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COVID-19 Vaccine Hesitancy Among Clinical Health Care Workers (HCWs) in Four Major Healthcare Systems in Metro Atlanta

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Abstract

COVID-19 Vaccine Hesitancy Among Clinical Health Care Workers (HCWs) in Four Major Healthcare Systems in Metro Atlanta

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Background: Since COVID-19 vaccines were approved for emergency use in late 2020, they remain the most effective known preventive measure for fighting the current pandemic. Several studies have highlighted COVID-19 vaccine hesitancy in the general population; however, little is known about the nature and extent of COVID-19 vaccine hesitancy in healthcare workers (HCWs) in Georgia. This current study assessed the prevalence and risk factors of COVID-19 vaccine hesitancy among clinical HCWs in four healthcare systems in metro Atlanta.
Method: The study included demographic and COVID-19 vaccination-related data collected from clinical HCWs. Data was collected through an anonymous cross-sectional survey using Qualtrics via email to all HCWs in May-June 2021. We estimated the prevalence of vaccine-hesitancy across clinical healthcare roles and assessed the predictors using a logistic regression model. We also examined the perception and reasons for vaccine hesitancy among vaccine-hesitant HCWs. All analyses were done in SAS 9.4 and statistical significance was assumed at a 0.05 level.
Results: A total of 3373 clinical HCWs were surveyed in this study with a response rate of approximately 18%. Overall, 9.7% of clinical HCWs were vaccine-hesitant. Physicians were the least vaccine-hesitant (1.8%), whereas paramedics (29.1%), medical/nursing assistants (14.6%), nurses (13.4%), and technologists (13.4%) were the most vaccine-hesitant groups. About half of the vaccine-hesitant clinical HCWs were nurses. Factors that were positively associated with vaccine-hesitancy included young age, previous COVID-19 infection, and children under 18 years at home. Higher education, Asian race, Hispanic ethnicity, and having a family member with critical COVID-19 were negatively associated with vaccine-hesitancy. Among all respondents, 54% doubted its effectiveness, 30% were concerned about side effects, and 40% did not agree to mandatory COVID-19 vaccination for HCWs. Among the vaccine-hesitant HCWs, the top concerns were side effects (45%), limited knowledge (18%), and wanting more people to get vaccinated (26%).
Conclusion: Vaccine hesitancy among clinical HCWs was highest among younger and less educated HCWs. A considerable proportion of HCWs had negative perceptions of COVID-19 vaccines and documented less confidence in getting this. Therefore, targeted interventions such as information leaflets, posters, or regular plenary presentations are needed to improve vaccine uptake among HCWs.

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Chapter 1: Introduction

1.1 Background

1.1.1 Vaccine hesitancy

World Health Organization (WHO) defines Vaccine Hesitancy (VH) as

- Delay in acceptance or refusal of vaccines despite availability of vaccine services.
- VH is complex and context-specific, varying across time, place, and vaccines.[1]

1.1.2 Vaccine hesitancy model

In 2011, the WHO EURO Vaccine Communication Working Group proposed a "3 Cs" vaccine hesitancy model highlighting three categories: complacency, convenience, and confidence (Figure 1.1). In this model, complacency refers to situations that can create perceptions of a vaccine as unnecessary. For example, many people, especially youngers, perceive that the risk of COVID-19 is low and doubt the severity of the disease. As a result, they are more likely to believe that they don't need a vaccine. The second term is convenience, which is primarily meant for the availability, affordability, and accessibility of vaccines. COVID-19 vaccines are free and widely available. However, some people may face difficulty in scheduling, traveling to the vaccination site, or taking time off from work to get the vaccines. The ability to understand the science behind vaccination and the quality of vaccination service can also strongly influence convenience. Finally, confidence is defined as trust in three different aspects of vaccination, including vaccine safety and effectiveness, the system that delivers it, and the decisions made by the policymakers. Some of the most influencing factors of COVID-19 vaccine hesitancy include lack of trust, the process of vaccine development, and the trustworthiness of related health information[2].

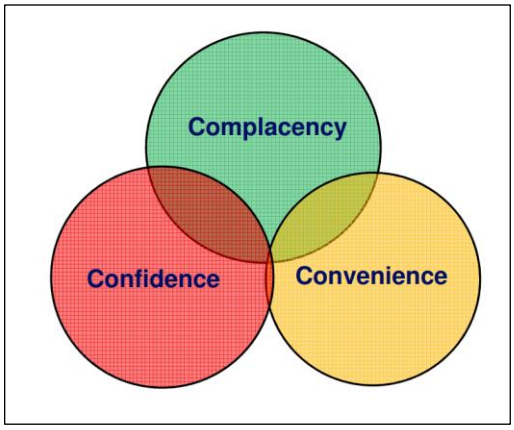


Figure 1.1: Vaccine hesitancy model.

1.1.3 COVID-19 pandemic

COVID-19 or Coronavirus Disease 2019, is caused by a novel virus named severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) which was first discovered from an outbreak in Wuhan province of China in December 2019[3]. Since its origin, it spread rapidly all over the world and WHO declared it a pandemic on 11 March 2020[4]. This ongoing COVID-19 pandemic continues to impact countries around the world. As of March 2022, the COVID-19 pandemic was responsible for 80 million confirmed cases and over 980,000 deaths in the United States[5]. Worldwide, as of March 2022, more than 497 million cases and 6.17 million deaths have been confirmed due to this pandemic[6]. It affected 224 countries and territories in the world.

1.1.4 Effect of COVID-19 pandemic in the United States

The United States is one of the most affected countries in the world by COVID-19. As of March 2022, more than 80 million cases and 0.98 deaths had been confirmed in the United States[7]. In the state of Georgia, more than 1.9 million cases and 31 thousand deaths occurred by the end of March 2022[8]. Georgia ranked 27th state based on COVID-19 cases per 100,000 population in May 2021.

1.1.5 Vaccine development for COVID-19

In December 2020, The Advisory Committee on Immunization Practices (ACIP) issued an interim recommendation for the use of the Pfizer-BioNTech COVID-19 vaccine in persons aged

16 years or older for the prevention of COVID-19. On December 11, 2020, US Food and Drug Administration (FDA) issued an Emergency Use Authorization (EUA) for the first COVID-19 vaccine – the Pfizer-BioNTech COVID-19 vaccine[9]. A week after, FDA approved Emergency Use Authorization (EUA) for the second COVID-19 vaccine- The Moderna COVID-19 vaccine. IN the United Kingdom, AstraZeneca and the University of Oxford's vaccine were approved for emergency use in early 2021[10]. In February 2021, the third COVID-19 vaccine- the Johnson and Johnson COVID-19 vaccine- received a EUA in the United States. Later, both Pfizer-BioNTech and Moderna vaccines were granted full approval by FDA in 2021[11].

1.1.6 COVID-19 Vaccination coverage worldwide

Till March 2022, about two-thirds of the world population received at least one dose of the COVID-19 vaccine, however, only 14.8% of people in low-income countries have received at least one dose. In the United States, about 82% population of five years or older received at least one dose of the COVID-19 vaccines[7].

1.1.7 COVID-19 Vaccination coverage in the state of Georgia

As of March 2022, In Georgia, 65% of the population has received at least one dose of the COVID-19 vaccine with 54% fully vaccinated population. Only 19% of Georgia's population has received a booster dose. Going back to April 2021, only 34% of the population in the state of Georgia had received at least one dose of the COVID-19 vaccines[8]. Georgia ranks 44 among all the states in the US, based on the percentage of the population fully vaccinated.

1.1.8 Importance of vaccine hesitancy among healthcare workers

Health care workers can play a crucial role in fostering vaccine acceptance among the vaccine-hesitant[12]. However, vaccine hesitancy among health care workers persists, which can play a detrimental effect on the overall vaccination program. A study conducted in February 2021 in France found that 23.1% of healthcare workers categorized themselves as hesitant to COVID-19 vaccine[13]. Another study among Canadian healthcare workers in December 2020 reported that 19.1% of the respondents declined to receive the COVID-19 vaccine at the time of the survey[14]. Confidence about the safety, effectiveness, and importance of vaccination among health care workers, especially those who are in direct contact with patients (e. g. Physicians, nurses,

medical assistants, paramedics), can effectively address the fears of their vaccine-hesitant patients.

1.2 Rationale of the study

Studies have shown that vaccine hesitancy among healthcare workers is highly context specific and can vary by profession, type of vaccine, and in time[15]. There is limited literature regarding the factors of vaccine hesitancy among healthcare workers. In this current study, we analyze data from a vaccine survey that was administered to healthcare workers in four major healthcare systems in metro Atlanta, GA to understand the factors and context of vaccine hesitancy among different types of clinical healthcare roles.

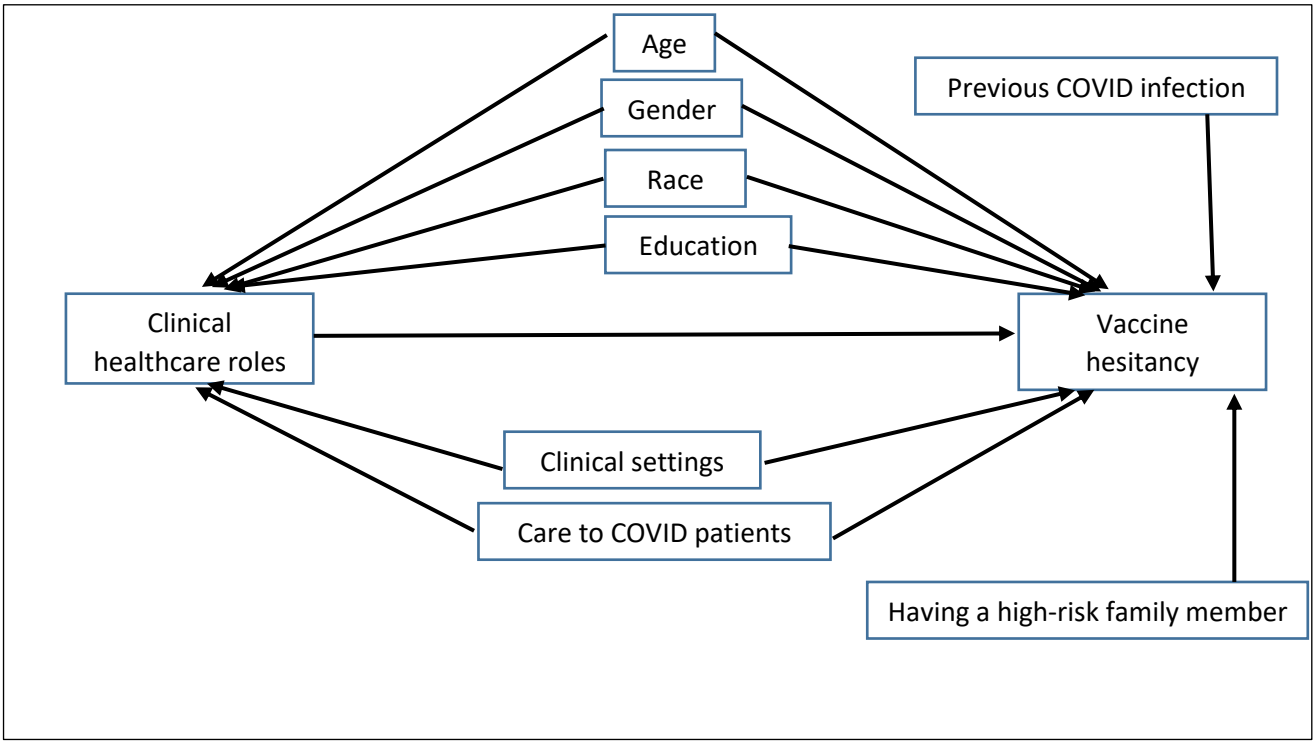
1.3 Public health significance of the study

This study will add knowledge to our understanding of vaccine hesitancy among healthcare workers. This information will be helpful in the future to help target vaccine hesitant groups and take prompt public health actions. Findings from this study will also help in planning awareness programs in healthcare systems to address vaccine hesitancy among healthcare workers.

1.4 Data source

The primary data was collected for the COVID-19 vaccine hesitancy study conducted in Emory, Grady, Morehouse, and Kaiser Permanente in May-June 2021. Data was collected using a study-specific questionnaire, which was developed in Qualtrics to obtain demographic data, COVID-19 vaccination status, reasons for not taking the vaccine, and opinions toward the COVID-19 vaccine. This survey was administered via email to listed healthcare workers in those healthcare systems from May to June 2021. Responses were entered into a Microsoft Excel database, which was used as a source dataset for this thesis project.

1.5 Directed acyclic graph



1.6 Research question

Is there any association between clinical healthcare roles and being COVID-19 vaccine-hesitant among the clinical healthcare workers in the healthcare systems in the metro Atlanta area?

1.7 Research hypothesis

Null hypothesis: The proportion of COVID-19 vaccine-hesitancy is the same across different clinical healthcare roles.

Alternate hypothesis: The proportion of COVID-19 vaccine-hesitancy is not the same across different clinical healthcare roles.

1.8 Objectives of the study

1.8.1 General objective

To estimate the proportion and risk factors of COVID-19 vaccine hesitancy by clinical healthcare roles among the clinical healthcare workers in the healthcare systems in the metro Atlanta area.

1.8.2 Specific objectives

2. To estimate the proportion of vaccine hesitancy among clinical healthcare workers working in the healthcare systems in metro Atlanta.
3. To identify the risk factors associated with clinical healthcare roles and vaccine hesitancy.
4. To describe the perception toward COVID-19 vaccines among the clinical healthcare workers by their vaccination status.
5. To explore the reasons for not getting the vaccine among vaccine-hesitant clinical healthcare workers.

Chapter 2: Literature Review

Vaccination is considered one of the most successful public health interventions, which has contributed to the decline in mortality and morbidity of many infectious diseases including the elimination of poliomyelitis in the Americas and the worldwide eradication of smallpox[16]. Despite this fact, a considerable number of people perceive vaccination as unsafe and unnecessary[17]. Surveys conducted in developed countries have found that respondents believe in the efficacy of vaccines but still lack confidence regarding their safety. This lack of confidence is a threat to the success of ongoing vaccination programs.

After the start of the COVID-19 pandemic, a number of studies assessed vaccine-hesitancy among the different populations. In early 2021, just before the availability of COVID-19 vaccines in the United States, a nationwide survey was conducted for a comprehensive and systematic assessment of COVID-19 vaccine hesitancy in a community-based sample of the American adult population. The results showed about 21% of participants would prefer to receive the vaccine. Important predictors for vaccine-hesitancy were female sex, having children at home, unemployment, low socioeconomic condition, less education, and a higher level of perception of getting the virus in the next year[18].

An earlier study in June 2020 with a nationally representative sample of 3,133 the adult US population found that about 20% of people in the United States would decline the vaccine. Distrust of vaccine safety, female gender, inconsistent risk messages from public health experts, and elected officials were found to reduce the vaccine uptake[19].

Another study among 1205 adults in Arkansas during July/August 2020 found one in five people to be hesitant about vaccines. Prevalence of vaccine hesitancy was found significantly higher among Black/ African Americans, with little to no fear of infection from COVID-19, lower education, and low trust in vaccines. Low education and general mistrust in vaccines were significantly associated with vaccine hesitancy[20].

From September 2020 to February 2021, a study investigated the change in vaccine acceptance in eight countries, including Denmark, the UK, Sweden, Germany, Italy, France, Hungary, and the USA. Overall, a moderate to low level of vaccine acceptance was observed in the USA

(54%). However, the study found increasing levels of vaccine acceptance over the course of the pandemic for that period when the vaccines were still being developed. Lack of trust in authorities, conspiratorial thinking, and a lack of concern about COVID-19 were associated with poor vaccine acceptance[21].

Janeta et al. evaluated vaccine hesitancy among US adults aged 65 and older who were enrolled in the Heatline clinical study in November 2020. The study found that 8.7% of the participants were unwilling to be vaccinated. Factors most strongly associated with vaccine hesitancy were women, the Black race, and safety concerns. More than 66% of vaccine-hesitant respondents said that they would talk with the health care provider before making a decision[22].

Among adults from three cities in the United States (Miami, FL; New York City, NY; San Francisco, CA) found 13% of the participants were hesitant to COVID-19 vaccines. Black race, low income, inattention to COVID-19 news, low satisfaction with health, and healthcare access were found to be significantly associated with vaccine hesitancy[23].

In a follow-up study among US adults in Understanding America Study (UAS) from October 2020 to March 2021, the proportion of vaccine-hesitancy was observed to be declined significantly by 10.8 percentage points from 46% in October 2020 to 35% in March 2021. Similarly, the estimates of public trust were also improved in all demographic groups during the study period. Young age (18-39 years), those without a degree, and low household income were found predictors of vaccine-hesitancy at the end of the study (in March 2021)[24].

A large cohort study among the US and UK participants in the smartphone-based COVID-19 symptom study from March 2020 to February 2021 was conducted to understand the racial difference in vaccine-hesitancy. In the US, the Black, followed by Hispanic and Asian were found to be more vaccine-hesitant compared to the non-Hispanic White[25].

In December 2020, a study assessed the impact of channels of information (traditional vs. social) on vaccine acceptance. The study found traditional channels, including National TV or newspapers increased the likelihood of vaccine acceptance, compared to social media[26].

In a nationwide online survey of 804 US adults in June 2020, about 14.8% of the respondents were unlikely to get vaccinated and another 23% were unsure. The willingness of getting the vaccine was highest among men, older people, non-Hispanic Whites, people having a college

degree, those who were married or partnered, and those vaccinated against influenza in the past season. Having general vaccine knowledge was found a strong predictor of vaccine intent[27].

Another cross-sectional study assessed the intent to be vaccinated against COVID-19 among a representative sample of US adults. The intention to be vaccinated was found in only 57.6% of the participants with 10.8% confirmed not to be vaccinated. Younger age, Black race, low educational attainment, and not having influenza vaccine in the prior year were independently associated with vaccine hesitancy. Lack of trust, need for more information, and antivaccine beliefs were identified as the potential reasons for vaccine hesitancy[28].

Dorman et al. conducted a survey in October-November 2020 to understand the *Confidence, Complacency,* and *Convenience* of COVID-19 vaccination and calculated risk versus benefits, and concern for protecting others. Vaccine-hesitancy was associated with young age, race, and low level of education. Non-Hispanic Asians were found to be the least hesitant and Blacks had the highest hesitancy. First responders were found to be least willing to be vaccinated. Vaccine safety, having concerns to protect others, and believing COVID-19 was not serious enough to merit vaccination were the strongest predictors of vaccine hesitancy[29].

In a community-based survey using social media platforms of the adult American population in June 2020 found that 22% of the study participants were not likely to get the vaccine. Female gender, low education, unemployment, low income, having children at home, and perceived threat of getting infected with COVID-19 in the next 1 year were significantly associated with vaccine hesitancy[30].

Several studies were conducted among healthcare workers to understand their vaccine hesitancy. A study on medical students in Southeast Michigan using an anonymous online survey found that 23% of the respondents were unwilling to take a COVID-19 vaccine immediately upon FDA approval. Lack of trust in public health experts and concerns about vaccine side effects had higher odds of being vaccine-hesitant[31].

Another study among both clinical and non-clinical healthcare workers in December 2020 found that only 57.5% of the individuals had expressed the intent to receive a COVID-19 vaccine. Physicians were the most receptive group with 80% having the intent to get the vaccine, whereas, nurses were the least receptive group with only 37% having the intent to get the

vaccine. Respondents who were young, female, and Black were less likely to get the vaccine. Participants expressed that safety, potential adverse effect, efficacy, and spread of vaccine development were strong determinants of a decision regarding vaccine acceptance[32].

A study among nursing homes and assisted living facility staff in Indiana found that only 45% of the respondents would have received the vaccine once the approval is given. Concerns about the vaccine side effects were the primary reason for vaccine hesitancy. Besides, younger, and non-White populations were found more vaccine-hesitant[33].

In New Mexico hospitals, a study was conducted in October 2020 to understand their attitudes towards upcoming COVID-19 vaccines. Only 36% of the respondents were willing to get the vaccine when available and 56% were not sure or would wait to review more data. Vaccine-hesitancy decreased with decreasing age, education, and income level. Healthcare workers with direct medical care had higher vaccine acceptance[34].

A study among healthcare workers in Lurie Children's Hospital in Chicago in December 2020 found that 18.9% of the respondents in that hospital fulfilled the criteria to be vaccine-hesitant. Female and Black healthcare workers were found to be more vaccine-hesitant[35].

A cross-sectional survey in February 2021 in a large medical center in the central United States found that 11.2% of the healthcare workers in that hospital were vaccine-hesitant. The hesitant healthcare workers mentioned inadequate information to make an informed decision about receiving the vaccine was the most important barrier to vaccine acceptance. Having greater than 10 years' work experience and confidence in vaccine safety were significantly associated with vaccine uptake[36].

An anonymous survey of employees at Yale health system looked at the prevalence and underlying reasons for COVID-19 vaccine hesitancy. They found 1 in 6 healthcare workers having the reluctance to get the vaccine in the first wave. The potential concern behind vaccine hesitancy was the lack of information regarding the vaccine's effectiveness and safety[37].

One study investigated the racial disparity of vaccine-hesitancy among healthcare workers in two large hospitals in Philadelphia. Vaccine hesitancy was found to be increased nearly 5-fold among Black HCWs, 2-fold among Hispanic HCWs, and by nearly 50% among Asian HCWs. They got a really high proportion of vaccine-hesitant healthcare workers, including 83% of Black HCWs

and 63.5% of Hispanic HCWs. Concerns about the side effects, the newness of the vaccine, and lack of vaccine knowledge were found to be the strong predictors of vaccine hesitancy[38].

Another study used the Health Belief Model framework to evaluate vaccine hesitancy among healthcare workers in 3 academic medical centers in the Chicagoland between March and May 2021. They found 15% of the respondents to be vaccine-hesitant. Black, allergy to any vaccine component, and support from the closest ones were significantly associated with vaccine-hesitancy[39].

A systematic review of vaccine-hesitancy among healthcare workers during late 2020 and early 2021 across the world found that the prevalence of COVID-19 vaccination hesitancy in healthcare workers had ranged from 4.3% to 72% (average of 22.5% across all studies with a total of 76,471 participants). Vaccine safety, efficacy, and potential side effects were the top reasons for COVID-19 vaccination hesitancy in healthcare workers. Respondents who were male, of older age, and doctoral degree holders (i.e., physicians) were less like to be vaccine-hesitant. Vaccine uptake probability was found to be influenced by the higher perceived risk of getting infected with COVID-19, direct care for patients, and history of influenza vaccination[40].

Another systematic review assessed the attitudes of healthcare workers toward COVID-19 vaccination in 13 published articles by February 2021. They found a wide range of vaccine acceptance, ranging from 27.7% to 77.3%. Men, older age, and physicians were found to the positive predictive factors for vaccine acceptance. Women and nurses were found to be more vaccine-hesitant. They identified a few potential barriers to vaccine acceptance including Previous influenza vaccination and self-perceived risk were facilitators. Concerns for safety, efficacy, and effectiveness, and distrust of the government. This study did not find direct care for COVID-19 cases was not a strong predictor of vaccine hesitancy[41].

Chapter 3: Methodology

3.1 Source population

The primary data was collected from both clinical and non-clinical healthcare workers working in four healthcare systems in the metro Atlanta area. The healthcare systems included Emory Healthcare, Grady Health System, Morehouse School of Medicine, and Kaiser Permanente. Primary data was collected from May to June 2021, which was conducted as an anonymous cross-sectional survey using Qualtrics via email. Only adults more than or equal to 18 years old were included in the study. Therefore, the source population of this study was all adult healthcare workers who were working in the four healthcare systems as the primary employee or a contractor from April to May 2021.

3.2 Study population

Among the source population, those who participated in the vaccine hesitancy survey from May to June 2021 and identified themselves as 'clinical' healthcare workers were considered as the study population.

3.3 Inclusion criteria

a. All the self-reported clinical healthcare workers who participated in the survey and had a non-missing response to the question on the type of healthcare roles were included in the study.
b. We included those clinical healthcare workers who had non-missing values for the question on receiving the COVID-19 vaccine.

3.4 Exclusion criteria

The primary survey only included adults aged more than or equal to 18 years. In this study, we excluded respondents who had missing values to the 'age-group' variable.

3.5 Sampling method

The primary survey design did not include a specific sampling technique. However, we assumed the inclusion of four major healthcare systems (and associated contractors) as a representation of

all healthcare systems in the greater Atlanta Metropolitan area. We considered each healthcare system in Atlanta as a cluster and assumed the primary sampling method of selecting four healthcare systems as consistent with a cluster sampling design. We did not conduct any sampling method to select respondents from the primary data and included all eligible samples in this study. We also did not consider any sampling adjustments to our current analysis, assuming the sample comes from a simple random sampling or a cluster sampling with one design effect.

3.6 Response rate

A total of 5,329 HCWs responded to the survey and 5,281 (99.10%) completed all questionnaire sections. Assuming an approximately 30,000 HCW in the four healthcare systems in metro Atlanta, GA, the response rate was close to 18%.

3.7 Study design and measure of association

This study is a cross-sectional design. The proportion of vaccine-hesitant clinical healthcare workers was found to be approximately 10%, which supports the rare disease assumption. Therefore, we used the odds ratio (OR) as our measure of association in this cross-sectional study.

3.8 Variables included in the analysis

The questionnaire used for the vaccine hesitancy survey is attached in appendix-02. We used the following variables from this survey in our current study.

3.8.1 Outcome variable

The outcome variable is vaccine hesitancy. The following question was used to collect this data:
Question: Have you received the COVID-19 vaccine?
Answer options:

- Yes – Moderna
- Yes – Pfizer
- Yes – Johnson and Johnson
- No – I'm scheduled to get it
- No – I plan to get it later
- No – I don't plan to get it

We defined someone as ‘vaccine-hesitant (yes)’ if s/he selected either ‘No-I plan to get it later’ or ‘No- I don’t plan to get it to this question. Else were defined as not being vaccine-hesitant.

3.8.2 Exposure variable

Our exposure variable was the type of clinical healthcare roles**.** The questionnaire included 12 types of clinical healthcare roles. We reclassified them down to nine types using the following criteria. We assumed ‘physician’ as the reference category.

Table 3.1: Recoding of exposure variable (types of the clinical healthcare roles)

Clinical roles in the questionnaire	**Clinical roles in the analysis**
Physician, Resident	Physician (Reference)
Nurse (RN, LPN)	Nurse
Technologist (Medical, Radiology, Procedural, Anesthesia, Lab, Pharmacy)	Technologist
Advanced Practice Provider (NP, PA, Anesthetist, Midwife)	Advanced Practice Provider (APP)
Medical/Nursing Assistant	Medical/Nursing Assistant (M/NA)
Pharmacist	Pharmacist
Paramedic, EMT	Paramedic, EMT
Care Coordination (Case Management, Social Services, Utilization Review)	Care Coordinator/ Clinical Support Services (CC/ CSS)
Clinical Support Services (Lactation, PT, OT, Speech Therapy, Audiology, Phlebotomy)	
Dietitian	Non-specific
Respiratory Therapist	
Others	

3.8.3 Primary Employers

The study was conducted in four healthcare systems. To make those healthcare systems anonymous in this report, we mentioned them in this study as A, B, C and D. However, we kept using the word 'Contractors' for those included in the contractor category.

3.8.4 Possible confounders

We assumed several variables that could be a potential confounder in the exposure and outcome relationship. We classified these under two groups based on individual/ family considerations:

Table 3.2: Classification of potential confounders:

Individual-level confounders	**Family member level confounders**
• Age-group • Sex • Education • Race • Previous COVID-19- diagnosis • Primary clinical settings • Care to COVID-19- patients	• Less than 18 years old family member at home • 65 years or older family member at home • Family member/s previous COVID-19 diagnosis • Family member/s hospitalization due to COVID-19 • Family member/s admission to ICU due to COVID-19 • Family member/s death due to COVID-19

3.8.5 Perception variables

There were 10 statements related to perception of COVID-19 vaccination included in the study questionnaire. Those statements are classified into two groups based on their supportive nature toward COVID-19 vaccination (table 3.3). Strong agreement for a 'positively themed' item supports the promotion of COVID-19 vaccination, whereas strong agreement for a 'negatively themed' item supports hesitancy toward COVID-19 vaccination.

Table 3.3: Statements related to perception of COVID-19 vaccination

Positively themed statements	**Negatively themed statements**
I think the COVID-19 vaccine is safe and effective	I am concerned that the COVID-19 vaccine was developed too fast
I trust the science behind vaccinations	I am concerned that the vaccine may not be effective against new variants
I think the vaccine should be required for healthcare workers	I am concerned about vaccine side effects
Vaccination is important as I am concerned about getting COVID-19	
I trust the government's policy on vaccination as implemented by the CDC	
People should continue wearing masks and practice social distancing even after getting the COVID-19 vaccine	
Fully vaccinated people may resume indoor and/or outdoor activities with no masks or physical distancing	

The level of agreement was assessed using a five-point Likert scale. Points on the scale were assigned in the following way:

Table 3.4: Likert scale used to measure perception of COVID-19 vaccination.

Agreement level	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Point	1	2	3	4	5

3.8.6 Variables for the reasons for not taking the COVID-19 vaccine

There were 10 reasons (including others) included in the study questionnaire for those who were vaccine-hesitant. This question was skipped for those who were not vaccine-hesitant. Respondents could select multiple reasons from the list. We created a separate yes/no variable for each reason, assuming those who did not select a particular reason would choose ‘no’ if there had been an option given as yes/no.

We observed several respondents selected the ‘others’ category and explained several other reasons for not taking the COVID-19 vaccine. We read all those responses and further categorized them using the presence of the following keywords (table 3.5).

Table 3.5: Keywords used to make new categories from ‘others’ reasons for not taking the COVID-19 vaccine.

Keywords in ‘others’ reasons	**New category**
Side effect, not safe, safety, post vaccine complication, be sicker, part of an experiment, part of initial testing, possible reinfection,	Fear of side effects/ safety issues
Efficacious, not enough trials, developed quickly, proven more, too fast, new, insufficient evidence/ data, not tested enough, lack of studies, more research, effect on people of color, long-term effects, not enough study, still researching, experimental stage, long-term follow up, on first page	Inadequate research/ effectiveness
Tested positive, already positive, immune, have immunity, natural antibody, recovered from COVID, immune system, immune response, exposed many times	Previously COVID-19 positive or being immune
Just fine, no need, miss work, low risk, experimental vaccine, being healthy, strong immunity, herd immunity, personal preference,	Not required or being healthy
Breastfeeding, pregnant, previous reaction to vaccines, recent another vaccination, underlying health conditions, childbearing age, having another treatment, autoimmune disease, preexisting condition, adverse effect to vaccinations, another procedure (mammogram), afraid of needles, allergic to ingredients, long allergy list, anaphylactic reaction to flu shot, many allergies	Have conditions not favouring vaccination
Not confident, do not trust, against beliefs, foreign body, don’t trust government, religious issue	Distrust in vaccine, science or leadership
FDA approved, full approval, emergency approval,	FDA approval
Blank, see above, see previous comments, see below, Cant vaccinate everything, my choice, no EUH business, N/A	Others/ non-specific

3.8.7 Variables for what could change mind to get the vaccine

There were 11 situations (including others) added to the questionnaire for vaccine-hesitant respondents to choose the condition that could change their mind about getting the vaccine. Similar to the coding strategy we applied for reasons for not getting vaccines, we created a separate yes/no variable for each situation, assuming those who did not select a particular situation would choose 'no' if there had been a yes/no option offered.

We again observed several respondents selected the 'others' category and explained several other situations for not changing their mint to get the COVID-19 vaccine. We read all those responses and further categorized them using the presence of the following keywords (table 3.6).

Table 3.6: Keywords used to make new categories from 'others' situations which could change mind to get the COVID-19 vaccine.

Keywords in 'others' situations	**New category**
More research to make sure safety and efficiency, long-term follow up data, clinical evidence, Evidence of long-term immunity, research on long-term side effects, finish the study, long term observation, double-blind human trial, More data,	Solid evidence on safety and efficacy
5 years/ more, time pass by, later, ample time, proper time frame, longer time in market, Years of proof, more time, more people getting it	More time
FDA approval, full authorization, standardized approval	Full FDA approval
Employer mandating, travel requirement,	Requirement for job/ travel
More transparency, honest information, consistency,	Fair communication and transparency
When people stop dying, religious, talking with church leader, I don't know, not trust, subside existing conditions, monetary incentives, Pregnancy, weaning breastfeeding, manufacturer immunity, N/A, prefer not to answer	Others/ non-specific

3.9 Data cleaning and coding

As we mentioned before, the primary data were recorded in a Microsoft excel dataset and we created the study dataset applying the inclusion and exclusion criteria mentioned before and including the variables of interest. We used the following methodology to apply the convenient coding criteria for each variable.

3.9.1 Primary clinical settings

Clinical setting was referred to the department of the hospital the healthcare workers were working at. There were six options to choose from, and respondents could select multiple answers. Therefore, we created an additional 'multiple' category for those who selected multiple options. Then we recorded this variable to a new variable including five categories (Table 3.8). We selected 'outpatients' as the reference category.

Table 3.8: Recode of primary clinical setting variable

Old categories for primary clinical settings	**New categories for primary clinical settings**
Outpatient	Outpatient (reference)
Inpatient	Inpatient
Perioperative services	
Emergency department	Emergency department
Intensive care unit (ICU)	Intensive care unit (ICU)
Women's health	Others/multiple
Others	
Multiple selections	

3.9.2 Age-group

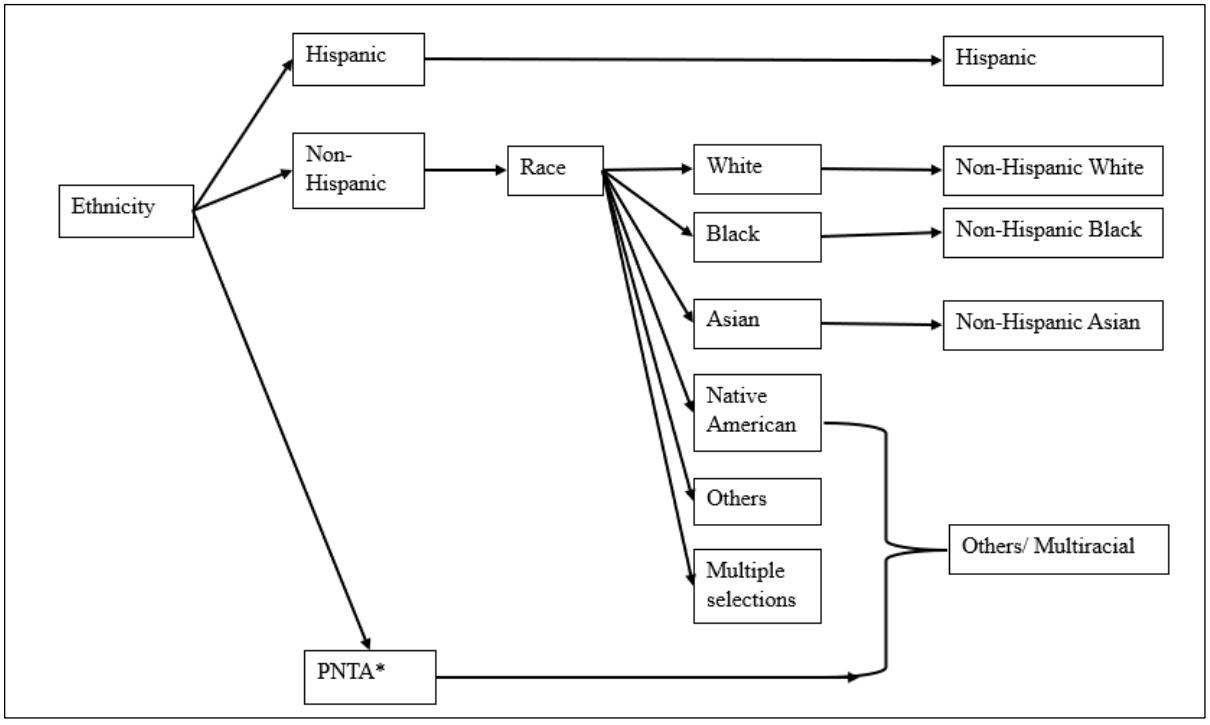
Age data were collected in years using five fixed categories, including 18-35, 36-45, 46-55, 56-65, and 66 and above. We considered the oldest age group (66 and above) as the reference age category.

3.9.3 Gender

Gender data were collected offering four categories, including male, female, non-binary and prefer not to answer. We combined 'non-binary' and 'prefer not to answer' to one category and named it 'others/ non-binary'. We assumed males as the reference category.

3.9.4 Race/ Ethnicity

There were two separate variables for race and ethnicity in the primary data. We combined these two variables into one 'Race/ethnicity variable using the following criteria (Figure 3.1). For the race variable, there was the option to select multiple answers. We created a separate category 'multiracial' for race before creating 'race/ethnicity' variable.



*Prefer not to answer.

Figure 3.1: Flowchart of creating 'race/ethnicity' variable from separate 'race' and 'ethnicity' variable.

We considered 'Non-Hispanic White' as the reference category for race/ethnicity variable.

3.9.5 Educational qualification

To collect data on educational qualifications, the study included the education question with 10 different options. We reclassified all those options into four categories using the following criteria (Table 3.7). We assumed ‘less than Bachelor’s degree’ as the reference category.

Table 3.7: Recode of educational qualifications variable.

Old education categories	**New education categories**
Did not graduate from high school	Less than Bachelor’s degree (reference)
High school diploma or equivalent	
Technical or occupational certificate	
Some college coursework completed	
Associate degree	
Bachelor's degree	Bachelor’s degree
Master's degree	More than Bachelor’s degree
Doctorate degree	
Professional certificate	Others
Prefer not to answer	

3.9.6 Under 18 or over 65 at home

The questionnaire included one question with seven different age ranges as options to choose if there was anyone living in the household corresponding to those age groups. We created a new variable ‘under_18’, which was coded as ‘yes’ if the respondents selected the option of having at least one family member aged less than 18 years. If not selected, it was coded as ‘no’. Similarly, another variable was created for having at least one family member aged more than 65 years. In both cases, the ‘no’ category was selected as the reference.

3.9.7 Self previous diagnosis of COVID-19

The question on the previous diagnosis had six different options to choose from. We recoded that variable to a binary yes/no variable, assuming ‘no’ as the reference (Table 3.9).

Table 3.9: Recode of self previous diagnosis of COVID-19

Old categories for previous COVID-19 diagnosis (self)	**New categories for previous COVID-19 diagnosis (self)**
Yes, mild or no symptoms	Yes
Yes, severe - requiring hospitalization	
Yes, severe - requiring ICU stay	
No	No
Not Sure	
Prefer not to answer	Missing

3.9.8 Family member/s previous diagnosis/ hospitalization/ death due to COVID-19

There was one question asking if there was a family member who was previously diagnosed with COVID-19 and subsequently admitted to hospital/ ICU or died. Respondents could select multiple options. Similar to the recoding strategy for self previous COVID-19 diagnosis, we created another binary variable for family members’ previous COVID-19 diagnosis. In addition to that, we created separate binary variables for hospitalization, ICU admission and death of family members as a result of COVID-19, using the respondent’s selection of related categories. For each situation, we assigned ‘no’ to everyone else who did not select that option. ‘No’ was considered as the reference category.

3.9.9 Care to COVID-19 patients

The question had three different options, yes, no, not sure. We created a new binary variable by combining ‘yes’ and ‘not sure’ to ‘yes’. We assumed ‘no’ as the reference category for the new variable.

3.10 Multivariable model development

We considered all the possible confounders as eligible for assessment to enter the multivariable logistic regression model. We used the following steps to finally select the variables to be included in the multivariable model. For each step, we only included one-degree interaction terms (exposure*covariate).

3.10.1 Collinearity diagnosis

We used condition indices (CI) and variance decomposition proportion (VDP) to diagnose collinearity. The logistic regression model included exposure, all the covariates, and all the interaction terms including exposure and covariates. To diagnose collinearity, we considered more than 30 CI, and two or more VDPs having >0.5. None of our terms in the model had a CI of more than 30 and we concluded no collinearity in our study dataset (Appendix-B). SAS macro (Collin_ 2011) was used for this step.

3.10.2 Interaction assessment

We used the Wald p-value to be < 0.05 to identify statistically significant interaction in the full model. As the exposure variable had 9 categories, which yielded a total of 172 exposure and covariate interaction terms in the full logistic regression model. None of the Wald p-values was statistically significant and we dropped all the interaction terms from our final model (Appendix-C)

3.10.3 Confounding assessment

To identify confounders statistically, we used a 10% difference in odds ratio from the full model to the reduced model. The full model included exposure and all the covariates (without any interaction term). The reduced model included exposure and all the covariates except the variable in consideration for confounding. The exposure had 9 categories, which resulted in 8 dummy variables and the same number of OR in each model. If we found at least one of the ORs having more than a 10% difference between the full and reduced model, we considered that variable dropped from the full model as the confounder. We found age group, education, race/ethnicity and self-previous COVID-19 diagnosis as the confounders between the exposure and outcome relationship (Appendix D) .

3.10.4 Stepwise multivariable logistic regression model development

As several variables were significantly associated with the outcome at univariate analysis, we considered a stepwise approach to develop the final logistic regression model. This stepwise selection process consists of a series of alternating forward selection and backward elimination steps. The forward selection process adds to the model the variable most statistically significant among those not in the model. The backward elimination process checked each variable in the model for continued significance. Score Chi-square value and the corresponding p-value was considered to determine the eligibility criteria to enter or stay in the model. A chi-square p-value of less than 0.15 was set for entry criteria, and a chi-square p-value of less than 0.20 was set for criteria to stay in the model. In the beginning, we had a total of 13 explanatory variables (other than the exposure variable) to enter the model. After this stepwise procedure, we ended up with 9 explanatory variables to be eligible for the multivariable logistic regression model. Variables excluded were, over 65 years old at home, family member's previous hospitalization due to COVID-19, a family member's death due to COVID-19, and primary clinical setting. We used SAS to conduct the above stepwise procedure (Table-3.10).

Table-3.10: Stepwise procedure to select variables for multivariate logistic regression.

Summary of Stepwise Selection (Entry p<0.15; Stay p<0.20)						
Step	**Effect**		**DF**	**Number In**	**Score Chi-Square**	**Pr > ChiSq**
	Variable	**Eligible to enter/ not**				
1	Sex	**Entered**	2	2	78.9733	<.0001
2	Previous COVID-19 diagnosis	**Entered**	1	3	48.61	<.0001
3	Age group	**Entered**	4	4	35.5594	<.0001
4	Race/Ethnicity	**Entered**	4	5	23.4655	0.0001
5	Under 18 at home	**Entered**	1	6	10.0984	0.0015
6	Family member/s in ICU due to COVID-19	**Entered**	1	7	5.6193	0.0178
7	Educational qualification	**Entered**	3	8	6.7754	0.0794
8	Family member/s previous COVID-19 diagnosis	**Entered**	1	9	2.9206	0.0875
9	Care to COVID-19 patient	**Entered**	1	10	2.3172	0.128
9	Primary clinical settings	**Not eligible**	1	10	0.5058	0.477
9	Over 65yrs at home	**Not eligible**	1	10	0.9161	0.3385
9	Family member/s hospitalized due to COVID-19	**Not eligible**	1	10	0.0493	0.8243
9	Family member/s died due to covid-19	**Not eligible**	1	10	1.329	0.249

3.11 Statistical analysis

All the statistical analysis was done in SAS version 9.4 and Microsoft Excel. In all instances, statistical significance was assumed at alpha=.05 level. Findings were described using the following steps:

3.11.1 Sample characteristics

All the variables in this analysis were categorical, and we used the frequency and percentage of each category to show the overall sample characteristics.

3.11.2 Frequency distribution by outcome variable

The frequency distribution of all the covariates by vaccine hesitancy was shown as a bivariate table using row percentages (proportion of vaccine hesitancy in each category). A Chi-square test was used to assess statistical significance. We assumed alpha to be at 0.05.

3.11.3 Univariate and multivariate associations

Odds ratio and 95% confidence interval was used as the measures of association for univariate and multivariable analysis.

3.11.4 Stratified analysis by healthcare systems

We conducted multivariable analysis by healthcare systems (A, B, C, D and Contractors) and reported the stratified associations.

3.11.5 Perception of COVID-19 vaccination

We used 100% horizontal bar charts to show the proportion of the different levels of agreement to each perception statement.

3.11.6 Reasons for not taking the COVID-19 vaccine

The frequency and proportion of each reason for not taking the COVID-19 vaccine were reported. The total number of vaccine-hesitant clinical healthcare workers was used as the denominator.

3.11.7 What could change the mind of getting the vaccine

The frequency and proportion of each condition that could change the mind of getting the COVID-19 vaccine were reported. The total number of vaccine-hesitant clinical healthcare workers was used as the denominator.

3.12 Ethical consideration

This study is based on an analysis of secondary data and was exempt from Institutional Review Board clearance.

Chapter 4: Results

4.1 Sample characteristics

A total of 3373 respondents from four healthcare systems were included in the analysis. Majority of the respondents came from the 'A' healthcare system followed by 'B', 'C', 'D' and 'Contractors' (Table 4.1). Of the 3373, 326 (9.7%, 95% CI 8.7%, 10.7%) were vaccine-hesitant and the remaining 3047 either had received the vaccine or were scheduled to get the vaccine by the time of participating in the survey. Among vaccine hesitancy healthcare workers, 236 (72.4%) had no plan to get the vaccine at the time of the survey (Table 4.2).

Table 4.1: Frequency distribution of clinical health care workers in the study sample by healthcare systems, COVID-19 vaccine hesitancy survey among clinical care workers in four healthcare systems in metro Atlanta, May-June 2021 (n=3373)

Healthcare systems	**Frequency**	**%**
A	1797	53.3
B	828	25.6
C	565	16.8
D	87	2.6
Contractors	96	2.9

Table 4.2: Frequency distribution of vaccination status in the study sample, COVID-19 vaccine hesitancy survey among health care workers in four healthcare systems in metro Atlanta, May-June 2021 (n=3373)

Vaccination status	**Frequency (%)**	**Vaccine hesitant**	**Frequency (%)**	**95% Confidence interval (%)**
No- I don't plan to get it	236 (7.0)	Yes	326 (9.7)	8.7-10.7
No- I plan to get it later	90 (2.7)			
No- I'm scheduled to get it	15 (0.4)	No	3047 (90.3)	89.3-91.3
Yes- Johnson and Johnson	23 (0.7)			
Yes- Moderna	471 (14.0)			
Yes- Pfizer	2538 (75.2)			

More than one-third of the clinical health care workers enrolling in this study were nurses (35.7%) followed by physicians (18.1%), technologists (9.5%), care coordinators/clinical support services (7.8%), advanced practice providers (7.1%), medical/nursing assistant (5.9%), pharmacist (3.7%), paramedic/ EMT (2.3%) and non-specific (9.8%). The majority of the study sample worked in either outpatient (29.3%) or inpatient (27.9%) departments. About 10.5% of the respondents worked in the emergency department or ICU.

The sample included 28.3% in the 18-35 years age group, followed by 24.6% in 36-45 years, 22.8% in 46-55 years, and 20.2% in the 56-65 years age-group. Only 4.1% of the clinical health care workers in the sample was 66 years or older. This sample is highly predominant by female (80.8%) health care workers. We found nearly half of the sample (46.4%) had a higher than bachelor's degree education. One-fifth of the respondents came from lower than bachelor's

degree education. Non-Hispanic White and Non-Hispanic Black were the two main types of race in the sample (48.2% and 32.4%, respectively) through the sample had a fair representation of Hispanic clinical health care workers (5.1%).

Nearly 40% of the respondents had at least one less than 18 years old household member in their home. Conversely, 14.2% of the respondents said that they had at least one household member aged more than 65 years. Among the respondents, 13.6% had a previous diagnosis of COVID-19 before participating in the survey. Nearly two-thirds of the participants had at least one family member with a previous diagnosis of COVID-19, among those, 24.8% (522/2108) were hospitalized and 7.1% (149/2108) were admitted to the ICU because of their COVID-19 illness. Before the commencement of the study, 11.9% of the participants already had lost at least one of their family members due to COVID-19. Exactly 70% of the clinical health care workers said that they had to provide direct care to COVID-19 patients at some point in their clinical services (Table 4.3).

Table-4.3: Demographic, clinical and COVID-19 illness history among study participants in COVID-19 vaccine hesitancy survey among clinical care workers in four healthcare systems in metro Atlanta, May-June 2021 (n=3373)

Variable	**Level**	**N (%) =3373**
Vaccination status	No (Vaccine hesitant)	326 (9.7)
	Yes	3047 (90.3)
Primary clinical roles	Physician	609 (18.1)
	Nurse	1205 (35.7)
	Technologist	322 (9.5)
	Advanced Practice Providers	240 (7.1)
	Medical/ Nursing Assistant	199 (5.9)
	Pharmacist	126 (3.7)
	Paramedic/ EMT	79 (2.3)
	Care Coordinator/ Clinical Support Services	263 (7.8)
	Nonspecific	330 (9.8)
Primary clinical setting	Outpatient	988 (29.3)
	Inpatient	942 (27.9)
	Emergency Department	234 (6.9)
	Intensive Care Units	120 (3.6)
	Multiple/Nonspecific	1089 (32.3)
Age group	18-35	953 (28.3)
	36-45	830 (24.6)
	46-55	770 (22.8)
	56-65	682 (20.2)
	66 & above	138 (4.1)
Sex	Male	583 (17.3)
	Female	2724 (80.8)
	Binary/Nonspecific	66 (2.0)
Educational qualification	Less than Bachelor	661 (19.6)
	Bachelor	1028 (30.5)
	More than Bachelor	1566 (46.4)
	Nonspecific	118 (3.5)
Race/Ethnicity	Non-Hispanic White	1625 (48.2)
	Non-Hispanic Black	1093 (32.4)
	Non-Hispanic Asian	309 (9.2)
	Hispanic	173 (5.1)
	Other/Multiracial	173 (5.1)
Under 18 at home	No	1792 (53.1)
	Yes	1188 (33.6)
	Missing	393
Over 65 at home	No	2558 (75.8)
	Yes	422 (12.5)
	Missing	393

Previous COVID-19 diagnosis	No/Not sure	2899 (85.9)
	Yes	458 (13.6)
	Missing	16
Family member/s previous COVID-19 diagnosis	No/Not sure	1240 (36.8)
	Yes	2108 (62.5)
	Missing	25
Family member/s hospitalized due to COVID-19	None	2826 (83.8)
	At least one	522 (15.5)
	Missing	25
Family member/s in ICU due to COVID-19	None	3199 (94.8)
	At least one	149 (4.4)
	Missing	25
Family member/s died due to COVID-19	None	2948 (87.4)
	At least one	400 (11.9)
	Missing	25
Care to COVID-19 patient	No	1012 (30.0)
	Yes	2361 (70.0)

4.2 Frequency distribution by vaccine hesitancy

We found highly significant association between vaccine hesitancy and primary clinical roles (chi-square p-value< 0.001). Among the primary clinical roles, physicians were found least vaccine-hesitant (1.81%) and paramedic/ EMTs were found highly vaccine-hesitant (29.11). In the remaining categories, medical/nursing assistants (14.57%), nurses (13.36%) and technologists (13.35%) were more vaccine-hesitant than the rest of the clinical roles. Primary clinical setting was also significantly associated with vaccine hesitancy (p-value=0.003). Clinical healthcare workers who were working in emergency departments (16.24%) or intensive care units (14.17%) were more vaccine-hesitant than those who worked in either outpatient (8.6%) or inpatient (9.3%) departments.

All demographic characteristics, including age group, sex, educational qualification, and race, were highly associated with the outcome (p-value <0.001). We observed a decreasing trend in the vaccine-hesitancy from young to old age groups (13.0% among the 18-35 years age group to 2.2% in the 66 and above age group). Among gender, females were found a little more vaccine-hesitant than males (9.3% vs. 7.2%), however, participants who did not specify their sex were extremely hesitant to COVID-19 vaccines (45.5%). People with more than a bachelor's degree were found less vaccine-hesitant than people without having that (5.0% vs. 13.77%). Among people who identified their race or ethnicity, non-Hispanic Blacks were mostly vaccine-hesitant than other racial groups (11.0% vs. 9.23% among non-Hispanic White or 1.9% among non-Hispanic Asian or 6.9% among Hispanics). Similar to sex, people who did not identify their educational status or race/ethnicity were found highly vaccine-hesitant (18.6% and 22.0%, respectively).

Having a minor at home was significantly associated with vaccine-hesitancy (p-value=0.003), whereas, having an over 65 years old was not significantly associated with the same (p-value=0.16). Participants who had a minor in their home were more vaccine-hesitant than those who had not (11.7% vs. 8.4%). History of providing direct care to COVID-19 patients had a significant association with vaccine hesitancy, however, participants who gave direct care to COVID-19 patients were found more vaccine-hesitant (10.5% vs. 7.7%).

Looking at the association between history of COVID-19 illness and vaccine-hesitancy, only self-previous diagnosis of COVID-19 and history of the death of a family member were significantly associated with the outcome (p-value <0.001 and 0.044, respectively). Participants who had a previous diagnosis of COVID-19 were highly vaccine-hesitant than those who did not (20.1% vs. 7.9%). Clinical health care workers who had missed at least one family member due to COVID-19 were found less vaccine-hesitant than the rest (6.8% vs. 9.9%) (Table 4.4).

Table-4.4: Frequency distribution of study participants by vaccine hesitancy in COVID-19 vaccine hesitancy survey among clinical care workers in four healthcare systems in metro Atlanta, May-June 2021 (n=3373)

Covariates	**Level**	**Vaccine hesitant (Row %)**		**Chi-square p-value**
		Yes N=326	**No N=3047**	
Primary clinical roles	Physician	11 (1.8)	598 (98.2)	**<.001**
	Nurse	161 (13.4)	1044 (86.6)	
	Technologist	43 (13.4)	279 (86.7)	
	Advanced Practice Providers	13 (5.4)	227 (94.6)	
	Medical/ Nursing Assistant	29 (14.6)	170 (85.4)	
	Pharmacist	4 (3.2)	122 (96.8)	
	Paramedic/ EMT	23 (29.1)	56 (70.9)	
	Care Coordinator/ Clinical Support Services	14 (5.3)	249 (94.7)	
	Nonspecific*	28 (8.5)	302 (91.5)	
Primary clinical setting	Outpatient	85 (8.6)	903 (91.4)	**0.003**
	Inpatient	88 (9.3)	854 (90.7)	
	Emergency Department	38 (16.2)	196 (83.8)	
	Intensive Care Units	17 (14.2)	103 (85.8)	
	Multiple/Nonspecific	98 (9.0)	991 (91.0)	
Age group (years)	18-35	124 (13.0)	829 (87.0)	**<.001**
	36-45	86 (10.4)	744 (89.6)	
	46-55	75 (9.7)	695 (90.3)	
	56-65	38 (5.6)	644 (94.4)	
	66 & above	3 (2.2)	135 (97.8)	
Sex	Male	42 (7.2)	541 (92.8)	**<.001**
	Female	254 (9.3)	2470 (90.7)	
	Binary/Nonspecific	30 (45.5)	36 (54.6)	
Educational qualification	Less than Bachelor	91 (13.8)	570 (86.2)	**<.001**
	Bachelor	135 (13.1)	893 (86.9)	
	More than Bachelor	78 (5.0)	1488 (95.0)	
	Nonspecific**	22 (18.64)	96 (81.4)	
Race/Ethnicity	Non-Hispanic White	150 (9.2)	1475 (90.8)	**<.001**
	Non-Hispanic Black	120 (11.0)	973 (89.0)	
	Non-Hispanic Asian	6 (1.9)	303 (98.1)	
	Hispanic	12 (6.9)	161 (93.1)	
	Other/Multiracial	38 (22.0)	135 (78.0)	
Under 18 at home	No	150 (8.4)	1642 (91.6)	**0.003**
	Yes	139 (11.7)	1049 (88.3)	
Over 65 at home	No	256 (10.0)	2302 (90.0)	0.159
	Yes	33 (7.8)	389 (92.2)	
Previous COVID-19 diagnosis	No/Not sure	230 (7.9)	2669 (92.1)	**<.001**
	Yes	92 (20.1)	366 (79.9)	

Family member/s previous COVID-19 diagnosis	No/Not sure	120 (9.7)	1120 (90.3)	0.821
	Yes	199 (9.4)	1909 (90.6)	
Family member/s hospitalized due to COVID-19	None	269 (9.52)	2557 (90.5)	0.966
	At least one	50 (9.58)	472 (90.4)	
Family member/s in ICU due to COVID-19	None	310 (9.7)	2889 (90.3)	0.138
	At least one	9 (6.0)	140 (94.0)	
Family member/s died due to COVID-19	None	292 (9.9)	2656 (90.1)	**0.044**
	At least one	27 (6.8)	373 (93.3)	
Care to COVID-19 patient	No	78 (7.7)	934 (92.3)	**0.012**
	Yes	248 (10.5)	2113 (89.5)	

4.3 Univariable associations

In accordance with what we observed in the bivariate analysis, the univariate associations reflected a similar picture in addition to comparing with the reference categories. Among the primary clinical roles, the odds of paramedic/EMTs being vaccine-hesitant were found about 22.3 times higher than physicians (95% CI 10.4, 48.1). Similar high odds of being vaccine-hesitant were also observed among medical/nursing assistants (OR 9.3, 95% CI 4.5, 18.9), nurses (OR 8.4, 95% CI 4.5, 15.6) and technologists (OR 8.4, 95% CI 4.3, 16.5). The odds ratio for the pharmacist did not reach statistical significance (OR 1.8, 95% CI 0.6, 5.7). Compared to the outpatient clinical settings, clinical health care workers working in the emergency departments (OR 2.1, 95% CI 1.4, 3.1) or intensive care units (OR 1.8, 95% CI 1.0, 3.1) had higher odds of being vaccine-hesitant.

Compared to the oldest age group (66 and above), participants in the 18-35 years age group had 6.7 times more odds of being vaccine-hesitant (95% CI 2.1, 21.5). Similar but lower odds were observed for the 36-45 years (OR 5.2, 95% CI 1.6, 16.7) and 46-55 years (OR 4.9, 95% CI 1.5, 15.6) age groups. The odds ratio for females compared to males did not reach statistical significance (OR 1.3, 95% CI 0.9, 1.9). Clinical health care workers with higher than a bachelor's degree had 67% lower odds of being vaccine-hesitant (95% CI 55%, 76%,) than those with less than a bachelor's degree. Compared to non-Hispanic Whites, non-Hispanic Asians had lower odds of being vaccine-hesitant (OR 0.19, 95% CI 0.09, 0.44). The odds ratios for non-Hispanic Blacks (OR 1.2, 95% CI 0.9, 1.3) and Hispanics (OR 0.7, 95% CI 0.4, 1.4) did not reach statistical significance. We observed significantly high odds of being vaccine-hesitant for those who did not specify their sex (OR 10.7, 95% CI 6.0, 19.1) or race (OR 2.8, 95% CI 1.9, 4.1) at the time of the survey.

For the remaining covariates, a significant odds ratio of being vaccine-hesitant was observed for having a minor at home (OR 1.5, 95% CI 1.1, 1.9), self-previous diagnosis of COVID-19 (OR 2.9, 95% CI 2.2, 3.8), death of family member due to COVID-19 (OR 0.7, 95% CI 0.4,1.0), and history of direct care to COVID-19 patients (OR 1.4, 95% CI 1.1, 1.8). An insignificant negative association was observed for those having one or more over 65 years at home (OR 0.8, 95% CI 0.5, 1.1) or any family member's previous admission to ICU because of COVID-19 (OR 0.6, 95% CI 0.7, 1.4). Approximately null associations were found for family members' previous diagnosis of COVID-19 (OR 1.0, 95% CI 0.8, 1.2) and family members' previous hospitalization due to COVID-19 (OR 1.0, 95% CI 0.7, 1.4) (Table 4.5).

Table-4.5: Univariate associations of vaccine hesitancy among study participants in COVID-19 vaccine hesitancy survey among clinical care workers in four healthcare systems in metro Atlanta, May-June 2021 (n=3373)

Covariates	**Level**	**Vaccine hesitancy= Yes**	
		OR (95% CI)	**OR p-value**
Primary clinical roles	Physician	Ref.	-
	Nurse	8.4 (4.5-15.6)	**<.001**
	Technologist	8.4 (4.3-16.5)	**<.001**
	Advanced Practice Providers	3.1 (1.4-7.1)	**0.006**
	Medical/ Nursing Assistant	9.3 (4.5-18.9)	**<.001**
	Pharmacist	1.8 (0.6-5.7)	0.330
	Paramedic/ EMT	22.3 (10.4-48.1)	**<.001**
	Care Coordinator/ Clinical Support Services	3.1 (1.4-6.8)	**0.006**
	Nonspecific*	5.0 (2.5-10.3)	**<.001**
Primary clinical setting	Outpatient	Ref.	-
	Inpatient	1.1 (0.8-1.5)	0.570
	Emergency Department	2.1 (1.4-3.1)	**<.001**
	Intensive Care Units	1.8 (1.0-3.1)	**0.049**
	Multiple/Nonspecific	1.1 (0.8-1.4)	0.751
Age group (years)	66 & above	Ref.	-
	18-35	6.7 (2.1-21.5)	**0.001**
	36-45	5.2 (1.6-16.7)	**0.006**
	46-55	4.9 (1.5-15.6)	**0.008**
	56-65	2.7 (0.8-8.7)	0.108
Sex	Male	Ref.	-
	Female	1.3 (0.9-1.9)	0.105
	Binary/Nonspecific	10.7 (6.0-19.1)	**<.001**
Educational qualification	Less than Bachelor	Ref.	-
	Bachelor	1.0 (0.7-1.3)	0.708
	More than Bachelor	0.3 (0.2-0.5)	**<.001**
	Nonspecific**	1.4 (0.9-2.4)	0.167
Race/Ethnicity	Non-Hispanic White	Ref.	-
	Non-Hispanic Black	1.2 (0.9-1.6)	0.136
	Non-Hispanic Asian	0.2 (0.1-0.4)	**<.001**
	Hispanic	0.7 (0.4-1.4)	0.318
	Other/Multiracial	2.8 (1.9-4.1)	**<.001**
Under 18 at home	No	Ref.	-
	Yes	1.5 (1.2-1.9)	**0.003**
Over 65 at home	No	Ref.	-
	Yes	0.8 (0.52-1.1)	0.161
Previous COVID-19 diagnosis	No/Not sure	Ref.	-
	Yes	2.9 (2.2-3.8)	**<.001**

Family member/s previous COVID-19 diagnosis	No/Not sure	Ref.	-
	Yes	1.0 (0.8-1.2)	0.821
Family member/s hospitalized due to COVID-19	None	Ref.	-
	At least one	1.0 (0.7-1.4)	0.966
Family member/s in ICU due to COVID-19	None	Ref.	-
	At least one	0.6 (0.3-1.2)	0.142
Family member/s died due to COVID-19	None	Ref.	-
	At least one	0.7 (0.4-1.0)	**0.045**
Care to COVID-19 patient	No	Ref.	-
	Yes	1.4 (1.1-1.8)	**0.012**

4.4 Multivariable associations

In the multivariable model, in addition to primary clinical roles, the eligible covariates were age group, gender, race, education, under 18 years old at home, self-previous COVID-19 diagnosis, family member's previous COVID-19 diagnosis, family member's admission to ICU due to COVID-19, and history of direct care to COVID-19 patient. After adjusting for other covariates, paramedic/ EMTs (aOR 12.0, 95% CI 4.6, 31.3), nurses (aOR 7.6, 95% CI 3.6, 16.4), Technologist (aOR 7.3, 95% CI 3.2, 16.8) and medical/nursing assistants had high odds of being vaccine-hesitant compared to physicians. In addition to those categories, advanced practice providers (aOR 3.0, 95% CI 1.2, 7.4), care coordinators/ clinical support services (aOR 3.2, 95% CI 1.3, 7.9) and nonspecific (aOR 4.4, 95% CI 1.9, 10.4) categories also had higher odds of vaccine-hesitancy.

In this multivariable analysis, 18-35 years age group (compared to the 66 years and above; aOR 6.7, 95% CI 1.6, 28.4), having at least one family member aged under 18 years (aOR 1.6, 95% CI 1.2, 2.1) and self-previous diagnosis of COVID-19 (aOR 2.7, 95% CI 2.0, 3.8) were positively associated with vaccine-hesitancy. Conversely, having more than a bachelor's degree (compared to less than a bachelor's degree; aOR 0.3, 95% CI 0.2, 0.5), non-Hispanic Asian (compared to non-Hispanic White; aOR 0.2, 95% CI 0.1, 0.5), and a family member's admission to ICU because of COVID-19 (aOR 0.4, 95% CI 0.2, 0.95) were negatively associated with vaccine-hesitancy. Besides, we found highly significant odds of vaccine-hesitancy for participants who did not identify their gender (aOR 8.4, 95% CI 3.9, 18.0), compared to male participants. A Family member's previous diagnosis of COVID-19 (aOR 0.8, 95% CI 0.6, 1.0) and history of providing care to COVID-19 patients (aOR 1.3, 95% CI 0.9, 1.8) did not reach statistical significance after adjusting for other covariates.

Table-4.6: Multivariate logistic regression model including the predictors of vaccine-hesitancy in COVID-19-19 vaccine hesitancy survey among clinical care workers in four healthcare systems in metro Atlanta, May-June 2021 (n=3373)

Covariates	**Level**	**Vaccine hesitancy = Yes**	
		aOR (95% CI)	**OR p-value**
Primary clinical roles	Physician	Ref.	-
	Nurse	7.6 (3.6-16.4)	**<.001**
	Technologist	7.3 (3.2-16.8)	**<.001**
	Advanced Practice Providers	3.0 (1.2-7.4)	**0.016**
	Medical/ Nursing Assistant	6.2 (2.5-15.3)	**<.001**
	Pharmacist	1.4 (0.4-5.3)	0.650
	Paramedic/ EMT	12.0 (4.6-31.3)	**<.001**
	Care Coordinator/ Clinical Support Services	3.2 (1.3-7.9)	**0.011**
	Nonspecific*	4.4 (1.9-10.4)	**<.001**
Age group (years)	66 & above	Ref.	-
	18-35	6.7 (1.6-28.4)	**0.010**
	36-45	4.2 (1.0-17.7)	**0.054**
	46-55	3.6 (0.9-15.4)	0.081
	56-65	2.0 (0.5-8.7)	0.350
Sex	Male	Ref.	-
	Female	1.1 (0.7-1.7)	0.643
	Binary/Nonspecific	8.4 (3.9-18.0)	**<.001**
Educational qualification	Less than Bachelor	Ref.	-
	Bachelor	1.0 (0.7-1.3)	0.708
	More than Bachelor	0.3 (0.2-0.5)	**<.001**
	Nonspecific**	1.4 (0.9-2.4)	0.167
Race/Ethnicity	Non-Hispanic White	Ref.	-
	Non-Hispanic Black	1.0 (0.7-1.4)	0.946
	Non-Hispanic Asian	0.2 (0.1-0.5)	**<.001**
	Hispanic	0.5 (0.3-1.0)	**0.040**
	Other/Multiracial	1.6 (1.0-2.7)	0.065
Under 18 at home	No	Ref.	-
	Yes	1.6 (1.2-2.1)	**0.002**
Previous COVID-19 diagnosis	No/Not sure	Ref.	-
	Yes	2.7 (2.0-3.8)	**<.001**
Family member/s previous COVID-19 diagnosis	No/Not sure	Ref.	-
	Yes	0.8 (0.6-1.0)	0.091
Family member/s in ICU due to COVID-19	None	Ref.	-
	At least one	0.4 (0.2-0.95)	**0.038**
Care to COVID-19 patient	No	Ref.	-
	Yes	1.3 (0.9-1.8)	0.129

4.5 Perceptions of COVID-19 vaccine

Among all the participants in the study, one-fourth perceived that the vaccine was developed too fast, 44% believed the vaccine was not effective against the new variant, and 30% were concerned about the vaccine's side effects. The majority perceived the vaccine as effective (73%) and had trust in the science (77%) and vaccination policy (56%). However, more than 40% of the participants did not agree with the requirement of vaccines for healthcare workers and 21% were against the continuation of most effective preventive measures including wearing masks and social distancing (Figure 4.1).

Among vaccinated clinical health care workers, 42% still believed that the vaccine was not effective against the new variants, 38% had a lack of trust in the CDC's vaccination policy and 42% agreed not to wear a mask or maintain social distance after being fully vaccinated. About 35% of vaccinated clinical health care workers did not agree with the requirement of vaccination for health care workers (Figure 4.2).

Among vaccine-hesitant clinical health care workers, 91% had doubt about the safety and effectiveness of COVID-19 vaccines, 87% were concerned about the vaccine's side effects, and 82% believed the vaccine was developed too fast. More than 90% had a lack of trust in the science behind vaccination (75%) and the CDC's vaccination policy (94%). More than 95% of vaccine-hesitant clinical health care workers did not support the requirement of vaccination for health care workers (Figure 4.3).

More than half of the nurses (53%) and paramedics/EMTs (52%) did not support the vaccine requirement for health care workers. Among physicians, who were the least vaccine-hesitant health care workers, about 18% did not agree with the requirement of vaccines for health care workers. About 18% of physicians, 23% of nurses and 37% of paramedic/EMTs were against the continuation of wearing masks and social distancing (Figure 4.4-4.6).

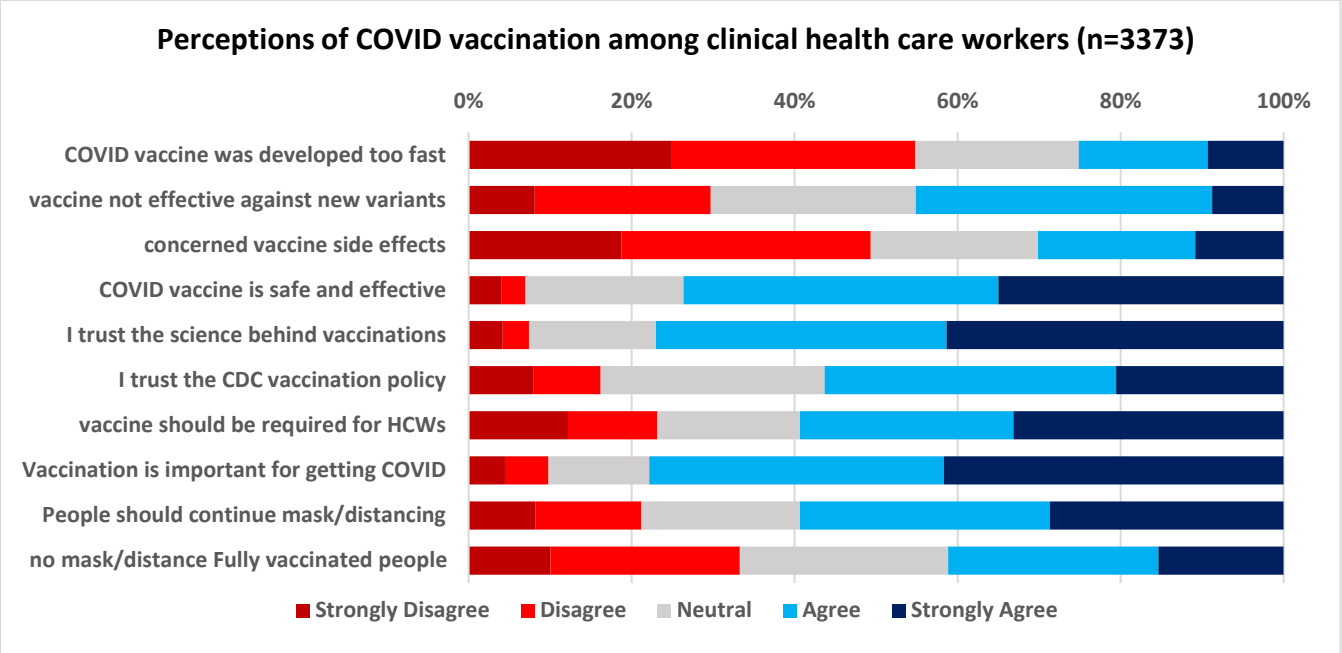


Figure 4.1: Perceptions of COVID-19 vaccination among participants in COVID-19 vaccine hesitancy survey among clinical care workers in four healthcare systems in metro Atlanta, May-June 2021 (n=3373)

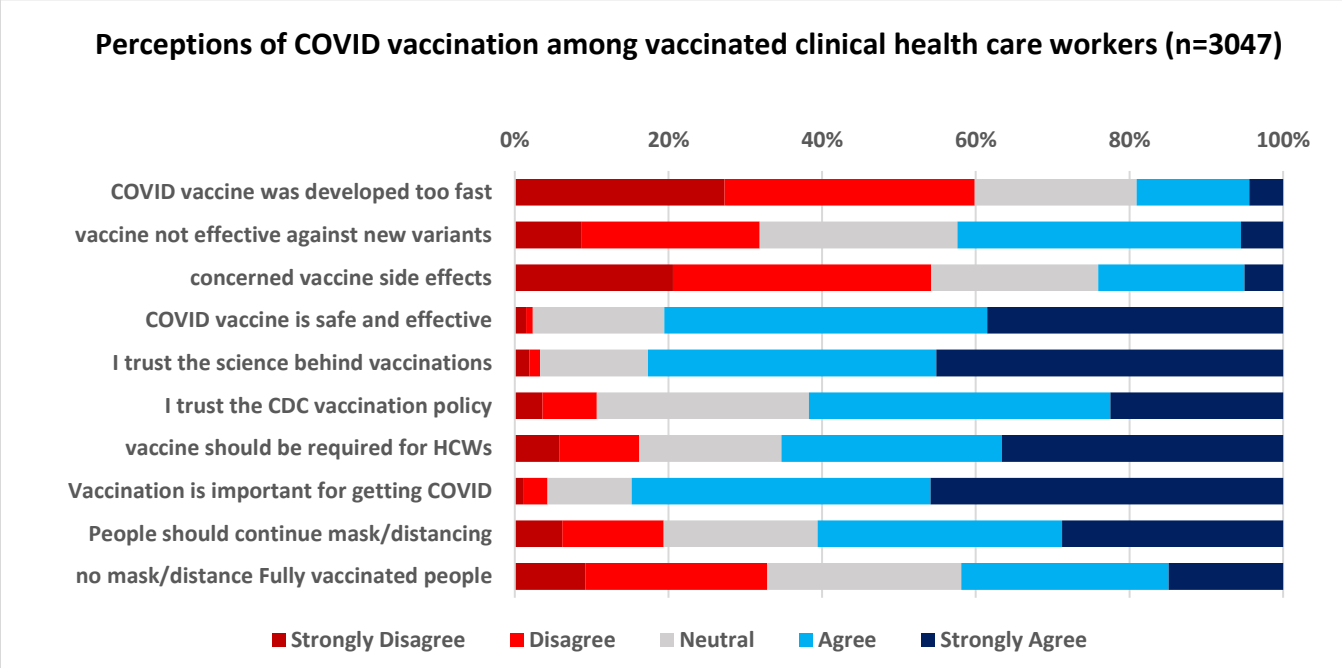


Figure 4.2: Perceptions of COVID-19 vaccination among vaccinated clinical health care workers in COVID-19 vaccine hesitancy survey among clinical care workers in four healthcare systems in metro Atlanta, May-June 2021 (n=3047)

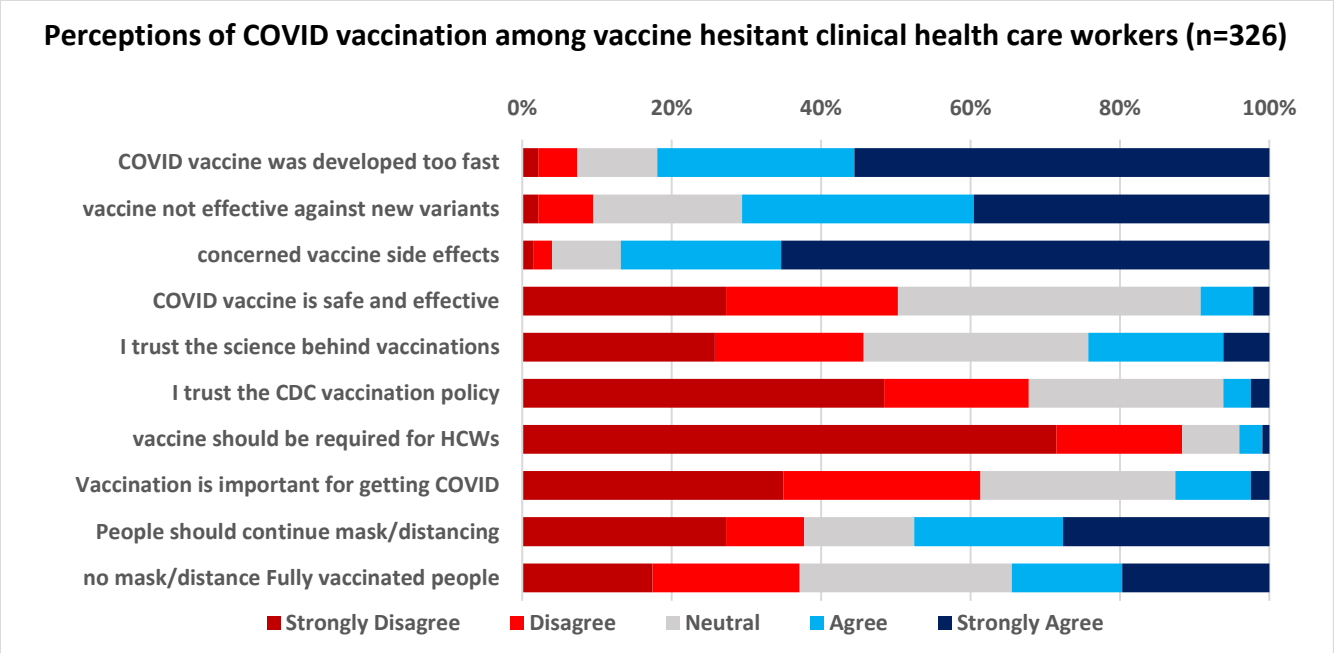


Figure 4.3: Perceptions of COVID-19 vaccination among vaccine-hesitant clinical health care workers in COVID-19 vaccine hesitancy survey among clinical care workers in four healthcare systems in metro Atlanta, May-June 2021 (n=326)

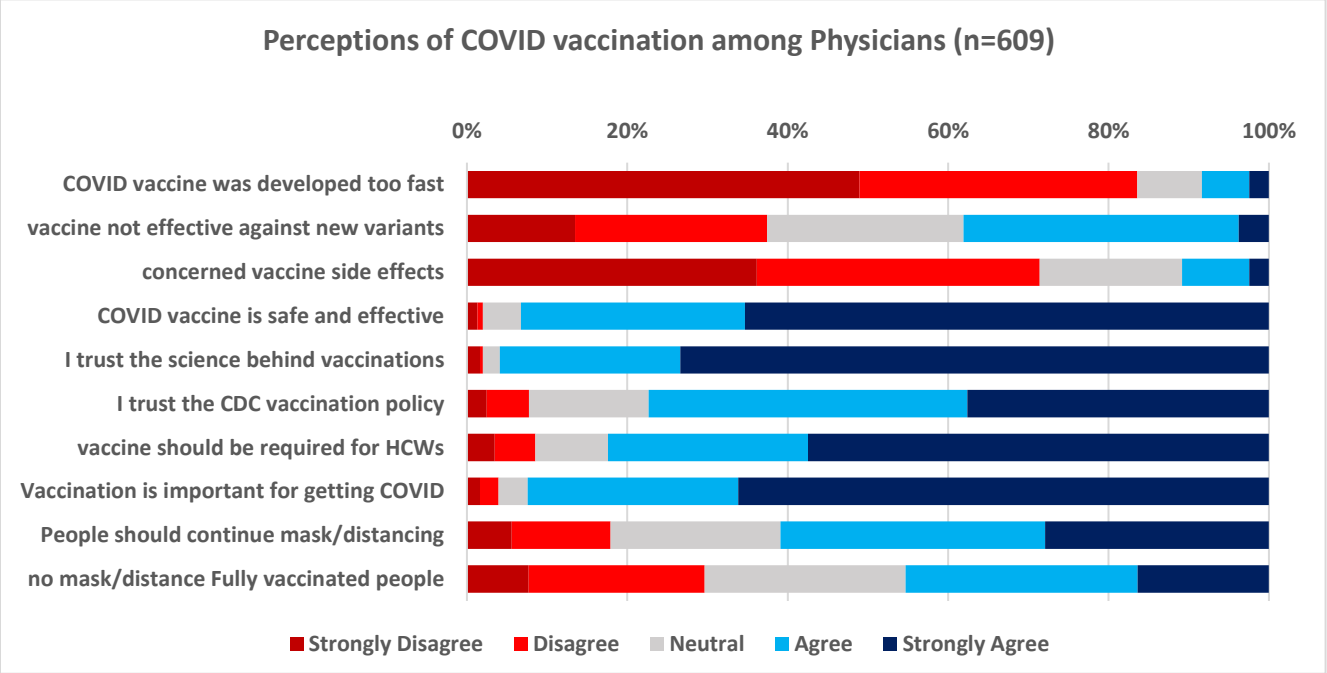


Figure 4.4: Perception of COVID-19 vaccination among Physicians in COVID-19 vaccine hesitancy survey among clinical care workers in four healthcare systems in metro Atlanta, May-June 2021 (n=609)

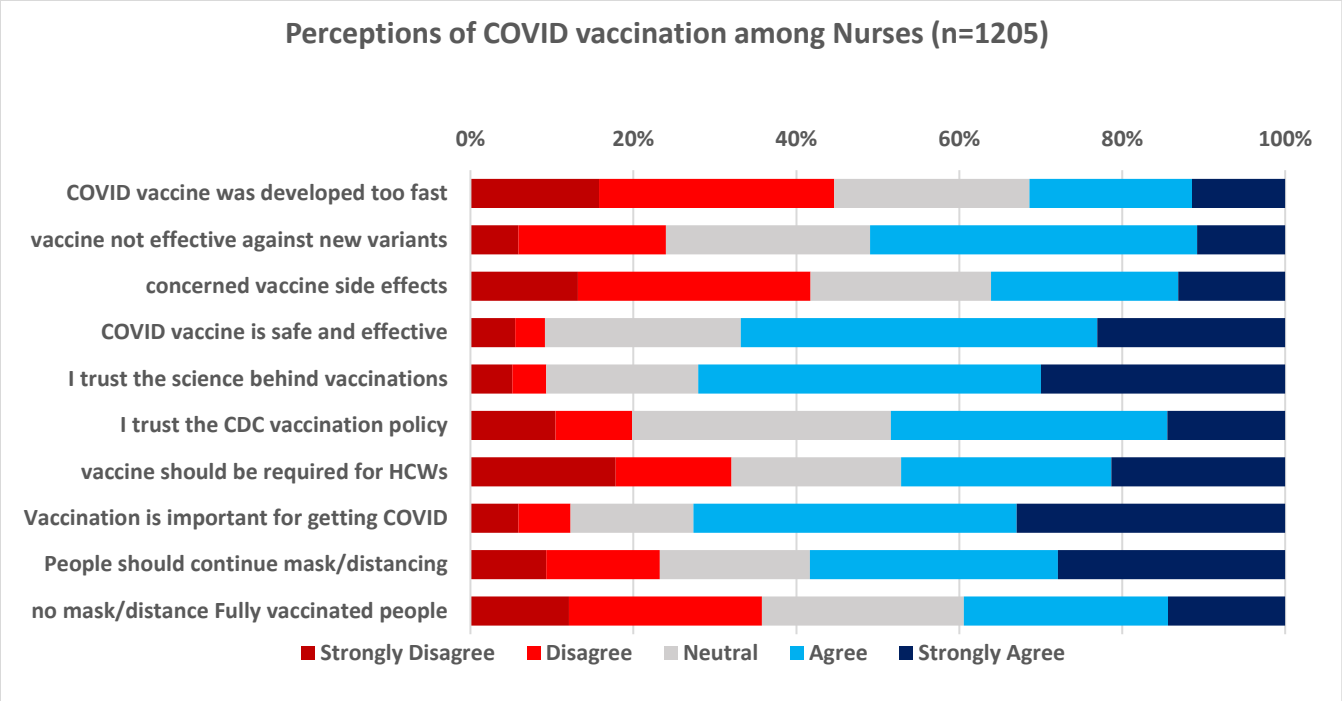


Figure 4.5: Perception of COVID-19 vaccination among Nurses in COVID-19 vaccine hesitancy survey among clinical care workers in four healthcare systems in metro Atlanta, May-June 2021 (n=1205)

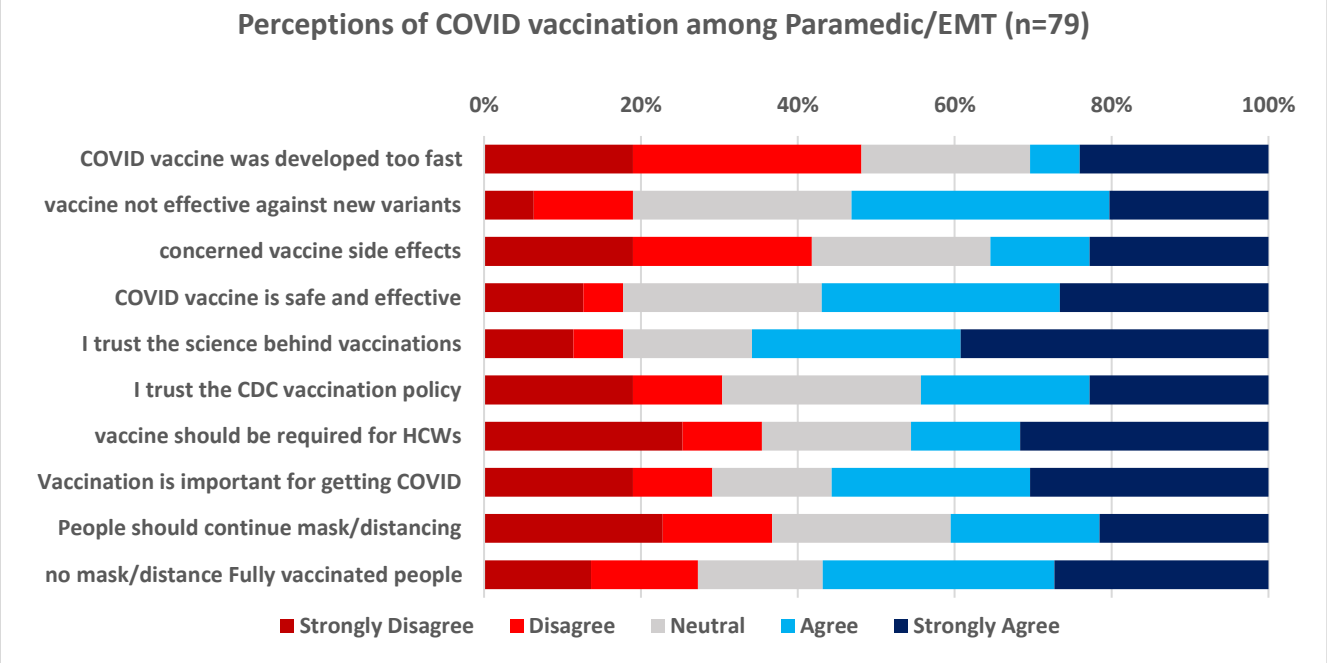


Figure 4.6: Perception of COVID-19 vaccination among Paramedics or EMTs in COVID-19 vaccine hesitancy survey among clinical health care workers in four healthcare systems in metro Atlanta, May-June 2021 (n=79)

4.6 Reasons for not taking the vaccine

Among the vaccine-hesitant health care workers, fear of side effects (148/326), delay for more people getting the vaccine (84/326), limited understanding of the vaccine (58/326), and assumptions on younger people do not need the vaccine (35/326) were the topmost reasons for not getting the vaccine. Many vaccine-hesitant participants selected 'Others' (139/326), which includes inadequate research behind the vaccine development (30/139), safety issues (24/139), contraindication for current vaccination (23/139), previous COVID-19 infection (19/139), distrust (13/139), no mandatory requirement (12/139), and wait for full FDA approval (7/139) (Table.

Table-4.7: Reasons for not getting the vaccine among the vaccine-hesitant clinical care workers in COVID-19 vaccine hesitancy survey among clinical health care workers in four healthcare systems in metro Atlanta, May-June 2021 (n=326)

Reasons	**Number (N=326)**
Fear of side effects/news about the vaccine scares me	148
I want to delay until more people get the vaccine	84
I don't understand enough about the vaccine	58
I don't believe in vaccines in general	26
My doctor advised me not to because of my medical condition	28
I am young and don't need the vaccine	35
My family does not want me to get it	11
Nonspecific	139
Safety issues	24
Inadequate research	30
Previously COVID-19 positive	17
Contraindication for vaccination	23
It is not required	12
I don't trust vaccine	13
Wait for full FDA approval	7
Non-specific	24

4.7 What could change the mind about getting the vaccine

As a response to the question of what could change vaccine-hesitant health care workers' minds about getting the vaccine, more than half said nothing would change their minds (174/326). Providing more education on vaccines (37/326) and allocating paid time off for getting the vaccine (20/139) could change the mind of about one-sixth of vaccine-hesitant clinical health care workers. In addition, providing solid evidence on vaccine safety and efficacy could help to change 44 vaccine-hesitant clinical health care workers' minds about getting the vaccine.

Table 4.8: What could change the mind of vaccine-hesitant clinical health care workers about getting the vaccine in the COVID-19 vaccine hesitancy survey among health care workers in four healthcare systems in metro Atlanta, May-June 2021 (n=326)

Conditions	**Number (N=326)**
Nothing would change my mind	174
More education (for example, webinars)	37
Paid time off	20
I plan on getting it but just haven't had the opportunity	17
Healthcare providers or friends/family recommend it	14
Easier access to the vaccine	10
Nonspecific	103
Solid evidence of safety and efficacy	44
More time	23
Full FDA approval	12
Fair communication and transparency	9
If required for job/travel	5
Non-specific	23

4.8 Willingness to recommend COVID-19 vaccine to friends and family

Overall, more than 85% of clinical health care workers had the willingness to recommend the vaccine to friends or families. Among vaccine-hesitant participants, 16.2% were likely to recommend the vaccine to others. Among non-vaccine-hesitant, only 2% were not willing to recommend the vaccine to their closest ones.

Table- 4.9: Willingness to recommend the vaccine to friends and families among clinical health care workers in the COVID-19 vaccine hesitancy survey among health care workers in four healthcare systems in metro Atlanta, May-June 2021 (n=326)

Level of willingness	Total (Col %, n=3373)	Vaccine hesitant (col %, n=326)	Non-vaccine hesitant (col %, n=3047)
Extremely likely	75.0	6.4	82.3
Somewhat likely	10.6	9.8	10.7
Neither likely nor unlikely	8.5	40.8	5.0
Somewhat unlikely	1.3	7.1	0.7
Extremely unlikely	4.6	35.9	1.3

Chapter 5: Discussion

Vaccination is considered one of the most successful public health interventions, which has contributed to the decline in mortality and morbidity of many infectious diseases including the elimination of poliomyelitis in the Americas and the worldwide eradication of smallpox[42]. However, vaccine hesitancy always poses a significant barrier to controlling vaccine-preventable diseases. We found approximately 10% of the clinical HCWs in our survey were COVID-19 vaccine-hesitant. This estimate is less than other studies conducted around the timeframe of this study[31- 35,37-38]. Only one study conducted in February got a similar proportion (11.2%) of vaccine-hesitancy to this study[36]. We assume, vaccine-hesitant healthcare workers in this study were less willing to participate in the study, and the level of vaccine hesitancy we got is likely and underestimate.

We observed physicians were the least vaccine-hesitant clinical healthcare group, which was also evident in another study conducted in December 2020[32]. Nurses made up 36% of all respondents; of whom 13.4% were vaccine-hesitant. Vaccine-hesitant nurses were almost half of vaccine-hesitant people in this study, signifying one of the most important clinical healthcare roles eligible for future public health interventions. In addition to nurses, we observed those who have direct contact working with patients (technologists, paramedics/EMTs, and medical/nursing assistants) were more vaccine-hesitant. We observed that vaccine-hesitant nurses were relatively evenly distributed across the different demographic categories, indicating that the inherent socio-cultural beliefs were in place irrespective of clinical role, age, race, ethnicity, or educational level. One recent study demonstrated that the decision to vaccinate was highly influenced by what the healthcare workers' colleagues and others close to them thought about the vaccine and least influenced by mass media marketing. Assumptions about nursing knowledge and level of vaccine confidence should not be made given the myriad of external influences that may be confounding decision making. Utilizing nurses' human connection skills, medical background, as well as extensive interfacing with other HCW across educational levels, creates an opportunity for promoting vaccine uptake among HCW and the community. Leveraging their position in society and their large numbers is an important piece of vaccine promotion and they should be directly involved with policy-making and communication campaigns.

This study found that younger healthcare workers are less likely to be vaccine-hesitant than older people, which we also got in many studies conducted before this study[22,27-29,32-34,40-41]. It is fairly expected because it was well established that the severity of COVID-19 is high among older and immunocompromised people. Many studies found females as more vaccine-hesitant than males[18-19,22,27,30,32,35,40], however, we did not find any significant differences. Interestingly, we found high odds of being vaccine-hesitant for people who did not specify their gender, race, ethnicity, or educational qualifications. We assume, vaccine-hesitant HCWs were not comfortable identifying themselves in this study and selected a 'nonspecific' option for demographic questions.

Black race was found to be an important predictor of vaccine-hesitancy in many previous studies[,20,23,27-29,32-33, 36-41], however, we did not find a significant association for the Black race in our study. This may reflect changing perspectives in the Black community over the course of the pandemic and vaccine administration. Low educational level was found a significant predictor of vaccine hesitancy in our study, which was also observed in many previous studies[18,20,24,27-30,34,40].

HCWs with prior COVID-19 infections were also highly vaccine-hesitant (20.1%), possibly reflecting the misconception that natural immunity adequately protects against reinfection. We found having under 18 at home as a significant predictor of vaccine hesitancy, however, in another study having children at home was observed as a predictor of vaccine acceptance[30]. The topmost concerns about COVID-19 vaccination included side effects, efficacy, and safety concerns based on the speed at which vaccine development occurred; these are consistent with other literature reflecting similar concerns in the community[29,32-33,36-38,40-41].

Interestingly, we observed a considerable proportion of HCWs did not agree with the requirement of COVID-19 vaccines to HCWs. It can possibly be explained by the lack of knowledge regarding vaccine effectiveness, which is related to confidence in referring vaccination to others. In a few previous studies, lack of knowledge/information was observed as a strong predictor of vaccine hesitancy among healthcare workers[36-38].

Healthcare workers' willingness to be COVID-19 vaccinated is important for the people who trust physicians, hospitals, researchers, and public authorities for their informed decision-making. Therefore, HCWs have a great role to play to foster vaccine acceptance. This is even more important for the COVID-19 pandemic, where vaccination has been proved as the most

effective measure against this disease. Several studies in the general population on COVID-19 vaccine hesitancy have found that people who were recommended the vaccine by healthcare providers were less vaccine-hesitant than people who did not[43-44]. Vaccine -hesitant healthcare workers are less likely to recommend the vaccines to the general public, which may hamper the success of ongoing vaccination programs. Increased efforts are needed to increase HCW trust and confidence in COVID-19 vaccines, allowing them to be effective champions for wider dissemination in the community.

One major strength of this study is the large sample size, spanning four health systems, representing diverse races, ethnicity, gender, and age groups. Limitations include potential selection bias related to the low response rate (18%); vaccine-hesitant HCW may have been less likely to respond likely to maintain social desirability, especially in the healthcare setting. Our survey was completed in mid-2021, and may not reflect current vaccine hesitancy rates, especially after COVID-19 vaccine mandates began. Regardless, this data remains relevant as new vaccines directed at emerging variants as well as the need for boosters remain a significant controversy in the discussion of vaccine mandates for HCW.

As vaccine mandates roll out across the country, vaccine-hesitant HCWs must choose between keeping their beliefs or leaving their jobs. Strategies to increase vaccine uptake and combat misinformation should be directed at younger age groups and those with lower education status, especially those who are "on the fence," who are more likely to be influenced than those who are adamantly opposed[45]. Appealing to trusted colleagues to assist with vaccine promotion in these age groups could be an effective measure to decrease vaccine hesitancy. In addition, community outreach to external community organizational leadership could also promote vaccine uptake not only in the community but also in the HCWs who belong to these trusted communities.

A considerable proportion of HCWs had negative perceptions of COVID-19 vaccines and documented less confidence in getting this. Vaccine clinical guidance is still evolving (e.g., adding booster doses) as the pandemic still ongoing and new COVID-19 variants continue to emerge. Further training of clinical HCWs, especially nurses, in techniques such as motivational interviewing, or decision aids to build confidence to counter misconceptions is urgently needed. Formal training, information leaflets, or regular plenary presentations on these techniques should be integrated into healthcare organizations to promote trust and increase vaccine uptake.

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Appendices

Appendix-A: Survey questionnaire

CROSS COVID-19 Vaccine Survey

Q1 **COVID Vaccine Survey - Emory/Grady/Morehouse/Kaiser Permanente**

We would like to understand your thoughts about the COVID vaccine. This brief survey will take about 5 minutes to complete. Your responses will be anonymous and participation is voluntary.

Q2 **1. Which of the following is your PRIMARY employer?**

- o Emory (1)
- o Grady (12)
- o Morehouse (4)
- o Kaiser Permanente (5)
- o Other/Contractor (15)

Q3 **1a. Please provide your PRIMARY employer below.**

Q4 **1a. Which of the following is your PRIMARY place of employment at Emory?**
(The place where you work the majority of the time)

- o Emory Decatur Hospital (EDH) (7)
- o Emory Healthcare Incorporated (EHI) (10)
- o Emory Hillandale Hospital (EHH) (8)
- o Emory Johns Creek Hospital (EJCH) (4)
- o Emory LTAC Hospital (ELTACH) (9)
- o Emory Orthopedics & Spine Hospital (EUOSH) (5)
- o Emory Rehabilitation Hospital (18)
- o Emory Saint Joseph's Hospital (ESJH) (3)
- o Emory Specialty Associates (ESA) (15)
- o Emory University Hospital (Clifton Road, EUH) (1)
- o Emory University Hospital Midtown (EUHM) (2)
- o Emory Wesley Woods Hospital (EWWH) (6)
- o Grady Memorial Hospital (GMH) (17)
- o The Emory Clinic (TEC) (16)

Q5 **1a. Which of the following is your PRIMARY <u>place</u> of employment at Grady?**
(The place where you work the majority of the time)

- Crestview (19)
- Grady Memorial Hospital (2)
- Grady Neighborhood Clinic (15)
- IDP (18)

Q6 **1a. Which of the following is your PRIMARY <u>place</u> of employment at Morehouse?**
(The place where you work the majority of the time)

- Grady Memorial Hospital (2)
- Morehouse Healthcare Clinic (15)

Q7 **1a. Which of the following is your PRIMARY <u>place</u> of employment at Kaiser Permanente?**
(The place where you work the majority of the time)

- Kaiser Health Plan (2)
- Permanente Medical Group (15)
-

Q8 **2. What is your primary healthcare role?**

- Clinical (1)
- Non-Clinical (2)

Q9 **2a. Clinical Role**

- Advanced Practice Provider (NP, PA, Anesthetist, Midwife) (1)
- Care Coordination (Case Management, Social Services, Utilization Review) (6)
- Clinical Support Services (Lactation, PT, OT, Speech Therapy, Audiology, Phlebotomy) (5)
- Medical/Nursing Assistant (9)
- Technologist (Medical, Radiology, Procedural, Anesthesia, Lab, Pharmacy) (10)
- Nurse (RN, LPN) (8)
- Dietitian (12)
- Pharmacist (4)
- Physician, Resident (7)
- Paramedic, EMT (15)
- Respiratory Therapist (11)
- Other (14)

Q10 **2a. Please provide your clinical role below.**

Q11 **2b. Clinical Setting**
(select all that apply)

- Outpatient (1)
- Inpatient (4)
- Emergency Department (5)
- Perioperative Services (6)
- ICU (7)
- Women's Health (8)
- Other (9)

Q12 **2b. Please provide your clinical setting below.**

Q13 **2c. Have you cared for COVID patients directly?**

- Yes (1)
- No (4)
- Not sure (5)

Q14 **2a. Non-Clinical Role**

- Administrative (Finance, Patient Access, Bed Management, Safety, Quality, Informatics, Administrative Assistant) (1)
- Environmental Services (13)
- Facility Support (Facilities Management, Food & Nutrition, Parking, Public Safety, Transporters) (12)
- Manager/Unit Leader (14)
- Other (16)

Q15 **2a. Please provide your non-clinical role below.**

Q16 **3. Do you have a leadership role?**

- o Supervisor (1)
- o Manager (8)
- o Director (9)
- o Medical Director (10)
- o Chief of Service (11)
- o Executive (12)
- o None (13)

Q17 **4. Do you have anyone <u>living in your household</u> in these age groups?**
(select all that apply)

- o Under 18 (1)
- o 18-35 (4)
- o 36-45 (5)
- o 46-55 (6)
- o 56-65 (7)
- o 66 or older (8)
- o N/A (27)

Q18 **5. Have you had a diagnosis of COVID?**

- o Yes, mild or no symptoms (1)
- o Yes, severe - requiring hospitalization (13)
- o Yes, severe - requiring ICU stay (14)
- o No (16)
- o Not sure (17)
- o Prefer not to answer (18)

Q19 **5a. Have ANY of your family members* or friends had a diagnosis of COVID?***
Family members living with you or anywhere else, for example, distant family members(select all that apply)

- o Yes, mild or no symptoms (1)
- o Yes, severe - requiring hospitalization (13)
- o Yes, severe - requiring ICU stay (14)
- o Yes, died from COVID (15)
- o No (16)
- o Not sure (17)
- o Prefer not to answer (18)

Q20 **6. What are your thoughts about the COVID vaccine?**

	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
I am concerned that the COVID vaccine was developed too fast (1)	○	○	○	○	○
I am concerned that the vaccine may not be effective against new variants (19)	○	○	○	○	○
I am concerned about vaccine side effects (20)	○	○	○	○	○
I think the COVID vaccine is safe and effective (21)	○	○	○	○	○
I trust the science behind vaccinations (22)	○	○	○	○	○
I think the vaccine should be required for healthcare workers (23)	○	○	○	○	○

Vaccination is important as I am concerned about getting COVID (25)	○	○	○	○	○
I trust the government's policy on vaccination as implemented by the CDC (26)	○	○	○	○	○
People should continue wearing masks and practice social distancing even after getting the COVID vaccine (28)	○	○	○	○	○
Fully vaccinated people may resume indoor and/or outdoor activities with no masks or physical distancing (30)	○	○	○	○	○

Q21 **6a. Please provide any other thoughts about the COVID vaccine.**

_____

_____

_____

Q22 **7. Have you received the COVID vaccine?**

- o Yes – Moderna (1)
- o Yes – Pfizer (19)
- o Yes – Johnson and Johnson (20)
- o No – I'm scheduled to get it (23)
- o No – I plan to get it later (22)
- o No – I don't plan to get it (21)

Q23 **7a. What are your reasons for the delay or not getting the COVID vaccine at all?** *(select all that apply)*

- o Fear of side effects/news about the vaccine scares me (1)
- o My doctor advised me not to because of my medical conditions (23)
- o I don't understand enough about the vaccine (24)
- o I want to delay until more people get the vaccine (26)
- o I don't know how to sign up to get the vaccine (27)
- o I am young and don't need the vaccine (28)
- o I don't believe in vaccines in general (29)
- o My family does not want me to get it (31)
- o I don't have the time (30)
- o Other (32)

Q24 **7a. Please provide the reasons you don't have the time.**

_____

Q25 **7a. Please provide your reasons for delaying or not getting the COVID vaccine at all.**

_____

Q26 **7b. What would change your mind about getting the vaccine?**
(select all that apply)

- o More education (for example, webinars) (1)
- o Supervisor/Manager recommending it (33)
- o Physician or healthcare provider recommendation (35)
- o Friends or family recommending it (36)
- o Nothing would change my mind (37)
- o I plan on getting it when the one dose is available (38)
- o I plan on getting it but just haven't had the opportunity (39)
- o Paid time off (42)
- o Childcare (43)
- o Easier access to the vaccine (34)
- o Other (40)

Q27 **7b. Please provide more information about what would make access easier for you.**

_____

Q28 **7b. Please provide more information about what would change your mind.**

_____

Q29 **8. How likely are you to recommend the vaccine to friends and family?**

- Extremely likely (36)
- Somewhat likely (37)
- Neither likely nor unlikely (38)
- Somewhat unlikely (39)
- Extremely unlikely (40)

Q30 **9. How old are you?**

- 18-35 (1)
- 36-45 (4)
- 46-55 (5)
- 56-65 (6)
- 66 or older (7)

Q31 **10. What is your gender?**

- Male (8)
- Female (10)
- Non-binary (11)
- Prefer not to answer (7)

Q32 **11. What is your race?**
(select all that apply)

- Black (8)
- White (9)
- Native American (10)
- Asian (11)
- Other (7)

Q33 **11a. Please provide your race below.**

_____

Q34 **12. What is your ethnic background?**

- Hispanic (1)
- Non-Hispanic (4)
- Prefer not to answer (5)

Q35 **13. What is your highest level of education?**

- Did not graduate from high school (1)
- High school diploma or equivalent (4)
- Technical or occupational certificate (5)
- Some college coursework completed (6)
- Associate degree (13)
- Bachelor's degree (8)
- Master's degree (9)
- Doctorate degree (10)
- Professional certificate (11)
- Prefer not to answer (12)

Appendix B: Collinearity diagnostic

_VARNAM2	VDP1	VDP2	VDP3	VDP4	VDP5	VDP6	VDP7	VDP8	VDP9	VDP10	VDP11	VDP12	VDP13	VDP14
EIGENVAL	0.0057	0.0236	0.0379	0.0469	0.0488	0.0638	0.0681	0.0834	0.0981	0.1052	0.1261	0.1481	0.1613	0.2145
CONDINDX	47.5803	23.4356	18.5246	16.6329	16.3223	14.2709	13.8085	12.4783	11.5093	11.1118	10.1502	9.3648	8.9747	7.7811
Intercept	0.9199	0.0001	0.0041	0.0004	0.0018	0.0602	0.0114	0.0006	0.0001	0.0000	0.0001	0.0001	0.0000	0.0001
PRIROLE_CLINIC	0.8959	0.0111	0.0046	0.0036	0.0000	0.0797	0.0027	0.0000	0.0005	0.0001	0.0000	0.0000	0.0002	0.0003
prirole_set	0.0331	0.0013	0.0595	0.0127	0.0001	0.0361	0.5638	0.1816	0.0002	0.0025	0.0032	0.0009	0.0008	0.0044
age_group	0.2763	0.1897	0.1846	0.2127	0.0410	0.0217	0.0077	0.0003	0.0041	0.0000	0.0000	0.0001	0.0006	0.0010
gender	0.2808	0.6519	0.0013	0.0054	0.0002	0.0094	0.0050	0.0010	0.0000	0.0002	0.0006	0.0001	0.0001	0.0011
edu_cat	0.1053	0.0519	0.0193	0.1440	0.4498	0.0186	0.0765	0.0061	0.0438	0.0035	0.0033	0.0001	0.0013	0.0026
race_cat	0.0111	0.0621	0.0122	0.0198	0.0056	0.0115	0.0035	0.0028	0.7317	0.0049	0.0233	0.0007	0.0067	0.0099
under18	0.0453	0.0026	0.0055	0.0044	0.0056	0.0089	0.1228	0.6030	0.0282	0.0001	0.0720	0.0004	0.0098	0.0014
over65	0.0004	0.0090	0.0132	0.0544	0.0022	0.0000	0.0240	0.0267	0.0232	0.0295	0.0336	0.0066	0.6825	0.0091
fam_diag	0.0606	0.0294	0.0014	0.3849	0.3376	0.0387	0.0159	0.0000	0.0023	0.0018	0.0207	0.0031	0.0067	0.0079
fam_diag_HOSP	0.0000	0.0015	0.0000	0.0487	0.0797	0.0065	0.0046	0.0129	0.0195	0.4413	0.0271	0.1337	0.0092	0.1238
prev_diag	0.0088	0.0026	0.0038	0.0174	0.1217	0.0081	0.0115	0.0486	0.0111	0.1170	0.5103	0.0106	0.0420	0.0001
fam_diag_ICU	0.0003	0.0001	0.0010	0.0010	0.0027	0.0002	0.0011	0.0010	0.0001	0.0153	0.0041	0.6629	0.0246	0.1968
fam_diag_died	0.0010	0.0008	0.0007	0.0106	0.0154	0.0000	0.0004	0.0158	0.0032	0.5084	0.0774	0.0837	0.0008	0.1954
care_covid	0.1481	0.0595	0.5804	0.0601	0.0009	0.0521	0.0093	0.0056	0.0004	0.0002	0.0001	0.0000	0.0008	0.0008
PRIROLE_CLINICage_group	0.2506	0.1832	0.1566	0.2065	0.0441	0.0194	0.0526	0.0028	0.0074	0.0000	0.0002	0.0000	0.0033	0.0023
PRIROLE_CLINICgender	0.2462	0.5865	0.0007	0.0065	0.0089	0.0380	0.0254	0.0015	0.0002	0.0000	0.0008	0.0002	0.0001	0.0004
PRIROLE_CLINICedu_cat	0.1154	0.0795	0.0089	0.1276	0.4489	0.0004	0.0834	0.0086	0.0330	0.0017	0.0087	0.0005	0.0013	0.0047
PRIROLE_CLINICrace_cat	0.0134	0.0624	0.0087	0.0299	0.0108	0.0010	0.0093	0.0045	0.7315	0.0058	0.0294	0.0011	0.0043	0.0043
PRIROLE_CLINICcare_covid	0.1621	0.0685	0.6658	0.0348	0.0008	0.0000	0.0002	0.0043	0.0009	0.0001	0.0008	0.0005	0.0005	0.0012
PRIROLE_CLINICprirole_set	0.0297	0.0019	0.0601	0.0264	0.0002	0.0932	0.5024	0.2000	0.0008	0.0024	0.0003	0.0000	0.0026	0.0034
PRIROLE_CLINICunder18	0.0480	0.0037	0.0004	0.0075	0.0024	0.0533	0.0898	0.6125	0.0193	0.0000	0.0651	0.0010	0.0124	0.0014
PRIROLE_CLINICover65	0.0008	0.0076	0.0128	0.0518	0.0007	0.0000	0.0225	0.0248	0.0244	0.0387	0.0386	0.0054	0.6720	0.0074
PRIROLE_CLINICfam_diag	0.0640	0.0274	0.0003	0.3892	0.3721	0.0020	0.0262	0.0015	0.0014	0.0006	0.0195	0.0014	0.0026	0.0072
PRIROLE_CLINICfam_diag_HOSP	0.0000	0.0008	0.0000	0.0584	0.0879	0.0075	0.0082	0.0152	0.0230	0.4100	0.0311	0.1396	0.0034	0.1278
PRIROLE_CLINICprev_diag	0.0068	0.0012	0.0064	0.0166	0.1245	0.0228	0.0169	0.0567	0.0130	0.1047	0.5012	0.0081	0.0383	0.0004
PRIROLE_CLINICfam_diag_ICU	0.0009	0.0000	0.0003	0.0006	0.0023	0.0014	0.0004	0.0002	0.0000	0.0142	0.0028	0.6764	0.0235	0.1888
PRIROLE_CLINICfam_diag_died	0.0018	0.0012	0.0030	0.0082	0.0186	0.0003	0.0004	0.0148	0.0019	0.4826	0.0723	0.1016	0.0001	0.2026

To be continued ….

_VARNAM2	VDP15	VDP16	VDP17	VDP18	VDP19	VDP20	VDP21	VDP22	VDP23	VDP24	VDP25	VDP26	VDP27	VDP28
EIGENVAL	0.2623	0.4168	0.4771	0.5423	0.7310	0.8805	1.0539	1.1186	1.2853	1.4194	1.5305	1.7279	2.3340	12.9888
CONDINDX	7.0369	5.5826	5.2176	4.8941	4.2153	3.8407	3.5106	3.4076	3.1790	3.0250	2.9131	2.7417	2.3590	1.0000
Intercept	0.0001	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000	0.0006	0.0000	0.0000	0.0000	0.0000	0.0001
PRIROLE_CLINIC	0.0002	0.0000	0.0000	0.0003	0.0001	0.0000	0.0001	0.0000	0.0004	0.0001	0.0000	0.0000	0.0000	0.0001
prirole_set	0.0003	0.0037	0.0025	0.0130	0.0559	0.0198	0.0000	0.0005	0.0032	0.0000	0.0000	0.0001	0.0003	0.0005
age_group	0.0194	0.0189	0.0046	0.0125	0.0003	0.0001	0.0000	0.0001	0.0032	0.0003	0.0001	0.0003	0.0001	0.0002
gender	0.0386	0.0005	0.0002	0.0006	0.0004	0.0001	0.0001	0.0001	0.0022	0.0000	0.0000	0.0000	0.0001	0.0002
edu_cat	0.0117	0.0004	0.0022	0.0347	0.0120	0.0011	0.0032	0.0016	0.0064	0.0000	0.0000	0.0000	0.0002	0.0003
race_cat	0.0044	0.0000	0.0014	0.0100	0.0053	0.0000	0.0598	0.0077	0.0010	0.0024	0.0005	0.0003	0.0008	0.0004
under18	0.0003	0.0000	0.0008	0.0032	0.0100	0.0627	0.0004	0.0000	0.0081	0.0028	0.0000	0.0009	0.0001	0.0005
over65	0.0000	0.0015	0.0035	0.0027	0.0014	0.0030	0.0017	0.0008	0.0001	0.0088	0.0018	0.0592	0.0009	0.0002
fam_diag	0.0015	0.0001	0.0767	0.0022	0.0014	0.0001	0.0001	0.0006	0.0018	0.0031	0.0002	0.0002	0.0006	0.0004
fam_diag_HOSP	0.0001	0.0000	0.0126	0.0018	0.0020	0.0013	0.0156	0.0312	0.0000	0.0012	0.0116	0.0016	0.0120	0.0003
prev_diag	0.0001	0.0010	0.0101	0.0083	0.0021	0.0032	0.0014	0.0041	0.0005	0.0476	0.0009	0.0066	0.0000	0.0003
fam_diag_ICU	0.0000	0.0003	0.0000	0.0001	0.0000	0.0001	0.0001	0.0014	0.0001	0.0011	0.0676	0.0000	0.0178	0.0001
fam_diag_died	0.0002	0.0001	0.0015	0.0004	0.0000	0.0019	0.0022	0.0462	0.0065	0.0002	0.0079	0.0011	0.0180	0.0002
care_covid	0.0030	0.0663	0.0028	0.0058	0.0003	0.0004	0.0001	0.0000	0.0025	0.0001	0.0000	0.0000	0.0001	0.0003
PRIROLE_CLINICage_group	0.0243	0.0219	0.0055	0.0161	0.0004	0.0001	0.0005	0.0000	0.0014	0.0002	0.0000	0.0001	0.0002	0.0003
PRIROLE_CLINICgender	0.0790	0.0013	0.0005	0.0008	0.0011	0.0001	0.0002	0.0000	0.0009	0.0004	0.0000	0.0000	0.0001	0.0002
PRIROLE_CLINICedu_cat	0.0040	0.0000	0.0021	0.0364	0.0196	0.0010	0.0098	0.0012	0.0015	0.0011	0.0001	0.0002	0.0001	0.0003
PRIROLE_CLINICrace_cat	0.0047	0.0004	0.0007	0.0045	0.0049	0.0000	0.0428	0.0092	0.0076	0.0067	0.0002	0.0001	0.0010	0.0004
PRIROLE_CLINICcare_covid	0.0022	0.0434	0.0031	0.0066	0.0001	0.0004	0.0003	0.0000	0.0023	0.0004	0.0000	0.0001	0.0001	0.0003
PRIROLE_CLINICprirole_set	0.0001	0.0036	0.0010	0.0053	0.0429	0.0158	0.0006	0.0000	0.0041	0.0022	0.0000	0.0002	0.0004	0.0004
PRIROLE_CLINICunder18	0.0008	0.0010	0.0012	0.0008	0.0084	0.0563	0.0037	0.0003	0.0008	0.0079	0.0002	0.0012	0.0001	0.0004
PRIROLE_CLINICover65	0.0010	0.0028	0.0020	0.0052	0.0015	0.0035	0.0029	0.0008	0.0081	0.0039	0.0013	0.0584	0.0011	0.0002
PRIROLE_CLINICfam_diag	0.0026	0.0000	0.0687	0.0026	0.0033	0.0001	0.0008	0.0003	0.0039	0.0005	0.0005	0.0006	0.0005	0.0004
PRIROLE_CLINICfam_diag_HOSP	0.0000	0.0000	0.0104	0.0009	0.0004	0.0014	0.0080	0.0330	0.0083	0.0000	0.0121	0.0014	0.0111	0.0003
PRIROLE_CLINICprev_diag	0.0000	0.0001	0.0114	0.0044	0.0002	0.0023	0.0000	0.0061	0.0122	0.0360	0.0006	0.0084	0.0000	0.0003
PRIROLE_CLINICfam_diag_ICU	0.0002	0.0002	0.0003	0.0000	0.0000	0.0000	0.0002	0.0014	0.0011	0.0027	0.0636	0.0001	0.0183	0.0001
PRIROLE_CLINICfam_diag_died	0.0000	0.0000	0.0023	0.0001	0.0000	0.0019	0.0070	0.0501	0.0001	0.0016	0.0084	0.0005	0.0183	0.0002

Appendix C: Interaction assessment

Interaction term	Exposure category	Wald p-value	Interaction term	Exposure category	Wald p-value
prirole_clinic*age_group	APP	0.9928	prirole_clinic*education	APP	0.9099
prirole_clinic *age_group	APP	0.923	prirole_clinic*education	APP	0.6878
prirole_clinic *age_group	APP	0.9999	prirole_clinic*education	APP	.
prirole_clinic *age_group	APP	0.9528	prirole_clinic*education	CC/CSS	0.9456
prirole_clinic *age_group	CC/CSS	0.9872	prirole_clinic*education	CC/CSS	0.9403
prirole_clinic *age_group	CC/CSS	0.9963	prirole_clinic*education	CC/CSS	0.9438
prirole_clinic *age_group	CC/CSS	0.975	prirole_clinic*education	EMT	0.9918
prirole_clinic *age_group	CC/CSS	0.9666	prirole_clinic*education	EMT	0.942
prirole_clinic *age_group	EMT	0.9837	prirole_clinic*education	EMT	0.9567
prirole_clinic *age_group	EMT	0.9556	prirole_clinic*education	M/NA	0.9991
prirole_clinic *age_group	EMT	0.9664	prirole_clinic*education	M/NA	0.9576
prirole_clinic *age_group	EMT	0.9724	prirole_clinic*education	M/NA	0.9376
prirole_clinic *age_group	M/NA	0.9973	prirole_clinic*education	Nurse	0.993
prirole_clinic *age_group	M/NA	0.9505	prirole_clinic*education	Nurse	0.5956
prirole_clinic *age_group	M/NA	0.952	prirole_clinic*education	Nurse	0.7899
prirole_clinic *age_group	M/NA	0.9698	prirole_clinic*education	Others	0.9507
prirole_clinic *age_group	Nurse	0.9415	prirole_clinic*education	Others	0.1746
prirole_clinic *age_group	Nurse	0.9702	prirole_clinic*education	Others	0.3554
prirole_clinic *age_group	Nurse	0.9789	prirole_clinic*education	Pharmacist	0.9808
prirole_clinic *age_group	Nurse	0.9702	prirole_clinic*education	Pharmacist	0.9774
prirole_clinic *age_group	Others	0.9592	prirole_clinic*education	Pharmacist	0.9556
prirole_clinic *age_group	Others	0.9703	prirole_clinic*education	Technologist	0.9935
prirole_clinic *age_group	Others	0.9684	prirole_clinic*education	Technologist	.
prirole_clinic *age_group	Others	0.9888	prirole_clinic*education	Technologist	.
prirole_clinic *age_group	Pharmacist	0.9831	prirole_clinic*race	APP	0.9725
prirole_clinic *age_group	Pharmacist	0.853	prirole_clinic*race	APP	0.9352
prirole_clinic *age_group	Pharmacist	0.9262	prirole_clinic*race	APP	0.8329
prirole_clinic *age_group	Pharmacist	.	prirole_clinic*race	APP	0.815
prirole_clinic *age_group	Technologist	0.9214	prirole_clinic*race	CC/CSS	0.8937
prirole_clinic *age_group	Technologist	0.8141	prirole_clinic*race	CC/CSS	0.9976
prirole_clinic *age_group	Technologist	0.8791	prirole_clinic*race	CC/CSS	0.885
prirole_clinic *age_group	Technologist	.	prirole_clinic*race	CC/CSS	0.8978
prirole_clinic *gender	APP	0.8904	prirole_clinic*race	EMT	0.8257
prirole_clinic *gender	APP	0.9927	prirole_clinic*race	EMT	0.9846
prirole_clinic *gender	CC/CSS	0.9592	prirole_clinic*race	EMT	0.948
prirole_clinic *gender	CC/CSS	0.8653	prirole_clinic*race	EMT	0.7441
prirole_clinic *gender	EMT	0.876	prirole_clinic*race	M/NA	0.9684
prirole_clinic *gender	EMT	0.8713	prirole_clinic*race	M/NA	0.9481
prirole_clinic *gender	M/NA	0.861	prirole_clinic*race	M/NA	0.9976
prirole_clinic *gender	M/NA	0.9024	prirole_clinic*race	M/NA	0.8833
prirole_clinic *gender	Nurse	0.9557	prirole_clinic*race	Nurse	0.9466
prirole_clinic *gender	Nurse	0.9838	prirole_clinic*race	Nurse	0.7772
prirole_clinic *gender	Others	0.9662	prirole_clinic*race	Nurse	0.9746
prirole_clinic *gender	Others	0.9564	prirole_clinic*race	Nurse	0.9793

prirole_clinic *gender	Pharmacist	0.9427		prirole_clinic*race	Others	0.9964
prirole_clinic *gender	Pharmacist	0.9447		prirole_clinic*race	Others	0.9653
prirole_clinic *gender	Technologist	0.9584		prirole_clinic*race	Others	0.9906
prirole_clinic *gender	Technologist	0.993		prirole_clinic*race	Others	0.8219
prirole_clinic *care_covid	APP	0.7739		prirole_clinic*race	Pharmacist	0.9499
prirole_clinic *care_covid	CC/CSS	0.6156		prirole_clinic*race	Pharmacist	0.9536
prirole_clinic *care_covid	EMT	0.9901		prirole_clinic*race	Pharmacist	0.9413
prirole_clinic *care_covid	M/NA	0.2462		prirole_clinic*race	Pharmacist	0.9978
prirole_clinic *care_covid	Nurse	0.2888		prirole_clinic*race	Technologist	0.9958
prirole_clinic *care_covid	Others	0.5733		prirole_clinic*race	Technologist	0.9522
prirole_clinic *care_covid	Pharmacist	0.9858		prirole_clinic*race	Technologist	0.9568
prirole_clinic *care_covid	Technologist	.		prirole_clinic*race	Technologist	0.8792
prirole_clinic*clinc_settings	APP	0.7179		prirole_clinic*under18	APP	0.7307
prirole_clinic*clinc_settings	CC/CSS	0.9208		prirole_clinic*under18	CC/CSS	0.6303
prirole_clinic*clinc_settings	EMT	0.9683		prirole_clinic*under18	EMT	0.7174
prirole_clinic*clinc_settings	M/NA	0.9133		prirole_clinic*under18	M/NA	0.7677
prirole_clinic*clinc_settings	Nurse	0.8743		prirole_clinic*under18	Nurse	0.7245
prirole_clinic*clinc_settings	Others	0.8714		prirole_clinic*under18	Others	0.9799
prirole_clinic*clinc_settings	Pharmacist	0.892		prirole_clinic*under18	Pharmacist	0.8527
prirole_clinic*clinc_settings	Technologist	0.8504		prirole_clinic*under18	Technologist	0.6888
prirole_clinic* fam_covid	APP	0.849		prirole_clinic*over65	APP	0.8605
prirole_clinic* fam_covid	CC/CSS	0.6087		prirole_clinic*over65	CC/CSS	0.803
prirole_clinic* fam_covid	EMT	0.6041		prirole_clinic*over65	EMT	0.99
prirole_clinic* fam_covid	M/NA	0.6052		prirole_clinic*over65	M/NA	0.9007
prirole_clinic* fam_covid	Nurse	0.85		prirole_clinic*over65	Nurse	0.9648
prirole_clinic* fam_covid	Others	0.9379		prirole_clinic*over65	Others	0.8752
prirole_clinic* fam_covid	Pharmacist	0.6279		prirole_clinic*over65	Pharmacist	0.8006
prirole_clinic* fam_covid	Technologist	0.6704		prirole_clinic*over65	Technologist	0.9849
prirole_clinic*family_hospitalize	APP	0.8939		prirole_clnic*prev_covid	APP	0.8246
prirole_clinic*family_hospitalize	CC/CSS	0.9912		prirole_clnic*prev_covid	CC/CSS	0.6996
prirole_clinic*family_hospitalize	EMT	0.8178		prirole_clnic*prev_covid	EMT	0.8766
prirole_clinic*family_hospitalize	M/NA	0.863		prirole_clnic*prev_covid	M/NA	0.7324
prirole_clinic*family_hospitalize	Nurse	0.8815		prirole_clnic*prev_covid	Nurse	0.7775
prirole_clinic*family_hospitalize	Others	0.9163		prirole_clnic*prev_covid	Others	0.9031
prirole_clinic*family_hospitalize	Pharmacist	0.9032		prirole_clnic*prev_covid	Pharmacist	0.8672
prirole_clinic*family_hospitalize	Technologist	0.8405		prirole_clnic*prev_covid	Technologist	0.7928
prirole_clinic*family_died	APP	0.8047		prirole_clinic*family_icu	APP	0.8349
prirole_clinic*family_died	CC/CSS	0.9459		prirole_clinic*family_icu	CC/CSS	0.911
prirole_clinic*family_died	EMT	0.8917		prirole_clinic*family_icu	EMT	0.8883
prirole_clinic*family_died	M/NA	0.8386		prirole_clinic*family_icu	M/NA	0.947
prirole_clinic*family_died	Nurse	0.8754		prirole_clinic*family_icu	Nurse	0.9339
prirole_clinic*family_died	Others	0.7679		prirole_clinic*family_icu	Others	0.9172
prirole_clinic*family_died	Pharmacist	0.9913		prirole_clinic*family_icu	Pharmacist	0.9784
prirole_clinic*family_died	Technologist	0.9843		prirole_clinic*family_icu	Technologist	0.9323

Appendix D: Confounding assessment

Full model	Variable dropped OR % Change >10% change? (Yes/no)	Odds ratios (reference category- Physician), % change in ORs, and decision on confounding							
		APP	CC/CSS	EMT	M/NA	Nurse	Others	Pharmacist	Technologist
Full model (ORs)		**3.007**	**3.181**	**12.038**	**5.89**	**7.456**	**4.383**	**1.346**	**7.421**
Primary clinical settings, age group, gender, race, under 18 at home, over 65 at home, family member/s previous COVID, family member hospitalized due to covid, family member/s in ICU due to COVID, family member/s died due to COVID, Previous diagnosis of COVID, care to COVID patient	**Primary clinical settings**	3.059	3.26	11.919	5.985	7.575	4.422	1.372	7.36
	% Change	1.73%	2.48%	-0.99%	1.61%	1.60%	0.89%	1.93%	-0.82%
	>10% change? (Yes/no)	No	No	No	No	No	No	No	No
	age-group	3.066	3.631	15.598	7.466	7.5	4.432	1.542	7.791
	% Change	1.96%	14.15%	29.57%	26.76%	0.59%	1.12%	14.56%	4.99%
	>10% change? (Yes/no)	No	Yes	Yes	Yes	No	No	Yes	No
	Gender	3.274	3.183	11.411	5.882	7.401	4.459	1.314	7.552
	% Change	8.88%	0.06%	-5.21%	-0.14%	-0.74%	1.73%	-2.38%	1.77%
	>10% change? (Yes/no)	No	No	No	No	No	No	No	No
	Education	2.884	3.089	14.614	7.181	8.44	4.77	1.286	8.735
	% Change	-4.09%	-2.89%	21.40%	21.92%	13.20%	8.83%	-4.46%	17.71%
	>10% change? (Yes/no)	No	No	Yes	Yes	Yes	No	No	Yes
	Race	3.394	3.577	13.887	6.594	8.28	4.92	1.455	8.309
	% Change	12.87%	12.45%	15.36%	11.95%	11.05%	12.25%	8.10%	11.97%
	>10% change? (Yes/no)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
	Under 18 at home	3.029	2.916	11.329	5.44	6.909	3.99	1.318	6.88
	% Change	0.73%	-8.33%	-5.89%	-7.64%	-7.34%	-8.97%	-2.08%	-7.29%
	>10% change? (Yes/no)	No	No	No	No	No	No	No	No
	Over 65 at home	2.994	3.164	12.151	6.05	7.509	4.39	1.34	7.457
	% Change	-0.43%	-0.53%	0.94%	2.72%	0.71%	0.16%	-0.45%	0.49%
	>10% change? (Yes/no)	No	No	No	No	No	No	No	No
	Family member COVID	3.006	3.202	12.307	5.961	7.506	4.406	1.342	7.51
	% Change	-0.03%	0.66%	2.23%	1.21%	0.67%	0.52%	-0.30%	1.20%
	>10% change? (Yes/no)	No	No	No	No	No	No	No	No
	Family member/s in the hospital	3.006	3.184	12.043	5.892	7.46	4.385	1.346	7.424
	% Change	-0.03%	0.09%	0.04%	0.03%	0.05%	0.05%	0.00%	0.04%
	>10% change? (Yes/no)	No	No	No	No	No	No	No	No
	Family member/s in ICU	2.995	3.158	11.965	5.868	7.4	4.358	1.36	7.333
	% Change	-0.40%	-0.72%	-0.61%	-0.37%	-0.75%	-0.57%	1.04%	-1.19%
	>10% change? (Yes/no)	No	No	No	No	No	No	No	No
	Family member died	2.979	3.154	12.052	5.956	7.467	4.398	1.344	7.368
	% Change	-0.93%	-0.85%	0.12%	1.12%	0.15%	0.34%	-0.15%	-0.71%
	>10% change? (Yes/no)	No	No	No	No	No	No	No	No
	Previous COVID diagnosis (self)	3.271	3.405	14.082	7.022	8.438	4.711	1.491	8.661
	% change	8.78%	7.04%	16.98%	19.22%	13.17%	7.48%	10.77%	16.71%
	>10% change? (Yes/no)	No	No	Yes	Yes	Yes	No	Yes	Yes
	Care to COVID patient	3.006	3.101	12.162	5.693	7.275	4.122	1.244	6.793
	% Change	-0.03%	-2.51%	1.03%	-3.34%	-2.43%	-5.95%	-7.58%	-8.46%
	>10% change? (Yes/no)	No	No	No	No	No	No	No	No

>>>>>>>>>>>>>>>>>>>The end<<<<<<<<<<<<<<<<<<<