Examining Inequality in the Vaccine System in the COVID-19 Pandemic Era

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Hamsini Muralikrishnan

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

Advisor

MC Forelle, Department of Engineering and Society

Introduction

Most people acknowledge the presence of bias, housed within communities and institutions, but the degree of this bias is often overlooked. As a product of this bias, disparities emerge, which essentially is a stark difference in an effect, service, opportunity, etc. between two or more groups. Disparities exist in institutions, notably in healthcare, and linger due to years of historical conditioning. In regards to healthcare, differences are magnified or heightened when the globe reaches a valley, in times of an epidemic or pandemic.

The healthcare system is at the intersection of political, social, and cultural issues for a multitude of sectors, namely the vaccine system. Outside the umbrella of health-related factors, the healthcare system poses disproportionate effects on populations along racial lines. The bias built into the healthcare system influences factors such as healthcare access, vaccine access, and insurance affordability, making it harder for some racial groups to interact with these services than others. Structural barriers, such as transportation, remnants of residential segregation, and healthcare insurance impede racial groups' relationship with the healthcare industry. Specifically, these barriers perpetuate the health-related disparities observed amongst racial groups, specifically African Americans. Location of vaccine clinics relative to residential areas may be inconvenient for people to access, based on ownership of a car or proximity to public transportation in neighborhoods of lower socioeconomic status (Njoku et al., 2021). This inconvenience discourages Black residents from getting medical help when needed, being informed about virus outbreaks, enquiring about symptoms, getting tested, and or even vaccinated. However, lack of transportation can also be attributed to remnants of racial residential segregation (Li & Yuan, 2021). Although racial segregation ended, its remnants have been noted as a "fundamental cause of racial disparities in health" (Williams & Collins, 2001). The degree of residential segregation is prominent specifically for African Americans.

Communities affected by this residual segregation are characterized by poor living conditions and crowded housing. These living conditions are more prone to illness and promote its rapid spread due to unhygienic and "inimical" environments (Williams & Collins, 2001). Furthermore, residential segregation has shaped the socioeconomic conditions for communities, which intertwines with redlining and affects residents' access not only to hospitals, but also to healthcare insurance.

In this paper, I argue that during COVID-19, inequality, amongst the Black community, rose through multiple venues surrounding the vaccine system, notably vaccine hesitancy, literacy, and rollout/access practices. First, the literature review will set the stage and cover background on prior outbreaks and pandemics. In this context, the literature review will define and discuss structural barriers and health-related factors such as medical mistrust, health literacy, and healthcare access. To answer the research question, I will conduct content/ thematic analysis. For the data, I will gather information specific to the COVID-19 vaccine, relying on datasets and academic journal articles focused on 2019 - present day. The content of this data will cover vaccine hesitancy, literacy, and distribution differences among the Black vs. White populations. In the analysis, I find that there is low vaccine/health literacy, high vaccine hesitancy, and limited vaccine rollout/access amongst the Black community, which contribute to low observed vaccination rates, producing high susceptibility to COVID-19 effects and a peak in COVID-19 disparities. I conclude the paper with a discussion of how this research can be adapted by policymakers, possible effects of this research in the healthcare industry, and scope for potential future research.

Literature Review

Medical hesitancy encompasses the mistrust in the medical industry including medical practices and employees. Throughout instances in history, some racial groups, specifically the Black population, have cultivated a strained relationship not only with the healthcare system, but also the government. As noted by Laurencin (2021), African Americans have noted the "nation's history of racism in medical research and in medical care as key reasons for their hesitancy" (p.544). In terms of medical research, one large incident to note concerns Henrietta Lacks. In 1951, Henrietta Lacks, a Black woman, had been diagnosed with cervical cancer and her cells had been extracted and researched unknown to her, yielding groundbreaking results ("Henrietta lacks: Science must right a historical wrong," 2020). In an article discussing the history of medical mistrust, Nweke et al. (2022) mentions how "Black patients have been left vulnerable to the extractionary nature of what is often considered groundbreaking research and noteworthy academic discovery, such as the HeLa cells of Henrietta Lacks" (p.26). The fear and worry surrounding medicine have become a constant sentiment of hesitancy. In terms of medical care, there is a discrepancy in quality of patient care that is provided by physicians, which can stem from the ethnicity of the physicians (Laurencin, 2021). Laurencin (2021) explains that while African Americans comprise 13% of the US population, only 4% are US healthcare physicians. This lack of guarantee that all patients would receive the same attentive care and the "systemic mistreatment" (Nweke et al., 2022, p.27) contributes to the Black patients' mistrust in the medical industry (Laurencin, 2021). Furthermore, medical hesitancy also emerges from outcomes of past epidemics such as influenza (Nuwarda et al., 2022). High mortality rates and low vaccine efficacy are observed during outbreaks amongst minority groups (Willis et al., 2021), while neighboring higher income communities have made it through peaks in diseases

and seen more victory or hope in that aspect (Machingaidze & Wiysonge, 2021). This general trend in history contributes to people's low vaccine confidence, furthering the level of hesitancy in getting vaccinated. Additionally, roots of medical mistrust extend beyond the healthcare system to the government, in the discussion of slavery. Here, a power imbalance between the Black and White communities was born, but the racial attitudes and bias from this time did not end with the abolishment of slavery (Jamison et al., 2019). Instead, they permeated the walls of many institutions, specifically healthcare, which furthered the hesitancy in getting medical help or trusting medical information amongst Black citizens.

Vaccine roll out and coverage has been prioritized for wealthy communities over low-income communities. For low-income communities, structural barriers have confounded residents' ability to access healthcare institutions to utilize their services. Access to vaccines is limited in neighborhoods of lower socioeconomic status or in neighborhoods where there are still remnants of segregation or redlining, as there aren't many clinics nearby (Njoku et al., 2021). Based on a study covering outcomes and disparities of past pandemics, Walker et al. (2014) found that with the measles outbreak, "racial/ethnic minority children [predominantly Blacks] were at three to 16 times greater risk for measles than were non-Hispanic white children," as they had not been vaccinated (p.7). Additionally, statistical analysis was performed to quantify the degree of disparity in vaccine coverage between the White and Black communities for past outbreaks. Aside from the varicella vaccine, results of difference testing found that vaccine coverage for African Americans was significantly lower compared to the White population and even for the influenza vaccine, disparities in vaccine coverage were noted to be widened across for race, ethnicity, and socioeconomic factors (Barker et al., 2002). Regardless of impeding factors such as unequal access to clinics or transportation issues, low vaccine distribution

amongst racial minority groups has been normalized during peaks and stagnant stages of outbreaks (Linn et al., 2010).

Race is associated with health literacy levels, which affects citizens' readiness to get medical help. Prior to discussion, health literacy is defined as what "enables people to understand the reasons behind medical recommendations and take cognizance of the possible outcomes of their actions" (Engelbrecht et al., 2022, p. 2). Factors such as income and education level affect one's grasp on healthcare concepts, shaping different health literacy levels (Osborn et al., 2007). Across multiple studies, families characterized by this low income and education levels, and therefore low health literacy, were predominately Black (Osborn et al., 2007). With low health literacy, researchers found that there was low, even a lack of, adherence to medication. In one specific study discussing HIV, individuals with low literacy skills have been more likely to possess a poor working knowledge of their disease and its treatment (Osborn et al., 2007). Kalichman et al. (2000) expanded on this and found that infected patients with limited literacy had less general knowledge of the disease and their own treatment compared to patients with adequate literacy, and that they were less likely to have an undetectable viral load. Generally, low health literacy has congregated amongst the African American community due to habitual association with low education levels, which is rooted in limited access to reliable educational resources.

Marvin's (1998) framework in *Inventing an Expert* examines the relationship between electrical engineers and the user community. In this discussion, she explains how aliens or non-experts were taken advantage of on the premise of knowledge by experts in the field. Marvin emphasizes that "as race, class, and station converged between experts and the technologically non conversant in stories of their encounters, coercion and deception were less and less

prominently featured" (Marvin, 1998, p.33). Experts felt that integrity did not need to be practiced or preserved amongst non-expert communities (Marvin, 1998). Using experts' belief in intellectual inferiority, Marvin (1998) further develops this idea of exercising knowledge as power to further their agenda. This framework will be applied, in a focused sense, to evaluate how differences in vaccine literacy levels can work to exacerbate disparities in COVID-19 effects among racial minority groups.

While Marvin's framework examines the specific power dynamic between the vaccine system and the Black community, I will use Winner's (1980) framework in *Do Artifacts Have Politics?* to examine the broader issue of discrimination in the vaccine system. This framework examines multiple instances in history where artifacts exercise politics– such as the overpasses designed by Robert Moses and the innovation of pneumatic molding machines by Cyrus McCormick. Both of these innovations were strategically designed to exercise power and control over disadvantaged groups– in the case of Robert Moses, the overpasses prevented buses, heavily utilized by racial minority groups and low-income families, from accessing parks and recreational activities (Winner, 1980). Winner (1980) essentially highlights that artifacts or systems have been implemented with a discriminatory bias built into the design or have been implemented in a specific social climate to exercise power over disadvantaged communities. I will apply this framework to look at the concept of vaccine hesitancy and how innate bias built into the vaccine system, due to the harsh racial climate, has built an untrustworthy foundation for the relationship between the Black community and the vaccine system.

Methods

This research will explore the research question: *In light of the recent pandemic, how has inequality risen through the vaccine system?* To answer this question, I will conduct

content/thematic analysis, relying on primary and secondary sources as venues of evidence. For primary sources, I relied on Google Scholar and UVA Library sources to gather datasets that include surveys and studies that were conducted to quantify the degree of disparity among racial groups. Essentially, with data such as socioeconomic status, race, ethnicity, or living conditions, researchers were able to see if there was a correlation between these variables and factors such as vaccine hesitancy, vaccine literacy, or vaccine distribution, which directly related to COVID-19 effects. The significance of these relationships was evaluated and I can pull from this to make more sound claims in the STS research paper. For secondary sources, I again pulled from Google Scholar and UVA Library sources to find dense academic journal articles that focus on the contributions of structural barriers, and differences in vaccine access, literacy levels, or hesitancy levels in furthering observed COVID-19 disparities. These journal articles performed comparative analyses between racial groups, social groups, or areas to understand how these factors affected one's ability to ultimately get vaccinated and be less susceptible to COVID-19, by lowering positivity, hospitalization, and mortality rates.

To preface prior to analysis, minority communities of low socioeconomic status and low income are predominantly Black or Hispanic. For this research and analysis, mentions of these communities will concern the Black population as they are noted to be "disproportionately affected by poverty, fallible public school system, unsafe neighborhoods, ... and chronic health conditions" (Johnson-Agbakwu et al., 2020, p. 52).

Analysis

During the COVID-19 pandemic, African Americans were more hesitant to vaccinate, which worked to further effects of COVID-19 amongst this community. Medical mistrust, which contributes to this vaccine hesitancy, is defined as "distrust of healthcare providers, the health

care system, medical treatments, and the government as a steward of public health" (Bogart et al., 2021, p. 200). This idea of medical mistrust is prominent among African Americans, due to the pattern of mistrust, between these individuals and institutions, that has been well established prior to the pandemic. In a study done by Willis et al. (2020), researchers conducted a survey, asking questions related to COVID-19 health literacy, fear of infection, general trust in vaccines, and COVID-19 vaccine hesitancy. Based on survey results, they found a significant association between fear of COVID-19 infection and mistrust in vaccines, and vaccine hesitancy. Other factors such as race, age, ethnicity, socioeconomic status, etc. were noted and this vaccine hesitancy was high among low-income communities (Willis et al., 2021, pp. 2201-2202). Essentially, with high vaccine hesitancy rooted in medical mistrust, mistreatment of African Americans, or fear of infection, there are low observed vaccination rates. With low vaccination rates, these communities are more susceptible to COVID-19, contributing to disparities in COVID-19 positivity, hospitalization, and mortality rates. Additionally, Liu & Li (2021) analyzed results from multiple survey studies focusing on COVID-19 vaccination.

From May-June 2020, the researchers conducted an initial survey to gauge the state of COVID-19 disparity and results elicited that vaccination hesitancy and refusal is highly correlated with the Black American community (Liu & Li, 2021). At the end of the year, the researchers conducted another survey to evaluate any progression on the vaccine hesitancy front, but they found that racial disparities are still present and "in particular, revealed that past experience of racial discrimination plays an important role in producing racial differences in attitudes towards COVID-19 vaccines" (Liu & Li, 2021, p. 5). This history of mistrust and mistreatment of African Americans propels this community to question the vaccine's efficacy, in addition to panic surrounding the rapid spread and unfamiliarity associated with COVID-19 at the time. In a

study comparing vaccine hesitancy among all racial groups, researchers found that Black groups had the highest overall vaccine hesitancy, due to either low confidence in the vaccine/science or wariness of the healthcare system as a whole (Liu & Li, 2021). This sentiment of medical mistrust is a product of years of innate system discrimination and targeted racism towards the Black community (Winner, 1980). The vaccine and the overarching healthcare systems are innately biased towards minority groups, specifically the Black community, hindering their access to health services and furthering health disparities (Winner, 1980). This tendency to favor the White population is an aspect that is native to the healthcare system due to the nature of authority figures and the hostile racial climate carrying forth a political agenda (Winner, 1980).

COVID-19 vaccine distribution and access differed amongst communities of varying racial backgrounds, largely affecting the Black community. As explained by Tartar et al. (2020), COVID-19 vaccine distribution has been prioritized in areas of high socioeconomic status– the wealthiest of countries and the wealthiest of areas within the United States. These areas of low socioeconomic status had comparably poor living conditions consisting of crowded housing and unhygienic environments, making them prone to illness. Efforts for vaccine distribution in low-income areas should be prioritized due to the large number and rapid spread of illnesses. Tartar et al. (2021) explains that without this region-based priority, "COVID-19 'hot spots' and opportunities for the emergence of new, potential "escape variants" of SARS-COV-2 may deepen the ongoing COVID-19 pandemic challenges" and disparities among the Black American community (p.2). In a study done by Asundi et al. (2022), researchers look into differences in vaccine distribution and access across the globe. The study results elicited that "almost 85% of global vaccine doses administered have been in high- and upper-middle-income countries" (Asundi et al., 2022, p.1036), while only a small percentage of low-income countries have

received a vaccine dose. Additionally, in the beginning of the pandemic, minority communities suffered more due to pre-existing conditions and housing quality/conditions. But, as wealthier communities were given more attention, vaccine rollout happened earlier here. Other communities suffered harsher from COVID-19 effects, furthering the pandemic's disparities on minority groups. Furthermore, to identify factors relevant to unequal vaccine distribution, Bayati et al. (2022) analyzed nineteen studies to compare and contrast their respective findings. In these studies, researchers identified two groups of factors: economic and social where "thirteen studies (68.42%) referred to the factors of economic characteristics and all studies referred to the factors of demographic and social characteristics of individuals" (pp. 4-5). Essentially, demographic and social factors, referring to race and ethnicity, are regularly mentioned and highly correlated with the discussion of vaccine access or distribution inequity.

As argued above, the healthcare system is racially biased and its actions in terms of vaccine distribution are racially motivated. However, some may argue that the healthcare industry takes these actions for business purposes. Essentially, economics is at the forefront of their actions, rather than racial bias confounding their decisions or actions. Acharya et al. (2021) explains that as "many LICs have low socio-economic status with low levels of education, income, and occupation, these factors may directly affect the vaccine-purchasing and accepting processes of their people" (p.1). So, to preserve economic integrity and to ensure that vaccine supply does not go to waste, healthcare businesses prioritize communities of higher socioeconomic status that have a high demand for vaccines and can afford this. But this view fails to consider Winner's (1980) perspective that there is innate bias within the healthcare system, which does produce disparities between racial groups, in regards to vaccine access.

Lower levels of health or vaccine literacy amongst African Americans furthered COVID-19 disparities. Low health literacy is associated with factors such as race which are associated with lack of higher education or low income, leading to low understanding concerning the seriousness of the pandemic. Racial minorities, specifically African Americans, won't be able to identify symptoms of COVID-19, know when to get tested, or get medication, which sufficiently contributes to higher positivity and hospitalization rates (Rodon et al., 2022). During the beginning of the pandemic, there was a lot of hysteria, miscommunication, misinformation, and lack of understanding of the new virus. One aspect of health literacy level is rooted in the general willingness to educate African Americans. In a study done by Szilagyi et al. (2021), findings confirm that comparatively, healthcare professionals and other outreach groups don't make an active effort to educate African Americans on vaccination options, COVID-19 symptoms, testing, or quarantine guidelines. Misinformation to Black Americans does not only come from social media, but also from healthcare professionals taking advantage of the power dynamic. Marvin's (1998) *Inventing the Expert* can be applied to understand that healthcare experts exploit their relationship with non-experts, in this case the Black community, by spreading misinformation or withholding information through inadequate education. By exploiting their relationship and using knowledge as power, experts exacerbated disparities amongst *aliens* (Marvin, 1998). Furthermore, groups with high health literacy, such as the White population, also take advantage of people with low health literacy, by spreading misinformation through social media and promoting anti-vaccine beliefs/attitudes. Additionally, in a study done by Kricorian et al. (2021), "race and ethnicity were also significantly associated with belief in COVID-19 vaccine safety ($\chi2 = 11.42$, $df = 4$, $p < .05$), with White respondents disproportionately believing the vaccine was safe and Black respondents believing that it was

unsafe (both $p < .05$)" (p. 6). Black respondents' disbelief in vaccine safety was not based on concrete scientific data, but emerged because of hesitancy and limited understanding of the science behind the vaccine and its effects. Structural barriers, such as access to the internet due to redlining in low-income communities, impacts residents' ability to educate themselves on virus progression, testing, and vaccine resources. But, even with access to the internet or resources, understanding COVID-19 information, surrounding symptoms, testing, quarantine requirements, and vaccination require a high level of health literacy (Popa et al., 2022).

Conclusion

This research develops an understanding of the depth of bias in the healthcare and vaccine systems which targets racial minority groups, particularly African Americans. Years of racism and the White supremacy mindset have molded the healthcare system, regardless of laws and policies that have been passed to reverse years of reform and the racist attitude. Specifically, in the most recent pandemic, racism has permeated through the vaccine system, eliciting disparities in vaccination rates and COVID-19 effects amongst the Black community. Policymakers, who can pass policies or laws, can adapt this research to emphasize healthcare equity explicitly. In terms of vaccine distribution, healthcare policymakers should prioritize vaccine roll out and medical care in disadvantaged communities. With vaccine literacy, residents or a community outreach group can develop a program that educates disadvantaged communities about healthcare and related news or trends, keeping them up to date. Ultimately, this research can not only bring awareness to the reality of racism and bias that exist within institutions, but also open a possible venue for establishing true healthcare equity. In regards to future research, I think it would be good to focus on a different racial group, to provide a different perspective when discussing the healthcare disparities. Currently, there is a lot of data surrounding healthcare

disparities concerning African Americans and Hispanics, so it would be interesting to focus on another racial group and see if more data concerning other racial groups has accumulated in later years. Furthermore, with this paper, the data has been more global, rather than region specific, so being more specific would narrow the breadth of research.

References

Acharya, K. P., Ghimire, T. R., & Subramanya, S. H. (2021). Access to and equitable distribution of COVID-19 vaccine in low-income countries. *Npj Vaccines*, *6*(1). https://doi.org/10.1038/s41541-021-00323-6

Asundi, A., O'Leary, C., & Bhadelia, N. (2021). Global covid-19 vaccine inequity: The scope, the impact, and the challenges. *Cell Host & Microbe*, *29*(7), 1036–1039. https://doi.org/10.1016/j.chom.2021.06.007

Barker, L. E., Luman, E. T., McCauley, M. M., & Chu, S. Y. (2002). Assessing Equivalence: An Alternative to the Use of Difference Tests for Measuring Disparities in Vaccination Coverage. *American Journal of Epidemiology*, *156*(11), 1056–1061. https://doi.org/10.1093/aje/kwf149

Bayati, M., Noroozi, R., Ghanbari-Jahromi, M., & Jalali, F. S. (2022). Inequality in the distribution of covid-19 vaccine: A systematic review. *International Journal for Equity in Health*, *21*(1). https://doi.org/10.1186/s12939-022-01729-x

Bogart, L. M., Ojikutu, B. O., Tyagi, K., Klein, D. J., Mutchler, M. G., Dong, L., Lawrence, S. J., Thomas, D. R., & Kellman, S. (2021). Covid-19 related medical mistrust, health impacts, and potential vaccine hesitancy among Black Americans living with HIV. *JAIDS Journal of Acquired Immune Deficiency Syndromes*, *86*(2), 200–207. https://doi.org/10.1097/qai.0000000000002570

Engelbrecht, M. C., Kigozi, N. G., & Heunis, J. C. (2022). Factors Associated with Limited Vaccine Literacy: Lessons Learnt from COVID-19. *Vaccines*, *10*(6), Article 6. https://doi.org/10.3390/vaccines10060865

Jamison, A. M., Quinn, S. C., & Freimuth, V. S. (2019). "You don't trust a government vaccine": Narratives of institutional trust and influenza vaccination among African American and white adults. *Social Science & Medicine*, *221*, 87–94. https://doi.org/10.1016/j.socscimed.2018.12.020

Johnson-Agbakwu, C. E., Ali, N. S., Oxford, C. M., Wingo, S., Manin, E., & Coonrod, D. V. (2020). Racism, covid-19, and health inequity in the USA: A call to action. *Journal of Racial and Ethnic Health Disparities*, *9*(1), 52–58. https://doi.org/10.1007/s40615-020-00928-y

Kalichman, S. C., Benotsch, E., Suarez, T., Catz, S., Miller, J., & Rompa, D. (2000). Health literacy and health-related knowledge among persons living with HIV/AIDS. *American Journal of Preventive Medicine*, *18*(4), 325–331. https://doi.org/10.1016/s0749-3797(00)00121-5

Kricorian, K., Civen, R., & Equils, O. (2021). Covid-19 vaccine hesitancy: Misinformation and perceptions of vaccine safety. *Human Vaccines & Immunotherapeutics*, *18*(1). https://doi.org/10.1080/21645515.2021.1950504

Laurencin, C. T. (2021). Addressing Justified Vaccine Hesitancy in the Black Community. *Journal of Racial and Ethnic Health Disparities*, *8*(3), 543–546. https://doi.org/10.1007/s40615-021-01025-4

Li, M., & Yuan, F. (2021). Historical redlining and resident exposure to covid-19: A study of New York City. *Race and Social Problems, 14*(2), 85-100. doi:10.1007/s12552-021-09338-z

Linn, S. T., Guralnik, J. M., & Patel, K. V. (2010). Disparities in Influenza Vaccine Coverage in the United States, 2008. *Journal of the American Geriatrics Society*, *58*(7), 1333–1340. https://doi.org/10.1111/j.1532-5415.2010.02904.x

Liu, R., & Li, G. M. (2021). Hesitancy in the time of coronavirus: Temporal, spatial, and sociodemographic variations in covid-19 vaccine hesitancy. *SSM - Population Health*, *15*, 100896. https://doi.org/10.1016/j.ssmph.2021.100896

Machingaidze, S., & Wiysonge, C. S. (2021). Understanding covid-19 vaccine hesitancy. *Nature Medicine*, *27*(8), 1338–1339. https://doi.org/10.1038/s41591-021-01459-7

Marvin, C. (1988). Inventing the Expert. In *When Old Technologies were new: Thinking about electric communication in the late nineteenth century* (pp. 9-62). New York: Oxford University Press.

Nature Publishing Group. (2020, September 1). *Henrietta lacks: Science must right a historical wrong*. Nature News. Retrieved March 15, 2023, from https://www.nature.com/articles/d41586-020-02494-z

Njoku, A., Joseph, M., & Felix, R. (2021). Changing the narrative: Structural barriers and racial and ethnic inequities in covid-19 vaccination. *International Journal of Environmental Research and Public Health, 18*(18), 9904. doi:10.3390/ijerph18189904

Nuwarda, R. F., Ramzan, I., Weekes, L., & Kayser, V. (2022). Vaccine Hesitancy: Contemporary Issues and Historical Background. *Vaccines*, *10*(10), Article 10. https://doi.org/10.3390/vaccines10101595

Nweke, N., Isom, J., & Fashaw-Walters, S. (2022). Health Equity Tourism: Reckoning with Medical Mistrust. *Journal of Medical Systems*, *46*(5), 27. https://doi.org/10.1007/s10916-022-01812-4

Osborn, C. Y., Paasche-Orlow, M. K., Davis, T. C., & Wolf, M. S. (2007). Health Literacy: An Overlooked Factor in Understanding HIV Health Disparities. *American Journal of Preventive Medicine*, *33*(5), 374–378. https://doi.org/10.1016/j.amepre.2007.07.022

Popa, A. D., Enache, A. I., Popa, I. V., Antoniu, S. A., Dragomir, R. A., & Burlacu, A. (2022). Determinants of the hesitancy toward covid-19 vaccination in Eastern European countries and the relationship with health and vaccine literacy: A literature review. *Vaccines*, *10*(5), 672. https://doi.org/10.3390/vaccines10050672

Rodon, C., Chin, J., & Chevalier, A. (2022). Assessing covid-19 health literacy (COHL) and its relationships with sociodemographic features, locus of control and compliance with social distancing rules during the first lockdown in France. *Health Education Research*, *37*(3), 143–154. https://doi.org/10.1093/her/cyac009

Szilagyi, P. G., Thomas, K., Shah, M. D., Vizueta, N., Cui, Y., Vangala, S., & Kapteyn, A. (2021). Likelihood of COVID-19 vaccination by subgroups across the US: Post-election trends and disparities. *Human Vaccines & Immunotherapeutics*, *17*(10), 3262–3267. https://doi.org/10.1080/21645515.2021.1929695

Tatar, M., Shoorekchali, J. M., Faraji, M. R., & Wilson, F. A. (2021). International COVID-19 vaccine inequality amid the pandemic: Perpetuating a global crisis?. *Journal of global health*, *11*, 03086. https://doi.org/10.7189/jogh.11.03086

Walker, A. T., Smith, P. J., Kolasa, M., & Centers for Disease Control and Prevention (CDC) (2014). Reduction of racial/ethnic disparities in vaccination coverage, 1995-2011. *MMWR supplements*, *63*(1), 7–12.

Williams, D. R., & Collins, C. (2001). Racial residential segregation: A fundamental cause of racial disparities in health. *Public Health Reports*, *116*(5), 404–416.

Willis, D. E., Andersen, J. A., Bryant-Moore, K., Selig, J. P., Long, C. R., Felix, H. C., . . . McElfish, P. A. (2021). Covid-19 vaccine hesitancy: Race/ethnicity, Trust, and Fear. *Clinical and Translational Science, 14*(6), 2200-2207. doi:10.1111/cts.13077

Winner, L. (1980). Do Artifacts Have Politics? *Daedalus*, *109*(1), 121–136. http://www.jstor.org/stable/20024652