredient of successful psychotherapeutic techniques, even branching into its own particular approach: Emotional Awareness and Expression Therapy (Lumley, M.A. et al). Moreover, emotional awareness is also crucial to the efficacy of cognitive behavioral therapy, leading to specific improvements in one’s ability to cope with worry (Davis, J.P. et al). Thus, by acknowledging one’s own emotions, people are able to live fuller, more mentally healthy lives.

Additionally, having a standard measurement for happiness sets a limit on one’s pursuit of happiness. Using the Maslow’s pyramid as a model for potential levels of happiness (Maslow), a happiness questionnaire could easily fall into the fallacy of evaluating different levels of happiness according to a singular standard. This is to say that one person could respond with a 10 on a happiness questionnaire given the satisfaction of his physiological needs, while another person would only respond with a 10 after having gained a sense of self-respect. By evaluating happiness using merely one universalized system, people who responded with satisfactory levels of happiness since their basic needs have been fulfilled would be discouraged from furthering their quest of exploring happiness on deeper, more meaningful levels. Essentially, a homogenizing measurement of happiness impedes the exploration of more significant levels of life satisfaction and self-realization.

It is important that people should neither end their quest for happiness nor seek for a quick way to obtain it. The key to happiness is held only in oneself, and thus to achieve the “greatest good” and “the highest intellect of human nature,” one must personally, carefully, and persistently embark on their own individual pursuit of ultimate happiness, beyond the measurements of standardization and quantification.

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## **Proposal to Legitimize Japanese Government By Wenjia Su**

### **Introduction to Current Japanese Government**

Japan's antiquity can be traced back to its unification over a thousand years ago during the Taika Reformation. This long history of unity paved the way for the development of a distinctive governmental structure. Operating as a constitutional monarchy, Japan's evolution was distinctive, shaped by limited interactions with Western civilizations. However, the arrival of Commodore Matthew Perry's expedition compelled Japan to confront its limitations and adopt Western ideologies. As a nation with over a millennium of existence, Japan has crafted two noteworthy constitutions, penned in 1889 and 1947, both of which integrated Western ideologies. The Meiji Constitution drew inspiration from Prussian and Austrian models, prioritizing traditional Japanese nationalist values. On the other hand, the 1947 Constitution, crafted in the aftermath of World War II, was influenced by British and American constitutional principles. Despite their disparate approaches, both documents share a common purpose: to serve the interests of the people. Although the Meiji Constitution played a pivotal role in establishing the modern Japanese government's structure and pro-Western stance, the revised Constitution from the Showa era exerts a more significant influence on the contemporary Japanese state. However, the legitimacy of the present Japanese government, as defined by Western standards of authoritative governance, remains incomplete. Therefore, to further legitimize the current Japanese government, there is a need for the government to seek greater autonomy from the existing circumstances.

As a consequence of their pursuit of hegemony during World War II, Japan, and Germany were compelled to sign treaties that specifically mandated their demilitarization. This stern measure posed significant challenges to their authority, particularly pronounced in Japan's case. Enshrined within the new Japanese Constitution, Article 9 states, "Aspiring sincerely to an international peace based on justice and order, the Japanese people forever renounce war as a sovereign right of the nation and the threat or use of force as means of settling international disputes. To accomplish the aim of the preceding paragraph, land, sea, and air forces, as well as other war potential, will never be maintained. The right of belligerency of the state will not be recognized." This provision effectively relinquished Japan's ability to establish a conventional military force. However, it did permit the Japanese government to maintain a Self-Defense Force comprised of trained citizens, albeit solely for defensive purposes. Francis Fukuyama, in his work "The Origins of Political Order," defines a state as one possessing a justified capacity for warfare, capable of engagement in conflicts. Clearly, due to the post-World War II constitutional frameworks, Japan forfeited its prerogative to possess a conventional military. Despite the establishment of the Self-Defense Force, which was deemed appropriate for nations wary of aggrandizement, concerns regarding the Japanese government's authority arose due to the absence of a robust military or comprehensive self-defense mechanism. The aftermath of World War II led to a scenario wherein Japan, restrained by its constitution, could not wield a traditional

military force, raising questions about the government's ability to ensure the nation's complete protection and security.

The United States responded by deploying troops to Japanese territories, establishing 23 bases, to address this challenge. However, this American intervention had unintended consequences, particularly concerning Japan's self-defense system and the legitimacy of its government, especially concerning the rights of Japanese citizens. The presence of American armed forces in Japanese territories gave rise to two significant issues. The American military presence posed a direct challenge to the authority of the Japanese government. This challenge can be understood through the lens of Machiavellian political thought, which underscores the complex emergence of state authority and security. The inherent tension between a foreign military force and the host nation's governance created an intricate power dynamic, potentially undermining the Japanese government's perceived legitimacy. Furthermore, the legal framework and enforcement mechanisms in Japan faced ambiguity when dealing with American soldiers. This ambiguity resulted in preferential treatment for American military personnel, granting them privileges not afforded to Japanese citizens. This disparity created a sense of unequal justice and eroded the perceived integrity of the Japanese legal system. The resultant suspicion and mistrust cast doubt on the collective identity of Japanese citizens as equal participants in the state. These challenges had far-reaching implications, undermining the social contract between the Japanese government and its citizens. In several instances, U.S. troops could circumvent legal consequences by evading trial in Japanese courts, instead facing penalties from the U.S. military jurisdiction in North America. This eroded the foundational principles of accountability and justice, unsettling the delicate balance required for social stability in Japan. The deployment of U.S. troops to Japanese territories, while initially aimed at addressing security concerns, inadvertently introduced a series of challenges that disrupted the equilibrium of Japan's social and political landscape. The resulting strain on the social contract and the erosion of citizen trust necessitate a thoughtful reevaluation of the role of foreign forces in domestic affairs and the preservation of Japan's sovereignty and governance.

### **Key to Justification**

The crux of rectifying this precarious situation lies in addressing the disruptive influence of the United States on Japan's social equilibrium. To restore balance, I propose that Japan assumes the role of a buffer zone between the United States and China. Achieving this requires Japan to forge stronger ties with neighboring Asian nations, particularly China, which holds closer geographic proximity. Given Japan's status as the third-largest economic entity, its significance makes it an attractive prospect for other nations. Japan has the potential to engage China in collaborative military endeavors, potentially leading to a scenario where the United States withdraws to North America, thus resolving the societal imbalance. Moreover, the Japanese government could leverage its amicable relations with both China and the United States to its advantage. By attaining military stability through cooperation with China, Japan could declare itself neutral, fostering a unique position that enables trade with both Western and

Eastern nations. This strategic equilibrium not only facilitates trade but also creates opportunities for resource-rich transactions with countries such as Iraq. In the realm of economics, Japan's geographic isolation necessitates a resource-efficient approach. Japan's prowess in producing high-quality manufactured goods could be balanced by engaging in resource trade with other nations. This economic equilibrium, in turn, paves the way for sustainable military development. Japan could capitalize on its diplomatic relationships to procure cost-effective weaponry from China while obtaining sophisticated armaments from the United States, thereby enhancing its self-defense capabilities.

After stabilizing the economic environment, Japan should then send people to the US for education and start developing high-technology companies and try to be more independent from the US. Having an extremely well-developed research environment, Japan's engineering and natural science research are both worlds leading. It is relatively easy for them to further put research into production use. This then allows Japan to strengthen its social stability through economic stability. In sum, the process of legitimizing Japan is based on the process of becoming economically independent while protected and supported by both China and the US. By making the economy stable after the death of former Prime Minister Abe Shinzo, Japan will be able to stabilize and legitimize its rules.

Economic independence plays a pivotal role in justifying the authority of the Japanese government due to its significant impact on political, economic, and military aspects. This concept differs from the current situation where Japan maintains a close relationship with the United States due to the following reasons:

1. Economic independence grants Japan the ability to make autonomous political decisions without the influence of external powers, such as the United States. This newfound sovereignty allows Japan to shape its internal affairs according to its citizens' preferences and interests, fostering a stronger sense of self-governance. The absence of American interventions provides the Japanese government with more leeway in crafting domestic policies, enhancing its perceived authority and legitimacy in the eyes of its citizens.
2. With economic independence, Japan can invest more resources in bolstering its IT industry and research capabilities. This move can lead to the growth of local companies and industries, fostering economic dominance in both domestic and global markets. This economic empowerment enables Japan to compete on a larger scale, diminishing its reliance on foreign products and increasing its influence over its economy. Such economic prowess contributes to the government's authority by showcasing its ability to manage the country's economic well-being effectively.
3. Economic prosperity resulting from independence equips Japan with the means to enhance its military capabilities. The government's ability to afford modern, effective weaponry and fortify its Self-Defense Force strengthens national security, ensuring the country's ability to defend its territory. This, in turn, bolsters the Japanese government's authority by fulfilling its primary duty of safeguarding its citizens and maintaining territorial integrity.

The amalgamation of political autonomy, economic dominance, and military strength aligns with the ideas of philosophers like Rousseau and Machiavelli. Rousseau's concept of the social contract emphasizes the importance of consent and mutual benefit between the government and its citizens. A self-reliant and stabilized society, devoid of foreign military intervention, cultivates a sense of unity, security, and satisfaction, thereby upholding the essence of the social contract.

### **Authorizing the Solution**

Machiavelli's notion of a successful state, as articulated in "Discourses on Livy," resonates with the proposed scenario. A state's strength is not solely derived from its military might but also from its ability to provide its citizens with a united, secure, and contented environment. Economic independence contributes to this vision by enabling the government to fulfill its responsibilities effectively, solidifying its authority through the tangible benefits it brings to the populace. The pursuit of economic independence by Japan serves as a multifaceted justification for the authority of its government. Through increased political autonomy, economic domination, and military strengthening, Japan can align with the principles of renowned philosophers while cultivating a stable and secure society that effectively satisfies the social contract between the government and its citizens.

While the Meiji Constitution provided a suitable foundation for Japan's governmental system aligned with its citizens and culture, there persist multiple challenges affecting the current Japanese government. However, this proposal encounters a constraint in determining the political stance of Japan's predominant right-wing party. Given historical tensions and current political complexities, this party may be hesitant to foster amicable relations with China. Furthermore, the resolution of the territorial dispute with Russia is a prerequisite to establishing a relatively stable economic environment, given Japan's dependence on resource trade as an island nation. Given these complexities, achieving stability and sovereignty for Japan entails collaborative and communicative efforts with neighboring countries, a necessary step to navigate historical intricacies, address territorial concerns, and secure a prosperous future in harmony with its cultural identity.

### **Conclusion**

Holistically, the proposal encapsulates substantive advocacy for fostering a climate of economic harmony within Asia, concurrently laying out a strategic framework designed to assist Japan in cultivating a well-balanced economic ecosystem that facilitates its holistic and comprehensive development. This blueprint not only serves as a foundation for technological advancements but also paves the way for the enhancement of military capabilities. As Japan gains augmented influence within the economic market and fortifies its military prowess, the legitimacy of the current Japanese government is substantially heightened, solidifying its standing and authority on both domestic and international fronts.



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## The Color of *La La Land*: How Colors are Significant to a Film's Story By Jude Schaffner

### Introduction

Films are known to have strong connections to their viewers on a psychological level. Experiments have been conducted, such as the eye-tracking experiment (Rédei), that test different scenes to see how viewers might respond to different visual stimuli. Rédei's coverage of these experiments brought forth discussion over the vast difference in a laboratory experiment regarding film pieces and the experience uniquely felt within a cinema. Viewers are more likely to be stimulated if they are in an environment with the specific purpose of observing films (Rédei). Movies have become so deeply rooted in our society. They are cultural events and hold strong connections to many of their viewers. The film industry has gone through many innovations since the first motion picture, which was a 2 second clip of a horse jockey riding on a horse called *The Horse in Motion*. Innovations include longer films, higher quality, and eventually color. Color in film has a deep history dating back to the 1800s, with many different methods being used to tint the physical film reel from the original black and white images, and altering them (Schrader). Movies like *Singin' in the Rain* (1952) surround themselves with these kinds of industry shifts and innovations. The film follows an actor, Don Lockwood, who meets a showgirl and falls for her heavily. Amidst the main love story going on in the foreground lies a story of how Hollywood had to adapt to a boom in talking films (films that incorporated audio along with the visuals). Many in the industry were reluctant traditionalists who appreciated the film they had at the time without on set audio. However, they chose to adapt and overcome their predispositions, as it was the only way to survive (Pfeiffer). These predispositions were definitely an obstacle for color films to come into the mainstream, progressive filmmakers paved the way for what film is now. While not necessarily making any innovations in the film industry Kevin Brownlow, a film restorationist, appreciates and discusses further processes of coloring film, as well as the impact it can have on a motion picture, in an interview conducted by Victoria Jackson and Sarah Street, coming from the peer-reviewed *The Moving Image: The Journal of the Association of Moving Image Archivists*. Brownlow has worked to restore many old silent films into color. The article revolves around an interview conducted with him giving his insight on film color's effect on silent films. The interview delves into specific cases of Brownlow working on restoring films, and the processes of coloring these silent films. One example of these restored films is Abel Gance's *Napoleon*, which initially premiered in 1927. The restored and rescored version premiered in London in 1980 and New York in 1981 (Jackson & Street). The article also discusses some limitations with specific tints and colors that were difficult to figure out, but not necessarily impossible, as he pointed out that others have discovered ways of managing the issues he ran into. It explains some processes that involve overlapping white, red, and blue tints, similar to the 3-D effect, and also very early processes of coloring films in the late 1800s (Jackson & Street). It describes the process of tinting and toning, which was the most common process that these restorers used. Certain restoration projects would have varying efforts based on the importance of a screening. Less important screenings would have less tinting effort, while

more prestigious events and venues would have full effort put in to have the best product (Jackson & Street). This article only exemplifies this niche group of people who satisfy this demand for color within older films. This subculture of the film community reinforces and revives old techniques and reels to keep films fresh and give them a modern touch to make them appealing to new audiences. It allows for these audiences to be introduced to a vast catalog of films that they may have never seen without these restoration projects. The way color works within movies brought forth the question of: How do the colors blue, red, and purple work to describe the characters and tone within *La La Land*?

### **The Film: La La Land**

The focus of research surrounds the critically acclaimed *La La Land*, which released in 2016, and at the 2017 Oscars was nominated for 14 awards, and won 6 of them. While it was nominated for Best Picture, it lost to *Moonlight* (2016) (Puente, et al.). The film takes place in Los Angeles and follows Mia and Sebastian, whose lives become intertwined as they continuously run into each other and eventually fall in love. Sebastian, a jazz musician and aficionado, seeks to open his own club and save jazz to the best of his ability. Mia, a struggling actor, works as a barista on the Warner Brothers Lot. Sebastian eventually gets a gig with an old friend's new jazz band, The Messengers, and Mia quits her job at the coffee shop to focus on a play she is writing. These two different lives, Sebastian's being very mobile, and Mia's being stationary, eventually caused a rift in their relationship. Mia's play does not go well, and Sebastian does not enjoy the music he plays in the band. Their rift leads to a breakup. Mia goes home to Nevada, and Sebastian stays in Los Angeles, until he gets a call for Mia to be the lead star in a film, and rushes to Nevada to tell her. Mia auditions for the role and gets it, meaning she'll go to Paris. Sebastian is staying in Los Angeles, but the two are at peace with each other. Five years go by. Mia is a renowned actor and Sebastian opened his own club, naming it Seb's, as suggested earlier in the film by Mia. The two recognize that they truly loved each other, but could not keep a stable relationship without emotionally harming one another (Chazelle, et al.). The film provides an ethereal and vivid experience of these two lovers' story, filling the movie with jazz and color, making it appealing to the senses of sight and sound. These two senses are undoubtedly the most important during the film experience. Krin Gabbard further analyzes the film, specifically in the area of its cultural significance, in his article "*La La Land* Is a Hit, but Is It Good for Jazz?" He discusses how jazz, within the film *La La Land*, is not only a key part of the score, but also the narrative of the film as a whole. Upon its release, the film received much criticism for its portrayal of jazz with two white people as the leads, when jazz is culturally significant to African American communities. Gabbard describes the controversial take on jazz in the modern day and criticizes the goal of the film to "save jazz" when it makes use of a cultural practice that does not stem from white communities. However, Gabbard states that the film does a good job at addressing the topic of jazz's relevance within the modern day, even when navigating treacherous waters. The director of the film, Damien Chazelle, takes inspiration from classic films such as *Casablanca* (1942) and *Singin' in the Rain* (1952) to enhance his

characters' emotions and build the world's aesthetic (Gabbard). The film aims to find magic within the grit and texture of everyday life. Michael Legrand, a French jazz composer was a huge inspiration to Justin Hurwitz, the composer of *La La Land*'s score, who is also an avid jazz enthusiast. This connection to Legrand exemplifies his passion for the art through his compositions such as "Another Day of Sun", which is featured in the opening scene of the film (Gabbard). One connection made to common musical tropes was through the initial hostility of two soon-to-be lovers through the use of dance and song as seen in "A Lovely Night"(Gabbard). The film sets itself apart from others, which can be seen through the seamless transitions into musical numbers, and the filming of musical numbers where the actors actually sang during camera roll, instead of the audio being added in later (Gabbard). Comparing *La La Land* to one of Chazelle's older films, which is also a musical, *Guy and Madeline on a Park Bench*, Chazelle is becoming known for his very difficult musical numbers in regards to both narrative and cinematography (Gabbard). During the film, there is a conflict in jazz of the old and new age. Sebastian wants to keep the older, traditional form of jazz, he's a purist, while many others in the film, including John Legend's Keith encourage him to start moving to the new age. Him going to this new age is what causes a spiraling of events that leads to an ending in the relationship between Mia and Sebastian. Though the film may be racially problematic, it does a good job of expressing the culture of jazz (Gabbard).

### **Significance of Music**

In a study conducted by Innes-Ker, it was found that music within a movie, its score, induces an emotional response. Music, if significant enough, can evoke an emotion for the audience to adopt (Innes-Ker 63). Music pertaining to a specific emotion can help to evoke that emotion to viewers, whether that be happiness, sadness, or fear (Innes-Ker 62). Innes-Ker brings forth the idea that a "movies' ability to enthrall humans is based on their ability to engage our evolved capacities and concerns" (Innes-Ker 63). The capacities and concerns in question are a person's emotions. Given that a film's score is significant enough to evoke an emotional response in viewers, then it would enthrall or grasp their attention, proving to be more memorable (Innes-Ker 63). The YouTube channel Every Frame a Painting uploaded a social experiment in 2016 titled, "The Marvel Symphonic Universe," which tested the memory of Vancouver citizens on major movie theme songs such as Star Wars, Harry Potter, and James Bond. Many of them were able to recognize the theme songs of these franchises. However, when asked to recite a Marvel theme song, all of those interviewed paused and hesitated, unable to think of the tunes from the highest grossing movie franchise (Every Frame a Painting). The video goes on to explain the different aspects of Marvel music versus other franchises, such as emotional provocativity and consistency. Because the Marvel projects are so numerous, the composers are going to vary, and therefore so would the score and main themes (Every Frame a Painting). The Avengers theme song becomes more recognizable because of the consistent motif used throughout the entire franchise, but the Iron Man movies tend to have varied motifs (Every Frame a Painting). The goal of this experiment was to point out how consistent and repetitive

motifs are more significant and resonant with audiences. Throughout *La La Land*'s score there are consistent motifs that are repeated throughout the film, and would therefore be more recognizable to those who have viewed the movie.

### **Colors Within a Film**

An important part of a film's experience and attraction to an audience is what is actually shown on screen, and how it is shown. If a scene is messy or disorganized a viewer might be led to be displeased. Conversely, if it were a minimal and organized environment the viewer might become at peace. Studies have shown that when given a visual piece, a music piece, and a combination, participants said that music pieces greatly influenced their enjoyment of a visual sequence, but that the visual sequence was strong standing alone (Langkjær). Color, throughout the ages, has been surrounded by questions that were theoretical and material, artistic and scientific, aesthetic and commercial, and even racial or political (Brownlee). The desire for color goes back to the 19th century, and a growing demand for pigments and paints, which many painters provided from their studios (Brownlee). One theory surrounding human perception of color comes from a lecture titled *On the Theory of Light and Colors*(1801), in which Thomas Young, a British polymath, discussed his theories surrounding color as a wave and three-color vision, which suggested that humans see on a spectrum of red, green, and blue (Young). An adapted version of this theory was later tested and confirmed by Hermann Von Helmholtz, a German physicist, in 1855. The process of coloring films has severely innovated throughout history. Initially there were single colored, single strip, reels, with red, blue, and yellow tints. Eventually cameras were developed that shot two different reels that could be overlaid to create a color effect. Technicolor was developed first in 1921, tinting two identical reels, one cyan and the other magenta, that could be combined in order to create a near full color effect, only discluding a yellow tint (Schrader). A future version of Technicolor used a three-strip method that was developed in 1932, and took all three tints including yellow to create a full spectrum of color on the screen (Schrader). Film, of course, has its roots in a lack of color, the black and white format. Once color was introduced, the majority of people had a hard time wanting to see black and white now that they had this intriguing and highly desired version of the motion picture (Schrader). Color creates this entirely new world for viewers to enjoy and be immersed into. The jump from black and white to color allowed for directors to have such greater expression within their films. Directors, such as Alfred Hitchcock, took great advantage of this color and vividly applied it to his films, with *Vertigo* (1958) being the best example of this color usage (Schrader). The intention of colors may lie in the specific emotion or concept a director might try to convey. Color psychology, as described by the London Image Institute, assigns emotional and psychological connotations to specific colors. The color red is often associated with strong emotions like passion and love, as well as strength and power. The color blue is associated with loyalty and serenity as well as dependability. The color purple is often associated with ambition, immaturity, and impracticality, and supposedly attracts the sensitive and compassionate. All three of these colors are significant according to the London Image Institute,

with red being the most attractive, blue being the most favored, and purple being the most lavish and royal. A director choosing to display a given color implies a creative choice that attempts to convey a certain emotion without forcing other elements to do so (London Image Institute). Giving a film color gives it more realism, allowing for it to be more believable to an audience, more relatable and easily connected to. Color is one of the most crucial pieces to a film, and even a lack thereof can suggest some tone for the movie. The way color works within *La La Land* needs further inspection to observe its impact on the world that is built within the film as well as the tone and aesthetic it sets for a viewer.

## Methods

*La La Land* is an abundant display of color constantly filling the screen. It is stimulating to the senses. This film is culturally significant and relevant because it is a critically acclaimed film with an 8/10 on IMDB, a 91% critic score and 81% audience score on Rotten Tomatoes. The film was nominated for 14 Oscars and won 6 of those at the 2017 Academy Awards. *La La Land* also contains an all star cast, with Emma Stone and Ryan Gosling playing the lead roles, along with J.K. Simmons and John Legend playing supporting roles in the film. The researcher conducted a film color analysis on the film *La La Land*. The criteria for what scenes were observed include the scenes associated with the film's soundtrack. As discussed in the literature review, the music within *La La Land* is significant and resonates with audiences due to its repetitive motifs. Therefore it followed the tracklist (See Appendix). The selected scenes were observed multiple times in an attempt to make a connection between the colors blue and red, being tested for their representation and general tone throughout the film's most significant scenes. The film was observed until all possible data surrounding the two main colors and their mixture, purple, was collected to be analyzed. Finding a hybrid function of the colors and their representation in tones, characters, and ideas, would be beneficial in making inferences on the intent of the story and the overarching themes and motifs that the director may have provided without making it blatantly obvious.

Data collection began when the colors blue and red showed prevalence within the selected scenes. Any of these scenes that contain these colors had their timestamp noted in a notebook or Google Document. The tone, characters, ideas, and objects that were presented within the scene were also taken note of for later for comparison and analysis. Significance in the color purple was also taken note of in order to test for its possible connections with tones, characters, and ideas. Consistency between the colors shown and the tone, characters, ideas, or objects presented were also acknowledged during observations. Visuals exhibit many details when developing the story of a film. More specifically, color on the screen can set the tone for the scene and attempt to give the viewer a deeper understanding of the emotion within that scene, as well as the underlying themes that coincide with these colors. Color gives emotion and strength to a scene. Compared to a black and white scene, a color scene would be more impactful on a viewer (Schrader). Blue and red were significantly shown throughout the film *La La Land*, and they may represent the protagonists, Mia and Sebastian, as characters. Blue is seen on Mia

for multiple sequences, while red is associated with Sebastian. Color significance in film dates back to its widespread distribution within the film industry in the 1930s. The efforts of Alfred Hitchcock and other directors who took advantage of this advancement in film technology, making great use of color, proved to have a greater effect on the strength and emotion of a scene (Schrader). The colors could provide not only an emotion or tone in a scene, but also a descriptive and representative concept provided by the colors and applied to their respective characters. The researcher made use of the London Image Institute's definition of Color Psychology, as well as their interpretation of emotions relating to specific colors (London Image Institute).

Director commentary and director interviews were also observed to take note of Damien Chazelle's vision for the film, and what tone he may have set for scenes. These commentaries were observed after initial observations of the film were completed. Damien Chazelle is best known for his films *Whiplash* (2014), *La La Land* (2016), *First Man* (2019), and most recently *Babylon* (2022). While *First Man* is different from the other films like *Babylon* in terms of formatting, it still maintains Damien Chazelle's very aesthetic filmmaking style (Valladares). Taking a closer look at this "Chazellian" style could add to the discovery of more content within *La La Land*. "Chazellian" is a term, whose operational definition in this research refers to the style of Damien Chazelle's direction when he is creating his films. To find out more about this unique director's style, observing director commentary would be helpful in getting the thought process of the director himself, instead of completely relying on inferences. Director commentaries and interviews provide an accurate, primary source for information regarding the formation of and intent behind each scene.

Taking into consideration Chazelle's commentary and filmmaking intent, along with the scenes that were taken note of upon multiple observations, the researcher can then begin to make inferences about the possible tones, characters, and ideas that are connected to the colors blue, red, and their mixture, purple, starting the data analysis process.

There are no inherent risks involved in performing this method. Moderation in film observation frequency should be applied. Repeated back-to-back observations could cause eyestrain due to the overexposure to a screen. A solution to this, if the researcher has sensitive eyes, could be to use blue light blocking eye glasses. These glasses would help to prevent any severe damage from being caused to the researcher's eyes. Regardless of eye protection, the researcher should still maintain moderation when observing the film, spacing out each viewing.

The data collected was analyzed by looking at how the colors blue and red in the marked scenes show consistency between concepts such as the tones, characters, and ideas. The researcher then cross-applied these scenes and their descriptions with the London Image Institute's color psychology chart (See Appendix). This added an extra layer of what the color means, as well as the director's intent for including that color. The data hopes to find significant instances of blue and red being used consistently with certain concepts. If instances of blue and red are not consistent with the observed concepts, the research question would be nulled, and data would not be significant enough to prove what is being hoped for within the question. A

conclusion would then be made based on the nullified research question. These consistencies were used, along with information taken from director commentary, and the color-emotion chart in order to make connections between the the color in the scene, and the provided tone or intent of that color, whether it be to represent a character or inflict an emotion on the audiences. These connections were to confirm or deny the importance of the colors blue, red, and purple within *La La Land*. This was then to be used to support an overall inference or conclusion about these color's purposes and their relationship with each other throughout the story, whether it shows a coming together, a separation, or both.

## Results

Of the selected 14 scenes from the main soundtrack, all displayed a significant display of color, with 12 displaying significant use of blue, red, and/or purple. Scenes with significant use of blue included *Mia and Sebastian's Theme*, *Herman's Habit*, *Planetarium*, *Start a Fire*, *Engagement Party*, and *The End*. In these scenes, Mia was strongly associated with the color blue, whether it be with her clothing, lighting, background, and surrounding objects. The most consistent tones displayed were more sad, including senses of melancholy, anxiety and frustration. According to color psychology the color blue is a calm and soothing color, related to being content (London Image Institute). Moving onto scenes with a significant display of red colors, scenes within this category included *Someone in the Crowd*, *Mia and Sebastian's Theme*, and *Start a Fire*. Red, while being prominent in fewer scenes than the other colors, still proved significant in character associations with Sebastian. Sebastian was shown prominently with the color red, whether that be in lighting, his vehicle, clothing, or surroundings. Scenes containing red proved consistent tones that were more happy, showing a stark contrast to the tones of blue scenes. Calmed, soothed, and/or joyed were specific tones that all leaned towards happiness in terms of tone. According to color psychology, the color red is associated with passion and strong emotions, as well excitement (London Image Institute). Finally onto the scenes containing significant display of the color purple, which include the scenes *A Lovely Night*, *City of Stars*, *Planetarium*, *Summer Montage*, *Audition*, *Epilogue*, and *The End*. Purple was the most recurrent color, appearing in the most scenes out of the three observed colors. The association for this color was not one of a single character, but a conjunction of both Mia and Sebastian. Purple was representative of their relationship, being present in scenes where their relationship was growing or changing via lighting, clothing, and background or surroundings. The most consistent tone within these scenes was a sense of romanticism. Color psychology defines the color purple as being associated with ambition and spirituality (London Image Institute). Directory commentary was unavailable for the film, and the few director interviews available mainly discussed Chazelle's inspirations and intent for the film as a whole. He gave no insight into what the colors meant.

## Analysis



As discussed in the results, the colors blue, red, and purple displayed significant notions towards strong connections with characters and tones throughout the film. Starting with the specified blue scenes; most of the scenes with blue maintained a consistent tone and character association of Mia. With scenes such as *Engagement Party* and *The End* having a somber and melancholic tone, while *Mia and Sebastian's Theme* and *Start a Fire* contained a more anxious and frustrated tone when blue was shown. Overall, these scenes maintained a categorically sad or depressing tone. However, the scenes *Herman's Habit* and *Planetarium* within the film both make significant use of a light blue color (See Fig. 1 and Fig. 2).

Fig. 1 "Planetarium," Damien Chazelle, La La Land, 2016



This light blue color was interpreted to be a waning anxiety. As the color's shade lightens, so does the tone. The observed tone in these scenes lean towards romanticism, with both characters being flirtatious with each other. No longer was blue associated with sadness or anxiety in these scenes, it was changed and lightened due to the growing presence of a bond and relationship between Mia and Sebastian. As discussed in the results, color psychology associates blue with having a calmed and soothed state (London Image Institute). This understanding of the color blue comes at a direct contrast of the observed tones. Therefore, as Mia is the character most strongly associated with blue and she frequently experienced anxiety and frustration within these blue scenes, her surrounding herself with blue and blue lighting was interpreted to mean that she uses blue as an attempt to alleviate her anxiety. Moving onto the red scenes; the scenes provided maintained a consistent tone and character association of Sebastian. The scenes all leaned towards a more happy and uplifted tone. With the scenes *Mia and Sebastian's Theme*, *Start a Fire*, and *Someone in the Crowd* all providing relief or validation. *Mia and Sebastian's Theme* and *Start a Fire* both exemplify Sebastian's joy for jazz and the art, where he puts his livelihood on the line in pursuit of his dream of being a successful jazz artist. *Someone in the Crowd* does not include Sebastian, however, Mia, who was overwhelmed by the bustling Hollywood party, escaped to an entirely red-lit bathroom to decompress and find contentment. In *Someone in the Crowd* and *Mia and Sebastian's Theme*, Mia overcame her frustration and anxiety by finding the comfort of red lighting (See Fig. 3 and Fig. 4).

This would help to explain comfort she found in Sebastian and his presence, as well as reinforcing the notion that Sebastian is associated with red within the film. Color psychology associates red with strong emotions such as passion as well as having an exciting nature (London Image Institute). Again, Sebastian has a great passion and joy is jazz within the film, further solidifying his association with red. Mia finding solitude and relief in the red within *Someone in*

*the Crowd* and *Mia and Sebastian's Theme* was interpreted to be indicative of her attraction to Sebastian and his passionate and exciting nature. The final scenes to discuss would be the purple scenes, again, who's scenes maintained a consistent tone as well as associations with the relationship of Mia and Sebastian. These scenes help to describe the romantic progression of their relationship, holding a tone of romanticism throughout. *City of Stars* displays a vibrant light purple horizon as Sebastian describes his hopefulness towards the growing relationship, on a metaphorical horizon, between Mia and Sebastian. The scenes *Planetarium*, *Summer Montage*, *Epilogue*, and *The End* all described the continuity of their relationship. *Planetarium* describes the start of their relationship, as they share their first kiss and officially enter a relationship. *Summer Montage* describes the middle of their relationship, where they move in together and spend a large portion of their days together. *Epilogue* and *The End* describe the reminiscence of their relationship, as they reflect on their past together, putting a bittersweet end to their relationship. Color psychology associates purple with great ambition and spirituality (London Image Institute). The description of spirituality would help to explain the great connection they felt to one another as their relationship progressed. As for ambition, both Mia and Sebastian had their respective dreams of a successful acting career and owning a jazz club. Both achieved their aspirations, with Mia being a famous Hollywood actress and Sebastian owning his own club. *Audition* contains a light purple shirt as one of the few colors within the scene, which was interpreted to describe Mia's waning ambition. This audition was her last shot before she was ready to give up on her dream. Moreover, some scenes such as *Mia and Sebastian's Theme* and *Start a Fire* contained overlapping instances of blue and red. *Start a Fire* specifically was indicative of their growing separation where Sebastian was being taken over by the passion for jazz, and Mia felt pushed away, where she reverted back to anxiety and frustration. Sebastian was encapsulated in red lighting, while Mia was covered in blue lighting (See Fig. 5 and Fig. 6).



## Conclusion

Results for this research proved to hold a significant connection between the colors blue, red and purple, and how they relate to certain categories of tones as well as how they associate with specific characters within the film *La La Land*. These colors also proved to be emphatic of the tones and characters they hoped to express. The emphasis of the tones, story elements, and characters were achieved through the elaborate use of understood three techniques. The first being character associations, where Mia was associated with blue, Sebastian with red, and their relationship as purple. The second being emotional associations, where each color had a

categorical tone that could be applied to it, such as more sad or depressed with blue, more happy and uplifted with red, and more romantic with purple. The third technique would be the use of lighting, background, and other parts of set design, which helped to greatly emphasize the colors in the observed scenes. Each of these techniques were all helpful in coming to the conclusion that the colors blue, red, and purple within *La La Land* built upon the story and functionally described certain story elements such as characters and tones. This addresses the initial gap within the research of a lack of discussion over the large involvement of color within *La La Land* and how that involvement is significant and important with the given results. One limitation of my research, however, would include a possible bias, as personal observations led the research to this conclusion, and a change in the observer(s) of the film could be beneficial in removing this possibility. Another limitation of this research would include the narrowed criteria at which the film was observed. Had the film been observed in its entirety, more data may have been collected to either refute or support the current conclusion. Based on the results of this research, color has a significant impact on the film *La La Land* and further inspection of not only this film, but other films could prove even more significantly why director's should make great use of color within their works. Therefore this research has led to the understanding that color can either create or emphasize tones and environments, and an increased application of color to one's film would greatly encapsulate audiences, and connect to them emotionally, as was the overall director's intent of *La La Land*(Academy Conversations: La La Land).

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## **HIF1A Expression is a Common Cause for the Warburg Effect in Lung Cancer Tumors, Cervical Cancer Tumors, and Brain Cancer Tumors By Pranav Medida**

### **Abstract**

This paper focuses on the relationship between HIF1A expression and the warburg effect. Considering that the warburg effect is a hallmark of cancer, it's possible that it could be caused by a common mechanism within tumor microenvironments. This paper considers the common cause of that to be hypoxia and HIF1A overexpression. By experimenting on mouse models and cancer cell lines for lung tumors, brain tumors, and cervical tumors, we investigate to find whether HIF1A overexpression is, in fact, a common cause for the warburg effect among the tested cancer types. The results were very promising and with this understanding, treatments can be developed to block HIF1A expression which would cause the inhibition of the warburg effect and decrease cancer cell proliferation rate.

### **Introduction**

All cells require energy in the form of Adenosine Triphosphate(ATP) to perform a multitude of cellular functions. ATP is a product of cellular respiration which consists of three separate parts. The first step is glycolysis followed by the citric acid cycle(krebs cycle) and then the electron transport chain. Glycolysis oxidized glucose to create intermediates called pyruvates and 4 ATP per glucose(net gain of 2 ATP). Pyruvates are used in the following steps to create 36 ATP per glucose by the end of the electron transport chain. This metabolic pathway requires oxygen, but in the absence of oxygen, cells use an alternate pathway called lactic acid fermentation. Instead of going to the mitochondria to be oxidized in the citric acid cycle, the pyruvate produced in glycolysis goes to the cytoplasm and is then reduced to lactate using lactate dehydrogenase. By producing lactate, Nicotinamide adenine dinucleotide hydrogen(NADH) is reduced to Nicotinamide adenine dinucleotide(NAD<sup>+</sup>) which allows for glycolysis to occur again. Glycolysis relies on NAD<sup>+</sup> to act as a reducing agent and accept an electron to split glucose into 2 pyruvate molecules. This would allow glycolysis to keep running so that ATP can be produced despite the absence of oxygen. This would be used when you need to generate ATP rapidly during, for example, an intense workout.

The warburg effect, introduced by Otto Warburg, is a hallmark of cancer and follows a similar pathway to lactic acid fermentation despite the presence of oxygen giving it the name aerobic glycolysis. While it may seem inefficient, aerobic glycolysis requires fewer steps than the traditional metabolic pathway, which allows tumor cells to produce ATP 10-100<sup>1</sup> times faster. This rate of production compensates for the inefficiency of ATP production from aerobic glycolysis<sup>1</sup>. The quick rate of ATP production is also why tumor cells prefer this metabolic pathway to support their rapid cell proliferation.

Due to the efficiency of oxidative phosphorylation, many multicellular organisms evolved to utilize aerobic respiration as their primary strategy of ATP production. This created a heavy dependence upon oxygen for ATP production and exposure to hypoxic environments

caused organisms to evolve mechanisms to survive in a hypoxic environment. One of these adaptations was the introduction of Hypoxia Inducible Factors(HIF)<sup>4</sup> which would assist in mediating cellular metabolism during a state of hypoxia to allow for cell and tissue survival. HIF1 is made up of HIF $\alpha$ (HIF1 $\alpha$ , HIF2 $\alpha$ , HIF3 $\alpha$ ) and HIF1 $\beta$ <sup>3</sup>. During a state of hypoxia, HIF $\alpha$  forms a heterodimer with HIF1 $\beta$  which causes enhanced expression of metabolic enzymes. This increases the expression of pyruvate dehydrogenase kinase1(PDK1) which phosphorylates pyruvate dehydrogenase(PDH)<sup>3</sup>. PDH is necessary for the conversion of pyruvate into acetyl Coenzyme A(acetyl CoA)<sup>3</sup>. This prevents the citric acid cycle from following and decreases the need for oxygen. This causes an overall decrease in cellular metabolism. By enhancing the glycolytic enzyme expression, HIF1 enhances the rate of glycolysis to make more ATP.

Tumor microenvironments tend to exist in a state of hypoxia which causes HIF1 to be overexpressed<sup>5</sup>. Considering that the warburg effect is a hallmark of cancer it's possible that the HIF1 overexpression is a primary and common cause of the warburg effect in cancer. Understanding the relationship between the warburg effect and HIF1 expression is critical to creating a new therapeutic approach to cancer treatment. Finding a way to prevent the instigation of the warburg effect by blocking HIF1 expression would decrease the rate of cancer progression and could prove useful to cancer therapy.

## Results

To understand the relationship between HIF1A and tumor environments, data from the cancer genome atlas can be used to compare the levels of expression between cancer cells and normal cells. We can then compare it to the levels of oxygen within tumor environments to confirm that a state of hypoxia is what causes overexpression of HIF1A.

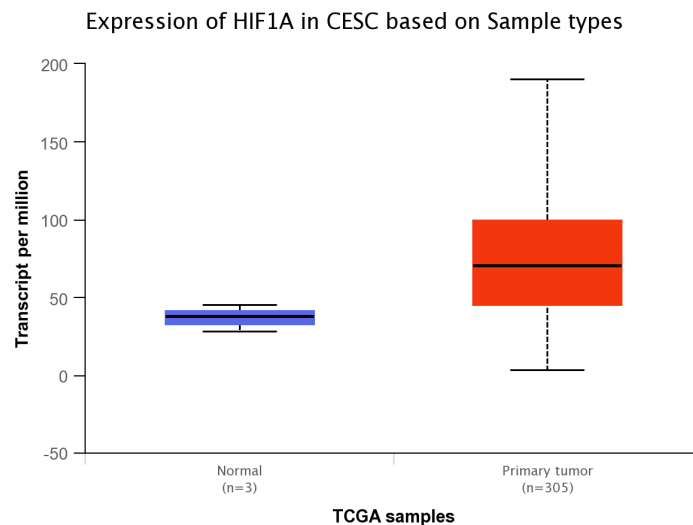


Figure 1A. HIF1A expression in Lung Adenocarcinoma compared to normal tissue sampling. HIF1A is shown to have much higher expression in tumor tissue compared to normal tissue.<sup>6</sup>  
 Figure 1B. HIF1A expression in Cervical squamous cell carcinoma compared to normal tissue sampling. HIF1A is shown to have a much higher level of expression in tumor samples.<sup>7</sup>

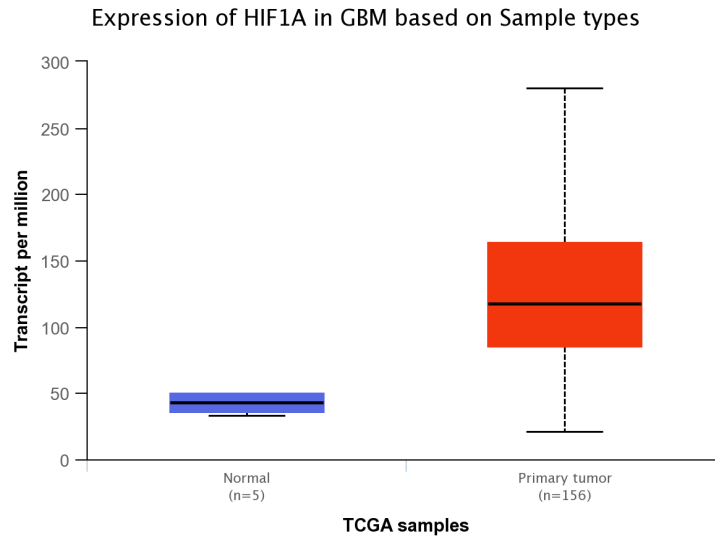
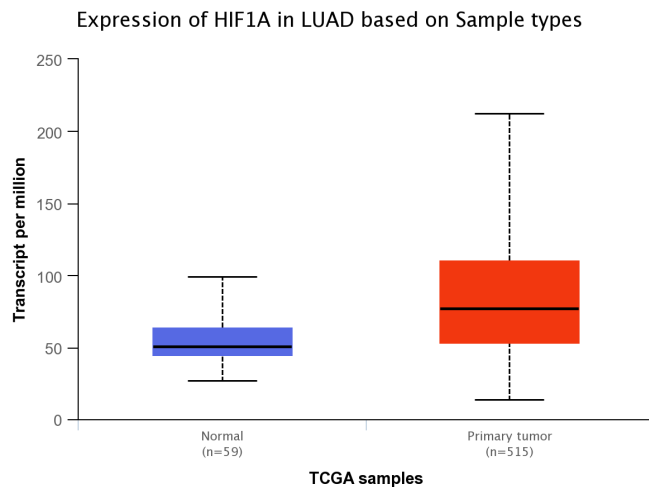


Figure 1C. HIF1A expression in Glioblastoma Multiforme. HIF1A is shown to have a much higher level of expression in tumor samples<sup>8</sup>.

As shown in Figure 1A, in Lung Adenocarcinoma, HIF1A is shown to have increased expression compared to normal lung cells. Furthermore, data comparing HIF1A expression in cervical squamous cell carcinoma and glioblastoma multiforme shows a similar trend in HIF1A expression between normal cells and tumor cells. The increase in all of these types of cancers indicates that it's potentially caused by a common trait that exists in all the tumor microenvironments.



Tumour type	Median tumour pO <sub>2</sub>	Median % oxygen	Median normal tissue pO <sub>2</sub>	Median % oxygen	Fold pO <sub>2</sub> decrease <sup>a</sup>
Brain	13.0	1.7	26.0	3.4	2.0
Lung cancer	14.3	1.9	ND	5.6	3.0
	16.6	2.2	42.8	5.6	2.6
Cervical cancer	9.0	1.2	42.0	5.5	4.7

Figure 2A. Oxygen levels in each cancer type compared to the normal amount of oxygen. Mouse model GL261 was shown to have a partial pressure of 13.0 atm which is 50% normal amount. Mouse model LSL-Kras-G12D had a partial pressure of oxygen of 16.6 atm which is 38.7% of the normal amount. Mouse model K14E7 had a partial pressure of oxygen of 9.0 atm which is 18.8% of the normal amount. Oxygen was measured using oxygen pO<sub>2</sub> microsensors.(hypothetical)<sup>9</sup>

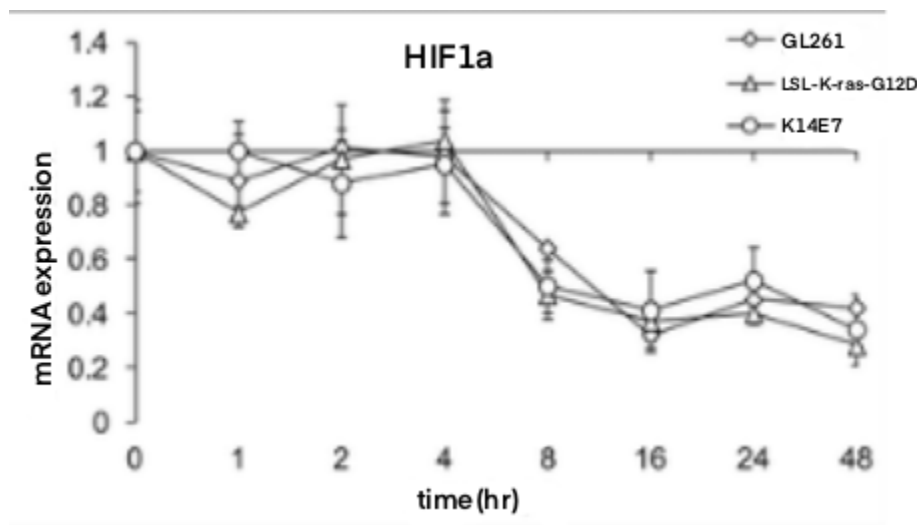


Figure 2B. mRNA expression in GL261, LSL-Kras-G12D, and K14E7 in a state of hypoxia with a linearly increasing level of oxygen through oxygen filled microbubbles. mRNA expression of HIF1A was highest during the lowest levels of oxygen presence and it decreased as oxygen levels increased indicating HIF1A expression is caused by hypoxia. mRNA of HIF1A was measured using qPCR.(hypothetical)<sup>10</sup>

By utilizing a mouse model for each respective cancer type, we can measure the oxygen levels within tumor microenvironments for each cancer type and compare it to normal levels of



oxygen. Following that, we can measure the HIF1A mRNA levels and compare it to normal levels to draw a direct correlation between the two. As shown in figure 2a, the oxygen levels are considerably lower for the tumor microenvironments in each tumor type. Tumors associated with the brain, lung, and cervical cancer were shown to have a drop in the partial pressure of oxygen. Lower partial pressure of oxygen indicates that there is less oxygen in tumors than normal. HIF1A expression is a reaction to hypoxia and considering the increased levels of HIF1A expression this shows that hypoxia is a common cause for the metabolism change that is induced by HIF1A expression which is supported by the data in figure 2b. Despite the fact that these are different types of cancers within different organs, the tumors each share a common physical property which causes the common metabolism change called the warburg effect through HIF1A expression.

### **Overexpression of HIF1A is a Direct Instigator of the Warburg Effect**

An indication of the warburg effect is an increased level of lactate since lactate is a byproduct of the warburg effect. By utilizing cell lines for each respective cancer type, we were able to experiment on the relationship between HIF1A and lactate. We manipulated the HIF1A expression in A549(lung cancer cells), SiHa(cervical cancer cells), and LN 229(brain cancer cells) by inducing a state of hypoxia and then measured the levels of lactate. As shown in figure 3, each type of cancer showed an increase in lactate levels when HIF1A expression was increased. Since HIF1A expression causes a greater rate of glycolysis, NAD<sup>+</sup> has to be regenerated from NADH to keep up with the increased rate of glycolysis. To do so, pyruvate is reduced to lactate which causes an increase in the levels of lactate. Consequently, a greater level of HIF1A expression causes greater lactate production. The relationship between lactate and HIF1A shown in figure 3 indicates that HIF1A upregulation is a direct cause for the warburg effect within the studied cancer types. As previously shown, the decreased levels of oxygen for each cancer type was associated with increased HIF1A expression which was, now, correlated with increased lactate production. Considering that hypoxia is a common trait of tumor microenvironments and it causes HIF1A expression, it's possible that hypoxia is a common cause of the warburg effect in lung cancer, cervical cancer, glioblastoma multiforme, potentially

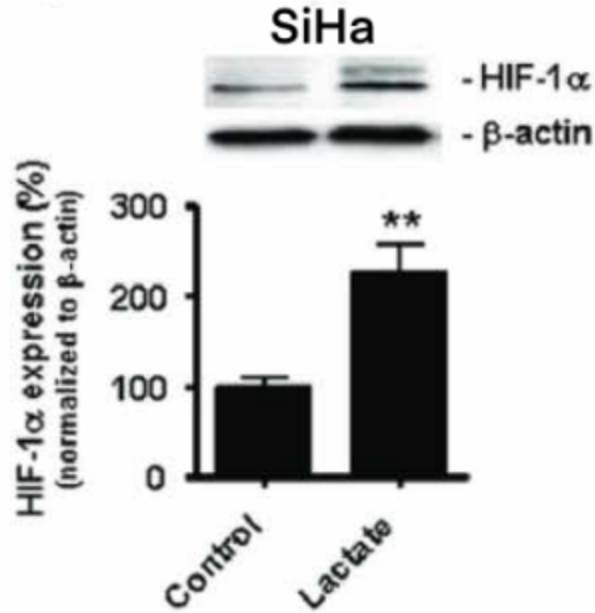


Figure 3A. SiHa was placed into a state of hypoxia to cause HIF1A overexpression and then the lactate levels were measured using bioluminescence imaging. As HIF1A expression increased, the lactate levels increased which indicates a direct relationship between the two.(hypothetical)<sup>11</sup>

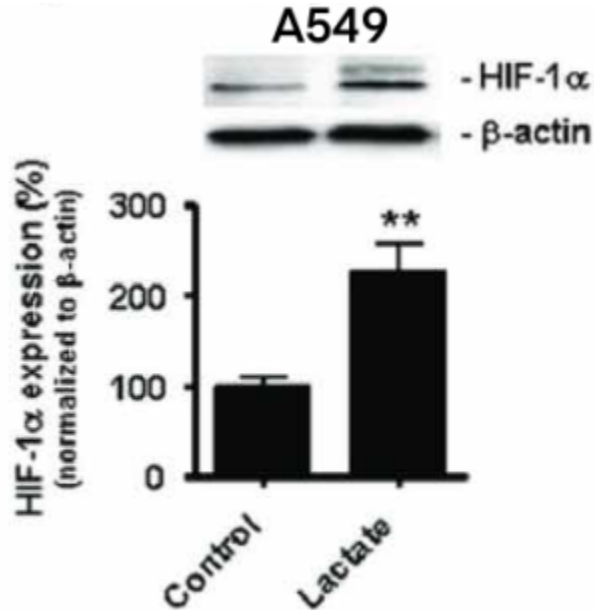


Figure 3B. A549 was placed into a state of hypoxia to cause HIF1A overexpression and then the lactate levels were measured using bioluminescence imaging. As HIF1A expression increased, the lactate levels increased which indicates a direct relationship between the two.(hypothetical)<sup>11</sup>

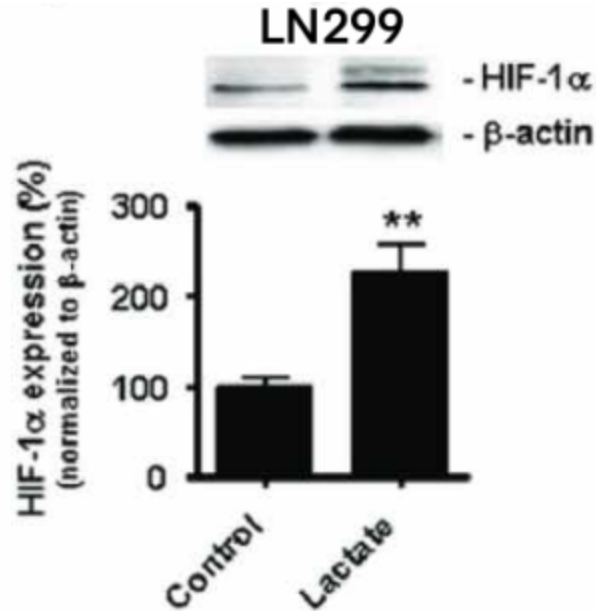


Figure 3C. A549 was placed into a state of hypoxia to cause HIF1A overexpression and then the lactate levels were measured using bioluminescence imaging. As HIF1A expression increased, the lactate levels increased which indicates a direct relationship between the two. (hypothetical)<sup>11</sup>

## Discussion

The warburg effect is a trait of cancer cells that provide them with the adaptability to survive and proliferate at an alarming rate. This study focuses on whether HIF1A overexpression is a common cause for the warburg effect within lung, brain, and cervical tumors. HIF1A reacts to a state of hypoxia. Considering the low decreased levels of oxygen within the tumors, it's not surprising to see that HIF1A is overexpressed in the tumors. Furthermore, increased HIF1A expression was associated with greater levels of lactate which is a product of the warburg effect. This directly shows the correlation between the two and is consistent with each tumor type. This tells us that HIF1A is a common instigator of the warburg effect within the cancer types studied. But due to the difference in origin of cancer, there doesn't seem to be one gene or mechanism that causes the warburg effect throughout all cancers. For example, we see lower expression of HIF1A within pancreatic cancer compared to normal pancreatic cells<sup>12</sup>. This shows an inconsistency, but even this inconsistency can be questioned further.

Specifically, whether there is an external mechanism that purposefully suppresses HIF1A expression to increase metastasis and invasion and whether HIF1A still plays a role in instigating the warburg effect in pancreatic cancer. If it does still play a role in the warburg effect, then it can potentially eliminate some doubt around the inconsistencies surrounding the expression of HIF1A, because other types of cancer can follow a similar style. Another path of research could be trying to find other genes that are primary instigators of the warburg effect. Despite understanding the genetic origin of the warburg effect, trying to prevent it is still very difficult

because therapy focused on this has to be localized to cancer cells. Finding other genes would help create treatments that target the proteins that are expressed by the genes in therapy. Further research could also dive into how to localize gene therapy or identify unique features about cancer cells to create treatment targeted towards that. With our understanding of the origin of the warburg effect, we can create treatments to counteract it and potentially slow down tumor progression and cell proliferation.

Due to the nature of the warburg effect, specifically the tendency to use glucose faster, more glucose and resources tend to be sent to cancer cells for their survival. This takes away from the energy that other organs need to function and can lead to worse functioning. By stopping the warburg effect, cancer cells wouldn't get most of the glucose and resources which would lead to a healthier and more beneficial distribution of resources and energy throughout the body. Cancer cells would be forced to rely upon oxidative phosphorylation which wouldn't be very efficient or beneficial due to the lack of oxygen. The lack of energy would dramatically decrease the rate of cell proliferation.

### **Materials and Methods**

1. The Cancer Genome Atlas Program (TCGA) database from the University of Alabama at Birmingham Cancer Data Analysis Portal (UALCAN) (<https://ualcan.path.uab.edu/analysis.html>) was used to obtain the expression of HIF1A expression in lung, brain, and cervical cancer tumors compared to normal tissue.
2. Mouse models for lung cancer(LSL-K-ras-G12D), cervical cancer(K14E7), and brain cancer(GL261) were purchased from Jackson Laboratory. By using oxygen microsensors, we were able to determine the partial pressure of oxygen and then compare that to normal levels of oxygen. We then measured mRNA levels by using a quantitative polymerase chain reaction method multiple times over a 48 hour time period while simultaneously increasing the oxygen levels in a linear manner. To increase oxygen levels, we used oxygen filled microbubbles.
3. A549, LN229, and SiHa were purchased from the American Type Culture Collection. Add 100 $\mu$ M of CoCl<sub>2</sub>(Cobalt (II) Chloride to the cells and incubate in a conventional incubator for 24 hours. This creates a state of hypoxia. A state of hypoxia will increase HIF1A expression which we measure. After 24 hours, lactate was measured using nuclear magnetic resonance.

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