Factors Impacting Vaccine Uptake, Safety, and Efficacy Concerns among Black and White Adults Previously Infected with COVID-19: A Survey-Based Study

ABSTRACT

FACTORS IMPACTING VACCINE UPTAKE, SAFETY, AND EFFICACY CONCERNS AMONG BLACK AND WHITE ADULTS PREVIOUSLY INFECTED WITH COVID-19: A SUREVEY-BASED STUDY

By

Klea Troka

DATE: April 26th, 2022

BACKGROUND: Despite COVID-19 disproportionality impacting Black communities, vaccine hesitancy may be higher in this group owing to longstanding and enduring systemic racism. In this study, we determined whether Black (vs White) adults within a Georgia (GA) integrated healthcare system, previously infected with COVID-19, were more or less likely to report vaccine hesitancy, report concerns about vaccine safety, and efficacy. We also explored how factors like social determinants of health and hardships faced during the COVID-19 pandemic can affect the impact race has on vaccine outcomes (uptake, safety concerns, efficacy concerns).

METHODS: We invited all adult members age ≥18 years at Kaiser Permanente Georgia, with a positive COVID-19 diagnosis between March 2020 and April 2021 to participate in a cross-sectional COVID-19-specific survey (n=17,608 eligible members) sent between June 2021 and August 2021. Participants self-reported race (White, Black) and were asked their willingness to receive a vaccine, concerns about vaccine efficacy, and vaccine safety. Descriptive statistics and Chi-Square tests were calculated. Multivariable logistic regression models were used to assess the association between race and three vaccine-specific outcomes (uptake, safety concern, efficacy concern), adjusted for age, sex, social determinants of health, chronic conditions and COVID-19 impact. Mediation analysis was used to assess the impact of education and COVID-19 experiences on the relation between race and vaccine outcomes.

RESULTS: In total, 482 adults (response rate 3%) completed the survey, but only 414 were eligible to take part in the analysis: mean age 51.3 years (SD=13.1), 32.6% males, and 38.5% reported Black race. A total of 288 (75.0%) participants reported having received the COVID-19 vaccine. Black adults had higher crude OR to not have received the COVID-19 vaccine (cOR=1.8 ; 95% CI: 1.1-2.9), but this was not significant when adjusted for age, sex, chronic conditions, and COVID-19 experiences. Black adults were more likely to have vaccine safety (aOR=2.3; 95% CI: 1.3-4.0) and vaccine efficacy concerns (aOR=2.3; 95% CI: 1.3-4.1) when compared to White adults. Having everyone with a high level of education would eliminate 37% of the effect of race on vaccine uptake and 12% on the effect of race on vaccine safety concerns. Having no one experience financial hardship would eliminate the effect of race on vaccine uptake (29%), vaccine safety concerns (14%), and vaccine efficacy concerns (12%).

CONCLUSION: Our results show that among adults diagnosed with COVID-19 in Georgia, Black adults were not less likely to have received the vaccine compared to White adults, despite having higher odds of being concerned about the vaccine safety and vaccine efficacy. Education and financial hardship negatively impacted the effect of race on vaccine outcomes.

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Author's Statement Page

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TABLE OF CONTENTS

ACKNOWLEDGMENTS iv

LIST OF TABLES…….vii

LIST OF FIGURES……viii

INTRODUCTION.....1

REVIEW OF THE LITERATURE.....5
2.1 COVID-19…….5
2.2 Vaccines…….9
2.3 Vaccine Hesitancy……12

METHODS AND PROCEDURES…….....15
3.1 Data Source & Study Population……..15
3.2 Survey and Medical Record……..15
3.3 Study Outcomes……...16
3.4 Covariates……..17
3.5 Statistical Analysis …….....19

RESULTS.....22
4.1 Study Population and Descriptive Statistics ……...……..22
4.2 Crude Odds Ratio……...23
4.3 Adjusted Odds Ratio……..24
4.4 Mediator Analysis……..25

DISCUSSION AND CONCLUSION.....27
5.2 Discussion of Research Questions.....27
5.3 Limitations and Strengths.....31
5.4 Future Implications.....32
5.5 Conclusion……...……..33

REFERENCES.....40

APPENDICES……..48

List of Tables

Table 1 Participant characteristics

Table 2 Crude and adjusted odds ratio for vaccine uptake and participant characteristics by race

Table 3 Multivariate logistic regression models for vaccine uptake

Table 4 Multivariate logistic regression models for vaccine safety concerns

Table 5 Multivariate logistic regression models for vaccine efficacy concerns

Table 6 Mediation analysis

List of Figures

Figure 1 Flowchart of study population

Figure 2 DAG for vaccine uptake

Figure 3 DAG for vaccine safety concerns

Figure 4 DAG for vaccine efficacy concerns

Figure 5 Forest plot of crude and adjusted odds ratio for all the outcomes

Chapter I - Introduction

As of April 20, 2022 a total of 80,648,481 COVID-19 cases and 987,601 COVID-19 deaths have been reported in the United States (U.S.) (1). The COVID-19 pandemic has highlighted longstanding racial inequities across different communities in the U.S. A higher rate of infection, hospitalizations, and deaths among the Black community have been shown since the beginning of the pandemic compared to Non-Hispanic White populations. (2)

As we enter the third year of the pandemic, these disparities still do exist, attributed to systemic racism, comorbidities, and social determinants of health (SDH). Black and African Americans are 2.5 times more likely to be hospitalized due to COVID-19 infection and 1.7 times more likely to die from it when compared to White, Non-Hispanic persons as of February 2022 (3). Research from Kaiser Permanente shows that Black people account for a slightly higher share of deaths from COVID-19 compared to their population share (14% vs 13%), a trend which has persisted since October 2021 (4).

A lot of studies explain COVID-19 racial disparities by attributing it to systemic inequities like poverty, poor housing conditions, low income, low level of education, and speaking a language different from English (5). Systemic inequities are also associated with chronic conditions, which do pose on their own an increased risk for severe illness from COVID-19. For example, among 540,667 adults hospitalized with COVID-19 from March 2020 to March 2021, 94.9% had at least one underlying chronic condition with hypertension, disorder of lipid metabolism being the most common ones while obesity, diabetes with complications, and anxiety disorders had the highest risk ratio for severe illness (6). These findings have been replicated in cohort studies as well (7-9).

When discussing the pathogenesis of a chronic disease, the biological factors cannot solely explain its full spectrum and this is why we account for SDH like neighborhood and environment, economic stability, social and community context, education and healthcare. There is a proven connection between SDH and chronic diseases like type 2 diabetes, obesity, cardiovascular disease, respiratory disease, cancers, kidney disease (10-11) in that those from x, y and z (i.e. low income, neighborhood poverty, low education) have an increased risk for these conditions compared to those in higher socioeconomic groups. The impact of chronic diseases has been more evident in Black communities (12) and the COVID-19 pandemic helped to make the issue more evident (13).

An analysis conducted to understand racial and ethnic disparities in years of potential life lost attributable to COVID-19 in 45 states and the District of Columbia found a state-to-state variation among racial/ethnic disparities in COVID-19 mortality, reaffirming once again that this burden is mainly driven by SDH whose degree of association with race/ethnicity varies by state (14) and by urban/rural region (15). We do see this situation in Georgia as well. Black make up only 31% of the population, but as of March 2021 Black did account for 40% of COVID-19 hospitalization and 34% of COVID-19 related deaths (16). A study conducted in Georgia concluded that the Black proportion in a county was positively and significantly associated with COVID-19 case and death rate in the spring and fall of 2020 (17).

This would not be the first time Georgia is experiencing disparities in health outcomes, as it has already a record of disparities between Blacks and Whites in diseases like infectious disease, cardiovascular disease, stroke, and cancer, due to limited healthcare resources, lower socioeconomic status and higher area-level disadvantage compare (18).

Another factor to consider when analyzing disproportionate COVID-19 outcome among the Black community is vaccine uptake. Different clinical trial studies have shown the efficacy of COVID-19 vaccines against infection, hospitalization, and death (19-21). Despite this, as of August 2021, data from the National Immunization Survey Adult COVID-19 Module showed that only 65.3% of the Black participants (>18 years old) had received at least one dose of a COVID – 19 vaccine, and only 60.9% were considered fully vaccinated (22). Even though there is an increase in vaccination numbers when compared to studies that were looking at intention to vaccinate in the months prior to vaccines made widely available, Black adults had still lower vaccination uptake when compared to White adults (23).

The CDC does not display vaccination uptake by race/ethnicity for each state, but an analysis from Kaiser Permanente (Sate reported data) shows that 55% of the White population in Georgia has received at least a COVID-19 vaccine dose and only 53% of the Black population (24).

Previous studies have been conducted to understand factors associated with race and the intent to get vaccinated before a vaccine was made available, but few have looked into factors that are associated with race and vaccine uptake when the vaccine was made widely available. Furthermore, there is not a lot of studies trying to understand personal feelings regarding vaccine efficacy and safety, as well as how people's personal COVID-19 experiences and hardships can impact their decision to get vaccinated or not.

Another important aspect is intention to get vaccinated after being previously infected with COVID-19. We know that prior infection gives immunity, but it fades over time and reinfections does occur (25). This is why vaccination is strongly recommended even after being diagnosed before with COVID-19 (26). The question is: Is there still vaccine hesitancy in

persons who have been previously infected with SARS-CoV-2 and are there still any racial differences?

Therefore, this study aims to explore the association between race and vaccine uptake, safety, and efficacy concerns among adults with a previous diagnosis of COVID-19 within an integrated healthcare system, and identify factors, including SDH and COVID-19-specific experiences, that may explain race-based differences in vaccine-related outcomes.

The specific aims of the study are as follows:

1. Determine the association between participant self-reported race and vaccine uptake, safety and efficacy concerns
2. Determine if the association between race and vaccine-related outcomes (uptake, safety, efficacy) are modified by factors such as gender, age, education, and income
3. Determine if the association between race and vaccine-related outcomes are modified by COVID-19 experiences, e.g. “job loss” “shift to remote working”

Chapter II Literature Review

1. COVID-19

2.1.1 Background

Coronavirus disease (COVID-19) is an infectious disease caused by the SARS-CoV-2 virus (27). It was first detected as a cluster of novel human pneumonia cases in Wuhan City, China back in December 2019 (28), and was declared a global pandemic by the World Health Organization (WHO) on March 11, 2020 (29). As of April 22, 2022, there have been 505,817,953 confirmed cases of COVID-19 and 6,213,876 deaths globally (30). According to the CDC COVID-19 Data Tracker there are 80,648,481 confirmed cases and 987,601 deaths due to COVID-19 in the US (1).

SARS-CoV-2 is a respiratory tract pathogen, and it is transmitted by inhalation of respiratory droplets and aerosol particles, deposition of the virus on exposed mucous membranes, and touching mucous membranes with hands contaminated with virus (31). WHO has currently established five variants of concern, alpha, beta, gamma, delta and omicron (32) with delta causing more severe cases, while omicron having the highest transmissibility (33). Currently, omicron subvariant BA.2 makes up 74.4% of the circulating variant in the US (34).

Symptoms of COVID-19 can appear 2 to 14 days after exposure with an average offset of 5 to 6 days (35). Most persons have mild symptoms to no symptoms at all, but some develop moderate to severe disease and require hospitalization (35). The most common symptoms include fever, cough, shortness of breath, loss of smell and/or taste, muscle pain, fatigue sore throat, nasal congestion, and respiratory distress (36). Clinical diagnosis of COVID-19 is made based on clinical manifestations and conformed with a molecular viral genome RT-PCR, or a rapid diagnostic test authorized by the U.S Food and Drug Administration (FDA) (37).

Older people, pregnant women, people with disabilities, people from racial and ethnic minority groups, as well as people with underlying medical conditions are more at risk to develop severe disease, be hospitalized, need intensive care, require a ventilator, and die from COVID-19 as compared to younger, White, without underlying medical condition (38). The first study published by the Center for Disease Control and Prevention (CDC) which aimed to investigate underlying health conditions among patient with COVID—19 disease concluded that 37.6% of the patients had at least one underlying health condition but made up 71% of those who required hospitalization (39). Persons with diabetes, chronic lung disease and cardiovascular disease were at higher risk to develop serve COVID-19 (39,40).

Data from the first year of the pandemic suggested that infection with SARS-CoV-2 offers 80% protection against reinfection in the first 90 days, but only 47% protection in individuals 65 years of age or older (41). In a study published in Nature, anti-SARS-CoV-2 spike antibodies started to decrease 4 months after infection and continued a gradually decrease at least 7 months after infection, while spike specific BMPc were present in the bone marrow even after 7-8 months post-infection (42).

2.1.2. COVID-19 and Racial Disparities

The fact that an influenza pandemic can pose a higher risk to racial/ ethnic populations due to broad disparities in underlying health status and social factors has been described since earlier (43). These disparities became evident within the first months of the COVID-19 pandemic. During April 2020, Chicago reported that 68% of deaths from COVID-19 were among Black people despite accounting for only 30% of Chicago's population (44). Data from the same month in Maryland showed that the top five ZIP codes for coronavirus cases were

predominantly Black and Brown (45). Seven out of 11 nursing homes with the highest number of deaths from COVID-19 in New York reported that 47% of their residents were non-White (46).

In contrast, a study published in JAMA on December 4, 2020, found that Black patients had a higher likelihood of testing positive for COVID-19 compared to White patients, but once hospitalized were less likely than White to develop critical illness or die from COVID-19 (47).

CDC analyzed data from hospitalized patients with COVID-19 from March to December 2020 to understand the trend in racial and ethnic groups in the US. Racial and ethnic disparities among hospitalized patients from COVID-19 were higher earlier in the pandemic April – July 2020, not so prominent during the rest of 2020, and still present as of December 2020 in all regions, mostly among Hispanics in the West (48). During the same period the US experienced an estimated 477,200 excess deaths of which approximately 74% can be attributed to COVID-19. After adjusting for age, overall excess death per 100,000 persons were higher among Indian/Alaska Native, Black, and Latino when compared to White and Asian individuals (49). When comparing emergency visits data due to COVID-19 from October to December 2020 for 13 States, Black persons experienced 1.4 times the rate of emergency department care visits due to COVID-19 compared to White persons. (50).

Disparities do not only exist among infection and hospitalization rates, but also in terms of treatment received. Data from 41 health care systems found lower use of monoclonal antibody treatment among Black, Asian, and Hispanic patients with a COVID-19 diagnosis, relative to White and non- Hispanic patients (51).

Though few studies explicitly examine this, it is thought that living in density populated neighborhoods, being more exposed to infection, having lower access to healthcare services and testing centers, are likely to explain these disparities (52).

2.1.3 COVID-19 in the State of Georgia

Black individuals in Georgia had an age-adjusted death rate of 1,042.8 (per 100,000 population) compared to 877.8 age-adjusted death rate in White persons during 2020 (53). This mortality disparity was more evident for diseases like diabetes (age-adjusted death due to diabetes for Black people is 39.5 compared to 18.7 for Whites) cardiovascular disease (287.5 age-adjusted death due to cardiovascular disease for Black compared to 234.4 for Whites) cancers (161 age-adjusted death due to cancer for Black vs 147 for Whites) (53). Black persons in the South have experienced longstanding disparities in health outcomes due to limited health care resources, higher area-level disadvantage, lower socioeconomic status, and a higher prevalence of comorbidities relative to White persons (54).

The COVID-19 pandemic has only magnified the disproportionate and long-standing health disparities experienced by Black communities. As of March 7, 2021, Black adults in Georgia made up 31% of the population, yet 32% of confirmed COVID-19 cases, 34% of deaths and 40% of hospitalizations (55). A study conducted by Baltrus et al. during April 2020, found that 1% increase in the proportion of Black people in a county in Georgia resulted in a 2.3 % increase in the county confirmed COVID-19 cases, and a 3% increase in the death rate (17). These results were confirmed in later studies as well. Porter et al. analyzed data from June-July 2020 in Augusta and counties in the highest quartile for COVID-19 mortality had higher proportions of Black residents and residents with income less than $20,000 (56).

A spatial analysis by age concluded that for White adults aged 18-64, health districts had an increase in mortality between 15% and 21%, while for Black adults this increase ranged from 7% to 42%. For adults aged 65 and over, White adults only had an increase under 10% in four health

districts, while Black adults had a mortality increase in most of the health districts ranging from 6% to 38% (57).

A study of 220 hospitalized and 311 non-hospitalized COVID-19 patients from March to April 2020 in six Atlanta hospitals concluded that older age, Black race, diabetes, male sex, smoking, obesity and lack of insurance were independently associated with hospitalization (58).

2. Vaccines

2.2.1 Vaccine Development and Success Stories

In 1796, Edward Jenner inoculated cowpox material to create immunity to smallpox and the first vaccine was developed one year later. Smallpox was globally eradicated in 1979 due to mass implementation of the vaccine (59). For a vaccine to be FDA approved, it goes through a rigorous process involving phase 1 and 2 (evaluation of safety profile), phase 3 (clinical trial with thousands of participants), phase 4 (continuous data monitoring) (60). Some vaccine success stories to mention involve: tetanus vaccine has reduced neonatal deaths by 88% when compared to the year 2000; being paralyzed due to polio has been reduced by 99.9% ; and children's life have been saved due to vaccines which protect them against measles, diphtheria, pertussis, and hepatitis B (61).

2.2.2 Covid-19 Vaccine

On May 5th, 2020 Pfizer and BioNTech announced that the first adult participants were dosed with COVID-19 vaccine at NYU Grossman School of Medicine and University of Maryland School of Medicine, as part of the ½ clinical trial phase evaluating the safety and efficacy dose of 4 mRNA vaccines (62). Pfizer released their final efficacy analysis on November 18. Their vaccine was 95% overall effective, 94% effective among individuals 65

years and older (63), and on December 11 the US FDA issued an Emergency Use Authorization (EUA) in individuals 16 years of age and older (64).

On May 12th, 2020 Moderna received US FDA "fast track" designation to investigate their mRNA candidate vaccine against the novel coronavirus (65). Interim analysis showed that Moderna vaccine was 94.1% effective in preventing COVID-19 illness including severe disease (19) and received FDA EUA in individuals 18 years of age and older on December 18 (66).

Johnsons & Johnson adenovirus single dose vaccine received EUA on February 27 after the vaccine showed that it was 85% effective in preventing COVID-19 disease, hospitalization and death, 28 days after receiving the vaccine (67).

The first phase of the vaccination strategy was to focus on vaccinating health care workers and residents of long term-care facilities. The next one was to vaccine community members age 65+ and those at high risk for worse COVID-19 outcomes. Pharmacies, grocery stores and mass vaccination events at large venues started to happen in California, Texas and then all over the country, while the Biden administration goal was to vaccinate 100 million individuals in the first 100 days of office (68).

The CDC published their first article on demographic characteristics of individuals who had received at least one dose of the vaccine during the first month of vaccination (14 December 2020 to 14 January 2021). Most individuals vaccinated were 50 years or older, women and non-Hispanic White (69).

As the distribution of the vaccine continued and supply was not a problem, the discussion about vaccine equity and barrier to receive the vaccine arose. Focusing the strategy on mass-vaccination site left individuals who were willing to get vaccinated but unwilling and unable to drive a long distance and receive care at unknown location, without the facilitation to receive one

(70). Only in May 2021 primary care doctors were able to vaccinate their patients at their own office and they played an important role in raising vaccination trust in their hesitant patients (71). Many employed individuals faced a barrier in receiving the vaccination as they were unable to get paid time off to get vaccinated (72).

Observational and cohort studies showed that vaccines were effective in preventing COVID-19 symptomatic infection, severe disease, and death (73-77). When Delta became the predominant variant, vaccine effectiveness fell from 90% in mid- December to 66% in mid-August. The study was conducted among a cohort of 4000 healthcare workers, but it was unclear if the differences were because of vaccine lower efficacy against the Delta variant, or wanning immunity due to the long time since vaccination (76). A test-negative case control study design in India resulted in a small difference between the effectiveness of the vaccine against the Alpha variant 93.7% and the Delta 88.0% (77).

Common vaccine side effects include headache, dizziness, fatigue, fever, chills, muscle pain, swelling and pain at the site of injection (78,79). Serious side effects are rare and they included: anaphylaxis, thrombosis with thrombocytopenia syndrome, myocarditis and pericarditis, and Guillain-Barre syndrome. A causal relationship has been found between Johnson & Johnson Janssen COVID-19 vaccine and thrombosis with thrombocytopenia syndrome in women(79). There is no evidence that COVID-19 vaccines have any negative impact on likelihood of conception and fertility rates (80). On August 2021 and January 2022, the Pfizer-BioNTech and Moderna vaccine received full approval by the FDA (81,82).

As of January 2022, unvaccinated people age 5 years or older have 2.3 times the risk of testing positive for COVID-19 and 14 time the risk of dying from COVID-19 when compared to people vaccinated with at least a primary vaccine series (82). Unvaccinated adults 18 years or

older have 7 times the risk to be hospitalized from COVID-19 when compared to fully vaccinated adults as in January 2022 (83). As of March 2022, 65.1% of the total US population is fully vaccinated (84).

3. Vaccine Hesitancy

2.3.1 Vaccine Hesitancy Definition

According to the SAGE Working Group on Vaccine Hesitancy, vaccine hesitancy means "*to delay in acceptance or refusal of vaccination despite availability of vaccination services".* The factors that influence this decision are divided into three groups: contextual, individual & group, vaccine/vaccination specific (85).

The model that best explains vaccine hesitancy is made of three components: *confidence* -in effectiveness, safety, the system that delivers them, and the reasons behind who decide who needs the vaccine; *complacency* -the existence of a low-risk perception from the vaccine-preventable disease; and *convenience* -the quality and easiness of the service (85).

Smallpox vaccine created from cowpox was received with hesitancy as it was against of beliefs to inject material from a cow to a human as well as concerns about the human influence into divine choices (86). Analyzed data from 10,380 online reports on vaccines from 144 countries during 2011-2021 resulted in 31% of them contained negative content associated with impacts on vaccine programs, vaccine safety, vaccine delivery programs and vaccine beliefs and perceptions (87).

2.3.2 COVID-19 Vaccine Hesitancy & Racial Differences

During April 2020, a survey-based study about intentions to get vaccinated against SARS-CoV-2 virus among a sample of 991 individuals showed that younger age, Black race, and lower education attainment were independent factors associated with a high rate of vaccine hesitancy (88). These findings together with female sex, living in rural areas, low income, not having

health insurance, medical mistrust, and exposure to myths and misconceptions have been replicated in several other studies before and after a COVID-19 vaccine was made available (23, 89-91).

During May 2020, 69% of the adults surveyed said they were willing to get a COVID-19 vaccine, and individuals who were non- Latinx Black or had higher safety concerns were less likely to receive a vaccine (92). Malik et al. studied determinants of COVID-19 vaccine acceptance: males compared to females, older adults (≥55 years) compared to younger adults, Asians compared to other races, and those who hold a higher education degree were more likely to accept a potential vaccine (93).

From national vaccination trends, intent to get vaccinate declined from 70% during April – May 2020 to 51% during September – December 2020 but it increased again during 2021(93,94). A cohort study with 4654 participants explored intentions to get vaccinated at baseline (August – December 2020) and at follow up (March – April 2021). Among person who were hesitant to get a vaccine at baseline, 32% had received at least one dose, 37% reported that intend to get a vaccine, and 32% were still hesitant (95).

The same trait happened with Black individuals as well. Bogart et al. collected the response of 206 Black adults between November 17, 2020 to December 2, 2020 and concluded that participants who held stronger mistrust beliefs about the vaccine itself, and those who resided in an area of high socioeconomic vulnerability, were more likely to say that they would not get vaccinated (96). A study by Moore among African American living in the southern U.S, only 1/3 of the study population were hesitant or resistant to a COVID-19 vaccine (December 2020 to April 2021). Younger age, being female, and having housing insecurity was associated with being resistant to the vaccine (18). In a cohort study with 1200 participants, Black individuals

experienced larger increase in vaccination intention than White individuals during March-June 2021, when compared to baseline in December 2020 (97).

Due to these previous studies finding that Black participants were more hesitant to get the vaccine, we want to:

1. Determine the association between participant self-reported race and vaccine uptake, safety and efficacy concerns

2. Determine if the association between race and vaccine-related outcomes (uptake, safety, efficacy) are modified by factors such as gender, age, education, and income

3. Determine if the association between race and vaccine-related outcomes are modified by COVID-19 experiences, e.g. “job loss” “shift to remote working”

Chapter III Methods

3.1 Data Source and Study Population

The data set for this study comes from a research study between Kaiser Permanente Georgia (KPGA) and Emory University, aiming to understand racial disparities in COVID-19 related outcome among KPGA members who were diagnosed with COVID-19. For our study, we focused on survey data that was obtained from all adult members aged ≥18 years at KPGA enrolled at the time of survey eligibility, with a positive COVID-19 diagnosis between March 2020 and April 2021 and a valid email address. Eligible adults were invited, via email, to participate in a cross-sectional COVID-19-specific survey (n=17,608 eligible members). The survey was sent between July 1, 2021, and August 15, 2021 and administered through Emory University's REDcap software.

All the responders consented to the survey. Exact duplicates, (same responder who filled the survey with the same exact answer) were deleted. The survey data was merged with comorbidity and demographics data, by study ID. All the observations from the same study ID, but not with the same answers were deleted manually (observations with the least amount of data were selected to be deleted). Observations in which the participants did not respond to any of the questions of the survey were also deleted. (Figure 1). The KPGA (IRB# 00000406), Emory Institutional Review Boards (IRB#: MOD004-STUDY00001631), and Georgia State University (IRB#: H22236) reviewed and approved this study.

3.2 Survey and Medical Record

The survey collected personal identifiable information on first and last name, year of birth and medical record number. This information was used to link each participant with a study ID so that they could be linked back to KPGA electronic medical records (EMR) data. The data

received from the survey was merged with data from KPGA EMR (using the study ID) which included information on comorbidities (hypertension, diabetes, obesity, anemia, neurological disease, tumor etc.) and demographics (age, sex, race, ethnicity).

Participants were asked about their race, sex, SDH like education, marital status, income, and more specific questions about COVID-19 like symptoms they experience, where did they go to take a test, how easy was healthcare access, and where did they first seek medical care. The survey can be found in Appendix 1.

To understand how COVID-19 disease can affect a person's health, the survey collected information on sleep, exercise, smoking and alcohol patterns before and after being diagnosed with COVID-19. Participants were asked how the COVID-19 pandemic has affected their life in terms of remote working, relationship breakdown, job loss, decrease in personal income, financial hardship, death of a loved one from COVID-19, responsible for providing care to a loved one, and childcare responsibilities.

The survey included question about COVID-19 vaccine as well. Participants were asked if they were vaccinated or not, had any intentions to do so in the future, and if they were concerned or not about vaccine safety and effectiveness. Lastly, the survey collected data about experiences with healthcare before and after COVID-19 diagnosis as well as medical mistrust.

3.3 Study Outcomes

The three primary outcomes for this study are: vaccine uptake, vaccine safety concern, and efficacy concern. To understand participant's intentions towards the vaccine they were asked if they have received a COVID-19 vaccine or plan on getting one when it becomes available to them "Have you received the COVID-19 vaccine or do you plan on getting the COVID-19 vaccine when it becomes available to you?". The answers were " Yes - I already have received

the vaccine", "Yes - I plan on getting the vaccine when it is available to me", " No – I have not received the vaccine and do not plan on getting the vaccine" and "Unsure".

Vaccine uptake was dichotomized as "Yes" (0) if they have received the vaccine, and "No" (1) if they had not received the vaccine. Vaccine safety concern was asked through the question "Are you concerned about the safety of the COVID- 19 vaccine?": "Yes", "No", or "Unsure". Vaccine safety concern was dichotomized "Yes" if the participants answered "Yes" or "Unsure" and "No" if the answer was "No". Our outcome of interest is having vaccine safety concerns. Vaccine efficacy concern was asked through the question "Are you concern about how well the vaccine will work?": "Yes", "No" or "Unsure". Vaccine efficacy concern was dichotomized as "Yes" if the response was "Yes" or "Unsure" and "No" if the response was "No". Our outcome of interest is having vaccine efficacy concerns.

3.4 Covariates

Demographics: Race, Sex, Age

Our primary exposure of interest is race. Race is a social construct, inequalities of which are influenced by class differences and SDH. In order to not use race just as a placeholder but get a better idea how these SDH impact our outcome of interest when race is the exposure, and follow guidelines on how to correctly measure race in epidemiology, we will use the self-reported race on the survey, and not the one from EMR data.

The survey asked: "What race or races do you consider yourself to be" and participants could choose "White", "Black or African American", "Asian", "American Indian or Alaska Native", "Native Hawaiian or Other Pacific Islander", "Prefer not to answer" and "Do not know". For the purpose of this study, we are using as our exposure of interest what participants self-reported as their race either White or Black.

Sex was dichotomized as male or female. To not have any missing information on participant's sex, we used the information coming from KPGA demographic records, since some of the participants did not respond to this question on the survey.

The survey asked participants "What year were you born?" where they had to choose an option from 1920 to 2003. This information was used to calculate their age as of January 2021. Later, age was grouped into six categories: 18-29, 30-39, 40-49, 50-59, 60-64, >65.

Socio Economic Factors: Education, Income, Marital Status

The survey asked: "What is the highest degree or level of school you have completed?" and responders could choose between "Some high school"; "High school graduate or some equivalent"; "Some college"; "Associate degree"; "Bachelor's degree"; "Graduate degree". We grouped the variables into 3 groups: High school graduate or some high school; Some college or associate degree; and Bachelor's or graduate degree.

Household income was assessed by asking the total 2019 household income before taxes, and for this study was grouped into: less than $50,000; $50,000-$99,999; $100,000-$149,999; more or equal than $150,000. Marital status was categorized as married, divorced, widowed, separated or never married.

Impact of the COVID-19 pandemic

Impact such as relationship breakdown, shift to remote work, job loss, income change, financial hardship, and death of a loved one were asked on the survey with questions like "Since March 2020, have you experienced a shift to remote working?"; "Since March 2020, have you experienced a relationship breakdown?"; "Since March 2020, have you experienced job loss?"; "Since March 2020, have you experienced decrease in personal income?"; "Since March 2020, have you experienced financial hardship?"; "Since March 2020, has someone you know died

from COVID-19?". The response to these questions was either "Yes" or "No". All of these variables were dichotomized as either "Yes" or "No".

Comorbidities

Data for comorbidities were taken from KPGA EMR data. We used the Charlson score (98) to define overall comorbidities the participant may have ever been diagnosed with prior to COVID-19 infection. The Charlson Comorbidy Index identifies adults that have been diagnosed with chronic pulmonary disease, malignancy, diabetes, renal disease, hypertension, cardiovascular disease, neurology disease, AIDS, obesity, anemia, tumor, vascular disease using ICD-9 and ICD-10 codes. The Charlson score was categorized as 0 (no comorbidities), 1-2 (presence of 1-2 comorbidities), and 3-7 to represent being ever diagnosed with 3-7 comorbidities. Then we took a closer look at three specific comorbidities: obesity, diabetes, and hypertension for a couple of reasons. First, there is a disparity in prevalence of these comorbidities among the Black population, second these comorbidities have been associated with worse COVID-19 outcomes, and third, previous research suggests disparities in diabetes care, blood pressure control rate, access to healthy food among Black vs White adults. We believe having these comorbidities may influence vaccine intentions and help in explaining racial disparities in vaccine uptake.

Diabetes and hypertension were dichotomized as either the participants has it (ever having the diagnosis) or not. Obesity was calculated using data on BMI, classified as BMI ≥ 30 kg/m^2 and dichotomized as present or not.

3.5 Statistical Analysis

All data was analyzed using statistical software SAS 9.4. Descriptive statistics such as mean, standard deviation and range were calculated for all the continuous variables (age).

Frequency and percentage were calculated for all the categorical variables. Chi-square statistics test, t-test and Fisher's exact t-test were used to test for differences for baseline characteristics by race as appropriate.

For each of our outcome of interest: vaccine uptake, vaccine safety concern, and vaccine efficacy concern, crude odds ratio were calculated and reported together with 95% CI and p-values using a bivariate logistic regression.

Multivariable logistic regression was used to assess the association between race and the three vaccine-specific outcomes adjusted for the other variables. To decide which variable to include in the final model, we started with race, and added other variables until reached the model with the lowest AIC (Table 3,4,5). Adjusted odds ratio were reported together with 95% CI and p-values. For vaccine uptake the adjusted model included: sex, age, education, income, obesity, diabetes, hypertension, number of comorbidities, financial hardship, remote work, income change and relationship breakdown. Vaccine safety was adjusted for age, sex, education, income, obesity, diabetes, hypertension, number of comorbidities, financial hardship, remote work, job loss, death of a loved one, and relationship breakdown. Variables included in the model for vaccine efficacy are age, sex, education, income, obesity, diabetes, hypertension, nr, of comorbidities, financial hardship, remote work, job loss, death of a loved one, and income change.

In order to better understand the impact of socioeconomic factors and COVID-19 experiences in mediating vaccine uptake, safety and efficacy concern when race is the exposure, we conducted a mediator analysis based on the VanderWeele mediation analysis when the outcome and exposure are binary (99-100). We decided on which variable to analyze as mediators based on our DAGS. DAG for vaccine uptake, safety concerns and efficacy concerns

are presented on Figure 2, 3, and 4. According to the DAGs, education and COVID-19 experiences are mediators in the pathway between race and vaccine outcomes, after adjusting for age, sex, and chronic condition. We conducted the mediation analysis for education, and COVID-19 experiences. Decision on which COVID-19 variables to include for the analysis were made from Table 1 and crude odds ratio.

Chapter IV Results

4.1 Study Population and Descriptive Statistics

We received 482 responders (2.7% response rate), and after taking all the steps described in the method's section, our final sample was left with 414 participants.

The mean age of the adults who completed the survey and were eligible for this study was 51.3 years (SD: 13.1), 67.4% are females and 38.5% reported Black race. From our study population the majority (59.2%) had a bachelor's or graduate degree, 35% make a total household income between $50,000 to $99,999 before taxes, and 64.3% were married. There was a significant difference among Black vs White adults regarding household income and marital status ($p=0.009$ and $p<0.0001$, respectively).

Obesity was the most common comorbidity with 60.8% of our study population being considered obese, 42.5% were diagnosed with hypertension and 19.1 % with diabetes. Only 12.1% of participants had two or more comorbidities. Significantly more Black participants were diagnosed with obesity (77.8%) and diabetes (24.1%) compared to White participants (52.4%, 15.9%) ($p<0.0001$ and $p=0.06$, respectively).

In terms of pandemic impact, 67.9% of the participants knew someone who had died from COVID-19, 49.3% have had their work shifted to remote, 30.2% had experienced a decrease in income, 23.6% financial hardship, and 12.5% lost their job. More Black adults (28.7%) had experienced financial hardship and shift to remote work (58.9%) when compared to White adults (19.1%, 42.9%) ($p=0.04$, $p=0.004$). No other significant differences were found among the two groups in terms of hardships faced during the pandemic.

A total of 288 (75%) participants reported having already received the COVID-19 vaccine: 68.9% Black adults vs 79.9% White adults ($p=0.09$). Significantly more Black adults

(47%) reported concerns about the COVID-19 vaccine safety compared to White adults (26.9%) ($p<0.0001$). Regarding vaccine efficacy concern, significantly more Black adults (65.9%) reported efficacy concerns compared to White adults (36.1%) ($p<0.0001$). All descriptive statistics results are presented in Table 1.

4.2 Crude Odds Ratio

Black adults had 1.8 higher odds of not being vaccinated, when compared to White adults (cOR: 1.8; 95% CI: 1.1-2.9). Black participants had significantly higher odds of having more vaccine safety concerns (cOR: 2.8, 95% CI: 1.8-4.3) and vaccine efficacy concerns (cOR: 2.9, 95% CI: 1.8-4.7), when compared to White participants.

Other factors associated with vaccine uptake included education, and age. Participants with a bachelor's or graduate degree had lower odds (cOR: 0.4, 95% CI: 0.2-0.9) of not being vaccinated when compared with participants with less than a high school diploma. Adults aged 65 years or older were more likely to have received the vaccine (cOR: 0.3, 95% CI: 0.1-0.9).

Those with at least one comorbidity had also lower odds of not being vaccinated (cOR: 0.5, 95% CI: 0.3-0.8) when compared to participants with no comorbidity. When taking into consideration the COVID-19 pandemic experiences, participant who experienced financial hardship (cOR: 1.9, 95% CI: 1.2-3.3) or relationship breakdown (cOR: 2.1, 95% CI: 1.2-3.7) were more likely to not being vaccinated when compared to participants who did not experience these hardships.

In terms of vaccine safety concerns and efficacy concerns, male participants appear less concerned for both safety (cOR: 0.5, 95% CI: 0.3-0.8) and efficacy (cOR: 0.4, 95% CI: 0.3-0.6) when compared to their female counterparts. Older participants were less worried for both safety (cOR: 0.2, 95% CI: 0.1-0.6) and efficacy (cOR: 0.3, 95% CI: 0.1-0.9) compared to younger

participants. Having a household income of more than $150,000 lowered the odds of the participants of being concerned about vaccine safety (cOR: 0.5, 95% CI: 0.3-0.9) when compared to participants with less than $50,000 per year. Participants with two or more comorbidities were also less worried about vaccine safety (cOR: 0.4, 95% CI: 0.2-0.8) in comparison to participants with no comorbidity.

Being never married was associated with higher concern for both safety (cOR: 1.9, 95% CI: 1.1-3.2) and efficacy (cOR: 2.2, 95% CI: 1.2-4.0) when compared to married participants. Obesity was also associated with higher odds of vaccine efficacy concerns safety (cOR: 1.8, 95% CI: 1.2-2.7).

Participants who experienced financial hardship (cOR: 2.2, 95% CI: 1.3-3.7), and relationship breakdown (cOR: 1.9, 95% CI: 1.2-3.3). had higher odds of having vaccine safety concerns, and participants who experienced death of a loved one (cOR: 1.6, 95% CI: 1.1-2.5), financial hardship (cOR: 2.2, 95% CI: 1.2-3.7), and decrease in personal outcome (cOR: 1.7, 95% CI: 1.1-2.6) had higher odds of having vaccine efficacy concerns.

All bivariate associations are presented in Table 2

4.3 Adjusted Odds Ratio

COVID-19 Vaccine Uptake

After adjusting for the other variables, Black participants did not have higher odds of not being vaccinated when compared to White participants (aOR: 1.8, 95% CI: 0.98-3.3). In the adjusted model, education remained a significant factor. Participants who had a Bachelor's of graduate degree had lower odds of not being vaccinated when compared to those with less than a high school degree (aOR: 0.3, 95% CI: 0.1-0.7) after accounting for race, gender, income, comorbidities and COVID-19 pandemic experiences. Having a comorbidity remained a

significant factor of having lower odds in not being vaccinated after accounting for all the other factors (OR: 0.4, 95% CI: 0.2-0.8) while those who experienced relationship breakdown (aOR: 2.3, 95% CI: 1.1-4.6) were related with higher odds of being not vaccinated.

COVID-19 Vaccine Safety Concern

Black participants had 2.3 higher odds of having vaccine safety concerns compared to White participants even after adjusting for age, sex, education, income, obesity, diabetes, hypertension, number of comorbidities and COVID-19 experiences (95% CI: 1.3 – 4.0).

COVID-19 Vaccine Efficacy Concern

After adjusting for sex, age, education, income, obesity, diabetes, hypertension, number of comorbidities and COVID-19 outcomes, Black participants had higher odds of having vaccine efficacy concerns (aOR: 2.3, 95% CI: 1.3-4.1). Male participants had lower odds of having vaccine efficacy concerns compared to female participants, even after adjusting for all the above factors (aOR: 0.5, 95% CI: 0.3-0.8). All adjusted OR are presented in Table 2. A forest plot with cORs and aORs for our vaccine outcomes is presented in Figure 5.

4.4 DAG and Mediator Analysis

Education

Education negatively impacts the effect of race on all vaccine outcomes. The higher the education, the less the effect of race on vaccine uptake. If we could set everyone on a counterfactual level of education with a Bachelor or graduate degree, we could eliminate 37% of the effect of race on vaccine uptake and 12% on the effect of race on vaccine safety concerns. All results for the mediation analysis are presented in Table 6.

Financial Hardship

The percentage mediated from financial hardship on the pathway between race and vaccine uptake is 12%, for vaccine safety is 5.5%, and for vaccine efficacy is 5%. Financial hardship positively affects the relation between race and vaccine outcome. If we had to set everyone to a level of not having experienced financial hardship, we could eliminate 29% of the effect of race on vaccine uptake, 14% on vaccine safety concerns and 12% on vaccine efficacy concerns.

Death of a loved one

The percentage mediated from death of a loved one on the pathway between race and vaccine uptake is 4%, for vaccine safety is 6%, and for vaccine efficacy is 6%. The experience of losing a loved one, positively affects the relation between race and vaccine outcome. Having everyone without the experience of losing a loved one, 21% of the effect of race on vaccine safety concerns, and 19% on efficacy concerns could be removed.

Remote Work

Remote work has a small negative mediation percentage for vaccine uptake (-14%), vaccine safety concerns (-1%), and vaccine efficacy concerns (-1%). If we would shift everyone to remote work, we would not eliminate a significant percentage of the effect of race on vaccine outcomes.

Job Loss

Job loss has a negative mediation percentage for vaccine uptake (-8%), vaccine safety concerns (-9%), and vaccine efficacy concerns (-6%). If no individual would lose their job during the pandemic, the effect of race on vaccine outcome would be non-significantly increased.

Chapter V Discussion and Conclusions

5.1 Discussion

This study examined race-based differences in vaccine uptake, safety and efficacy concerns among Black vs White population within a Georgia integrated healthcare system previously infected with COVID-19. After adjusting for other variables, there was no difference in vaccine uptake between Black and White members previously infected with COVID-19. Although, Black participants were more likely to have vaccine safety concerns and vaccine efficacy concerns compared to White participants, even after adjusting for potential confounders. When trying to understand what factors might explain these racial disparities, we see that education had a negative mediation on race-vaccine relation and setting a counterfactual value of high education for all, would remove 37% of the effect race has on vaccine uptake, and 17% of the effect race has on vaccine safety concerns.

COVID-19 experiences like financial hardship, or death of a loved one increased the relation of race and vaccine outcomes, and if all would not experience financial hardship, or the death of a loved one, the effect of race in vaccine outcomes would be diminished.

Overall, 17.7% of our study population was not vaccinated and did not plan so, while 7.3% of were unsure. Both percentages are a little bit higher than the National estimate vaccination hesitancy during August 2021 (10.5% will not get the vaccine and 3.5% were unsure) (101).

Georgia had a national vaccination rate estimate of 75% during August 2021, same with our study result (76%), but lags National estimates of total U.S adults (82%). When we look at vaccination rates by race, our study participants have a slightly lower vaccination uptake than the National estimation for the same period. Black participants (73%) in our study compared to

(77%) vaccination rate in National level estimates, White participants (79%) in our study compared to (83%) in National estimates (101). This once again shows what previously research has reported, vaccine uptake remains uneven across the country (102).

Even though Black adults had a higher crude OR of not being vaccinated (cOR: 1.8; 95% CI: 1.1-2.9), when we adjusted for variables like sex, age, education, chronic conditions, and COVID-19 pandemic experiences this disparity became insignificant (aOR: 1.8, 95% CI: 0.98-3.3). A study conducted between March 2020 and February 2021 showed that vaccine uptake was significantly lower among Black participants versus White (aOR: 0.71 95% CI: 0.64–0.79) (23). According to Kaiser Family Foundation COVID-19 Vaccine Monitor in April 2021, 59% of Black adults compared to 66% of White participants surveyed already got a dose of the vaccine or will do so as soon as possible, but the survey did not distinguish between being already vaccinated or planning to do so in the future (103).

When observing vaccine hesitancy trajectory among the Black community, a 7-month cohort study showed that Black community had rapid reductions starting from March 2021 (95,98). Since our survey was sent out during August 2021, our findings do align with the decrease hesitancy among the Black population. Furthermore, we did adjust for variables which impact vaccine intention independently of race, like education, sex, and age (91,92). We believe that adjusting for these variables can provide us with a closer to reality association of race and vaccine uptake.

Despite high vaccine uptake of our study population, ~35% of the participants had vaccine safety concerns and ~48% of the participants were concerned about vaccine efficacy. As discussed on Chapter 2, vaccine efficacy and safety trust are part of "confidence" in vaccines, one of the third components that can explain vaccine hesitancy. Previous studies which aim was

to understand attitudes towards a potential SARS-CoV-2, concluded that vaccine safety and efficacy concerns affected vaccine hesitancy (91,94). Our study aim was to see if Black and White members were different regarding these concerns and our conclusions showed Black adults more likely to be concerned. A previous study conducted between December 2020 and June 2021 showed that beliefs that the vaccines are safe and effective were positively associated with vaccine intentions, but no racial differences were found (98). A survey conducted in January 2021 from Kaiser Family Foundation showed that 90% of Black women in the study expressed concerns related to vaccine safety and vaccine long term impacts (104). Our study population is made up of 67% females, and 80% of Black participants are females, but even after adjusting for sex in our model, Black participants still had higher odds of having vaccine safety and efficacy concerns. These concerns can be explained in a lack of trust in medical institutions, rather than just the historical context (105).

When trying to see how SDH can explain vaccine outcomes, our results showed that if an intervention would be set to have everyone with a Bachelor or graduate degree, we would eliminate 32% of the effect race has on vaccine outcome and 17% of the effect on vaccine safety.

Experiences faced during the COVID-19 pandemic like shift to remote working, financial hardship, death of a loved one and job loss mediated the path between race and vaccine outcomes. From our descriptive statistics we saw that Black adults experienced more financial hardship, and death of a loved one. If an intervention would be set to have everyone without financial hardship, we would eliminate 29% of the effect of race on vaccine uptake, 14% on vaccine safety concerns, and 12% on vaccine efficacy concerns. Even though not significant, Black participants did experience more deaths of loved ones during the pandemic. If we would have had no deaths in both of the race groups, we would eliminate 21% of the effect of race on

vaccine safety concerns, and 19% on vaccine efficacy concerns. These results show us that a part of the effect race has on vaccine outcomes is mediated by factors like education, and COVID-19 experiences. We found another study which analyzed COVID-19 experiences as mediators and resulted that vaccine uptake disparities in Detroit could be eliminated by 18% if the level of trust in government would be equal between races, and 23% if the level of trust in healthcare would be equal by races (107).

Our study built upon previous research regarding vaccine hesitancy. Racial inequities are manifested as disparities in SDH, and together with medical mistrust due to prior history, have all contributed into a disproportionate vaccine uptake. Yet, there are hypothesis that this cannot be the full picture; rather other factors do influence (15). Our study showed that it is not just about socio-economic factors, but also about who faced the most difficulties during the pandemic. This further speaks to how the community of color was left unprotected during the beginning of the pandemic, and how social policies failed in providing fast pandemic relief in the form of paid leave, unemployment benefits, mental health support etc.

When we talk about vaccine hesitancy among the Black community is important to go behind prior history of medical mistrust, but to also understand that leaving a disadvantaged community in a more disadvantage position during a pandemic can increase their vaccine hesitancy, safety and efficacy concerns.

We can also hypothesize that better support that came in later during the pandemic like stimulus check, re-opening of businesses, and return to in person working, these can all have had their contribution into higher vaccine uptake that was seen later in the pandemic (second half of 2021). Making vaccine available and accessible to everyone might have contributed to the increase as well. We can recall here measurements like: money provided to take an uber to go get

vaccinated or getting the vaccine into your doctor's office, as well as having more Black doctors transmitting messages to get vaccinated.

Another important aspect of the study is prior infection with COVID-19 in our participants. We could not find any other study who looked specifically at adults who have been previously infected with COVID-19. Since prior infection does not provide long-term immunity, is important to understand racial disparities in vaccine uptake among this group, so public health measurements can be taken during new variants or booster shots campaigns.

5.2 Limitations and strengths

Our conclusions are prone to some limitations. Our survey sample is small and has limited generalizability. Self-responses are prone to misclassification. In addition, our sample is focused in Atlanta, Georgia an urban area and does not provide information in understanding how the situation in rural Georgia can be, and previous studies have shown that rural areas have been disproportionally affected by worst COVID-19 outcome and have higher vaccine hesitancy. Our participants are all members of KPGA, meaning participants have some form of insurance and can have better access to healthcare. Our mediation analysis is also done under the assumption that no unmeasured confounding exists between exposure and the mediator, as well as between the mediator and outcome. Future studies need to address these limitations by looking at larger sample sizes, including people with different access to healthcare, and taking a closer look at rural regions.

As a strength of the study, we can say that by combining three datasets (survey data, comorbidity and demographics data) we had a better understanding of these characteristics. Our study is focused into a specific group: adults previously infected with COVID-19, and we have not seen other studies with this target population in the US. During our study the vaccine was

widely available, and the delta variant had not hit yet. The study for the first time used vaccine safety concerns and vaccine efficacy concerns as outcome on their own, and for the first time studied the relationship between COVID-19 hardships and attitudes towards the vaccine.

5.3 Implications and Future Directions

In order to build upon this study, we believe it is important to view how COVID-19 experiences have shaped COVID-19 vaccine attitudes into a larger audience. Further studies to better understand the situation in rural areas are needed, as well as larger studies among patients previously infected with Covid-19. As additional doses are becoming advised, continuous studies are needed to understand disparities and increase efforts in vaccination rates, so we can prevent disparities in the uptake of additional vaccine doses. Furthermore, since there were racial differences among Black and White adults in vaccine safety and efficacy concerns, public health strategies should be better tailored to address safety and efficacy issues.

Our study results go behind just the COVID-19 pandemic. They can be useful in understanding disparities anytime vaccinations are needed, or a vaccination campaign is taking place. When talking about disparities in vaccine intentions and vaccine attitudes, we first need to see if we are taking down barriers and challenges of getting vaccinated that disproportionate populations face. It needs to be a public health measure not only to provide the vaccine and get the message out there that the vaccine is needed, but also facilitate the way to the vaccine by being fast in providing paid day leaves, transportation to the vaccine centers, bringing the vaccine at the primary care setting, allowing people who experience adverse vaccine effects to take a paid day off, and having people of different race and ethnicity transmit public health messages so everyone can feel represented. We saw that education plays an important factor, and even though a social intervention to provide everyone with high education is not attainable,

providing everyone with better education towards vaccines it is. It is important to educate everyone regarding vaccine benefits, safety, and efficacy, so we can empower everyone to make the most educated decision regarding their health.

5.4 Conclusions

Despite Black adults being more impacted by the COVID-19 pandemic in terms of hospitalization and deaths, there was a higher vaccine hesitancy among this population in the beginning of the pandemic compared to White adults Our study aim was to understand if racial disparities existed in the uptake of the vaccine, safety concerns, and efficacy concerns among the Black and White adult members at KPGA previously infected with COVID-19, and further explore some of the factors associated with these disparities. We found that adult Black members of KPGA were not more likely to not be vaccinated when compared to White members, despite being more likely to have vaccine safety and efficacy concerns than White members. Low education, financial hardship, and death of a loved one mediated the path between race and vaccine outcomes, and if we would have everyone in high education, without financial hardship, and without the death of a loved, we could eliminate some of the effect of race on vaccine outcomes. Our study indented to give a better picture of how race is connected to vaccine outcomes, but larger studies are needed to better explain all the other factors that impact this relation. Public health strategies and intervention need to be focused on these factors in order to diminish the impact race has on vaccine outcomes.

Table 1 Participant Characteristics (n= 414)

Characteristics	Total Population n (%)	Black Participants n (%)	White Participants n (%)	p-value *
N (%)	414	145 (38.5)	232 (61.5)	
Age, y				
Mean (SD)	51.3 (13.1)	49.7 (12.4)	52.9 (13.6)	**0.02**
Range	59	53	59	
Age group, y				0.1
18-29	23 (5.6)	9 (6.2)	12 (5.2)	
30-39	50 (12.1)	17 (11.7)	28 (12.1)	
40-49	110 (26.6)	47 (32.4)	49 (21.1)	
50-59	122 (29.5)	42 (28.9)	70 (30.2)	
60-64	35 (8.5)	9 (6.2)	23 (9.9)	
≥65	74 (17.9)	21 (14.5)	50 (21.6)	
Missing	0			
Sex				**0.0001**
Female	279 (67.4)	117 (80.7)	144 (62.1)	
Male	135 (32.6)	28 (19.3)	88 (37.9)	
Education				0.5
High school graduate or some high school	33 (8)	9 (6.3)	22 (9.5)	
Some college or associate degree	134 (32.8)	49 (34)	73 (31.5)	
Bachelor's or graduate degree	242 (59.2)	86 (59.7)	137 (59.1)	
Missing	5			
2019 Household Income				**0.009**
<$50,000	92 (23)	40 (27.9)	43 (18.9)	
$50,000-$99,999	140 (35)	59 (41.3)	74 (32.6)	
$100,000-$149,999	95 (23.8)	25 (17.5)	63 (27.8)	
≥$150,000	73 (18.3)	19 (13.3)	47 (20.7)	
Missing	14			
Marital Status				**<0.0001**
Married	263 (64.3)	70 (48.6)	169 (72.3)	
Divorced	59 (14.4)	30 (20.8)	25 (10.8)	
Widowed	9 (2.2)	4 (2.8)	5 (2.2)	
Separated	10 (2.4)	5 (3.5)	4 (1.7)	
Never married	68 (16.6)	35 (24.3)	28 (12.1)	
Missing	5			

Impact of the COVID-19 pandemic				
Shift to remote working	188 (49.3)	79 (58.9)	93 (42.9)	**0.004**
Death of a loved one from COVID-19	224 (57.9)	87 (63.5)	119 (54.1)	0.1
Financial hardship	91 (23.6)	39 (28.7)	42 (19.1)	**0.04**
Job loss	48 (12.5)	11 (8.1)	32 (14.6)	0.09
Decrease in personal income	117 (30.2)	43 (31.4)	62 (28.2)	0.6
Relationship breakdown	75 (19.4)	30 (22.1)	35 (15.9)	0.2
Comorbidities				
Obesity	248 (60.8)	112 (77.8)	120 (52.4)	**<0.0001**
Diabetes	79 (19.1)	35 (24.1)	37 (15.9)	**0.06**
Hypertension	176 (42.5)	68 (46.9)	94 (40.5)	0.2
No Comorbidity	203 (49.0)	72 (49.7)	111 (47.8)	0.4
< 2 Comorbidities	161 (38.9)	59 (40.7)	87 (37.5)	
2+ Comorbidities	50 (12.1)	14 (9.7)	34 (14.7)	
Vaccine Uptake				0.09
Already Vaccinated	288 (75)	93 (68.9)	175 (79.9)	
Plan on Getting the Vaccine	17 (4.4)	10 (7.4)	7 (3.2)	
Do not Plan	51 (13.3)	20 (14.8)	25 (11.4)	
Unsure	28 (7.3)	12 (8.9)	12 (5.5)	
Missing	30			
Vaccine Safety Concerns				**<0.0001**
Yes	133 (34.7)	63 (47.0)	59 (26.9)	
No	190 (49.6)	48 (35.8)	133 (60.7)	
Not sure	60 (15.7)	23 (17.2)	27 (12.3)	
Missing	31			
Vaccine Efficacy Concerns				**<0.0001**
Yes	184 (47.9)	89 (65.9)	79 (36.1)	
No	150 (39.1)	34 (25.2)	109 (49.8)	
Not sure	50 (13)	12 (8.9)	31 (14.2)	
Missing	30			

Characteristics	**Table 2** Crude and adjusted odds ratio for vaccine uptake and participant characteristics by race											
	Vaccine Uptake				**Vaccine Safety Concerns**				**Vaccine Efficacy Concerns**			
	Crude OR (95% CI)	P - value	Adjusted OR (95% CI)	P - valu e	Crude OR (95% CI)	P-value	Adjusted OR (95% CI)	P- value	Crude OR (95% CI)	P - value	Adjusted OR (95% CI)	P - value
Race												
White	REF		REF		REF		REF		REF		REF	
Black	**1.8 (1.1-2.9)**	**0.02**	1.8 (0.98-3.3)	0.06	**2.8 (1.8-4.3)**	**<.0001**	**2.3 (1.3-4.0)**	**0.002**	**2.9 (1.8-4.7)**	**<.0001**	**2.3 (1.3-4.1)**	**0.003**
Gender												
Female	REF	0.6	REF		**REF**		REF		REF		REF	
Male	0.9 (0.5-1.4)		1.2 (0.6-2.3)	0.6	**0.5 (0.3-0.8)**	**0.005**	0.7 (0.4-1.2)	0.2	**0.4 (0.3-0.6)**	**<.0001**	**0.5 (0.3-0.8)**	**0.009**
Age group, years												
18-30	REF		REF		REF		REF		REF		REF	
30-39	0.6 (0.2-1.9)	0.4	0.4 (0.1-1.6)	0.2	0.6 (0.2-1.7)	0.3	0.5 (0.2-2.1)	0.4	1.0 (0.4-2.9)	0.9	1.0 (0.3-3.6)	0.9
40-49	0.8 (0.3 -2.1)	0.7	0.9 (0.3-2.9)	0.8	0.6 (0.2-1.7)	0.4	0.6 (0.2-2.1)	0.5	1.1 (0.4-2.9)	0.8	1.1 (0.3-3.6)	0.9
50-59	0.5 (0.2-1.5)	0.2	0.5 (0.1-1.8)	0.3	0.5 (0.2-1.4)	0.2	0.7 (0.2-2.4)	0.6	1.1 (0.4-2.8)	0.9	1.1 (0.3-3.9)	0.8
60-64	0.5 (0.1-1.5)	0.2	0.4 (0.1-2.0)	0.3	**0.2 (0.1-0.6)**	**0.006**	0.2 (0.03-0.7)	0.02	**0.3 (0.1-0.9)**	**0.04**	0.3 (0.1-1.4)	0.2
≥65	**0.3 (0.1-0.9)**	**0.03**	0.4 (0.1-1.9)	0.3	**0.3 (0.1-0.8)**	**0.02**	0.6 (0.2-2.1)	0.4	0.7 (0.3-1.9)	0.5	1.2 (0.3-4.4)	0.8
Education												
≤High school	REF		REF		REF		REF		REF		REF	
Some college or associate	0.9 (0.4-2.1)	0.8	0.7 (0.3-1.9)	0.5	1.2 (0.5-2.6)	0.7	1.1 (0.4-2.9)	0.8	0.9 (0.4-2.1)	0.9	0.9 (0.3-2.5)	0.9
Bachelor's or graduate	**0.4 (0.2-0.9)**	**0.04**	**0.3 (0.1-0.7)**	**0.01**	0.7 (0.3-1.4)	0.3	0.6 (0.3-1.6)	0.4	0.6 (0.3-1.4)	0.3	0.6 (0.2-1.7)	0.4
Income												

<$50,000	REF		REF		REF		REF		REF		REF	
$50,000-$99,999	0.8 (0.4-1.5)	0.5	1.6 (0.7-3.5)	0.3	0.7 (0.4-1.3)	0.3	0.9 (0.4-1.8)	0.7	0.9 (0.5-1.7)	0.9	1.2 (0.6-2.6)	0.6
$100,000-$149,999	0.7 (0.4-1.4)	0.4	1.4 (0.6-3.5)	0.5	0.6 (0.3-1.0)	0.06	0.8 (0.3-1.8)	0.6	0.6 (0.3-1.1)	0.08	0.9 (0.4-1.9)	0.7
≥$150,000	**0.5 (0.2-1.1)**	**0.09**	1.2 (0.4-3.6)	0.7	**0.5 (0.3-0.9)**	**0.03**	0.9 (0.4-2.2)	0.8	0.6 (0.3-1.1)	0.1	0.9 (0.4-2.5)	0.9
Marital Status												
Married	REF				REF				REF			
Divorced	1.6 (0.8-3.1)	0.1			1.3 (0.7-2.4)	0.3			**1.9 (1.0-3.5)**	**0.05**		
Widowed	1.2 (0.2-6.2)	0.8			1.2 (0.3-4.9)	0.8			2.5 (0.5-12.8)	0.3		
Separated	**3.6 (1.0-12.9)**	**0.05**			4.8 (0.9-22.8)	0.05			7.6 (0.9-60.7)	0.06		
Never married	1.4 (0.7-2.6)	0.3			**1.9 (1.1-3.2)**	**0.03**			**2.2 (1.2-4.0)**	**0.01**		
Comorbidities												
Obesity	1.2 (0.7-1.9)	0.5	0.8 (0.5-1.6)	0.7	1.5 (0.9--2.3)	0.06	1.3 (0.7-2.2)	0.4	**1.8 (1.2-2.7)**	**0.009**	1.6 (0.9-2.7)	0.09
Diabetes	0.7 (0.4-1.3)	0.3	1.7 (0.6-4.5)	0.3	0.9 (0.6-1.6)	0.9	1.5 (0.6-3.5)	0.3	1.1 (0.7-1.8)	0.7	1.3 (0.6 – 2.9)	0.5
Hypertension	0.7 (0.4-1.2)	0.2	0.9 (0.6-4.5)	0.7	0.8 (0.5-1.1)	0.2	0.8 (0.5-1.5)	0.5	0.9 (0.6-1.3)	0.5	0.8 (0.4-1.4)	0.4
No Comorbidity	**REF**		REF		REF		REF		REF		REF	
<2 Comorbidities	**0.5 (0.3-0.8)**	**0.003**	**0.4 (0.2-0.8)**	**0.005**	0.7 (0.5-1.1)	0.2	0.6 (0.3-1.0)	0.06	0.8 (0.5-1.3)	0.4	0.7 (0.4-1.3)	0.2
2+ Comorbidities	**0.3 (0.1-0.8)**	**0.02**	0.3 (0.07-1.03)	0.05	**0.4 (0.2-0.8)**	**0.006**	0.3 (0.1-1.0)	0.05	0.8 (0.4-1.6)	0.5	0.7 (0.2-2.0)	0.5
Impact of the COVID-19 pandemic												
Shift to remote working	0.9 (0.6-1.5)	0.9	0.8 (0.4-1.5)	0.5	1.5 (0.9-2.2)	0.07	1.3 (0.8-2.3)	0.3	1.4 (0.9-2.2)	0.08	1.2 (0.7-2.1)	0.5
Death of a loved one from COVID-19	1.0 (0.6-1.6)	0.9			1.5 (0.9-2.2)	0.06	1.6 (0.9-2.6)	0.07	**1.6 (1.1-2.5)**	**0.02**	1.5 (0.9-2.5)	0.1
Financial hardship	**1.9 (1.2-3.3)**	**0.009**	**1.7 (0.7-3.9)**	**0.2**	**2.2 (1.3-3.7)**	**0.001**	**1.7 (0.9-3.3)**	**0.1**	**2.2 (1.3-3.7)**	**0.003**	2.1 (0.9-4.9)	0.07

Job loss	1.0 (0.5-2.1)	0.9			1.6 (0.9-2.9)	0.1	1.7 (0.8-3.9)	0.2	1.3 (0.7-2.5)	0.4	0.9 (0.4-2.4)	0.9
Decrease in personal income	1.6 (1.0-2.6)	0.05	1.2 (0.5-2.4)	0.7	1.4 (0.9-2.2)	0.1			1.7 (1.1-2.6)	0.03	1.1 (0.5-2.4)	0.8
Relationship breakdown	**2.1 (1.2-3.7)**	**0.006**	**2.3 (1.1-4.6)**	**0.02**	**1.9 (1.2-3.3)**	**0.01**	1.3 (0.6-2.5)	0.5	**1.5 (0.9-2.5)**	**0.2**	0.9 (0.4-1.8)	0.7

Table 3: Multivariate logistic regression models for vaccine uptake

MODEL	VACCINE UPTAKE aOR (95% CI)	Likelihood Ratio	p-value	AIC
Crude OR: Race	1.8 (1.1-2.9)	5.4	0.02	394.5
MODEL 1: Race + Age+ Gender	1.7 (1.01-2.79)	12.3	0.09	396.2
MODEL 2: MODEL 1 +Education+Income	1.7 (1.004 -2.9)	24.1	0.02	386.0
MODEL 3: MODEL 2+Obesity+Diabetes+Hypertension+Comorbidity	1.8 (0.99-3.3)	35.6	0.005	375.3
MODEL 4: Model 3 + Financial hardship + Relationship breakdown+ Remote Work+ Income Change	**1.8 (0.98-3.34)**	**46.1**	**0.001**	**370.1**

Table 4: Multivariate logistic regression models for Vaccine Safety Concerns				
MODEL	VACCINE SAFETY aOR (95% CI)	Likelihood ratio	p-value	AIC
CRUDE OR: Race	2.2 (1.36-3.56)	10.4	0.001	400.7
MODEL 1: RACE + Age + Gender	2.5 (1.6-3.9)	35.2	<.0001	469.8
MODEL 2: MODEL 1+ Education + Income	2.5 (1.6-4.1)	43.1	<.0001	462.3
MODEL 3: MODEL 2 + Obesity + Diabetes + Hypertension + Comorbidity	2.3 (1.4-3.8)	52.3	<.0001	457.7
MODEL 4: MODEL 3 + Remote work + Financial hardship + Job loss + Death of a loved one + Relationship breakdown	**2.3 (1.4-4.0)**	**64.3**	<.0001	**448.8**

Table 5: Multivariate logistic regression models for Vaccine Efficacy Concerns				
MODEL	VACCINE Efficacy aOR (95%CI)	Likelihood ratio	p-value	AIC
CRUDE OR: Race	2.3 (1.37-3.75)	10.6	0.0011	390.4
MODEL 1: RACE + Age + Gender	2.5 (1.6-4.1)	44.5	<0.0001	449.1
MODEL 2: MODEL 1+ Education + Income	2.6 (1.6-4.3)	46.7	<0.0001	447.3
MODEL 3: MODEL 2 + Obesity + Diabetes	2.3 (1.3 – 3.9)	53.8	<0.0001	445.3
MODEL 4: MODEL 3 + Relationship breakdown + Remote work + Financial hardship + Job loss + Death of a loved one+ Income change	**2.3 (1.3-4.1)**	**62.2**	**<0.0001**	**441.4**

Table 6: Mediation Analysis. Modeled for the mediator Education= Some College, Bachelor or graduate degree. Financial Hardship = Yes, Death of a loved one=Yes, Remote Work =Yes; Job Loss= Yes. All the models were adjusted for age, sex, obesity, hypertension, diabetes, and number of comorbidities. Percentage eliminated on bold are significant

Mediator		Vaccine Uptake	Vaccine Safety	Vaccine Efficacy
Education	% Mediated	-15%	-4%	-4%
	% Eliminated	**37%**	**12%**	7%
Financial Hardship	% Mediated	12%	5.5%	5%
	% Eliminated	**29%**	**14%**	**12%**
Death of a loved one	% Mediated	4%	6%	6%
	% Eliminated	14%	**21%**	**19%**
Remote Work	% Mediated	-14%	-1%	-1%
	NDE	6%	0.4%	0.05%
Job Loss	% Mediated	-8%	-9.3	-6.29
	NDE	-2%	-2.4%	-0.3%

Figure 1: Flowchart of Study Population

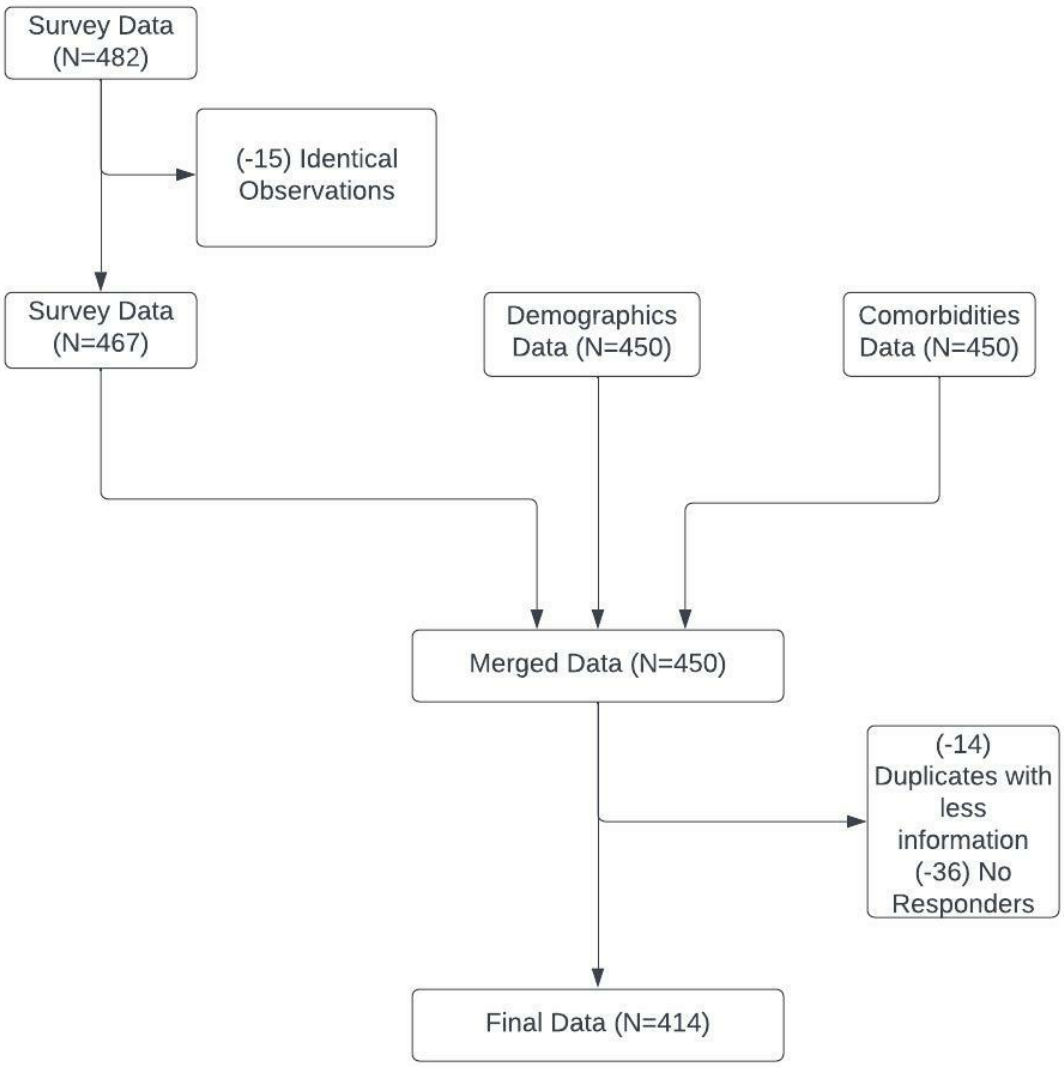


Figure 2: DAG Race and Vaccine Uptake

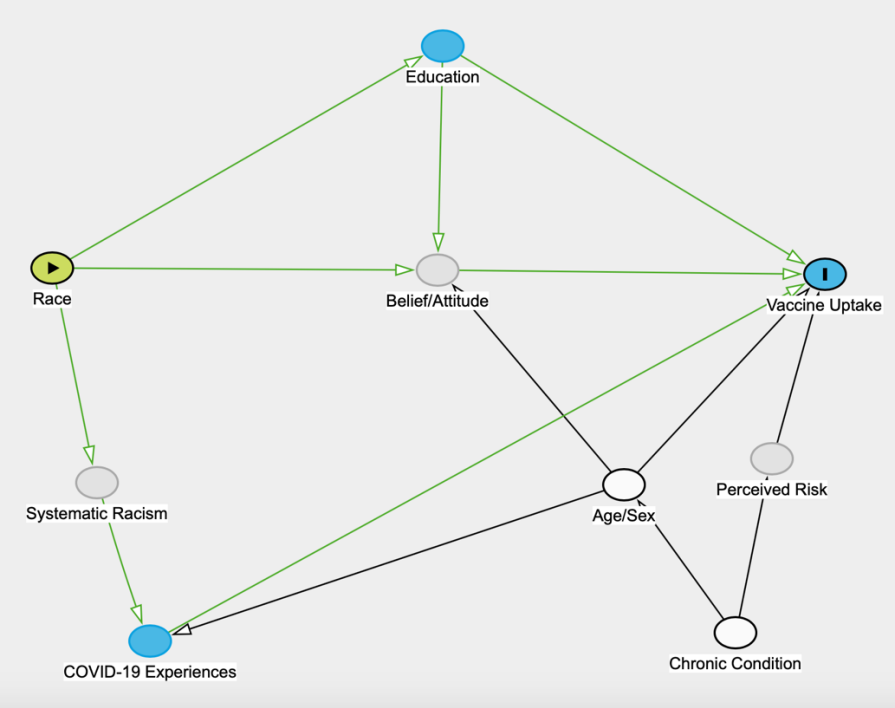


Figure 3: DAG Race and Vaccine Safety Concern

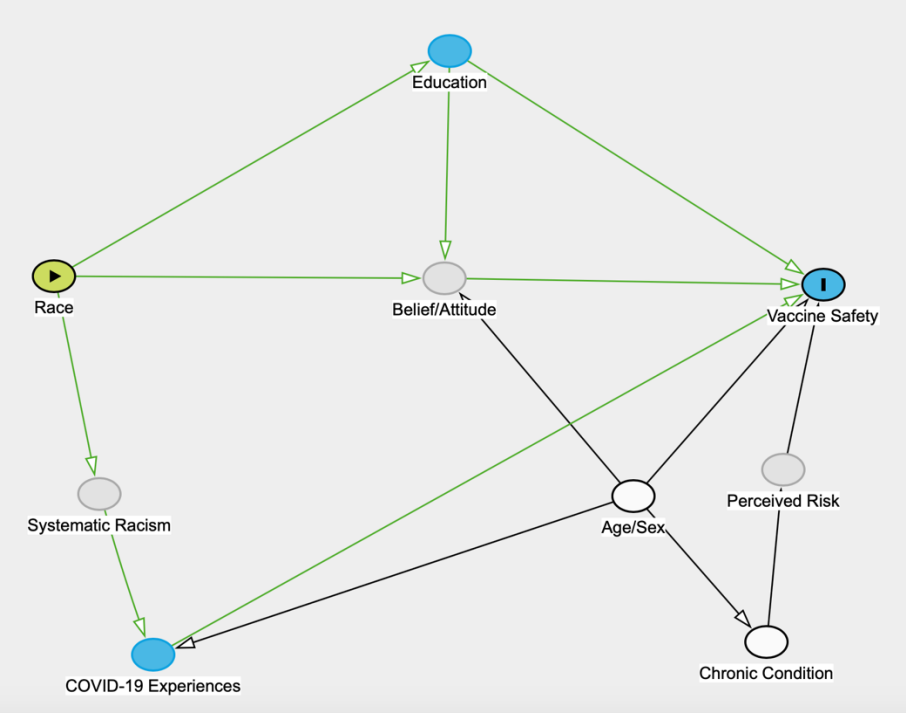


Figure 4: DAG Race and Vaccine Efficacy Concern

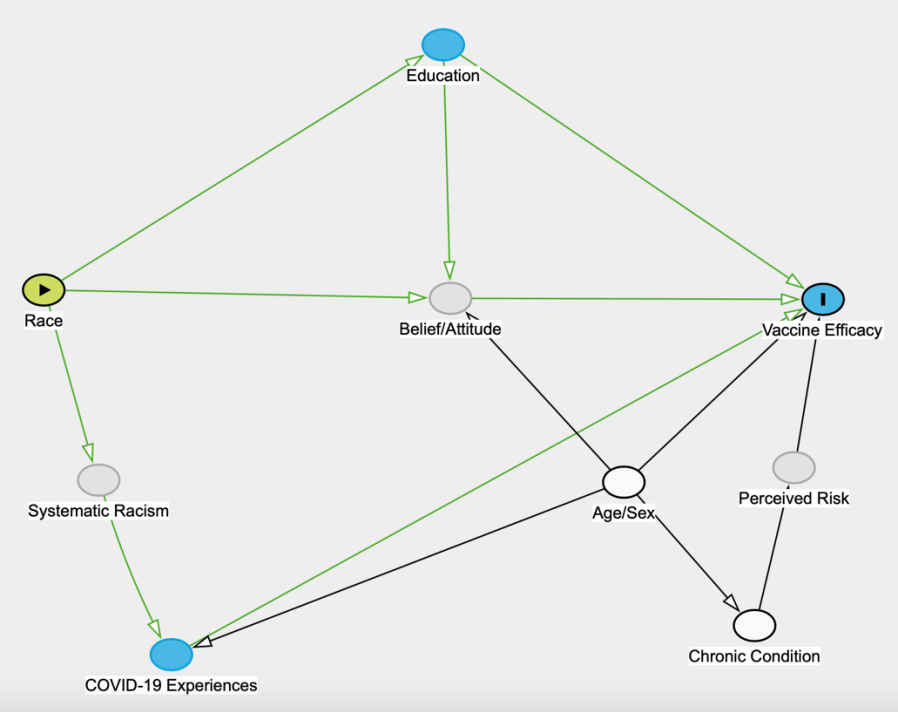
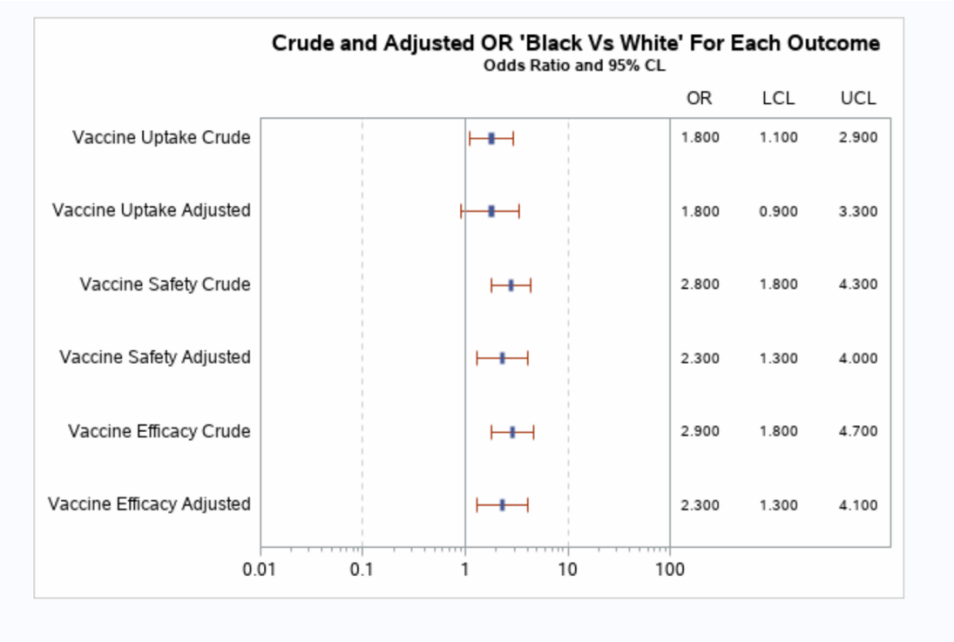


Figure 5: Forest Plot of Crude and Adjusted Odds Ratio for all the Outcomes



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Appendix 1 – Survey

First, we would like to ask you some basic questions*. Choose the option that is most appropriate for you.

1. First Name
2. Last Name
3. What year were you born?
    - Option Year 1920-2003
4. What is your sex?
    - Male
    - Female
5. What is your Kaiser Permanente Georgia Medical Record Number (MRN)?
6. What race or races do you consider yourself to be? Select all that apply.
    - White
    - Black or African American
    - Asian
    - American Indian or Alaska Native
    - Native Hawaiian or Other Pacific Islander
    - Prefer not to answer
    - Do not know
7. Do you consider yourself to be Hispanic or Latino?
    - Yes
    - No
    - Prefer not to answer
    - Do not know
8. What is the highest degree or level of school you have completed?
    - Some high school
    - High school graduate or equivalent
    - Some college
    - Associate degree (for example AA, AS)
    - Bachelor's degree (for example, BA, BS, AB)
    - Graduate degree (for example, master's, doctorate, PhD)
9. What is your marital status?
    - Married
    - Divorced
    - Widowed
    - Separated
    - Never married
10. In 2019, what was your total household income before taxes?
    - Less than $25,000
    - $25,000-$34,999
    - $35,000-$49,999
    - $50,000-$74,999
    - $75,000-$99,999
    - $100,000-$149,999

- $150,000-$199,999
- $200,000 and above

these variables are used for linkage purposes only.

11. Since March 2020, have any of the following impacted your ability to receive healthcare (for any health concerns, including COVID-19)? Select all that apply.
    - You canceled an appointment
    - You postponed or delayed seeking care
    - You tried to get care but were turned away
    - Your provider canceled an appointment
    - Your provider postponed or delayed an appointment
12. Did you experience any symptoms of COVID-19?
    - Yes
    - No

[if answered yes to Q12]

12a. What symptoms did you experience? Select all that apply

- Fever or chills
- Cough
- Shortness of breath
- Chest pain
- Sore throat
- Headache
- Muscle or body aches
- Runny nose
- Fatigue or excessive sleepiness
- Confusion
- Diarrhea
- Nausea
- Vomiting
- Loss of sense of smell or taste

13. When you first thought you might have COVID-19, how long did it take you to get a COVID-19 test?
    - Less than 1 day (i.e., you took a test on the same day you thought you might have COVID-19)
    - 1-2 days
    - 3-4 days
    - 5-6 days
    - 7 or more days
14. Where did you go to get a COVID-19 test? (*KPGA = Kaiser Permanente Georgia)
    - KPGA clinic or testing site
    - Non-KPGA pharmacy (e.g. CVS or Wallgreens
    - Georgia Department of Health test site
    - Non-KPGA (privately own testing site (e.g. testing lab or non-KPGA clinic)
    - Hospital
    - Other

15. Where did you first go to seek medical care when you started experiencing symptoms of COVID-19 or thought that you might have COVID-19?
    - Registered medical practitioner in the community
    - Nearby public health facility or hospital
    - Nearby private clinic
    - Nearby private hospital
    - Traditional healer
    - Community health worker
    - Other
    - Did not seek medical care

Now, we are going to ask you some questions about your health BEFORE you were diagnosed with COVID-19.

16. Before you were diagnosed with COVID-19, how would you have rated your overall physical health?
    - Excellent
    - Very good
    - Good
    - Fair
    - Poor
17. Before you were diagnosed with COVID-19, how much sleep would you say you were getting, on average, every night?
    - Less than 6 hours
    - 6-8 hours
    - 8-10 hours
    - More than 10 hours
18. Before you were diagnosed with COVID-19, on average, how many days per week did you engage in moderate to strenuous exercise (e.g. a brisk walk)?
    - 1
    - 2
    - 3
    - 4
    - 5
    - 6
    - 7
19. Before you were diagnosed with COVID-19, on average, how many minutes per exercise session did you engage in moderate to strenuous exercise (e.g., a brisk walk)?
    - Option 1-150 minutes
20. Before you were diagnosed with COVID-19, did you smoke tobacco?
    - Yes - Frequently
    - Yes – Infrequently
    - No - But I have smoked in the past
    - No – Never
    - No – But I am exposed to tobacco via secondhand/passive/environmental smoke

[if answered yes to Q20]

20a. How many cigarettes a day do you smoke?

- 10 cigarettes or less
- 11-20
- 21-30
- 31 or more

21. Before you were diagnosed with COVID-19, how often, on average, did you drink alcohol?
    - Never
    - Monthly or less
    - 2-4 times per month
    - 2-3 times per week
    - 4 or more times per week

[if answered yes to Q21]

21a. Before you were diagnosed with COVID-19, on average, how many alcoholic drinks did you have on a typical day when you were drinking?

- 1-2 drinks
- 3-4 drinks
- 5-6 drinks
- 7-9 drinks
- 10 or more drinks

21b. Before you were diagnosed with COVID-19, on average, how often did you have six or more alcoholic drinks on one occasion?

- Never
- Less than monthly
- Monthly
- Weekly
- Daily or almost daily

Now, we are going to ask you some questions about your health since being diagnosed with COVID-19. These questions relate to your health at the PRESENT TIME.

22. After you were diagnosed with COVID-19, how would you have rated your overall physical health?
    - Excellent
    - Very good
    - Good
    - Fair
    - Poor
23. After you were diagnosed with COVID-19, how much sleep would you say you were getting, on average, every night?
    - Less than 6 hours
    - 6-8 hours
    - 8-10 hours
    - More than 10 hours
24. After you were diagnosed with COVID-19, on average, how many days per week did you engaged in moderate to strenuous exercise (e.g., a brisk walk)?
    - 1

- 2
- 3
- 4
- 5
- 6
- 7

25. After you were diagnosed with COVID-19, on average, how many minutes per exercise session did you engage in moderate to strenuous exercise (e.g., a brisk walk)?
    - Option 1-150 minutes
26. After you were diagnosed with COVID-19, did you smoke tobacco?
    - Yes - Frequently
    - Yes - Infrequently
    - No - But I have smoked in the past
    - No – Never
    - No – But I am exposed to tobacco via secondhand/passive/environmental smoke

[if answered yes to Q26]

26a. How many packs, on average, do you smoke per day?

- 10 cigarettes or less
- 11-20
- 21-30
- 31 or more

27. After you were diagnosed with COVID-19, how often, on average, did you have a drink containing alcohol?
    - Never
    - Monthly or less
    - 2-4 times per month
    - 2-3 times per week
    - 4 or more times per week

[if answered yes to Q27]

27a. On average, how many drinks containing alcohol did you have on a typical day when you were drinking?

- 1-2 drinks
- 3-4 drinks
- 5-6 drinks
- 7-9 drinks
- 10 or more drinks

27b. After you were diagnosed with COVID-19, on average, how often did you have six or more alcoholic drinks on one occasion?

- Never
- Less than monthly
- Monthly
- Weekly
- Daily or almost daily

Now, we are going to ask you some questions about how the COVID-19 pandemic has affected your personal life more generally.

28. Since March 2020, have you experienced a shift to remote working?
    - Yes
    - No

[if answered yes to Q28]

28a. On a scale of 1-5, where 1=”not impacted at all” and 5=”majorly impacted”, how much has a shift to remote working impacted your personal daily life?
    - 1 (not impacted at all)
    - 2
    - 3
    - 4
    - 5 (majorly impacted)

29. Since March 2020, have you experienced a relationship breakdown?
    - Yes
    - No

[if answered yes to Q29]

29a. On a scale of 1-5, where 1=”not impacted at all” and 5=”majorly impacted”, how much has this relationship breakdown impacted your personal daily life?
    - 1 (not impacted at all)
    - 2
    - 3
    - 4
    - 5 (majorly impacted)

30. Since March 2020, have you experienced job loss?
    - Yes
    - No

[if answered yes to Q30]

30a. On a scale of 1-5, where 1=”not impacted at all” and 5=”majorly impacted”, how much has this job loss impacted your personal daily life?
    - 1 (not impacted at all)
    - 2
    - 3
    - 4
    - 5 (majorly impacted)

31. Since March 2020, have you experienced a decrease in personal income?
    - Yes
    - No

[if answered yes to Q31]

31a. On a scale of 1-5, where 1=”not impacted at all” and 5=”majorly impacted”, how much has this decrease in personal income impacted your personal daily life?
    - 1 (not impacted at all)
    - 2
    - 3
    - 4
    - 5 (majorly impacted)

32. Since March 2020, have you experienced financial hardship?

- Yes
- No

[if answered yes to Q32]

32a. On a scale of 1-5, where 1=”not impacted at all” and 5=”majorly impacted”, how much has this financial hardship impacted your personal daily life?

- 1 (not impacted at all)
- 2
- 3
- 4
- 5 (majorly impacted)

33. Since March 2020, has someone you know died from COVID-19?
    - Yes
    - No

[if answered yes to Q33]

33a. On a scale of 1-5, where 1=”not impacted at all” and 5=”majorly impacted”, how much has this death impacted your personal daily life?

- 1 (not impacted at all)
- 2
- 3
- 4
- 5 (majorly impacted)

34. Since March 2020, have you become newly responsible for providing care to a loved one?
    - Yes
    - No

[if answered yes to Q34]

34a. On a scale of 1-5, where 1=”not impacted at all” and 5=”majorly impacted”, how much has becoming newly responsible for providing care to a loved one impacted your personal daily life?

- 1 (not impacted at all)
- 2
- 3
- 4
- 5 (majorly impacted)

35. Since March 2020, have you become newly responsible for overseeing school or education for school-age children (e.g. homeschooling or facilitating virtual school)?
    - Yes
    - No

[if answered yes to Q35]

35a. On a scale of 1-5, where 1=”not impacted at all” and 5=”majorly impacted”, how much has becoming newly responsible for overseeing school or education for school-age children impacted your personal daily life?

- 1 (not impacted at all)
- 2
- 3
- 4
- 5 (majorly impacted)

36. Since March 2020, have you become newly responsible for childcare/daycare for children?

- Yes
- No

[if answered yes to Q36]

36a. On a scale of 1-5, where 1=”not impacted at all” and 5=”majorly impacted”, how much has becoming newly responsible for childcare/daycare for children impacted your personal daily life?

- 1 (not impacted at all)
- 2
- 3
- 4
- 5 (majorly impacted)

Now we are going to ask you some questions about the COVID-19 vaccine.

37. Have you received the COVID-19 vaccine or do you plan on getting the COVID-19 vaccine when it becomes available to you?
    - Yes – I already have received the vaccine
    - Yes – I plan on getting the vaccine when it is available to me
    - No – I have not received the vaccine and do not plan on getting the vaccine
    - Unsure
38. Are you concerned about the safety of the COVID-19 vaccine?
    - Yes
    - No
    - Unsure
39. Are you concerned about how well the COVID-19 vaccine will work?
    - Yes
    - No
    - Unsure
40. What concerns do you have about the COVID-19 vaccine? Select all that apply.
    - Immediate side effects from receiving the vaccine
    - Long-term side effects
    - How well the vaccine will protect me from COVID-19
    - How long the vaccine will protect me from COVID-19
41. Would you encourage your friends or family to get the vaccine?
    - Yes
    - No
    - Unsure

Now, we are going to ask you some questions about your experiences with the health care system more generally. This includes your experiences before, during and after your diagnosis of COVID-19.

42. Have you ever felt unfairly treated in getting medical care?
    - Yes
    - No
43. Have you ever felt that you were denied medical care or provided inferior or poor medical care?

- Yes
- No

44. Have you ever had to wait a long period of time before getting medical care?
    - Yes
    - No
45. Have you ever had trouble getting medical care from a specialist such as a heart doctor?
    - Yes
    - No

46. For the next set of statements, please indicate if you strongly disagree, disagree, agree, or strongly agree with each statement (select only one option for each item):

	Strongly disagree	Disagree	Agree	Strongly agree
When I make plans, I am almost certain that I can make them work				
Getting people to do the right thing depends upon ability; luck has nothing to do with it				
What happens to me is my own doing				
Many of the unhappy things in people's lives are partly due to bad luck				
Getting a good job depends mainly on being in the right place at the right time				
Many times I feel that I have little influence over the things that happen to me				

47. For the next set of statements, please indicate if you strongly disagree, disagree, agree or strongly agree with each statement

	Strongly disagree	Disagree	Agree	Strongly Agree
You had better be cautious when dealing with healthcare organizations				
Patients have sometimes been deceived or misled by healthcare organizations				
When healthcare organizations make mistakes, they usually cover it up				
Healthcare organizations have sometimes done harmful experiments on patients without their knowledge				
Healthcare organizations don't always keep your information totally private				
Sometimes, I wonder if healthcare organizations really know what they are doing				
Mistakes are common in healthcare organizations				

I trust that health care organizations will tell me if a mistake is made about my treatment				
Health care organizations often want to know more about your business than they need to know				
The patient's medical needs come before other considerations at health care organizations				
Health care organizations are more concerned about making money than taking care of people				
Health care organizations put the patient's health first				
Patients should always follow the advice given to them at health care organizations				
I typically get a second opinion when I am told something about my health				
I trust that health care organizations check their staff's credentials to make sure they are hiring the best people				
They know what they are doing at health care organizations				
I trust that health care organizations keep up with the latest medical information				

Appendix 2 - Interview Guide

Study Aim 2b: Understand factors that facilitate and impede health seeking behaviors at the interpersonal, family, community, and healthcare levels among members with COVID. These interviews will focus on how members navigated care and linked to care.

Part 1: COVID Status

1. How did you first learn that you were COVID positive?
2. Walk me through me through your daily experiences with COVID.
3. Tell me about a time you had a question(s) about COVID and got help with that question. (**informational support)**
    a. Who did you go to?
    b. What made you feel comfortable going to that source?
    c. Why did you trust this source?
    d. What is this person's connection to healthcare or the medical field, if any?
    e. Other people in network in healthcare field?
4. Tell me about a time you had a question but did not get an answer.
    a. What made it difficult?
    b. What could have made it easier?

Part 2: Care Navigation:

Now I want to talk with you about your experiences and interactions with providers and all health care employees. This can include any doctors, nurses, physician assistants, or anyone else involved in your care.

1. Start with your first interactions and walk me through the time when you felt you were recovered from COVID.
2. When did you first seek care for COVID?
    a. What lead you to seek care?
    b. Walk me through your symptoms with COVID?
    c. How did it take place? Phone? In-person? Video? Chat with a doctor?
3. How long was the time between you suspected you had COVID to the time you sought care?
4. I want you to think about the timing of you seeking care. Do you think it was too soon? Just right? Or later than you would have preferred? I want you to answer on a scale of 1 to 10.
    a. 1=too early
        i. *If closer to 1:* what are the reasons you felt it was too early?
    b. 5=just right
        i. *If closer to 5:* what makes you feel like you got care at the right time?
    c. 10=too late
        i. *If closer to 10:* what makes you feel like you went later than preferred?
5. What were your first interactions with a health professional about your care related to COVID? Please describe the interaction.
    a. How were you treated during this early interaction?
    b. How satisfied were you with this interaction?

    c. Did you feel like your needs were met?
6. We understand that there may have been multiple discussions with healthcare providers as you dealt with COVID. Please tell me about your story after this first encounter with a healthcare provider.
7. How did the health care professionals explain your treatment to you?
    a. *Probe:* How clear was the explanation?
    b. *Probe:* What was unclear in the explanation?
    c. *Probe:* What did you have trouble understanding about your diagnosis?
    d. *Probe:* What could have improved that experience for you?
8. What challenges did you have adhering to the treatment plan by providers?
    a. How realistic was this plan for you?
    b. How confident were you in this plan?
9. What challenges did you experience getting access to care?
    a. Transportation?
    b. Knowing how to access care and where to call?
    c. Knowing where to go?
10. How often did you have to serve as your own health advocate during your time having COVID?
11. Please think about your experiences having COVID and other experiences with health care or trying to get health care. Could you share an experience you have had with being treated differently because of the color of your skin?
    a. *Probe:* How did this make you feel?
    b. *Probe:* How did this change how your next health care encounter?

Part 3. Parallel needs and competing priorities

12. While you were handling your own healthcare, what else where you concerned about?
    a. Work?
    b. School
    c. Health of others?
13. Who else were you responsible for during this time?
14. How did you handle your responsibilities during this time?

Part 4. COVID lessons learned

<u>We want to learn more about your perspective on COVID-19.</u>

15. What, if anything, could have helped you in navigating COVID-19 your care? Or focus on your care?
16. How much control did you feel you had over your healthcare?
    a. What could have helped you have more control?
    b. What made you feel like you did not have control?
17. Were there any resources you needed to protect yourself but did not have?
18. If you had to summarize your experiences with COVID-19, what would you say?
19. What advice would you give to others about dealing with COVID-19?