

CHILD SCHOOLING AND OTHER FACTORS ASSOCIATED WITH COVID-19
VACCINE HESITANCY AMONG ADULTS THAT HAD NOT BEEN VACCINATED
IN THE FALL OF 2021

by

RYAN M. FISCHER

GERALD MCGWIN, COMMITTEE CHAIR
KATIA BRUXVOORT
HENNA BUDHWANI

A THESIS

Submitted to the graduate faculty of The University of Alabama at Birmingham,
in partial fulfillment of the requirements for the degree of
Master of Science

BIRMINGHAM, ALABAMA

2022

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MASTER OF SCIENCE IN APPLIED EPIDEMIOLOGY

ABSTRACT

Although COVID-19 vaccine hesitancy decreased noticeably over time during the first months of 2021, there was still a high degree of vaccine hesitancy in the United States at the time that the vaccine first became available to adolescents. Data from Phase 3.2 of the U.S. Census Bureau's Household Pulse Survey (July 21 – October 11th, 2021) was used to conduct an ecological study on COVID-19 vaccine hesitancy that investigated associations between vaccine hesitancy and socio-demographic characteristics as well as child school type (public school, private school, homeschool). Subjects that had not received a vaccine at the time of survey data collection were included in this study. Reasons for which they had not yet been vaccinated and the degree to which subjects were willing or not to receive a COVID-19 vaccine were examined. Reasons reported by adults for not receiving a vaccine themselves and reasons reported by adults with adolescent children for not getting their children vaccinated are also compared. Within-subject comparisons were made for subjects with adolescent children, and between-subject comparisons were made for vaccine hesitancy among adults that have adolescent children and vaccine hesitancy among adults that do not have adolescent children. Results from this study indicate a high degree of consistency between reasons for not receiving a vaccine, and for not having one's adolescent child vaccinated χ^2 , (36, $N = 6,544$) = 9,186.58, $p < 0.001$. The results of this study also indicate that there is a

slightly higher degree of vaccine hesitancy among parents of children that are in private school (AOR, 1.60 [95% CI, 1.12 - 2.29]) or homeschooled (AOR, 1.60 [95% CI, 1.07 - 2.39]) compared to parents of children in public school. Public health strategies need to address vaccine hesitancy by communicating transparently about vaccine safety and efficacy, highlighting the risks of COVID-19 infection, addressing vaccine misinformation, and educating parents on the role of vaccination.

Keywords: vaccine, hesitancy, COVID-19, school, adult, adolescent

TABLE OF CONTENTS

	<i>Page</i>
ABSTRACT	ii
LIST OF TABLES	v
LIST OF FIGURES	vi
INTRODUCTION	1
Hypotheses	6
METHODS	8
Data Source	8
Analyses	11
RESULTS	13
DISCUSSION	20
Strengths	22
Limitations	22
Conclusion	24
LIST OF REFERENCES	33

LIST OF TABLES

<i>Table</i>	<i>Page</i>
1 Descriptive Frequencies	25
2 McNemar's tests of Reasons Reported for not Receiving a COVID-19 Vaccine Compared to Reasons Reported for not Getting one's Adolescent Child Vaccinated	26
3 Categories of Reasons for Not Receiving COVID-19 Vaccine Among Adults with Adolescent Children and Their Associations with Vaccine Hesitancy	27
4 Categories of Reasons for Not Receiving a Vaccine Among Adults that Do Not Have Children and Their Associations with Vaccine Hesitancy	28
5 Chi-Square tests of Reasons for Not Receiving a Vaccine Reported by Adults with Children Compared to Reasons Reported by Adults that Do Not Have Children	29
6 Odds Ratios for Factors Associated with Vaccine Hesitancy	30

LIST OF FIGURES

<i>Table</i>	<i>Page</i>
1 Reasons for Not Receiving a Vaccine Among Adults with Adolescent Children	31
2 Reasons for Not Vaccinating One's Adolescent Child	32

INTRODUCTION

The COVID-19 pandemic has caused considerable death and disease globally.¹ Vaccines for SARS-CoV-2 have been available to the general adult population in the United States since April 19, 2021,² but although vaccines were easily accessible by the fall of 2021, vaccine uptake had slowed to a level that was inadequate to provide herd immunity.³ Vaccination against SARS-CoV-2 is an effective method to reduce the likelihood of COVID-19 infection and morbidity and mortality among those infected.^{4,5} As of February 17, 2022, approximately 214.5 million Americans or 64.6% of the population have been fully vaccinated (i.e., received 2 doses of an mRNA vaccine or 1 dose of the Janssen vaccine),¹ which is below the estimated level needed to attain herd immunity and prevent community spread.⁶ Vaccine hesitancy and suboptimal uptake of COVID-19 vaccines are primary reasons for the lengthened duration of the pandemic and present a major problem in the United States.^{7,8} Although COVID-19 vaccine hesitancy decreased noticeably over time during the first months of 2021,⁹ towards the fall of 2021 there was still a high degree of vaccine hesitancy both in the United States and abroad.¹⁰

Vaccine hesitancy is a complex topic. Vaccine sentiments around the world are generally positive, but evidence shows that negative views of vaccination are not uncommon, especially, somewhat paradoxically in countries with highly educated populations and better access to healthcare.¹¹ Vaccine-hesitant individuals comprise a heterogeneous group of people that vary in their degree of indecision about receiving

vaccines in general or about receiving specific vaccines. Vaccine-hesitant individuals may accept some vaccines but refuse others, they may opt for a delayed vaccine schedule or they may accept vaccines reluctantly.¹² These behaviors may be seen as irrational or “anti-science,” but instead of dismissing these beliefs out of hand, health care providers should work to establish a conversation about their concerns regarding vaccines.¹³ In the United States, Black Americans and other minorities have historically had increased rates of vaccine refusal because of discriminatory practices, structural racism, and mistreatment by medical professionals.^{14,15} Vaccine hesitancy has varied over time for vaccines in general and for specific vaccines since the development of the first vaccine,¹⁶ but common themes, beliefs, and concerns have remained constant.¹⁷ It is important to disentangle the commonalities and the novel characteristics of vaccine hesitancy to have a nuanced understanding of the issue and to be better able to combat it as developments such as the coronavirus pandemic unfold. Major factors that have been involved with vaccine hesitancy or refusal over time include sociodemographic characteristics,¹⁸⁻²⁰ social networks,²¹ social norms,²¹ vaccine safety concerns,²² perceptions of the risk of disease,²¹⁻²³ perceptions of a need for vaccines,²¹ emotions,²¹ past experiences with health services,¹⁹ and trust in health care providers and institutions.^{23,24}

Reasons for vaccine hesitancy are numerous but can be categorized into a handful of sentiments that include deliberation, distrust, or dissent.²⁵ Deliberation is the most mild form of vaccine hesitancy, and includes people who are considering vaccination, but are waiting to see if the vaccine is safe. Distrust, comprises a higher degree of vaccine hesitancy, and may include distrust of science, practitioners of medicine, the pharmaceutical industry, or the government.^{25,26} Dissent, which is comparable to distrust

in terms of degree of hesitancy and similarity of reasoning, includes beliefs that vaccines are not useful or effective, beliefs that diseases that can be prevented by vaccines are not a concern, or a simple disliking of vaccines.²⁵ These reasons for vaccine hesitancy are also captured in the “3C” model of vaccine hesitancy, that includes complacency, which is very similar to dissent, confidence, which is the antithesis of distrust and deliberation, and convenience, or the accessibility of vaccines.¹²

In the 3C model, complacency is when one believes that the need to vaccinate is low because the perceived risk of vaccine-preventable diseases is low.¹² If individuals do not experience an appreciable level of threat from disease, they will not engage in proactive behaviors like vaccination.²⁷ Complacent people are those that passively omit receiving vaccines instead of actively avoiding them. Confidence in the 3C model refers to the belief of competence of healthcare professionals that administer vaccines, trust in institutions and policy-makers that decide on the need for vaccines, as well as trust that vaccines are safe and effective.¹² People that do not have confidence in vaccines have often been exposed to vaccine misinformation that has distorted their perceptions of the risks of vaccination,²⁸⁻³⁰ or may be affiliated with people close to anti-vaccination movements.³¹ Beliefs that healthcare professionals or institutions are trying to coerce people into vaccination or mandating compulsory vaccination can also serve to reduce confidence in vaccines.³² Convenience, or the accessibility of vaccines to the public, is often reduced by structural barriers such as the physical availability of vaccines, geographic proximity to a place offering vaccines and travel time, affordability, and the willingness of the recipient to pay for the vaccine.¹² Often times personal matters or competing responsibilities in an individual’s life may reduce the convenience of a

vaccine by making it difficult to find the time to receive a vaccine, even though they desire to.^{21,33}

Parental vaccine hesitancy, which refers to the hesitancy a caregiver may have about having their child vaccinated, is an important topic as children older than age 11 years have been approved to receive the COVID-19 vaccine since July of 2021 and children between age 5 and 12 years have been able to get vaccinated since October 29, 2021. Even more recently, children older than 6 months have been approved to receive the vaccine as of June 18, 2022. Previous literature on parental vaccine hesitancy indicates that hesitancy may be increasing amid the COVID-19 pandemic.³⁴ Evidence from previous studies regarding parental vaccine hesitancy is mixed, with some studies reporting that parents may be more likely to vaccinate their children than to get vaccinated themselves,^{35,36} and others providing evidence for the contrary.³⁷⁻³⁹ Meta-analyses on worldwide COVID-19 vaccine hesitancy offer ample evidence that parental vaccine hesitancy is much higher on average than vaccine hesitancy among adults, with 60.1% of surveyed parents indicating that they intended to vaccinate their children,⁴⁰ and between 72.5% and 73.2% of adults reporting that they intended to receive a vaccine,^{38,39,41} although the number of parents indicating that they would vaccinate their children differed drastically among the studies considered. Parental vaccine hesitancy is found among a very heterogeneous group of people, but prior to the pandemic, multiple sources have described vaccine-hesitant parents more commonly being White, college-educated married women that live in high-income households.⁴²⁻⁴⁵ Other attributes associated with vaccine-hesitant parents include lower trust in the government, lower

perceived susceptibility of their children to disease, lower perceived severity of disease, and lower perceived vaccine safety when compared to parents of vaccinated children.⁴⁶

One factor that may be related to parental vaccine hesitancy is child schooling type. Evidence shows that parents who choose to homeschool their children are less likely to ensure that their children are up to date on immunizations,⁴⁷ and that a higher rate of vaccine exemptions for personal beliefs are obtained by parents that enroll their children in charter schools,⁴⁴ although these relationships have not been examined with regards to COVID-19 vaccines. The relationship between homeschooling and child vaccination uptake is likely due in part to laws that require children that enter public or private schools to be immunized against several infectious diseases including measles, diphtheria, and bacterial meningitis.⁴⁸ Not all states require proof of immunizations for homeschooled children,⁴⁹ so these children may not be assessed for routine immunizations, and parents may take advantage of this loophole by homeschooling their children. There is also clear evidence that amid the pandemic homeschooling has increased,⁵⁰ as some parents made efforts to keep their children and themselves from being exposed to COVID-19, and other parents have possibly tried to avoid having to vaccinate their children.

Although the association of primarily White mothers of higher socioeconomic status with parental vaccine hesitancy has been well documented,^{42-44,51} the advent of the recent coronavirus pandemic and the political climate over the last few years may have served to alter this relationship. In fact, some evidence indicates that White people, women, and people with a bachelor's degree or higher would be more likely to accept a COVID-19 vaccine compared to other sociodemographic groups,⁵² although this study

was performed before the vaccine was accessible. Many people that might not have been vaccine-hesitant before the pandemic, are now wary of the COVID-19 vaccine, due to the relative quickness with which it was developed,⁵³ sociopolitical factors stoked by increased partisanship over the last few years,⁵⁴ and COVID-19 vaccine misinformation on social media.³⁰

Understanding factors associated with COVID-19 vaccine hesitancy is an important topic in the context of the current pandemic. Interventions that take these factors into account may be developed that are targeted towards specific populations that have higher rates of vaccine hesitancy. Reductions in vaccine hesitancy will likely improve vaccine uptake and thereby help mitigate the pandemic, by reducing severe COVID-19 disease and death. Understanding factors related to vaccine hesitancy is also important for public health preparedness regarding emerging infectious diseases, future pandemics, and endemic diseases such as influenza.

Hypotheses

It is hypothesized that vaccine hesitancy among adults will be positively associated with parental vaccine hesitancy. To further elaborate on this relationship, reasons for not receiving a vaccine among adults are expected to differ from those reported for not having their adolescent children vaccinated, with parents being more likely to express reasons of deliberation for not receiving the vaccine themselves, and to more readily express reasons categorized as distrust or dissent for not wanting to have their adolescent children vaccinated. Another hypothesis is that dissent and distrust will be more strongly associated with vaccine hesitancy than deliberation. In addition, adults that do not have children are hypothesized to be more likely to express reasons of distrust

or dissent than adults that have adolescent children. Previously published literature that used Household Pulse Survey (HPS) data has categorized the different types of vaccine hesitancy into these categories (deliberation, distrust, and dissent),²⁵ and there has been previous work investigating parental vaccine hesitancy regarding intention to vaccinate adolescent children,⁵⁵ but there has not yet been an investigation comparing COVID-19 vaccine hesitancy among adults to parental COVID-19 vaccine hesitancy using HPS data. HPS data has previously been used to investigate socioeconomic status, demographic information, geographic location, and their associations with vaccine hesitancy, although none of the previously published works have solely investigated unvaccinated participants.^{9,25,56,57} It is also hypothesized that parental vaccine hesitancy will differ by child schooling type (public schooling, private schooling, and homeschooling) with a higher degree of hesitancy reported by parents of children that are homeschooled.

METHODS

Data Source

HPS survey data from the U.S. Census Bureau was used to conduct an ecological study on COVID-19 vaccine hesitancy. The HPS is an online survey that was created to assess how the COVID-19 pandemic affects people throughout the United States.⁵⁸

Topics in the survey include COVID-19 vaccination status, intention to receive a vaccine if not already vaccinated, reasons for not receiving a COVID-19 vaccine, geographic data, employment status, housing status, and physical and mental wellbeing. Survey data has been collected biweekly since April 2020. Data regarding parental vaccine hesitancy has been gathered since July 21, 2021, which was shortly after the COVID-19 vaccine became available for adolescent children aged 12 years and older. The survey is administered as an online survey across the United States to people that are captured in the Census Bureau's Master Address File, which has roughly 140,000,000 unique housing units. Typically, about 60,000 people respond to the survey every two-week period. The results of the survey are de-identified, the data are cleaned, and they are freely available to the public generally within two weeks after collection.

This study focuses on the portion of the population that had not received a vaccine at the time of survey data collection, and it examines the reasons for which they have not yet been vaccinated and the degree to which these people are willing or not to receive a COVID-19 vaccine. Within-subject comparisons were made for subjects with adolescent

children, and between-subject comparisons were made for vaccine hesitancy among adults that have adolescent children and vaccine hesitancy among adults that do not have adolescent children. Respondents that had missing information for vaccine receipt, those with missing intent-to-vaccinate self and their adolescent, those that have received the vaccine, those that had adolescent children that received the vaccine, those with children whose vaccine status was unknown, those without children 12 years old or older in their household (except for subjects included in the no-children comparison group), and those with missing child school type were excluded from the study population.

Data for 382,908 participants were captured for the 6 collection time periods of HPS Phase 3.2, beginning on July 21, 2021, and ending on October 11, 2021, and of those participants 43,859 (11.45%) had not yet received a single dose of the COVID-19 vaccine. Participants that did not complete questions regarding COVID-19 vaccine hesitancy, those that did not have children between the ages of 12 and 17 (except for those in the no-children comparison group), those that had already received the COVID-19 vaccine, participants whose children had already received the vaccine, and participants that had missing information regarding the type of school that their children attended were excluded from the analyses.

The HPS asks participants whether they have been vaccinated. For the purposes of this manuscript, “vaccinated” will refer to vaccination with a COVID-19 vaccine. If they have not yet been vaccinated, they are then asked about their intentions on getting a vaccine. This question gives the respondent five choices which form the basis for the primary outcome of this study: “definitely get a vaccine,” “probably get a vaccine,” “be unsure about getting a vaccine,” “probably NOT get a vaccine,” and “definitely NOT get

a vaccine.” Those who respond with “unsure,” “probably NOT,” or “definitely NOT” are classified as vaccine-hesitant for the purposes of these analyses. Participants that report not having been vaccinated are also asked about the reasons for their abstention and are allowed to select multiple reasons from a list of 11 responses that include options such as “I am concerned about possible side effects of a COVID-19 vaccine,” “I don’t know if a COVID-19 vaccine will protect me,” and “I don’t believe I need a COVID-19 vaccine.”

Participants are also asked whether they have children younger than 5 years old, between 5 and 11 years old, and between 12 and 17 years old. If they responded “yes” to having children between 12 and 17 years old, then they are asked if they intend to get those children vaccinated. This question has six answer choices: “definitely get the children a vaccine,” “probably get the children a vaccine,” “be unsure about getting the children a vaccine,” “probably NOT get the children a vaccine,” and “definitely NOT get the children a vaccine,” and “I do not know the plans for vaccination of the children aged 12-17 in my household.” Responses to this question informed the parental vaccine hesitancy outcome variable. As with the question regarding personal vaccine hesitancy, parents are considered vaccine-hesitant if they respond with “unsure,” “probably NOT,” or “definitely NOT.” Parents are then asked about reasons that they have not had their children vaccinated and may respond with multiple reasons from a list of 14 options that include “The children in this household are not members of a high-risk group,” “The children’s doctor has not recommended it,” and “Don’t trust COVID-19 vaccines.” Participants that have children are also asked about the number of which are enrolled in public school, private school, or that are home schooled. Other variables of interest in this

analysis include age, gender, race, ethnicity, educational attainment, and household income.

Analyses

Descriptive statistics were produced to assess COVID-19 vaccine uptake, vaccine hesitancy among adults, parental vaccine hesitancy, and intention of receiving a vaccine. Frequencies and proportions were stratified by age, sex, race, ethnicity, educational attainment, household income, and child schooling type. For subjects that had adolescent children, Pearson correlations assessed the strength of the relationship between vaccine hesitancy among adults with children and parental vaccine hesitancy and the reasons reported for not receiving a vaccine themselves and for not getting their adolescent children vaccinated. Reasons for not having one's adolescent child vaccinated and reasons for not receiving a vaccine were also compared within subjects using McNemar's chi-square tests. Frequencies of reasons for not receiving a vaccine and for not having one's adolescent child vaccinated were produced. Reasons for not receiving a vaccine and for not having one's adolescent child vaccinated were categorized into deliberation, dissent, and distrust, and adjusted logistic regressions were run to assess the relationships between these categories and vaccine hesitancy. Chi-square tests were used to compare reasons for not receiving a vaccine between respondents that had adolescent children and those that did not have children. To assess the variables age, sex, race, ethnicity, educational attainment, household income, and child schooling type as predictors of vaccine hesitancy among adults with children and parental vaccine hesitancy, unadjusted and adjusted logistic regressions were performed. Regressions were adjusted for all other variables that were included in the analyses: sex, age, race, education, child school type,

and household income. All statistical analyses were performed in SAS (version 9.4; SAS Institute, Inc.).

RESULTS

Data from 7,767 participants that had children were included in the primary analyses, of which 6,825 (87.9%) met the criteria for vaccine hesitancy among adults and 7,029 (90.4%) met the criteria for parental vaccine hesitancy (Table 1). 3,725 (48.0%) of participants indicated that they would definitely not receive a COVID-19 vaccine, and 4,132 (53.2%) of participants reported that they would definitely not vaccinate their children. These participants made up the largest groups regarding intention to vaccinate their adolescent children. As hypothesized, Pearson correlation results indicate a strong positive association between vaccine hesitancy among adults with children and parental vaccine hesitancy ($R = 0.71$, $p < 0.001$), and a strong correlation between the reasons reported for not receiving a vaccine and for not having one's adolescent child vaccinated ($R = 0.75$, $p < 0.001$) within the same group of subjects. Data from 22,012 participants that did not have children were also included in analyses in comparison to those that have adolescent children. 18,474 (83.9%) of those participants met the criteria for vaccine hesitancy (Table 1). Of these participants, 9,992 (45.4%) indicated that they would definitely not receive a vaccine.

There were differences in the reasons that participants reported for not receiving the vaccine themselves and for not having their adolescent children vaccinated as indicated by McNemar's within subject chi-square tests, although, contrary to what was hypothesized, the results of these analyses appear to differ by individual reason

irrespective of the category of vaccine hesitancy reason: deliberation, dissent, and distrust. 4,173 Parents reported a concern about possible side effects as a reason for not receiving a vaccine themselves and for not vaccinating their adolescent children, 862 reported it as a reason for not having their adolescent children vaccinated only, 470 reported it as a reason for not receiving a vaccine themselves only, and 1,699 participants did not select possible side effects either as a reason for not receiving the vaccine themselves or for not having their adolescent children vaccinated (Table 2). McNemar's chi-square analysis indicates a significant difference between the groups with participants more likely to use possible side effects as a reason to not have their adolescent children vaccinated exclusively rather than to not receive the vaccine themselves exclusively, X^2 , (1, $N = 7,204$) = 115.36, $p < 0.001$. Of the other reasons that are categorized as deliberation, no doctor recommendation for the vaccine, X^2 , (1, $N = 7,204$) = 31.61, $p < 0.001$ and concern about the cost of the vaccine, X^2 , (1, $N = 7,204$) = 44.55, $p < 0.001$ were slightly more likely to be reported as a reason for not getting one's child vaccinated compared to one's self, and planning to wait and see if the vaccine is safe, X^2 , (1, $N = 7,204$) = 128.54, $p < 0.001$ and lack of access to the vaccine, X^2 , (1, $N = 7,204$) = 33.49, $p < 0.001$ were more likely to be reported as reasons to not receive the vaccine versus as reasons not to vaccinate one's child. For reasons categorized as dissent, a belief that vaccines do not work or do not provide protection was more likely to be reported as a reason for one not to vaccinate themselves, X^2 , (1, $N = 7,204$) = 496.93, $p < 0.001$, while a belief that the vaccine is not needed was more likely to be reported as a reason to not vaccinate one's adolescent, X^2 , (1, $N = 7,204$) = 14.79, $p < 0.001$. For reasons of distrust, a lack of trust in the vaccine was more likely to be reported as a reason not to vaccinate

one's adolescent compared to oneself, $X^2, (1, N = 7,204) = 9.45, p = 0.002$. No significant difference was found regarding a lack of trust in the government, $X^2, (1, N = 7,204) = 0.04, p = 0.840$.

Reported reasons for not receiving the COVID-19 vaccine were generally consistent for vaccine hesitancy among adults with children and parental vaccine hesitancy. The most common reason for both vaccine hesitancy among adults with children and parental vaccine hesitancy was concern for possible side effects, with 64.3% reporting it as a reason for not receiving a vaccination themselves and 68.7% reporting it as a reason for not getting their adolescent children vaccinated (Figures 1 and 2). The next most common reason for vaccine hesitancy among adults with children and parental vaccine hesitancy was a distrust of COVID-19 vaccines, with 52.0% of adults reporting it as a reason for not receiving a vaccination themselves and 52.9 % reporting it as a reason for not getting their adolescent children vaccinated. 36.8% of participants indicated that they plan to see if the vaccine is safe and may get it later, and 30.5% reported that the same reason regarding their adolescent children.

As hypothesized, the reasons reported for not receiving a vaccine categorized as dissent and distrust were more greatly associated with vaccine hesitancy than reasons categorized as deliberation. In an adjusted logistic regression model of adults that have adolescent children, adjusted for sex, age, race, education, child school type, and household income, the greatest association with vaccine hesitancy was among those that reported reasons of dissent and distrust only (AOR, 25.08 [95% CI, 7.97 - 78.89]) compared to individuals that only reported reasons of deliberation (Table 3). There were also strong associations between reporting reasons that fell into all categories for not

receiving a vaccine and vaccine hesitancy (AOR, 9.75 [95% CI, 7.33 - 12.96]), reporting reasons only within the category of dissent and vaccine hesitancy (AOR, 9.42 [95% CI, 5.45 - 16.27]), and reporting reasons of distrust only and vaccine hesitancy (AOR, 5.20 [95% CI, 3.22 - 8.40]). In an adjusted logistic regression model using the same group of participants, adjusted for sex, age, race, education, child schooling, and household income, the greatest association with parental vaccine hesitancy was also among those that reported reasons of dissent and distrust only, but because all 114 respondents that reported these reasons only also fell into the category of parental vaccine hesitancy, that odds ratio is undefined (Table 3). There were strong associations between reporting dissent only and parental vaccine hesitancy (AOR, 25.31 [95% CI, 9.38 - 68.29]), distrust only and parental vaccine hesitancy (AOR, 6.81 [95% CI, 2.77 - 16.71]), as well as between all three categories and parental vaccine hesitancy (AOR, 19.29 [95% CI, 12.04 - 30.90]).

Among adults that do not have children, a very similar relationship between categories of reasons for not receiving a vaccine and vaccine hesitancy existed. All categories and combinations of categories of reasons for not receiving a vaccine were more associated with vaccine hesitancy than deliberation alone. In an adjusted logistic regression model of adults that had no children, adjusted for sex, age, race, education, and household income, the greatest association with vaccine hesitancy was among those that reported reasons of dissent and distrust only (AOR, 10.79 [95% CI, 7.00 - 16.63]) compared to individuals that only reported reasons of deliberation (Table 4). There were also strong associations between reporting reasons of dissent only and vaccine hesitancy (AOR, 8.68 [95% CI, 6.59 - 11.43]), reporting reasons only within the category of

distrust and vaccine hesitancy (AOR, 3.54 [95% CI, 2.83 – 4.42]), and reporting reasons from all three categories and vaccine hesitancy (AOR, 9.11 [95% CI, 7.71 – 10.75]).

Chi-square analyses indicate that adults with adolescent children consistently reported more reasons for not receiving a vaccine more often than adults with no children, and contrary to what was hypothesized, adults without children were not more likely to express reasons categorized as distrust or dissent than adults that have children (Table 5). Of the reasons in the deliberation category, concern about possible side effects, $X^2, (1, N = 27,439) = 144.02, p < 0.001$, and planning to see if the vaccine is safe before considering vaccination, $X^2, (1, N = 27,439) = 73.14, p < 0.001$ were reported by a higher percentage of adults with children compared to adults without adolescent children. No recommendation by a doctor, $X^2, (1, N = 27,439) = 1.78, p = 0.182$, and concern about the cost of the vaccine, $X^2, (1, N = 27,439) = 0.13, p = 0.720$ were likewise reported by slightly more adults with adolescent children, but results were not significant. Also in the deliberation category, “It is hard for me to get a COVID-19 vaccine” was reported by a slightly higher percentage of adults without children compared to adults with adolescent children, $X^2, (1, N = 27,439) = 5.57, p = 0.018$. A larger percentage of adults with children compared to adults without children reported all three of the reasons that were categorized as dissent: “I do not know if a vaccine will protect me,” $X^2, (1, N = 27,439) = 68.18, p < 0.001$, “I do not believe I need a COVID-19 vaccine,” $X^2, (1, N = 27,439) = 28.50, p < 0.001$, and “I do not think COVID-19 is that big of a threat,” $X^2, (1, N = 27,439) = 14.02, p < 0.001$. Of the reasons categorized as distrust, “I don’t trust the vaccine,” was more likely to be reported by adults with children $X^2, (1, N = 27,439) = 80.94, p < 0.001$, and there was no significant relationship between having adolescent

children and choosing the response “I don’t trust the government,” $\chi^2, (1, N = 27,439) = 0.17, p = 0.680$. Of note, a higher percentage of adults with no children chose the option “other” than adults with adolescent children, $\chi^2, (1, N = 27,439) = 17.17, p < 0.001$.

Unadjusted and adjusted odds ratios for vaccine hesitancy among adults with children and parental vaccine hesitancy for adults with adolescent children are presented in Table 6. The prevalence of vaccine hesitancy among adults with children in this sample was highest among male participants, those categorized as White race, those with higher income, and those with more education (Table 6). Parents with children that are homeschooled had the highest odds of vaccine hesitancy among adults with children among schooling types in unadjusted analyses (OR, 1.52 [95% CI, 1.12 - 2.07]), and after adjusting for sex, age, race, education, and household income AOR, 1.45 [95% CI, 1.20 - 2.45]). Parents of children that are in private school had the highest odds of parental vaccine hesitancy (OR, 1.94 [95% CI, 1.31 – 2.89]) compared to parents of children in public school as a reference before adjusting for covariates. After adjusting for sex, age, race, education, and household income, results indicated nearly identical odds ratios for parents of homeschooled children (AOR, 1.60 [95% CI, 1.12 - 2.29]) and parents of children in private school (AOR, 1.60 [95% CI, 1.07 - 2.39]). Among adults with no children, the prevalence of vaccine hesitancy was similar to that of adults with children, with the highest levels among males, participants older than 45, White participants, and those with the highest level of income (greater than \$100,000). Unlike adults with children, subjects with no children that had a college degree (Associate or Bachelor) had a higher unadjusted odds of vaccine hesitancy (OR, 1.25 [95% CI, 1.14 - 1.37]) and a higher adjusted odds of vaccine hesitancy (AOR, 1.20 [95% CI, 1.09 - 1.32]) than any

other education level when compared to individuals with a high school degree or less (Table 6).

DISCUSSION

By the fall of 2021, vaccine uptake for people initiating COVID-19 vaccination had slowed greatly and appeared to have plateaued. Most of the people that were willing to receive a vaccine had already received one. Even though the Pfizer and Moderna vaccines have been available to the general public for many months, and despite the strong evidence of the effectiveness and safety of the available vaccines,^{4,5} a sizeable portion of the public still report reluctance to receive the vaccine. Evidence that COVID-19 vaccine-induced immunity wanes over time, and that the Moderna and Pfizer vaccines have decreased effectiveness against infection with emergent variants has increased the necessity of booster shots,⁵⁹ although many people have yet to receive their second or even their first dose. This study characterized a portion of the population that had yet to receive any doses of the COVID-19 vaccine and examined the willingness to receive a vaccine among those people based on the reasons for which they have not yet been vaccinated.

The results of this study show a high degree of consistency between parents' reasons for not receiving a vaccine and their reasons for not yet having their adolescent children vaccinated as well as a strong association between vaccine hesitancy among adults with children and parental vaccine hesitancy. This runs counter to some prior studies that found parents having a higher degree of parental vaccine hesitancy,³⁷ and others that found a higher degree of hesitancy towards receiving a vaccine

themselves,^{36,60} although these prior studies were performed before a COVID-19 vaccine was available to the public. The degree of vaccine hesitancy reported by adults without children was very similar to that of adults with children, contrary to expectations. After adjusting for covariates parents of homeschooled children and parents of children in private school both had 60% higher odds of being vaccine-hesitant compared to parents of children in public school. Adults with adolescent children that had higher incomes, and those with more advanced levels of education had substantially higher odds of vaccine hesitancy, which may indicate that many people who are vaccine-hesitant are more affluent. This is not supported by previous studies that assessed demographic associations with vaccine hesitancy and vaccine non-receipt, which broadly indicate that adults of a lower socioeconomic status and those with less advanced levels of education were more vaccine-hesitant.^{25,57,61}

The differences in results between the present study and previous studies may be due in part to the fact that this study only includes unvaccinated adults, but vaccinated adults were included in the cohort of previous works. This may have narrowed the cohort unevenly as the demographics of the participants that reported being unvaccinated may not represent the general population. Also, some previous studies were performed before a large segment of the population was vaccinated. The differing results from this study may also indicate that one of the more long-lasting phenotypes of vaccine-hesitant people are affluent people that can afford to send their children to private schools or homeschool them.

Strengths

One major strength of this study is the large amount of data that the HPS acquires, and which is purposefully gathered to provide a representative sample of the United States in terms of race and ethnicity, social determinants of health, and geography. The present study highlights the importance of understanding the underlying mechanisms contributing to vaccine hesitancy, such as exposure to misinformation, distrust in healthcare professionals, or a belief that the vaccine is more dangerous than the disease. It also describes many aspects of the cohort of vaccine-hesitant people in detail. These characteristics should be considered in the design of effective interventions to increase vaccine uptake. It may be effective for public health professionals and government agencies to implement more proactive measures such as prebunking, or the pre-emptive refutations of misinformation about COVID-19, in order to reduce the belief and sharing of misinformation.⁶² Tailored messaging towards groups that are known to be more apt to be vaccine-hesitant, such as those that enroll their children in private and public schools may also help to reduce vaccine hesitancy. Some other strengths of this study include the relatively low cost of administering the survey and the overall accessibility and convenience of the online survey for participants.

Limitations

One study suggests that large scale surveys such as the HPS may not accurately portray the U.S. population, and that smaller, more selectively chosen samples provide more reliable responses.⁶³ Data from the HPS show that the percentage of respondents that reported having received a dose of the COVID-19 vaccine hovered around 87% for all the time periods considered in this study, and the percentage of those that had received

both doses was close to 83% for the entirety of the study. These percentages are considerably higher than the estimate given by the CDC on November 21st, 2021, near the end of the sample collection of the HPS. At that time the CDC estimated that approximately 69.4% of the population had received at least one dose of the vaccine,¹ indicating that the overall sample that responded to the HPS may not be a representative sample of the United States in terms of COVID-19 vaccination status. The high percentage of respondents that had already received a vaccine also minimized the size of the non-vaccinated cohort and increased the likelihood that subjects included in this study would be vaccine-hesitant. Most of the people that had not received a vaccine and responded to the survey for the time periods considered in this study are people that likely will not go on to get the vaccine, as the vaccine was widely available at that time, and the pool of people willing to receive the vaccine by this stage in the pandemic has diminished greatly.

There are other issues inherent with large scale surveys such as response bias, in which participants that respond to a survey may have certain characteristics that differentiate them from those that do not respond to the survey. Another issue is that vaccination status for respondents and their adolescent children was self-reported and may be subject to social desirability bias, which is when participants provide answers to surveys that they expect are desired, rather than what they believe. In the case of this study, participants could be reporting that they are not vaccine-hesitant, even if they are. Another factor that could have an impact on the present analysis is prior infection with COVID-19, which was not accounted for. A previously published article that used HPS

data found that people that had been previously infected with COVID-19 had nearly 50% lower odds of going on to get vaccinated against COVID-19.⁶⁴

Conclusion

Results from this study indicate a high degree of consistency between vaccine hesitancy among adults with adolescent children and parental vaccine hesitancy. The results of this study also indicate that there is a slightly higher degree of vaccine hesitancy among parents of children that are in private school or homeschooled compared to parents of children in public school. Tailored messaging towards people among these groups that are known to be more vaccine-hesitant and proactive methods taken by health professionals such as prebunking misinformation may be effective for countering vaccine-hesitant attitudes in the context of the COVID-19 pandemic and future pandemics. It is also very important to ensure transparency in regards to communications about the safety of COVID-19 vaccines as well as to stop and address the spread of vaccine misinformation in order to increase trust in vaccines, healthcare professionals, and government organizations that are a part of the response to COVID-19.⁶⁵⁻⁶⁷

Table 1

Descriptive Frequencies

	Adults with Adolescent Children N (%)	Adults without Children N (%)
Sex		
Male	2,511 (32.3)	9,523 (43.3)
Female	5,256 (67.7)	12,489 (56.7)
Age		
18-24	269 (3.5)	1,312 (6.0)
25-31	165 (2.1)	2,304 (10.5)
32-38	1,566 (20.2)	1,973 (9.0)
39-45	2,862 (36.9)	2,146 (9.8)
45+	2,905 (37.4)	14,277 (64.9)
Race		
Non-Hispanic White (reference)	5,374 (69.2)	16,759 (76.1)
Non-Hispanic Black	874 (11.3)	1,670 (7.6)
Hispanic	977 (12.6)	2,062 (9.4)
Non-Hispanic Asian	99 (1.3)	363 (1.7)
Non-Hispanic other/multiple races	443 (5.7)	1,158 (5.3)
Education		
Highschool or less	1,880 (24.2)	5,495 (25.0)
Some college	2,333 (30.0)	6,619 (30.1)
College graduate	2,661 (34.3)	7,573 (34.4)
Graduate degree	893 (11.5)	2,325 (10.6)
Household income		
Less than \$25,000	873 (11.2)	3,594 (16.3)
\$25,000 TO \$49,999	1,246 (16.0)	4,180 (19.0)
\$50,000 TO \$74,999	951 (12.2)	2,909 (13.2)
\$75,000 TO \$100,000	768 (9.9)	1,999 (9.1)
Greater than \$100,000	1,657 (21.3)	3,425 (15.6)
Missing	2,272 (29.3)	5,905 (26.8)
Child Schooling Type		
Public School	6,428 (82.8)	N/A
Private School	493 (6.4)	N/A
Homeschool	553 (7.1)	N/A
Multiple Schools	293 (3.8)	N/A
Intention on Getting Vaccine		
Definitely get a vaccine	352 (4.5)	1,586 (7.2)
Probably get a vaccine	590 (7.6)	1,952 (8.9)
Unsure about getting a vaccine	1,476 (19.0)	3,959 (18.0)
Probably NOT get a vaccine	1,624 (20.9)	4,523 (20.6)
Definitely NOT get a vaccine	3,725 (48.0)	9,992 (45.4)
Intention on Getting Vaccine for Children		
Definitely get the children a vaccine	288 (3.7)	N/A
Probably get the children a vaccine	450 (5.8)	N/A
Unsure about getting the children a vaccine	1,358 (17.5)	N/A
Probably NOT getting the children a vaccine	1,539 (19.8)	N/A
Definitely NOT getting the children a vaccine	4,132 (53.2)	N/A

Table 2

McNemar's tests of Reasons Reported for not Receiving a COVID-19 Vaccine Compared to Reasons Reported for not Getting one's Adolescent Child Vaccinated

Reason	Reason selected for not vaccinating self	Reason selected for not vaccinating child		p-value	Chosen more often as a reason not to vaccinate
		No	Yes		
Concern about possible side effects	No	1,699	862	<.001	Child
	Yes	470	4,173		
Doctor has not recommended it	No	6,050	385	<.001	Child
	Yes	244	525		
Plan to wait and see if it is safe	No	4,039	412	<.001	Parent
	Yes	808	1,945		
Concern about the cost of the vaccine	No	6,888	182	<.001	Child
	Yes	75	59		
Hard or impossible to get the vaccine	No	7,086	20	<.001	Parent
	Yes	77	21		
Don't believe the vaccine works or provides protection	No	4,868	277	<.001	Parent
	Yes	1,106	953		
Don't believe the vaccine is needed	No	4,063	773	<.001	Child
	Yes	629	1,739		
Don't trust the vaccine	No	3,056	624	.002	Child
	Yes	520	3,004		
Don't trust the government	No	4,094	296	.840	N/A
	Yes	291	2,523		
Other	No	5,254	199	<.001	Parent
	Yes	720	1,031		

Table 3

Categories of Reasons for Not Receiving COVID-19 Vaccine Among Adults with Adolescent Children and For Not Vaccinating Their Children and Their Associations with Vaccine Hesitancy

	N (%)	AOR (95% CI)
Adult Deliberation	1,583 (23.1)	Reference
Adult Distrust	412 (6.0)	5.20 (3.22 - 8.40)
Adult Dissent	518 (7.5)	9.42 (5.45 - 16.27)
Adult Deliberation and Distrust	634 (9.2)	1.45 (1.12 - 1.88)
Adult Deliberation and Dissent	913 (13.3)	5.01 (3.60 - 6.98)
Adult Distrust and Dissent	300 (4.4)	25.08 (7.97 - 78.89)
All Categories of Adult Hesitancy	2,509 (36.5)	9.75 (7.33 - 12.96)
Parental Deliberation	2,023 (29.2)	Reference
Parental Distrust	205 (3.0)	6.81 (2.77 - 16.71)
Parental Dissent	528 (7.6)	25.31 (9.38 - 68.29)
Parental Deliberation and Distrust	592 (8.6)	2.94 (2.00 - 4.32)
Parental Deliberation and Dissent	1,279 (18.5)	7.05 (4.86 - 10.23)
Parental Distrust and Dissent	114 (1.7)	Undefined
All Categories of Parental Hesitancy	2,183 (31.5)	19.29 (12.04 - 30.90)

Notes: Adult Deliberation consists of responses including “I am concerned about possible side effects of a COVID-19 vaccine,” “My doctor has not recommended it,” “I plan to wait and see if it is safe and may get it later,” “I am concerned about the cost of the COVID-19 vaccine,” and “It’s hard for me to get a COVID-19 vaccine.” Adult Dissent consists of responses including “I don’t know if a COVID-19 vaccine will protect me,” “I don’t believe I need a COVID-19 vaccine,” and “I don’t think COVID-19 is that big of a threat.” Adult Distrust consists of “I don’t trust COVID-19 vaccines” and “I don’t trust the government.” Parental Deliberation consists of the same responses as Adult Deliberation, but also includes “The children in this household are not members of a high-risk group,” “Other people need it more than the children in this household do right now,” “Concern about missing work to have the children vaccinated,” and “Unable to get a COVID-19 vaccine for children in this household.” Parental Dissent includes “Not sure if a COVID-19 vaccine will work for children” and “Don’t believe children need a COVID-19 vaccine.” Parental Distrust includes “Parents or guardians in this household do not vaccinate their children,” “Don’t trust COVID-19 vaccines,” and “Don’t trust the government.” Adjusted ORs are adjusted for age, sex, race, education, household income, and child schooling type.

Table 4

Categories of Reasons for Not Receiving a Vaccine Among Adults that Do Not Have Children and Their Associations with Vaccine Hesitancy

	N (%)	AOR (95% CI)
Adult Deliberation	4,401 (24.7)	Reference
Adult Distrust	1,270 (7.1)	3.54 (2.83 - 4.42)
Adult Dissent	1,828 (10.3)	8.68 (6.59 - 11.43)
Adult Deliberation and Distrust	1,406 (7.9)	1.85 (1.56 – 2.20)
Adult Deliberation and Dissent	2,278 (12.8)	3.76 (3.14 – 4.50)
Adult Distrust and Dissent	803 (4.5)	10.79 (7.00 – 16.63)
All Categories of Adult Hesitancy	5,802 (32.6)	9.11 (7.71 – 10.75)

Notes: Adult Deliberation consists of responses including “I am concerned about possible side effects of a COVID-19 vaccine,” “My doctor has not recommended it,” “I plan to wait and see if it is safe and may get it later,” “I am concerned about the cost of the COVID-19 vaccine,” and “It’s hard for me to get a COVID-19 vaccine.” Adult Dissent consists of responses including “I don’t know if a COVID-19 vaccine will protect me,” “I don’t believe I need a COVID-19 vaccine,” and “I don’t think COVID-19 is that big of a threat.” Adult Distrust consists of “I don’t trust COVID-19 vaccines” and “I don’t trust the government.” Adjusted ORs are adjusted for age, sex, race, education, and household income.

Table 5

Chi-Square tests of Reasons for Not Receiving a Vaccine Reported by Adults with Children Compared to Reasons Reported by Adults that Do Not Have Children

Reason		Adults without children N (%)	Adults with children N (%)	p-value	Chosen more often as a reason to not receive a vaccine by
Concern about possible side effects	Not reported	8,772 (43.81)	2,652 (35.77)	<.001	Adults with children
	Reported	11,252 (56.19)	4,763 (64.23)		
My doctor has not recommended it	Not reported	18,006 (89.92)	6,627 (89.37)	.182	Adults with children
	Reported	2,018 (10.18)	788 (10.63)		
I plan to wait and see if is safe and may get it later	Not reported	13,496 (67.40)	4,589 (61.89)	<.001	Adults with children
	Reported	6,528 (32.60)	2,826 (38.11)		
I am concerned about the cost of a COVID-19 vaccine	Not reported	19,667 (98.22)	7,278 (98.15)	.720	Adults with children
	Reported	357 (1.78)	137 (1.85)		
It is hard for me to get a COVID-19 vaccine	Not reported	19,663 (98.20)	7,312 (98.61)	.018	Adults with no children
	Reported	361 (1.80)	103 (1.39)		
I do not know if a vaccine will protect me	Not reported	15,288 (76.35)	5,301 (71.49)	<.001	Adults with children
	Reported	4,736 (23.65)	2,114 (28.51)		
I do not believe I need a COVID-19 vaccine	Not reported	14,198 (70.90)	5,011 (67.58)	<.001	Adults with children
	Reported	5,826 (29.10)	2,404 (32.42)		
I do not think COVID-19 is that big of a threat	Not reported	15,859 (79.20)	5,718 (77.11)	<.001	Adults with children
	Reported	4,165 (20.80)	1,697 (22.89)		
I don't trust the vaccine	Not reported	11,505 (57.46)	3,810 (51.38)	<.001	Adults with children
	Reported	8,519 (42.54)	3,605 (48.62)		
I don't trust the government	Not reported	12,304 (61.45)	4,536 (61.17)	.680	Adults with children
	Reported	7,720 (38.55)	2,879 (38.83)		
Other	Not reported	14,679 (73.31)	5,619 (75.78)	<.001	Adults with no children
	Reported	5,345 (26.69)	1,796 (24.22)		

Note: Column percentages are in parentheses.

Table 6

Odds Ratios for Factors Associated with Vaccine Hesitancy

	Adults with Adolescent Children Vaccine Hesitancy OR (95% CI)	Adults with Adolescent Children Vaccine Hesitancy Adjusted OR (95% CI)	Parental Vaccine Hesitancy OR (95%)	Parental Vaccine Hesitancy Adjusted OR (95%)	Adults without Children Vaccine Hesitancy OR (95% CI)	Adults without Children Vaccine Hesitancy Adjusted OR (95%)
Sex						
Male	Reference	Reference	Reference	Reference	Reference	Reference
Female	0.79 (0.68 - 0.92)	0.85 (0.73 - 0.99)	0.70 (0.59 - 0.84)	0.77 (0.64 - 0.92)	0.98 (0.91 - 1.06)	0.98 (0.91 - 1.05)
Age						
18-24	Reference	Reference	Reference	Reference	Reference	Reference
25-31	1.37 (0.82 - 2.31)	1.51 (0.89 - 2.57)	1.90 (1.02 - 3.55)	2.11 (1.12 - 3.97)	1.23 (1.04 - 1.45)	1.23 (1.04 - 1.46)
32-38	1.80 (1.28 - 2.52)	1.89 (1.33 - 2.68)	1.70 (1.18 - 2.44)	1.75 (1.20 - 2.56)	1.34 (1.13 - 1.57)	1.35 (1.13 - 1.61)
39-45	1.85 (1.34 - 2.55)	1.73 (1.24 - 2.41)	1.87 (1.31 - 2.65)	1.64 (1.14 - 2.36)	1.51 (1.27 - 1.80)	1.56 (1.31 - 1.86)
45+	1.85 (1.34 - 2.54)	1.59 (1.14 - 2.21)	1.96 (1.38 - 2.78)	1.54 (1.07 - 2.21)	1.63 (1.42 - 1.87)	1.59 (1.38 - 1.83)
Race						
White (non-Hispanic)	Reference	Reference	Reference	Reference	Reference	Reference
Black (non-Hispanic)	0.29 (0.24 - 0.34)	0.31 (0.26 - 0.37)	0.23 (0.19 - 0.27)	0.25 (0.21 - 0.30)	0.35 (0.31 - 0.39)	0.37 (0.33 - 0.41)
Asian (non-Hispanic)	0.39 (0.33 - 0.47)	0.41 (0.34 - 0.49)	0.36 (0.30 - 0.45)	0.38 (0.31 - 0.47)	0.52 (0.47 - 0.58)	0.54 (0.48 - 0.61)
Hispanic	0.30 (0.19 - 0.47)	0.28 (0.17 - 0.45)	0.35 (0.20 - 0.60)	0.32 (0.18 - 0.55)	0.27 (0.22 - 0.33)	0.26 (0.21 - 0.33)
Other/multiple races	0.78 (0.57 - 1.07)	0.79 (0.58 - 1.09)	0.73 (0.51 - 1.04)	0.76 (0.53 - 1.08)	0.83 (0.71 - 0.98)	0.87 (0.74 - 1.02)
Education						
High School or Less	Reference	Reference	Reference	Reference	Reference	Reference
Some College	1.32 (1.11 - 1.57)	1.29 (1.09 - 1.54)	1.37 (1.14 - 1.65)	1.34 (1.11 - 1.62)	1.18 (1.08 - 1.30)	1.17 (1.07 - 1.29)
College Graduate	1.69 (1.42 - 2.01)	1.55 (1.30 - 1.86)	2.13 (1.75 - 2.60)	1.97 (1.61 - 2.41)	1.25 (1.14 - 1.37)	1.20 (1.09 - 1.32)
Graduate Degree	1.93 (1.49 - 2.50)	1.68 (1.29 - 2.20)	3.11 (2.24 - 4.33)	2.69 (1.92 - 3.77)	1.17 (1.03 - 1.34)	1.08 (0.95 - 1.24)
Household income						
≤ \$25,000	Reference	Reference	Reference	Reference	Reference	Reference
\$25,000 to \$49,999	1.26 (1.00 - 1.60)	1.19 (0.94 - 1.51)	1.46 (1.14 - 1.88)	1.34 (1.04 - 1.73)	1.19 (1.06 - 1.33)	1.15 (1.02 - 1.29)
\$50,000 to \$74,999	1.86 (1.42 - 2.44)	1.60 (1.21 - 2.11)	2.30 (1.70 - 3.10)	1.86 (1.37 - 2.52)	1.50 (1.31 - 1.71)	1.41 (1.23 - 1.61)
\$75,000 to \$100,000	1.94 (1.45 - 2.60)	1.59 (1.17 - 2.14)	2.48 (1.78 - 3.44)	1.87 (1.33 - 2.62)	1.62 (1.39 - 1.88)	1.50 (1.29 - 1.76)
≥ \$100,000	2.47 (1.93 - 3.17)	1.93 (1.49 - 2.51)	3.97 (2.97 - 5.32)	2.79 (2.05 - 3.80)	1.82 (1.60 - 2.07)	1.67 (1.46 - 1.91)
Child schooling type						
Public school	Reference	Reference	Reference	Reference	N/A	N/A
Private school	1.23 (0.91 - 1.65)	1.07 (0.79 - 1.44)	1.94 (1.31 - 2.89)	1.60 (1.07 - 2.39)	N/A	N/A
Homeschooled	1.52 (1.12 - 2.07)	1.45 (1.07 - 1.97)	1.72 (1.20 - 2.45)	1.60 (1.12 - 2.29)	N/A	N/A
Multiple Schools	1.32 (0.89 - 1.95)	1.37 (0.92 - 2.03)	1.11 (0.74 - 1.66)	1.12 (0.74 - 1.69)	N/A	N/A

Note: Adjusted ORs are adjusted for all other variables in table.

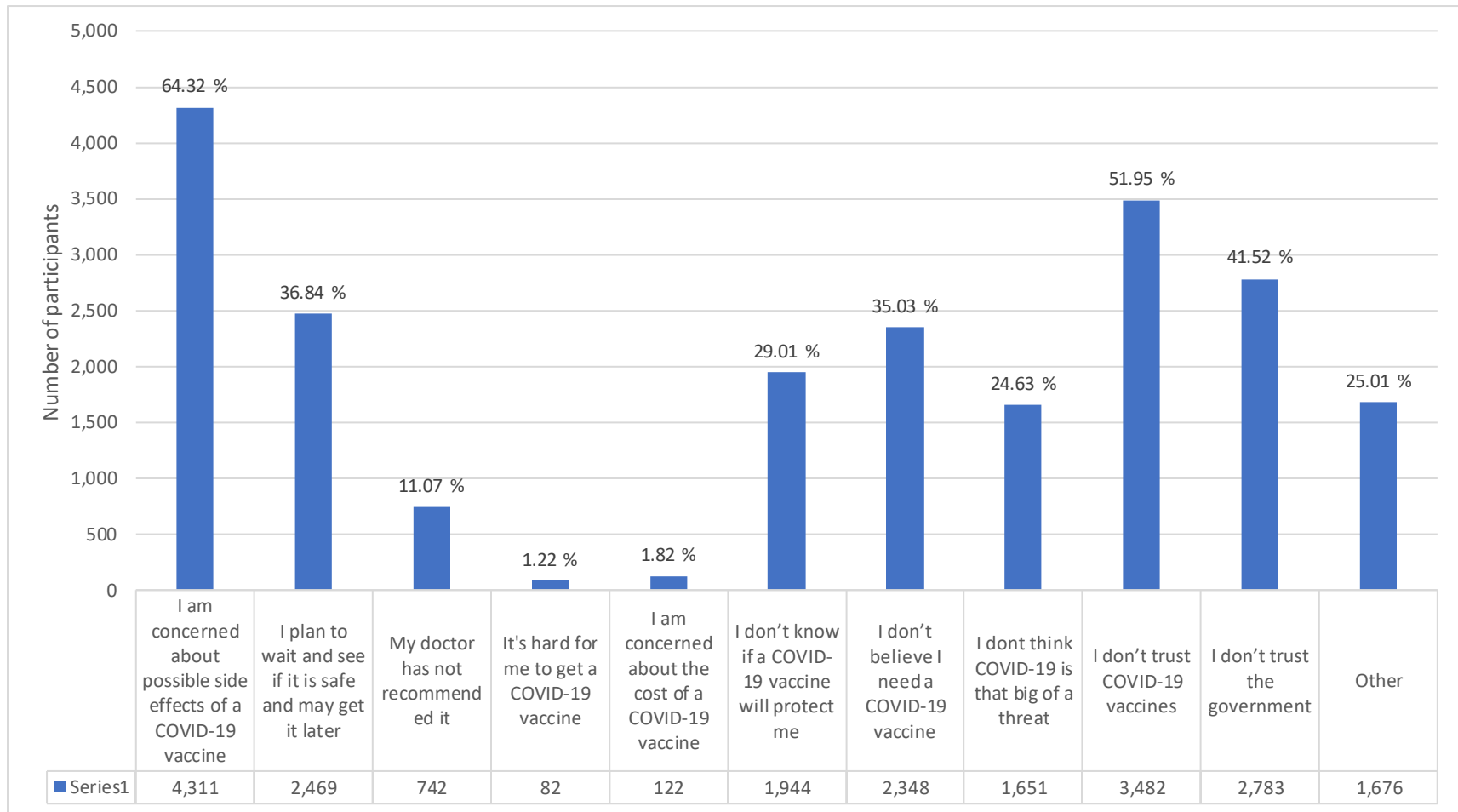


Figure 1. Reasons for Not Receiving a Vaccine Among Adults with Adolescent Children

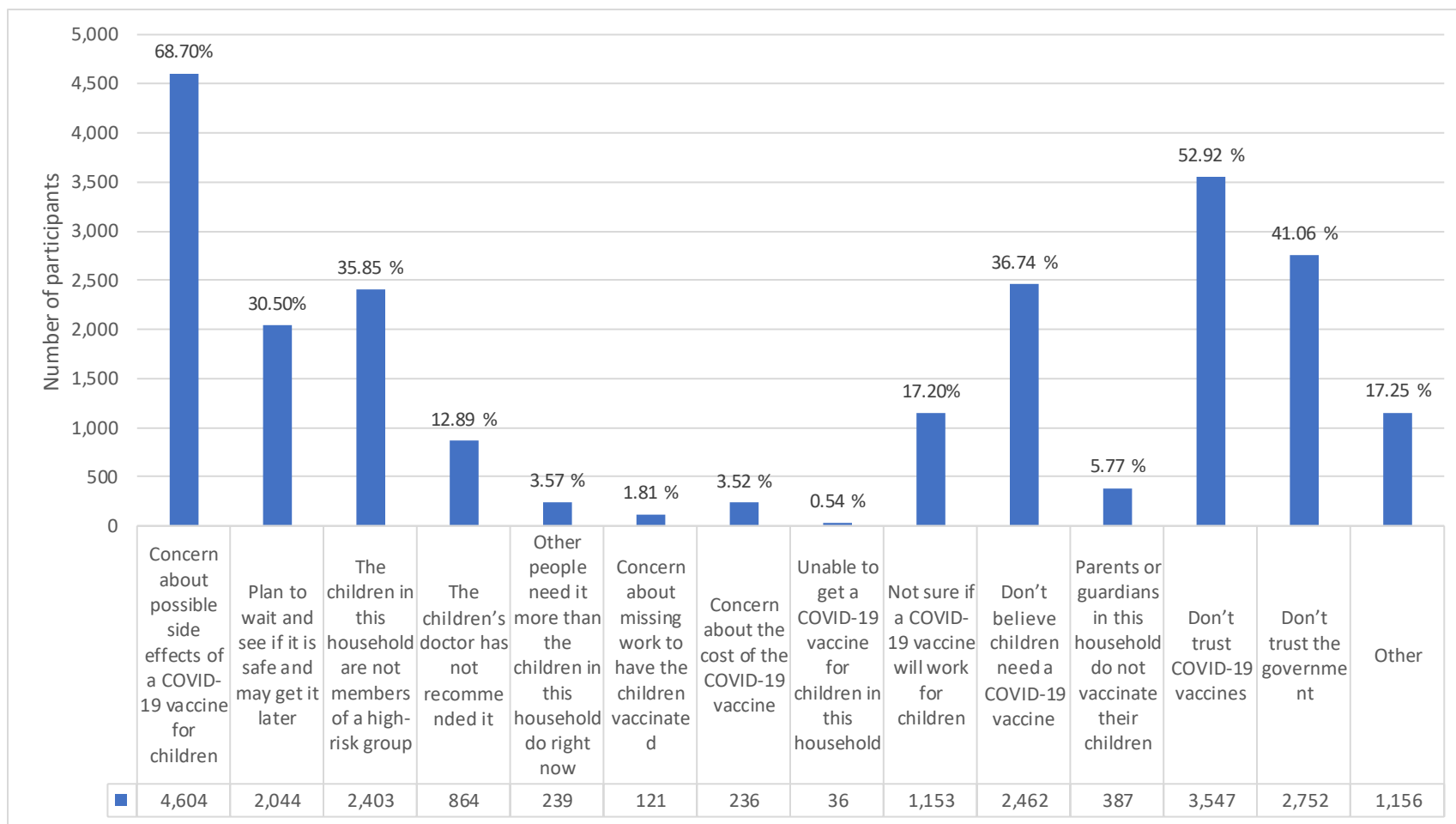


Figure 2. Reasons for Not Vaccinating One's Adolescent Child

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