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Assessing the Impact of Social Determinants on COVID-19 Vaccination Rates in Underserved Communities

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Abstract

The COVID-19 pandemic has exposed significant disparities in vaccination rates, particularly among underserved communities. This study explores the impact of social determinants of health, including income, education, and healthcare access, on COVID-19 vaccination uptake in marginalized populations. Using a cross-sectional design, data were collected from 100 individuals across different socioeconomic backgrounds to assess vaccination behavior. The results demonstrate that individuals with higher income, better education, and greater healthcare access had significantly higher vaccination rates, while those facing economic hardship and limited healthcare access were less likely to be vaccinated. The study highlights the need for targeted public health interventions that address structural barriers and misinformation to improve vaccine equity. Recommendations include expanding healthcare access in underserved areas, enhancing health literacy, and building trust through culturally sensitive outreach. Addressing these factors is crucial for reducing health disparities and ensuring a more equitable public health response.

INTRODUCTION

The COVID-19 pandemic has highlighted critical challenges in public health, including disparities in healthcare access and health outcomes across different population groups. Despite the rapid development and rollout of vaccines, substantial disparities in vaccination rates persist, especially in underserved communities. These disparities are driven by social determinants of health, which the World Health Organization defines as the conditions in which people are born, grow, live, work, and age, and which significantly affect individuals' health outcomes (World Health Organization, 2020). Understanding the role of these determinants is crucial in addressing inequities and achieving public health objectives, such as herd immunity.

Underserved communities, often characterized by low income, limited access to healthcare, and lower educational attainment, face unique barriers to vaccination. These barriers include logistical challenges, such as transportation to vaccination sites, limited access to digital technologies for scheduling appointments, and a lack of culturally appropriate health communication (Artiga et al., 2021). Additionally, historical mistrust of the healthcare system, particularly among racial and ethnic

minorities, exacerbates vaccine hesitancy, further reducing uptake in these populations (Scharff et al., 2010).

Income inequality has been a significant predictor of healthcare access and outcomes, with lower-income individuals experiencing greater challenges in accessing preventive services, including vaccines (Dubé et al., 2013). Communities with lower socioeconomic status often have fewer healthcare facilities, lower healthcare literacy, and higher rates of comorbidities, making them more vulnerable to the effects of the pandemic (Kim & Bostwick, 2020). Furthermore, education plays a critical role in health behavior, with individuals with higher levels of education being more likely to engage in preventive health practices, including vaccination (Freimuth et al., 2017).

Geographic location is another critical factor, as rural and inner-city neighborhoods frequently face distinct challenges regarding vaccine access. Rural areas may have limited healthcare infrastructure, resulting in long travel distances to vaccination sites, while inner-city areas may suffer from overcrowded healthcare systems (Murphy et al., 2021). The digital divide also disproportionately affects underserved populations, limiting access to information about vaccine availability and undermining outreach efforts (Mitchell et al., 2021). This combination of social, economic, and geographic barriers contributes to lower vaccination rates in these communities.

The COVID-19 pandemic has reinforced the need to address these social determinants of health to reduce inequities. Public health efforts must be tailored to the specific needs of underserved communities, taking into account factors such as language, culture, and local healthcare capacity. Various studies have suggested that community-based interventions, including mobile vaccination units, culturally sensitive outreach programs, and partnerships with trusted local organizations, can help reduce these disparities and increase vaccine uptake (Okoli et al., 2021).

Moreover, vaccine hesitancy, driven by misinformation and historical mistrust, must be addressed through transparent communication and community engagement. Effective public health campaigns should involve collaboration with community leaders and healthcare providers who can advocate for vaccination and address specific concerns (Quinn et al., 2019). Addressing these multifaceted barriers is crucial not only for managing the current pandemic but also for improving health equity in future public health crises.

Despite the availability of effective COVID-19 vaccines, significant disparities in vaccination rates persist, particularly among underserved communities. These populations, which often include racial and ethnic minorities, low-income individuals, and those with limited access to healthcare, face a complex array of social determinants of health that hinder their ability to get vaccinated. Factors such as income inequality, education level, geographic location, and healthcare access play critical roles in shaping vaccine uptake, exacerbating existing health inequities. Furthermore, historical mistrust of the healthcare system and vaccine hesitancy, driven by misinformation and cultural barriers, contribute to lower vaccination rates in these communities.

Current public health efforts to promote COVID-19 vaccination have not fully addressed these multifaceted barriers, leaving many underserved populations vulnerable to severe outcomes from the virus. Understanding how social determinants influence vaccination behavior is essential to developing targeted interventions that can improve vaccine equity. Without addressing these determinants, efforts to control the pandemic and reduce health disparities will continue to face significant challenges. This research seeks to investigate the specific social determinants that affect COVID-19 vaccination rates in underserved

communities and to propose evidence-based strategies to improve vaccine distribution and uptake in these populations.

METHODS

Research Design

This study utilized a quantitative, cross-sectional research design to investigate the impact of social determinants of health on COVID-19 vaccination rates within underserved communities. The cross-sectional design was selected as it provides a snapshot of the variables of interest at a single point in time, allowing for the examination of associations between social determinants and vaccination behavior. A quantitative approach was appropriate for this research as it facilitated the collection of numerical data that could be subjected to statistical analysis to draw meaningful conclusions regarding the relationship between variables.

The central aim of this research was to examine the influence of social determinants of healthsp ecifically income, education, geographic location, and healthcare accessnon vaccination uptake in marginalized populations. These communities, often characterized by lower socioeconomic status, limited healthcare access, and higher rates of vaccine hesitancy, are particularly vulnerable to the effects of the COVID-19 pandemic and present a critical focus for public health interventions.

Sample Selection

The study sample consisted of 100 individuals from underserved communities, selected using a purposive sampling method. This sampling technique ensured that participants had characteristics relevant to the research question, including low-income status, minority ethnic background, rural or urban residency, and limited access to healthcare. The purpose of purposive sampling was to intentionally focus on populations who are more likely to face barriers in accessing vaccines, such as those with lower income, lower levels of education, and those living in rural areas.

To ensure representation from various socio-economic backgrounds, the sample was stratified based on income levels (low, middle, and high) and educational attainment (high school, some college, bachelor's degree, graduate degree). Additionally, geographic location was considered, with participants selected from both rural and urban areas, ensuring the study captured the specific challenges faced by people living in different environments. By including individuals from diverse demographic groups, the study aimed to provide a comprehensive analysis of the factors influencing vaccination uptake across different segments of underserved populations.

Data Collection

Data for this study were collected using structured surveys administered to participants either in person or via phone interviews. The surveys included both closed and open-ended questions, allowing for the collection of quantitative data alongside some qualitative insights. The survey was designed to capture critical information, including demographic data (age, gender, income, education level, and employment status), access to healthcare services, vaccine knowledge, and vaccination status.

In addition to the survey data, secondary data were gathered from publicly available vaccination databases and healthcare records. These databases provided additional insights into vaccination trends across different regions and allowed for the validation of self-reported data on vaccination status. The secondary data also helped to assess broader vaccination rates in underserved communities and to identify any discrepancies between reported and actual vaccination figures.

The survey included questions on healthcare access, such as whether the respondent had a primary healthcare provider, how far they lived from the nearest vaccination center, and whether they had experienced any barriers in obtaining a vaccine. Vaccine knowledge was assessed through questions about participants' understanding of vaccine benefits, possible side effects, and sources of vaccine-related information. Vaccination status was recorded as either vaccinated or not vaccinated, with additional details on the timing of vaccination and the type of vaccine received, where applicable.

Data Analysis

The collected data were analyzed using statistical software, which facilitated the application of both descriptive and inferential statistical techniques. Descriptive statistics were used to summarize the demographic characteristics of the sample and provide an overview of vaccination rates across different socio-economic groups. Measures such as mean, median, and standard deviation were used to describe continuous variables (e.g., age), while frequencies and percentages were employed to summarize categorical data (e.g., income level, vaccination status).

Inferential statistics were applied to test the relationships between the independent variables (income, education, healthcare access, geographic location) and the dependent variable (vaccination status). Logistic regression analysis was used to explore the strength of associations between these social determinants and the likelihood of receiving the COVID-19 vaccine. Significance testing was conducted to determine which factors were statistically significant in influencing vaccination behavior. Odds ratios were calculated to assess the relative likelihood of vaccination among different groups, based on their social determinants.

Additionally, the results were presented in tables and charts to provide a visual representation of the relationships between social determinants and vaccination rates. These visualizations helped to clearly convey the disparities in vaccination uptake and highlighted key areas where interventions could be targeted.

This research adhered to ethical standards outlined by the institutional review board (IRB) of the hosting university. All participants were fully informed about the purpose of the study and were assured that their participation was voluntary and confidential. Informed consent was obtained from all participants before data collection, and they were made aware of their right to withdraw from the study at any time without any consequence. Personal identifiers were removed from the data to maintain participant confidentiality, and all data were stored securely in accordance with data protection regulations.

Given the sensitive nature of the topic, special care was taken to ensure that participants felt comfortable sharing their personal information, particularly regarding their healthcare access and vaccination status. Researchers were trained to provide assistance to participants who had difficulty completing the survey, ensuring that all respondents had an equal opportunity to participate.

While the study provides valuable insights into the social determinants of vaccination rates in underserved communities, several limitations must be acknowledged. As a cross-sectional study, it only captures data at one point in time, meaning that causal relationships cannot be established. The study's reliance on self-reported data also introduces the potential for bias, as participants may overstate or understate their vaccination status due to social desirability or recall bias.

Furthermore, although the sample was purposively selected to capture a diverse range of socio-economic backgrounds, the findings may not be fully generalizable to other regions or populations with different characteristics. Future studies could

employ longitudinal designs to assess changes in vaccination behavior over time and explore causal relationships more comprehensively.

RESULTS AND DISCUSSION

This chapter presents the findings from the analysis of the relationship between social determinants of health and COVID-19 vaccination rates among underserved communities. The results were derived from both the survey data and secondary data sources. This section is divided into the following sub-sections: 3.1 Demographic Overview, 3.2 Descriptive Statistics, 3.3 Factors Influencing Vaccination Rates, 3.4 Significance Testing, and 3.5 Discussion of Key Findings.

Demographic Overview

A total of 100 participants from underserved communities were included in the study, which aimed to capture a broad representation of the population based on socio-economic status, education, and geographic location. Table 1 summarizes the demographic characteristics of the sample.

Table 1. Demographic Characteristics of the Sample

Variable	Category	Percentage (%)
Income Level	Low	35%
	Middle	40%
	High	25%
Education Level	High School	30%
	Some College	25%
	Bachelor's Degree	25%
	Graduate Degree	20%
Healthcare Access	Good	30%
	Moderate	35%
	Limited	35%
Geographic Location	Urban	60%
	Rural	40%

As shown in Table 1, the sample included a wide range of individuals across different income levels, education backgrounds, and healthcare access categories. The majority of participants were from urban areas (60%), while 40% were from rural areas. This demographic distribution was essential to capture the variations in vaccination rates influenced by geographical location.

Descriptive Statistics

Descriptive statistics were calculated to understand the general characteristics of the sample and the vaccination rates among different demographic groups. The results indicate that vaccination rates varied significantly based on income, education, and healthcare access.

Table 2. Relationship Between Income, Education, Healthcare Access, and Vaccination Rates

Income Level	Education Level	Healthcare Access	Vaccination Rate (%)
High	Graduate Degree	Good	90%
High	Graduate Degree	Moderate	100%
High	Bachelor's Degree	Limited	10%
Middle	Some College	Good	75%
Middle	Bachelor's Degree	Moderate	60%
Low	High School	Limited	20%
Low	No Diploma	None	5%

From Table 2, it is evident that higher income groups, particularly those with good or moderate healthcare access, exhibited the highest vaccination rates. For instance, individuals in the high-income bracket with a graduate degree and good healthcare access had a vaccination rate of 90%, while those with moderate healthcare access had a perfect vaccination rate of 100%. However, vaccination rates decreased significantly for individuals with limited access to healthcare. High-income individuals with limited healthcare access, for example, had a vaccination rate of only 10%, which indicates that healthcare access is a crucial determinant of vaccination uptake.

Factors Influencing Vaccination Rates

The analysis revealed three key factors that significantly influenced vaccination rates: income, education, and healthcare access. Each of these factors is discussed below:

Income Level Impact

Table 3. Income Level Impact on Vaccination Rates

Income Level	Education Level	Healthcare Access	Vaccination Rate (%)	Notes
High	Graduate Degree	Good	90%	High vaccination rate among wealthy, educated individuals
High	Graduate Degree	Moderate	100%	Wealthy, highly educated, moderate access → full vaccination
High	Bachelor's Degree	Limited	10%	Limited access lowers rates despite high income

High-income groups had the highest vaccination rates, especially those with good or moderate healthcare access. For instance, high-income individuals with a graduate degree and good healthcare access had a 90% vaccination rate, while those with moderate access had 100%. This reinforces the conclusion that wealthier individuals with better access to healthcare are more likely to be vaccinated. However, vaccination rates in high-income groups drop significantly for individuals with limited healthcare access, as shown by the 10% vaccination rate among high-income individuals with a bachelor's degree and limited access. This indicates that even high-income individuals face barriers when access to healthcare is restricted.

Income was found to be a major determinant of vaccination uptake. As shown in Table 2, high-income individuals had the highest vaccination rates, particularly those with good or moderate healthcare access. This finding aligns with previous research indicating that higher income levels are associated with better healthcare access and higher likelihood of receiving preventive services, such as vaccinations (Dubé et al., 2013; Figueroa et al., 2021).

The data also highlighted that even within the high-income group, individuals with limited healthcare access exhibited lower vaccination rates. This underscores the importance of healthcare infrastructure in ensuring that individuals, regardless of income, can access vaccination services. For example, among high-income individuals with a bachelor's degree but limited access to healthcare, the vaccination rate was only 10%, suggesting that barriers such as lack of transportation, long distances to vaccination sites, or limited clinic hours may hinder access even for wealthier individuals.

Education Level Impact

Table 4. Education Level Impact on Vaccination Rates

Income Level	Education Level	Healthcare Access	Vaccination Rate (%)	Notes
Middle	Bachelor's Degree	Moderate	60%	Higher education improves uptake in middle-income groups
Middle	High School Diploma	Limited	40%	Lower education correlates with lower uptake
Low	Some College	Limited	15%	Some college education raises rates compared to no diploma
Low	No Diploma	No Access	5%	Lowest uptake due to both low education and no access

Higher education levels are associated with higher vaccination rates across all income levels. For example, middle-income individuals with a bachelor's degree and moderate healthcare access had a 60% vaccination rate, which is higher than middle-income individuals with only a high school diploma (40%) and limited access. Similarly, low-income individuals with some college education and limited access had a 15% vaccination rate, which is still higher than those with no diploma and no healthcare access (5%). This suggests that education positively influences individuals' willingness to get vaccinated, but access to healthcare remains a critical factor.

Education is closely tied to health literacy, which plays a key role in shaping individuals' health behaviors and their willingness to engage in preventive health measures, such as vaccination. Higher education levels are associated with better understanding of vaccine benefits, reducing vaccine hesitancy (Freimuth et al., 2017; Williams et al., 2021).

Healthcare Access Impact

Table 5. Healthcare Access Impact on Vaccination Rates

Income Level	Education Level	Healthcare Access	Vaccination Rate (%)	Notes
Middle	-	Good	75%	Access strongly improves vaccination in middle-income groups
Middle	High School Diploma	Limited	40%	Limited access significantly reduces vaccination uptake
Low	No Diploma	No Access	5%	Complete lack of access results in the lowest vaccination rates

Healthcare access has a profound influence on vaccination rates. Across all income and education groups, individuals with good or moderate healthcare access had significantly higher vaccination rates than those with limited or no access. For instance, among middle-income individuals with good healthcare access, the

vaccination rate was 75%, whereas those with limited access had only 40% vaccinated. Among low-income individuals, those with no healthcare access had the lowest vaccination rates, with only 5% of individuals without a diploma getting vaccinated. This emphasizes the importance of improving healthcare access to boost vaccination rates, particularly in underserved populations.

The results of this study provide compelling evidence that social determinants of health namely income, education, and healthcare access significantly influence COVID-19 vaccination rates in underserved communities. These findings align with a growing body of research suggesting that health disparities, shaped by these determinants, play a pivotal role in vaccination behavior (Kim & Bostwick, 2020; Artiga et al., 2021). This section will explore the implications of these findings in greater detail, discuss the study's limitations, and propose recommendations for public health interventions to improve vaccine uptake.

Significance Testing

To further investigate the impact of social determinants on vaccination rates, inferential statistical tests were conducted. Logistic regression was used to model the relationship between income, education, healthcare access, and vaccination status. The results of the regression analysis indicated that healthcare access was the strongest predictor of vaccination status, followed by education and income.

Table 6. Logistic Regression Results

Variable	Odds Ratio (OR)	95% Confidence Interval	p-value
Income (High)	4.12	2.09 - 8.09	0.001
Education (Bachelor's Degree)	3.87	1.85 - 8.10	0.002
Healthcare Access (Good)	6.73	3.44 - 13.13	<0.001

As shown in Table 3, the odds of being vaccinated were significantly higher for individuals with higher income, higher education levels, and good healthcare access. The variable with the highest odds ratio was healthcare access, indicating that individuals with good healthcare access were over six times more likely to be vaccinated than those with limited access.

The data indicate a clear disparity in vaccination rates based on income levels, with higher-income individuals being more likely to get vaccinated. This result is consistent with previous studies that have shown how income inequality affects access to healthcare and preventive services (Dubé et al., 2013; Figueroa et al., 2021). Wealthier individuals are more likely to have better access to healthcare resources, such as primary care providers and vaccination clinics, and can afford to take time off work for vaccination appointments (Brown et al., 2012). Additionally, they may live in areas with higher availability of healthcare services, making it easier for them to access vaccines (Murphy et al., 2021).

However, it is important to note that even within high-income groups, individuals with limited healthcare access had lower vaccination rates, underscoring the critical role of healthcare infrastructure in promoting vaccination. This finding echoes research by Yancy (2020) and Bunch (2021), which highlights how systemic barriers within the healthcare system, such as limited clinic hours, distance from healthcare providers, and out-of-pocket costs, can prevent even wealthier individuals from accessing vaccines.

Education emerged as a key factor in determining vaccination rates, with individuals who had higher levels of education being more likely to get vaccinated. This relationship between education and health behavior is well-documented, as

education improves health literacy, enabling individuals to make informed decisions about vaccination and understand the benefits of immunization (Freimuth et al., 2017; Quinn et al., 2019). Higher education levels are also associated with greater trust in healthcare systems and public health initiatives, which can reduce vaccine hesitancy (Williams et al., 2021).

Conversely, individuals with lower levels of education were more likely to remain unvaccinated, particularly if they also lacked healthcare access. This supports findings from prior studies, such as those by Scharff et al. (2010) and Brewer et al. (2020), which suggest that lower education levels are correlated with both reduced vaccine knowledge and higher susceptibility to misinformation. As misinformation has been a significant driver of vaccine hesitancy during the COVID-19 pandemic (Loomba et al., 2021), it is essential to address the information gaps through targeted education campaigns tailored to the needs of less-educated populations (Jamison et al., 2020).

The most striking finding of this study is the profound impact that healthcare access has on vaccination rates. Across all income and education levels, individuals with good or moderate access to healthcare were significantly more likely to be vaccinated. In contrast, those with limited or no access were far less likely to receive the vaccine, even if they belonged to higher-income or more educated groups. This supports the argument that healthcare access is a fundamental determinant of health outcomes, as proposed by the Social Determinants of Health framework (World Health Organization, 2020).

Limited healthcare access encompasses a range of barriers, including lack of insurance, geographic isolation, transportation difficulties, and limited availability of healthcare providers (Rust et al., 2020). In underserved rural and urban areas, where healthcare infrastructure is often inadequate, individuals face significant logistical challenges in accessing vaccination services (Mitchell et al., 2021). This is consistent with previous research showing that vaccine distribution efforts must address structural barriers to reach marginalized populations effectively (Okoli et al., 2021; Fenton et al., 2021).

Vaccine hesitancy also played a role in the observed disparities, particularly among individuals with lower education levels and limited healthcare access. Mistrust in vaccines, driven by historical injustices and contemporary misinformation, remains a major obstacle to achieving high vaccination rates (Scharff et al., 2010; Dubé et al., 2013). Communities of color, in particular, may harbor distrust toward the healthcare system due to past abuses, such as the Tuskegee Syphilis Study, which has left a legacy of skepticism toward medical interventions (Quinn et al., 2019).

Addressing vaccine hesitancy requires a multifaceted approach, including transparent communication from trusted community leaders, culturally sensitive outreach, and education efforts tailored to the concerns of specific populations (Freimuth et al., 2017; Yancy, 2020). Public health campaigns should focus on building trust and fostering community engagement, especially in areas where mistrust is a significant barrier to vaccine uptake (Artiga et al., 2021).

CONCLUSION

This study highlights the significant role that social determinants of health particularly income, education, and healthcare access play in influencing COVID-19 vaccination rates in underserved communities. The findings demonstrate that individuals with higher income levels and better healthcare access are more likely to be vaccinated, while those with lower education levels and limited access face significant barriers to vaccination. Moreover, the study underscores the importance of healthcare infrastructure in promoting equitable vaccine distribution, revealing

that even wealthier individuals may struggle with vaccination if healthcare access is restricted. Addressing these disparities will require targeted public health interventions that expand healthcare access, enhance health literacy, and build trust in vaccination efforts, particularly in marginalized populations. By focusing on the structural and informational barriers that contribute to vaccine hesitancy, public health policies can improve vaccination rates and reduce health inequities, ensuring a more effective response to current and future public health crises.

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