ABSTRACT

Title of Dissertation: An Analysis of the Factors that Influence Vaccination Rates

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Due to the current rise of the vaccine hesitancy movement, there has been an increase in vaccine-preventable disease outbreaks (Mnookin, 2011; Reich, 2016). Parental rationalizations for opting out of vaccinations vary; however, some of the more commonly cited rationalizations include concerns for their child's safety, distrust of medical professionals, and protection of civil liberties and individual decision-making processes (Glanz et al., 2013). Team IPOV has added to the literature body by examining how parents' levels of knowledge about diseases, vaccine beliefs, and trust in institutions, medical professionals, and vaccines influence their levels of vaccine hesitancy, while adding the additional scope of the varicella and influenza vaccines and diseases.

A hierarchical linear regression test revealed that trust exhibits the highest marginal impact on vaccine acceptance, followed by beliefs, and then, knowledge. Thus,

while all three factors provided significant predictive insight into parents' levels of vaccination hesitancy, parents' trust in the varicella and influenza vaccines appear to possess the most significant impact over parents' levels of vaccine hesitancy. Consequently, in considering future methods of alleviating vaccine hesitancy and increasing herd immunity, it is important to consider the ways in which trust can be built for the varicella and influenza vaccines.

AN ANALYSIS OF THE FACTORS THAT INFLUENCE VACCINE HESITANCY

by

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Table 1.
McDonald's Omega Test to Determine Scale Reliability and Questions to Drop

Scale	If Item Dropped	Point Estimate	95% Confidence Interval
Vaccine Acceptance		0.926	(0.916, 0.935)
Q6	0.927		
Q7	0.922		
Q8	0.927		
Q12	0.922		
Q13	0.923		
Q14	0.925		
Q15	0.922		
Q16	0.933		
Q17	0.922		
Q21 A	0.918		
Q21 B	0.917		
Q21 C	0.919		
Q21 D	0.920		
Q21 E	0.920		
Q21 F	0.921		
Q22 A	0.919		
Q22 B	0.920		
Q22 C	0.920		
Q22 D	0.921		
Q22 E	0.921		
Q22 F	0.922		
Knowledge		0.692	(0.650, 0.735)
Q33	0.666		
Q34	0.695		
Q35 A	0.651		
Q35 B	0.689		
Q35 C	0.660		
Q35 D	0.678		
Q36	0.650		
Q37	0.659		
Q39	0.647		
Beliefs (before)		0.727	(0.690, 0.764)
Q25	0.692		
Q26	0.694		
Q27	0.693		
Q28	0.699		
Q29	0.707		
Q30	0.720		
Q31	0.713		
Q32	0.741		
Q38	0.744		
Q42	0.694		

Q43	0.696		
Beliefs (after)		0.756	(0.723, 0.790)
Q25	0.728		
Q26	0.731		
Q27	0.729		
Q28	0.734		
Q29	0.739		
Q30	0.752		
Q31	0.750		
Q42	0.730		
Q43	0.733		
Trust		0.777	(0.747, 0.806)
Q18	0.721		
Q23 A	0.719		
Q23 B	0.812		
Q23 C	0.808		
Q24 A	0.718		
Q24 B	0.727		
Q40	0.761		
Q41	0.730		

Table 2.

Descriptive Statistics for Vaccine Acceptance, Trust, Beliefs, and Knowledge Scales

Scales	Mean	Standard Deviation	Skewness	Kurtosis
Vaccine Acceptance				
Varicella	3.97	0.827	-1.05	1.09
Influenza	3.72	0.910	-0.695	-0.0750
General	3.39	0.780	-0.141	0.125
Combined	3.77	0.759	-0.731	0.354
Knowledge				
Varicella	1.25	1.16	-1.31	0.732
Influenza	4.04	2.90	-1.26	1.45
Combined	5.29	3.51	-1.18	1.04
Beliefs				
Varicella	3.77	0.955	-0.531	-0.601
Influenza	4.04	1.22	-0.850	-0.720
General	3.68	0.842	-0.415	0.218
Combined	3.79	0.758	-0.319	-0.438
Trust				
General	3.45	0.734	-0.103	-0.628

Note. Questions on each scale that were not vaccine-specific were denoted “general.” Descriptive statistics that included all questions on a particular scale were denoted “combined.”

Table 3.

Pearson's Correlations between Vaccine Acceptance, Beliefs, Trust, and Knowledge

Measure	1	2	3	4
1. Vaccine Acceptance	—			
2. Knowledge	0.354***	—		
3. Beliefs	0.682***	0.249***	—	
4. Trust	0.714***	0.405***	0.585***	—

*** $p < .001$.

Table 4.

Hierarchical Linear Regression Explaining the Influence of Trust, Beliefs, and Knowledge on Vaccine Acceptance

Model		R^2	ΔR^2	ΔF	β	p
1		0.125	0.124	72.4		< .001
	Vaccine Acceptance					< .001
	Knowledge				0.354	< .001
2		0.515	0.389	405		< .001
	Vaccine Acceptance					< .001
	Knowledge				0.0780	.0220
	Trust				0.682	< .001
3		0.621	0.106	140.		< .001
	Vaccine Acceptance					< .001
	Knowledge				0.0720	.0170
	Trust				0.451	< .001
	Beliefs				0.401	< .001

Table 5.

Paired Samples T-Tests to Compare Vaccine Acceptance, Knowledge, and Beliefs for the Varicella and Influenza Vaccines

Scale	Varicella		Influenza		*W*	Student Test			
	M	*SEM*	*M*	*SEM*		*t*	df	*p*	*ES*
Vaccine Acceptance	3.97	0.0370	3.72	0.0400	0.901	-8.52	506	< .001	-0.378
Knowledge	1.25	0.0510	4.04	0.129	0.980	23.4	506	< .001	1.04
Beliefs	3.77	0.0420	4.04	0.0540	0.908	5.72	506	< .001	0.254

Note. p-value is for two-tailed paired sample student t-test. *M, SEM,* and *ES* represent mean, standard deviation, and effect size, respectively.

Table 6.

Descriptive Statistics by Race

Race	Mean	*SD*	Skewness	Kurtosis
Vaccine Acceptance				
African American	3.54	0.693	-0.170	-0.00200
Hispanic	3.68	0.780	-0.518	-0.119
Asian	3.88	0.606	-0.753	0.654
Caucasian	3.82	0.768	-0.905	0.755
Other	3.73	0.839	-0.688	-0.181
Knowledge				
African American	3.56	4.01	-0.936	0.454
Hispanic	4.67	4.05	-1.03	0.384
Asian	4.89	3.69	-0.484	-0.890
Caucasian	5.77	3.12	-1.25	1.30
Other	6.75	2.49	-0.950	0.413
Beliefs				
African American	3.65	0.711	0.0580	-0.800
Hispanic	3.61	0.713	-0.0570	-0.672
Asian	3.85	0.712	-0.386	-0.447
Caucasian	3.86	0.778	-0.479	-0.213
Other	3.72	0.506	-0.241	-0.903
Trust				
African American	3.23	0.699	0.0380	-0.801
Hispanic	3.42	0.740	0.0880	-0.783
Asian	3.44	0.671	-0.0190	-0.540
Caucasian	3.49	0.740	-0.193	-0.510
Other	3.76	0.698	-0.184	-1.64

Note. SD represents standard deviation.

Chapter I: Introduction

Vaccines have transformed disease prevention since their invention (Moss, 2011; Nyhan et al., 2014; Skinner & Johnson, 2017; Shelby & Ernst, 2013). From their conceptual beginnings, vaccines have morphed into the best preventative measure for contagious disease today, improving substantially in safety, effectiveness, and accessibility (Shelby & Ernst, 2013). However, the propagation of the anti-vaccination movement, and by extension the vaccine hesitancy movement, is a major public health concern; while there are some individuals who are unable to be vaccinated due to medical concerns, there are others who have chosen not to vaccinate their children for non-medical reasons. The execution of this varies; there are those who choose not to vaccinate at all, while other individuals have chosen to engage in vaccination schedules that are distinct from the vaccination schedule recommended by the Centers for Disease Control and Prevention. Vaccine exemptions stemming from non-medical factors, as well as adherence to alternative vaccination schedules, lower the overall vaccination rate, which has resulted in a notable decrease in herd immunity; this principle is the idea that a vaccinated majority protects the minority of the population that is unable to receive vaccines, and this majority immunity is essential for protecting those who cannot be vaccinated. Therefore, the rise of vaccine hesitancy, as well as the observed decrease in herd immunity, may be playing a crucial role in causing the re-emergence and continued presence of many vaccine-preventable diseases (Dubé et al., 2013; Glanz et al., 2013; Kennedy et al., 2011; Machekanyanga et al., 2017; Mnookin, 2011; Poland & Jacobson,

2001; Reich, 2016; Tafuri et al., 2014; Vrdelja et al., 2018; CDC, 2019; Dempsey et al., 2011; Moss, 2011; Skinner & Johnson, 2017).

In this present study, Team IPOV aimed to more deeply understand the growing vaccine hesitancy movement. Seeking to develop an understanding of why parents might make different decisions about vaccinating their children, Team IPOV was focused on understanding the factors that might influence vaccine hesitancy among parents. Based on literature and existing research, Team IPOV has selected the influenza (flu) and varicella (chickenpox) diseases and vaccines and "knowledge", "vaccine beliefs", and "trust" as the variables of focus.

While Team IPOV recognizes that this research project was partially conducted and published during the global COVID-19 pandemic and that this might have had a potential effect, the Team took every effort to prepare and control for this. Despite this obstacle, Team IPOV has succeeded in contributing to the vaccine hesitancy literature; Team IPOV discovered the presence of significant relationships between vaccine hesitancy and knowledge, vaccine beliefs, and trust. Most notably, the Team found trust to have the most significant predictive impact on vaccine hesitancy. Furthermore, a significant difference was found between influenza and varicella.

As such, the results of this study provided vital insight into vaccine hesitancy; specifically, it succeeded in providing vital insight into potential directions for future research and potential alleviation of this vaccine hesitancy phenomenon.

Chapter II: Background

Declining vaccination rates in industrialized nations is an interesting phenomenon that places significant risk on public health (Flaherty, 2011). Approximately 5-10% of individuals have intense anti-vaccination sentiments (Dubé et al., 2013); however, a more notable proportion of individuals are considered to be only hesitant about vaccines and their administration (Dubé et al., 2013). Vaccine attitudes exist on a continuum from absolute refusal to absolute acceptance; vaccine hesitancy falls within this continuum (SAGE, 2014). Individuals who identify with this sentiment typically delay or refuse vaccines despite those vaccines being both available as well as readily accessible to those individuals (SAGE, 2014). Considering that a majority of individuals can be categorized as vaccine hesitant, it is critical to focus on further understanding vaccine hesitancy in particular. It is also more effective to target hesitancy as opposed to opposition because hesitancy is not as extreme of an ideology and is, therefore, more likely to yield improved vaccination rates upon intervention. Growing distrust in institutions, evident in the distrust between patients and physicians, and social, cultural, and religious rationalizations all contribute to the underlying biases of vaccine hesitancy and the overarching anti-vaccination movement, which has existed since the Victorian age (Mnookin, 2011; Tafuri et al., 2014).

Vaccine Hesitancy

The Strategic Advisory Group of Experts (SAGE) on Immunization's working definition of vaccine hesitancy provided much guidance in this present project. SAGE defined vaccine hesitancy as follows: ‘‘Vaccine hesitancy refers to the delay in acceptance or refusal of vaccines despite availability of vaccination services. Vaccine hesitancy is complex and context-specific[,] varying across time, place[,] and vaccines. It includes factors such as complacency, convenience, and confidence" (SAGE, 2014). A closer look at Quinn et al. (2019), *Measuring vaccine hesitancy, confidence, trust and flu vaccine uptake: Results of a national survey of White and African American adults*, may provide further clarification on these "3 Cs", complacency, convenience, and confidence. The study outlines the "3 Cs" as follows:

> **"complacency**, which describes individuals who "do not perceive a need for a vaccine, do not value the vaccine;" **convenience**, defined as access to vaccines; and **confidence**, defined as "trust in the effectiveness and safety of vaccines, the system that delivers them, including the reliability and competence of the health services and health professionals and the motivations of policy-makers who decide on the needed vaccines." (Quinn et al., 2019, 1168-1169)

Team IPOV values the SAGE (2014) definition of vaccine hesitancy, as well as Quinn and colleagues' write-up on the "3 Cs" of vaccine hesitancy. As such, this is the definition the present study will follow.

In an effort to offer a conceptual real-life example of the phenomenon of vaccine hesitancy, one needs to look no further than alternative vaccination schedules. Parental concern with the "rigor" of the timeline associated with pediatrician-recommended

vaccine schedules has been a common way for parents to rationalize against vaccination or to rationalize vaccine hesitancy. Therefore, parents' concerns regarding recommended vaccine schedules has led to the creation of alternative vaccination schedules (Offit & Moser, 2009). More specifically, a recently conducted study found that of the 13% of parents who reported utilizing some form of an alternative vaccination schedule, 53% refused only certain vaccines and/or 55% chose to delay some vaccines until the child reached an older age (Dempsey et al., 2011). Parents' decision to utilize an alternative vaccination schedule, such as by choosing to delay, withhold, separate, or space out the administration of certain vaccines or by choosing to "naturally inoculate", is one that plays an important role in the overall vaccine hesitation and anti-vaccination movement and is therefore also important to understand (Offit & Moser, 2009).

As such, this summary should demonstrate that comfort with vaccines resides on a spectrum (*Figure C1)*, and that vaccine hesitancy is more of an attitude that can lead to behaviors. This present study will evaluate the concept of vaccine hesitancy within this spectrum, and look at it in a unitary fashion in an attempt to be comprehensive. To do so, Team IPOV will utilize the SAGE (2014) definition of vaccine hesitancy in the context of attitude and behavior, and will look specifically at the potential effects of knowledge, beliefs, and trust on parents' comfort levels with vaccines.

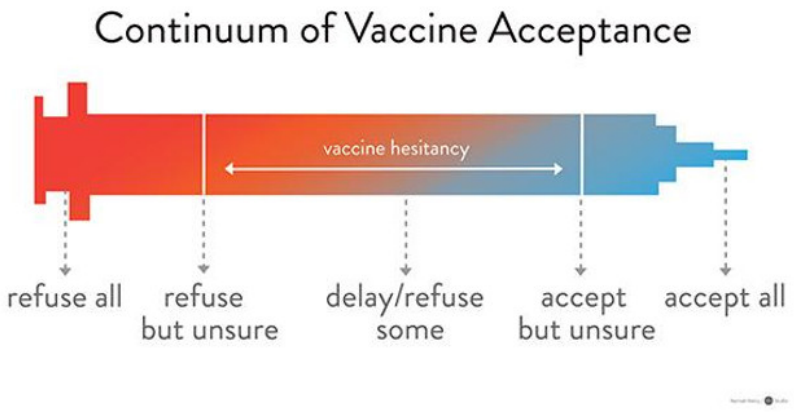


Figure C1. Visual representation of the "Continuum of Vaccine Acceptance". Graph referenced in Savoia et al. (2021).

Factors Influencing Vaccine Hesitancy

Over the course of the past few decades, more researchers have been exploring the rationalizations behind some guardians/parents' hesitation to vaccinate their children. Kennedy et al. (2011) analyzed existing data in order to identify the extent of American parents' confidence, or lack thereof, in vaccines. The study found that the vast majority of parents (83%) had already vaccinated their children, while 11% planned to vaccinate their children with all recommended vaccines. Furthermore, it was found that 5% of parents indicated that they were willing to vaccinate their children with only some of the recommended vaccines, 2% of parents were unwilling to vaccinate at all, and only 23% of parents had absolutely no concerns about administering vaccines to their children (Kennedy et al., 2011).

Over the past several years, researchers have uncovered factors that are noted for influencing levels of vaccine hesitancy among parents. These factors include, but are not limited to, increased parental research, knowledge about diseases and vaccines, personal experiences, religion, social networks, concerns for the child's safety, distrust of medical professionals, and protection of civil liberties and individual decision-making processes (Dubé et al., 2013, Kennedy et al., 2011; Machekanyanga et al., 2017; as cited in Attwell & Freeman, 2015; Glanz et al., 2013). The present study will examine the following factors: knowledge, beliefs, and trust.

Levels of Knowledge

A parent/guardian's level of knowledge about vaccine-preventable diseases plays a major role in ultimately deciding whether or not to vaccinate their child. However, many parents are not as informed about these vaccines, vaccine locations, and vaccination schedules as they think. Dubé et al. (2013) found that 43.2% of mothers surveyed were comfortable with the amount of knowledge they had about their child's vaccination, but 70% of the same women showed low levels of correct knowledge in regards to vaccine information (Dubé et al., 2013). This holds true for knowledge of diseases as well; for example, varicella is known to be a very common and highly contagious disease; however, studies have found that parents might underestimate its incidence and severity (Vezzosi et al., 2017). In a 2017 study conducted in Naples, Italy, Vezzosi et al. (2017) found a majority of parents knew varicella was an infectious disease (91.9%) and knew it was transmitted "mainly person to person by airborne respiratory

droplets, direct contact with vesicle fluid of chickenpox cases and of patients with herpes zoster (68.9%)" (Vezzosi et al., 2017). However, this study also showed that despite the fact most parents knew a vaccine was available (82.6%), a much smaller proportion knew the number of doses needed (34.2%) (Vezzosi et al., 2017). Other studies have shown that increasing knowledge of this disease and its corresponding vaccination is crucial in improving vaccination rates (Vezzosi et al., 2017). As such, Team IPOV developed an interest in adding to the literature by further exploring the role of knowledge of diseases in influencing vaccine hesitancy.

Finally, a discussion on knowledge would be remiss if information regarding knowledge sources, and parental research, was not included. Recently, the decision-making power has shifted from being solely in the hands of the physician to being shared between doctors and parents. This shift is due to parents beginning to play a more active role in maintaining a healthy lifestyle for their children - part of this involvement is increased research into medical topics through the use of the Internet as a resource. Researchers have found that parents' research into vaccines to be a critical influencer of their vaccine hesitancy (Kennedy et al, 2011; Dubé et al., 2013). Specifically, research has found vaccine hesitant mothers are more likely than vaccine accepting mothers to research vaccines before deciding whether or not to administer vaccines to their child. It was found that a growing amount of this parental research was conducted through media outlet consultations, like the Internet, and through their social networks - specifically, many parents sought advice from healthcare professionals, family members, and friends (Kennedy et al., 2011; Dubé et al., 2013; Brunson, 2013).

Conclusively, the role of knowledge - and other involved factors such as knowledge sources or the role of misinformation[1] - are critical in understanding vaccine hesitancy; and as such, a focus on knowledge in this present study is understandable.

Beliefs

Another factor that may influence an individual's likelihood of being vaccine hesitant is one's vaccine-related beliefs. Research has found the existence of an association between a parent/guardian's negative perceptions of unfavorable aspects that correspond with vaccination-- such as believing the vaccine to be unsafe or anticipating that it will result in certain adverse reactions or side effects-- and decreasing vaccination rates. Additionally, it has been found that the manner in which a vaccine is valued, rather, if parents believe that vaccines are important, useful, and/or effective, also holds an impact on vaccination rates (Smith et al. 2017).

Moreover, a parent/guardian might hold the belief that there are more risks associated with the vaccine compared to the illness or that their child has low susceptibility to the illness (Smith et al., 2017). However, parents who received vaccinations without experiencing complications prior and who believed vaccination did not pose a risk to their child, even if it did not contribute to benefits, were more likely to vaccinate their child (Smith et al., 2017). All of these beliefs have the potential to contribute to or discourage an individual's hesitancy towards vaccines, whether they influence individually or work in tandem.

Trust

Finally, as Quinn et al. (2019) states, the final aspect of vaccine hesitancy, confidence, is defined as ‘‘trust in the effectiveness and safety of vaccines, the system that delivers them, including the reliability and competence of the health services and health professionals and the motivations of policy-makers who decide on the needed vaccines” (as referenced in Quinn et al., 2019). Team IPOV developed an interest in further exploring the role of trust on vaccine hesitancy; as such, effort was taken to investigate the different players outlined in the aforementioned definition, as well as to note literature that highlighted their respective effect on vaccine hesitancy.

The rise of the anti-vaccination and vaccine hesitancy movements coincide with a decline in the public trust of scientists’ role in society, as well as in their ability to solve pressing current issues. This results in a loss of legitimacy in modern scientific institutions (Gauchat, 2011). A recent study supports this thought; this study analyzed search engine results that appeared when web users searched for keywords like “vaccine,” “vaccination,” and “immunization.” The researchers were then able to analyze the themes that the search results fell under. Three of the main anti-vaccination search result themes were, “belief in alternative models of health, promotion of parental autonomy and responsibility, and suspicions of expertise” (Gauchat, 2011).

Healthcare professionals significantly impact parents/guardians’ education regarding vaccine safety. Parents that are opposed to or hesitant towards vaccinations are additionally noted to have a low confidence and trust in medical professionals, public health agencies, and government-provided vaccine information (Glanz et al., 2013).

Further discussion on this changing relation is warranted; one study examined parents' vaccine decision-making process in relation to their levels of trust in the information from their physicians. The study utilized both quantitative and qualitative data that was obtained from a sample of 854 parents who were members of the Kaiser Permanente Colorado health plan, the state with the second-highest number of nonmedical exemptions to immunization in the nation (Glanz et al., 2013; CDC, 2018). By comparing survey results of parents who accepted, delayed, and refused vaccinations for their children, the study found major differences in vaccine decision timing, as well as parents' confidence in vaccine information and trust in their pediatricians' advice. In essence, most parents who accepted vaccines, a moderate number of parents who delayed vaccines, and a minimal number of parents who resisted vaccines actually trusted their pediatrician's advice regarding vaccination (Glanz et al., 2013).

Expanding upon the previous discussion of trust between physicians and patients and vaccine hesitancy, recent studies also support the hypothesis that vaccine hesitancy conformity is a part of the larger societal context of distrust in public institutions. Since the late 20th century, there has been a noted growing trend of distrust in the federal government and other institutions, as represented by a study conducted by the Pew Research Center on "Public Trust in Government," where a record 24% of the population reported trust in the federal government -- a shocking decline from the 1964 reports where 77% of people reported trust in the federal government (Nekola, 2017). In connection to vaccines, recent studies have found that those who have less faith in government are also less likely to vaccinate, which may have drastically impacted herd

immunity and willingness to follow government-recommended vaccine schedules (Mesch & Schwirian, 2015).

Variables Acknowledgement

Finally, Team IPOV acknowledges that while these three variables can be very interconnected, we treated them as separate entities through careful question construction and by controlling for their effect during our data analysis (Hardwig, 1991).

Vaccines of Focus

Although vaccine hesitancy is a phenomenon that is present for many different vaccines, Team IPOV will focus on two specific kinds: the influenza and varicella vaccines. The administration of these vaccines varies both in terms of age at vaccination, number of doses, and being considered mandatory or voluntary, therefore offering a greater level of diversity in analyzing the hesitancy of parents. According to the Centers of Disease Control and Prevention's chart of recommended ages for immunization, the varicella vaccination is given in two doses and the influenza vaccination is given twice for children aged 6 months to a year and then once every year throughout the child's life (CDC, 2018). Furthermore, of these two vaccines, the varicella vaccine is approached by parents with the most concern (Gust et al., 2008).

Seasonal Influenza Vaccine

Team IPOV has chosen to focus on the seasonal influenza vaccine due to its suggested schedule of administration and its status as a voluntary vaccine. Prior to age one, this vaccine is given to a child in two doses; however, after the age of one, this vaccine is given once each year (CDC, 2018). Unlike the varicella vaccine, the seasonal influenza vaccine is both voluntary and annual (Malone & Hinman, 2007). However, there is still significant refusal of the influenza vaccine among vaccine hesitant parents; in 2013, only 58.3% of children in Washington state received an influenza vaccine (Strelitz et al., 2015)

According to the CDC, minor symptoms associated with receiving the influenza vaccine include hoarseness, cough, aches, fever, itching, fatigue, and headaches. At the site of injection, it is also possible that swelling, soreness, or redness may occur. Additionally, the eyes may become red, itchy, or sore. More serious side effects, while rare, include an increased likelihood of seizure and an increased probability of developing Guillain-Barré Syndrome. As with any other vaccination, post-injection symptoms can include fainting, prolonged shoulder pain, and a potentially severe allergic reaction (CDC, 2015). In the Vaccine Information Statement for the influenza vaccine, the CDC acknowledges that the vaccine contains small amounts of thimerosal and that the seasonal influenza vaccination is additionally covered by the National Vaccine Injury Compensation Program (CDC, 2018).

Varicella Vaccine

Team IPOV chose to focus on the varicella vaccination for multiple reasons. One such reason is that the varicella vaccine is considered to be mandatory, as mentioned previously (Malone & Hinman, 2007). Moreover, Gust et al. (2008) found that the varicella vaccine prompted the most doubt among parents who either refused to vaccinate their children with the vaccine or agreed to varicella vaccination despite feeling unsure about the decision. Some contributing factors to parental doubt include concerns about the effectiveness as well as safety/side effects (Gust et al., 2008). Minor post-injection symptoms include soreness in the arm, a local rash and/or redness, and fever. Additionally, serious adverse effects such as seizures, pneumonia, and meningitis can also occur; however, this is rare. Furthermore, fainting after injection, prolonged shoulder pain, a potentially severe allergic reaction, as well as a rash over the entire body are all possible side effects (CDC, 2018). This vaccine is also the least likely to be administered to children with non-medical exemptions (Salmon et al., 2005).

Present Study

The present study drew on guidance from the literature, and examined the relationship between levels of knowledge, trust, and beliefs on vaccine hesitancy for the influenza and varicella vaccines. We asked the following research questions:

1. What are parents' levels of knowledge, beliefs, and trust toward the varicella (chickenpox) and influenza (flu) vaccinations?

2. What are the relations between parents' levels of knowledge, beliefs, and trust to their vaccine hesitancy?

Hypotheses

After conducting initial research and developing research questions, Team IPOV came up with four hypotheses related to our research questions. The hypotheses are as follows:

1. On average, parents will have low levels of knowledge/limited understanding of the varicella disease, but a slightly higher level of knowledge/understanding of the influenza disease.
2. Participants on average will have more neutral beliefs about vaccines.
3. Parents on average will have low levels of trust.
4. There will be a significantly positive relationship between levels of knowledge, positive beliefs, trust, and vaccine hesitancy.

The first three hypotheses relate to research question one and correlate with each of our three variables, knowledge, beliefs, and trust. The final hypothesis predicts the interactions between the three variables and vaccine hesitancy posed in the second research question.

With regard to our first research question, we hypothesized that on average, parents will have low levels of knowledge/limited understanding of the varicella disease, but a slightly higher level of knowledge/understanding of the influenza disease. This

knowledge hypothesis is based on the literature indication that people know less about diseases and vaccines than they think that they do, as well as our awareness of the difference between the prevalence of the diseases and vaccines (Dubé et al., 2013; Vezzosi et al., 2017).

Furthermore, we also hypothesized that the participants on average will have more neutral beliefs about vaccines. In doing so, we assumed that parents will follow a normal distribution of vaccine beliefs - we rationalized that parents, on average, typically have had no experience with vaccine-related complications, contributing to belief neutrality. Moreover, we assumed that parents typically perceive that vaccines do not pose a significant risk to their child, even if those vaccines do not contribute to potential benefits. Thus, in accordance with the literature, we hypothesize that, on average, parents hold neutral beliefs about vaccines. We anticipated, however, that there might be a difference in beliefs between the two diseases and vaccines, due to their prevalence in society.

We hypothesized that parents on average will have low levels of trust. This hypothesis is based on the literature indication that individuals have lower levels of trust in scientists, doctors, and the government in today's society (Gauchat, 2011; Glanz et al., 2013; Nekola, 2017; Mesch & Schwirian, 2015).

Finally, we hypothesized that there will be a significantly positive relationship between levels of knowledge, positive beliefs, trust, and vaccine hesitancy. We based this hypothesis on the following idea: the more accurate someone's knowledge is of the diseases, the more likely they are to accept vaccines. Further, the more positive one's

vaccine beliefs are, the more likely they are to accept vaccines, and finally, the more they trust those who create and distribute vaccines, they are more likely they are to accept vaccines.

Study Terminology Acknowledgement

We acknowledge that our participants' family and home lives may be unique. As such, it is critical to provide the following clarification: for simplicity, Team IPOV will utilize the term "parent" when referring to all individuals who are considered to be parents and/or guardians.

Chapter III: Methodology

Survey Design

The survey was carefully designed to target each variable of interest - levels of knowledge, trust, beliefs, and vaccine hesitancy - and the varicella and influenza vaccines.

For levels of knowledge, the *knowledge* scale was carefully created in an effort to understand a baseline of parents' levels of knowledge of the varicella and influenza diseases. To do so, questions pertaining to potential symptoms and the manner in which the diseases spread were adapted from Ali et al. (2018) article, *Knowledge, Attitude, Awareness, and Barriers Toward Influenza Vaccination Among Medical Doctors at Tertiary Care Health Settings in Peshawar, Pakistan–A Cross-Sectional Study* (Ali et al., 2018). This was done in an effort to ensure our scales' reliability and validity, and the process of adaption included duplicating questions and including language to change the focus of the question to the varicella vaccine. The knowledge scale contains six questions, with "Yes" (coded as 1), "No" (coded as -1), or "I don't know"/"Unsure" (coded as 0) answer options [*Appendix B*].

For beliefs, the *belief* scale was created in an effort to understand parents' beliefs and conceptions of vaccines and influencing factors. To do so, questions pertaining to this topic were adapted from Quinn et al. (2019) article, *Measuring vaccine hesitancy, confidence, trust and flu vaccine uptake: Results of a national survey of White and*

African American adults, for our purposes with a similar process as listed above (Quinn et al., 2019). The belief scale contains 11 questions [*Appendix B*].

To operationalize trust, the *trust* scale was created through adapting the questions pertaining to the variable trust within Quinn et al. (2019) article, *Measuring vaccine hesitancy, confidence, trust and flu vaccine uptake: Results of a national survey of White and African American adults*, and Frew et al. (2019) article, *Development of a US trust measure to assess and monitor parental confidence in the vaccine system* (Quinn et al., 2019; Frew et al., 2019). The trust scale contains five questions [*Appendix B*].

To operationalize the vaccine hesitancy variable, the *vaccine acceptance* scale was created. This scale is intended to mirror the real-life phenomenon of the spectrum of vaccine attitudes - scoring a lower score on the vaccine acceptance scale would demonstrate a lack of acceptance and increased hesitancy, while scoring a higher score would demonstrate an increased comfort and acceptance with vaccines. As such, for the rest of Chapters III and IV, the concept of "vaccine hesitancy" will be referred to as "vaccine acceptance" in an effort to mirror this real life phenomenon and the language used in our study. This scale was created through adapting Quinn et al. (2019) article, *Measuring vaccine hesitancy, confidence, trust and flu vaccine uptake: Results of a national survey of White and African American adults*, for our purposes (Quinn et al., 2019). The vaccine acceptance scale contains eleven questions [*Appendix B*].

Additionally, demographic questions were added at the end to record the respondents' gender identity, age, race and ethnicity, levels of education, income, and region of the United States.

Finally, in an effort to ensure the clarity and comprehensibility of the survey questions, Team IPOV enlisted family members and friends to take the survey in a preliminary pilot test (please note that this pilot data was not included in the present study). In doing so, Team IPOV was capable of better pinpointing the specific questions that were worded in a fashion which rendered them easily misunderstood or confusing. Any such questions that were identified were consequently rewritten in a more understandable manner, and the process was repeated. Overall, this process both increased and ensured the clarity of the survey questions. At the conclusion of this step, Team IPOV began to prepare to launch the survey.

COVID Acknowledgement

Team IPOV recognizes that the progress of our methodology occurred during the global COVID-19 Pandemic, and that the subject matter of our research is tangentially related to this issue. As a result, Team IPOV postponed the release of the survey to late Fall 2020, and questions pertaining to the various manners of impact from the COVI-19 Pandemic were added at the end of the survey [*Appendix B*].

Survey Procedures

After finalizing scales, Team IPOV prepared to launch the survey over the Qualtrics XM Software Program. Specifically, we made use of Qualtrics' Market Research Panels service to recruit participants and gather respondents' data. This Qualtrics recruitment process included contacting a pre-arranged pool of respondents that

have agreed to be contacted by a market research service that met our demographic criteria (Qualtrics, n.d.). As Team IPOV was interested in learning about vaccine acceptance within the United States, the parameters of our target sample are as follows: parents over the age of 18 that reside in the United States. Additionally, a quota was set so the sample recruited by Qualtrics would mirror the population demographics of the United States - a 50% female-male split, 75% white, and 25% non-white split (U.S. Census, 2020). Based on budgeting and statistical parameters, Team IPOV was able to collect a sample size of 507 participants.

The Qualtrics survey opened with the participants being shown the IRB consent form, which they were asked to read through and, if they agreed to participate, electronically sign their agreement. Then, participants were shown the basic screening questions to ensure that the participant met our parameters. Specifically, these questions sought to determine whether or not the respondent lived in the United States, if the respondent has children, and how many children the respondent has. If the participants did not meet the criteria, they were thanked for their time and removed from participating. If participants did meet these criteria, participants were directed to the survey. Participants were then instructed to base their answers on their youngest child if they had multiple children, and demographic information regarding the parents' age and their child's age was recorded.

The participants were then directed through the survey, where the questions were randomized to prevent priming and to increase survey validity. The survey took on average 9.8 minutes. After completing, participants were thanked for their time.

Participants were then compensated for their time with a pre-agreed upon amount that was contractually determined between Qualtrics and the participant.

Data Analysis

Data Preparation & Scales Reliabilities

Upon successful data collection, the data was downloaded off of the Qualtrics software program. Python code was created to go through the participant responses and code them according to our codebook, and this output was manually checked for accuracy by two researchers. Upon the completion of this step, the data was ready for further analysis.

Through the use of the JASP statistical software, a McDonalds Omega Test was run to check the reliability of the items within a scale. A test was run for each variable scale, and

we specifically dropped an item if its inclusion would have lowered the overall measure reliability well below the acceptable threshold of 0.7 (Raykov, 2007; JASP Team, 2020).

Levels of Knowledge, Beliefs, Trust, and Vaccines

In an effort to answer the following research questions, “What are parents’ levels of knowledge, beliefs, and trust toward the varicella (chickenpox) and influenza (flu) vaccinations?”, a general descriptive statistics test for knowledge, beliefs, trust, and vaccine acceptance was run.

Knowledge. To do so, a Python code was created to sum each individual participant's answers. Therefore, if all knowledge questions were answered correctly, the total sum would be 7, while if none were answered correctly, the total sum would be -7. Alternatively, if all knowledge questions were answered with "I do not know", the total sum would be 0. Thus, a spectrum of parents' levels of knowledge was created - "incorrect in understanding of the disease" to "not knowledgeable about the disease" to "knowledgeable about the disease".

This output was then entered into JASP, and then separate general descriptive tests for the varicella vaccine and the influenza vaccine were run. Additionally, a bar graph was created in an effort to visualize these responses (JASP Team, 2020).

Beliefs. The process to prepare for this test included: ensuring the questions across the scale were all on the same scale by multiplying the questions that needed it by 5/3, averaging each participants' scores across all beliefs questions, and entering this data into JASP and running the general descriptive statistics test (JASP Team, 2020). Similar to the knowledge scale, a spectrum for vaccine beliefs was created. If participants answered all belief questions with responses that reflected negative vaccine beliefs, their average score would be 1, while if all belief questions were answered with responses that reflected positive vaccine beliefs, their average score would be 5. Alternatively, if all participants answered all belief questions neutrally, their average score would be 3. Thus, the spectrum for vaccine beliefs ranges as follows: "strongly negative" to "neutral" to "strongly positive".

Trust. Each participants' responses across all trust questions were averaged and entered into JASP for the general descriptive statistics test (JASP Team, 2020). As such, another spectrum was created - an average score of 1 indicates low trust, while an average score of 5 indicates high trust.

Vaccine Acceptance. To ensure all the questions were on the same scale, we multiplied item scores by 5/3, averaging each participants' scores across all vaccine acceptance questions, and entering this data into JASP, and running the general descriptive statistics test (JASP Team, 2020). As such, a final spectrum was created - if participants answered all vaccine acceptance questions with responses that reflected complete hesitancy/opposition, their average score would be 1, while if all vaccine acceptance questions were answered with responses that reflected total vaccine acceptance, their average score would be 5. Alternatively, if all participants answered all questions neutrally, their average score would be 3.

Relationship between Parents' Levels of Knowledge, Beliefs, Trust, and Vaccine Acceptance

To answer, "What are the relations between parents' levels of knowledge, beliefs, and trust to their vaccine hesitancy?", Pearson's Correlation and hierarchical linear regression tests were run with "vaccine acceptance" as the dependent variable and "levels of knowledge", "beliefs", and "trust" as the independent variables. It is important to note that in regards to knowledge, this variable was treated as a unitary psychological concept.

Additional Analyses

Between the Two Vaccines. The previous analyses revealed some interesting results about potential differences between the two vaccines. As such, in an effort to understand if there is a difference between the two vaccines in terms of parents' levels of knowledge, beliefs, and levels of vaccine acceptance, three separate paired t-tests were run. As there are no vaccine-specific trust questions, the trust scale was not included in this test.

Other. Team IPOV was interested in understanding the potential role of demographic factors on vaccine acceptance. First, in regard to racial identity, in JASP, the data was split by responses to the demographic question that asked participants their racial identity, and then a general descriptive statistics test was run for each scale. Next, another general descriptive statistics test was run to look at the participants' and their children's ages in relation to each scale. To do so, participants were grouped by age, and the data was then split by parent age group for each scale. This process was repeated for the reported age of the participants' child's age group. Additionally, the role of gender identity was examined by repeating the process used in the racial identity and age examination.

Parent's information sources were also acknowledged through the creation of a frequency graph that demonstrated which sources parents reported receiving information from. It is important to note that participants had the option to select more than one response, and that those multiple responses were included in the graph. Finally, a general descriptive statistics test was run. This procedure was replicated for participants' response

to their impact from COVID-19. Similar to information sources, participants had the option to select more than one response, and each response was included in this report.

Chapter IV: Results

Demographics of Sample

As a quota was set in an effort to recruit a sample that would mirror the demographics of the United States, the demographics of the sample were checked. By gender identity, the sample had a 50.3%-49.3% female-male split, with 0.4% of the sample identifying as “Other”, and a racial/ethnic identity break-down as follows: 64.3% Caucasian, 17.2% Hispanic, 11.6% Black/African American, 5.3% Asian, and 1.6% Other.

Scale Reliabilities

We conducted a single-test reliability McDonalds Omega test to check the reliability of the items within each scale. Table 1 shows these bivariate correlations. For the vaccine acceptance and trust scales, their bivariate correlations were above the .7 threshold, and as such, no items were removed. However, for the beliefs scale, the initial point reliability estimate statistic was .673, and as such, each individual item was looked at. It was determined that two items lowered the reliability within the scale, and that their removal would increase the point estimate reliability score. As such, items 32 and 38 were removed, and the new scale was above the .7 threshold. Finally, for the knowledge scale, the initial point reliability estimate statistic was .692. As this was below the threshold of .7, each individual item was looked at, and it was determined that no item was able to be removed which would increase the reliability. We acknowledge that the

threshold of .7 has been used and that it is considered to be the cutoff. However, as attenuation would be most pronounced at the ends of the sample distribution, and as such, lower reliabilities would most likely dampen variable relations (Osterlind, 2010). Therefore, it is extremely unlikely that lower reliability instruments would result in a Type II experimental error, and the items were kept [Table 1].

Levels of Knowledge, Beliefs, Trust, and Vaccines

Table 2 shows the means, standard deviations, skewness, and kurtosis for the measured variables (knowledge, beliefs, trust, vaccine acceptance). The absolute values of skewness and kurtosis were less than 2 for each measure, showing that the normality assumption was met.

The breakdown by scale provided further insight; for knowledge of influenza, parents on average scored 4.04, while for varicella, parents scored 1.250 [Table 2]. A bar graph was created to look at the frequency by question; across the board, there was high frequency in answering questions correctly, with a uniformity in frequently answering correctly for influenza questions that had to do with the severity (Q36), symptoms (Q37), and fatality (Q39) of influenza. Interestingly, although parents were able to correctly identify varicella symptoms (Q33), there was a higher frequency of incorrectly evaluating the disease's fatality (Q34). Further, despite parents' understanding of the flu's severity and symptoms, parents struggled with identifying the manners in which influenza disease was transmitted (Q35 A-D) (Fig. C2).

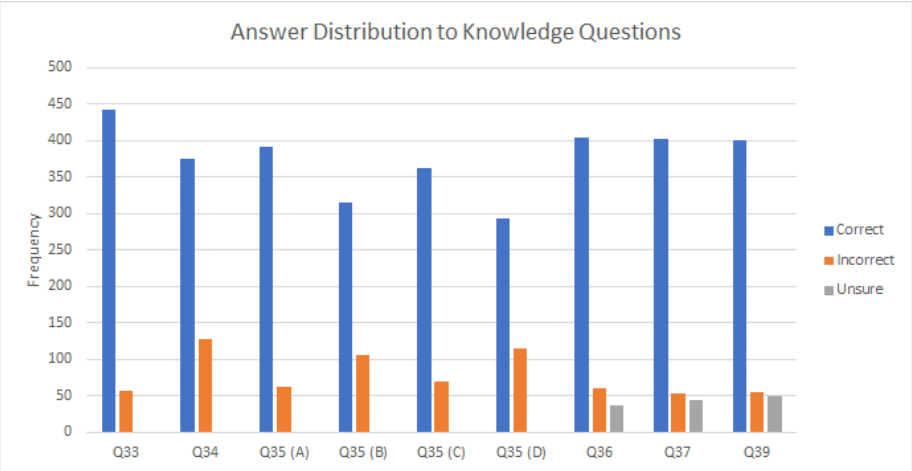


Figure C2. Frequency graph of answer distribution to Knowledge Scale Questions

Moving forward, for belief questions, on average, parents scored 4.04 for the influenza beliefs, a 3.77 for the varicella vaccine, and a 3.68 for general vaccine beliefs. For trust questions, on average, parents scored 3.45, and finally, for vaccine acceptance, on average, parents scored a 3.72 for the influenza vaccine, a 3.97 for the varicella vaccine, and a 3.39 for general vaccine questions [Table 2].

Relationship between Levels of Knowledge, Beliefs, Trust and Vaccine Acceptance

Associations

We calculated bivariate correlations in order to determine the associate relations between the study variables. As shown in Table 3, the bivariate correlations revealed a significant, positive, and moderately strong association for all of the study variables. Knowledge exhibited a correlation of .354 with our vaccine acceptance variable, while beliefs exhibited a correlation of .682 and trust exhibited a .714 correlation with the

aforementioned vaccine acceptance variable. All correlations displayed p-values less than .001, indicating statistical significance at the 5% significance level [Table 3].

Table 2.

Descriptive Statistics for Vaccine Acceptance, Trust, Beliefs, and Knowledge Scales

Scales	Mean	Standard Deviation	Skewness	Kurtosis
Vaccine Acceptance				
Varicella	3.97	0.827	-1.05	1.09
Influenza	3.72	0.910	-0.695	-0.0750
General	3.39	0.780	-0.141	0.125
Combined	3.77	0.759	-0.731	0.354
Knowledge				
Varicella	1.25	1.16	-1.31	0.732
Influenza	4.04	2.90	-1.26	1.45
Combined	5.29	3.51	-1.18	1.04
Beliefs				
Varicella	3.77	0.955	-0.531	-0.601
Influenza	4.04	1.22	-0.850	-0.720
General	3.68	0.842	-0.415	0.218
Combined	3.79	0.758	-0.319	-0.438
Trust				
General	3.45	0.734	-0.103	-0.628

Note. Questions on each scale that were not vaccine-specific were denoted "general." Descriptive statistics that included all questions on a particular scale were denoted "combined."

Table 3.

Pearson's Correlations between Vaccine Acceptance, Beliefs, Trust, and Knowledge

Measure	1	2	3	4
1. Vaccine Acceptance	—			
2. Knowledge	0.354***	—		
3. Beliefs	0.682***	0.249***	—	
4. Trust	0.714***	0.405***	0.585***	—

*** $p < .001$.

Hierarchical Linear Regression

We conducted a hierarchical multiple regression analysis to examine how well parents' levels of knowledge, beliefs, and trust explained their levels of vaccine acceptance. In the hierarchical multiple regression analysis, we first entered knowledge to account for its explanatory power in vaccine acceptance, and then entered trust, and then, beliefs. Table 4 summarizes the results of our analysis. With an R^2 change of .125, the knowledge variable can explain 12.5% of the variance in vaccine acceptance on its own. In the full model, the knowledge variable has a standardized beta value of .072, with a corresponding p-value of .017. At the 5% significance level, this is a positive and statistically significant marginal effect. Adding the trust variable to the model results in an R^2 change of .389, which means that after controlling for knowledge, adding trust to the model explained an additional 38.9% of the variance in vaccine acceptance scores. In the full model, the trust variable has a beta coefficient of .451 with a p-value less than .001, which indicates that trust is a positive and a relatively strong predictor of vaccine acceptance. Finally, adding the beliefs variable to the regression results in an incremental R^2 increase of .106. This means that above and beyond knowledge and trust, beliefs account for an additional 10.6% of explanatory power in the variance of vaccine acceptance scores. With a standardized beta coefficient of .401, and a p-value less than .001, this indicates that beliefs are another positive and statistically significant predictor of vaccine acceptance [Table 4]

A closer look at the standardized regression coefficient reveals that trust exhibits the highest marginal impact on vaccine acceptance, followed by beliefs, and then,

knowledge. Comparing the change in R^2 from incrementally adding variables to our regression further demonstrates that trust accounts for the highest proportion of variance in vaccine acceptance, followed by knowledge, and then beliefs [Table 4].

Cumulatively, we can determine that there exists strong positive relationships between *levels of knowledge, beliefs,* and *trust,* and *vaccine acceptance*.

Table 4.

Hierarchical Linear Regression Explaining the Influence of Trust, Beliefs, and Knowledge on Vaccine Acceptance

	Model	R^2	ΔR^2	ΔF	β	p
1		0.125	0.124	72.4		< .001
	Vaccine Acceptance					< .001
	Knowledge				0.354	< .001
2		0.515	0.389	405		< .001
	Vaccine Acceptance					< .001
	Knowledge				0.0780	.0220
	Trust				0.682	< .001
3		0.621	0.106	140.		< .001
	Vaccine Acceptance					< .001
	Knowledge				0.0720	.0170
	Trust				0.451	< .001
	Beliefs				0.401	< .001

Additional Analyses

Between the Two Vaccines

A paired samples t-test was run to determine if there is a difference between the variables across each variable. Table 5 summarizes the results of this analysis; p-values

less than .001 were found for all scales, indicating that there are significant differences between the two vaccines for each scale. Furthermore, effect sizes must be acknowledged; vaccine acceptance and trust both had a relatively small effect, while knowledge had a large effect. While it is worth noting that the results are slightly skewed and kurtotic (with absolute values slightly greater than 1), as a general practice, OLS tests, of which t-tests are a part, are robust to normality violations. As a result, these strong results are unlikely to change if the distribution for this variable was more normalized [Table 5].

Table 5.

Paired Samples T-Tests to Compare Vaccine Acceptance, Knowledge, and Beliefs for the Varicella and Influenza Vaccines

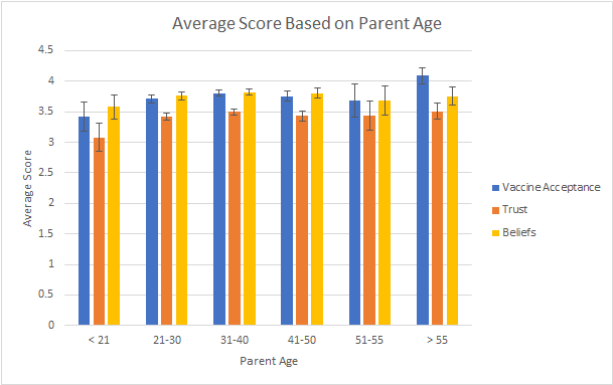
Scale	Varicella		Influenza		*W*	Student Test			
	M	*SEM*	*M*	*SEM*		*t*	df	*p*	*ES*
Vaccine Acceptance	3.97	0.0370	3.72	0.0400	0.901	-8.52	506	< .001	-0.378
Knowledge	1.25	0.0510	4.04	0.129	0.980	23.4	506	< .001	1.04
Beliefs	3.77	0.0420	4.04	0.0540	0.908	5.72	506	< .001	0.254

Note. *p*-value is for two-tailed paired sample student t-test. *M, SEM,* and *ES* represent mean, standard deviation, and effect size, respectively.

Demographics and Scales

The results from the general descriptives test for racial identity by scale may be found in Table 6, and may be visualized with Figures C11 and C12; for beliefs, trust, and levels of vaccine acceptance, for all racial identities, parents on average were relatively neutral. Interestingly, however, for knowledge, those who identified as “African American/Black” had the lowest average score of answering questions correctly, while

those who identified as “Other” had the highest, followed by “White/Caucasian”, “Asian/Pacific Islander”, and finally “Hispanic/Latino/a” respectively [Table 6].



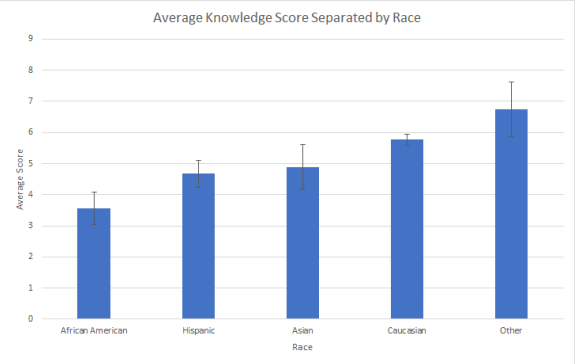
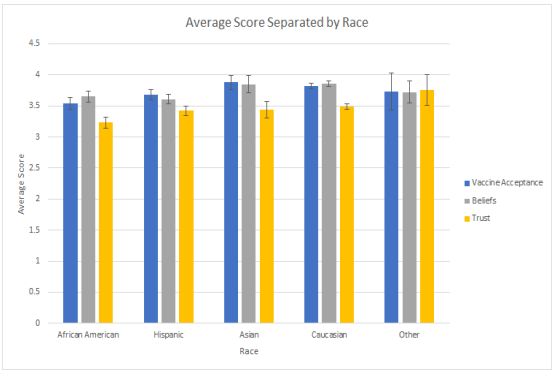


Figure C11 (Left) & C*12* - Average Score on Vaccine Acceptance, Belief, and Trust Scales by Racial Identity. Error bars indicated ±1 S

The results for age by scale may be found in Figures C3 and C4. For parents’ ages, on average, parents under the age of 21 had less knowledge about the varicella and influenza diseases, less positive vaccine beliefs, lower trust, and slightly more hesitant vaccine attitudes in comparison to their older counterparts. Interestingly, parents over the age of 55 had the most vaccine accepting attitudes, and parents aged 31-40 were most knowledgeable (*Fig*. C3, *Fig*. C4).



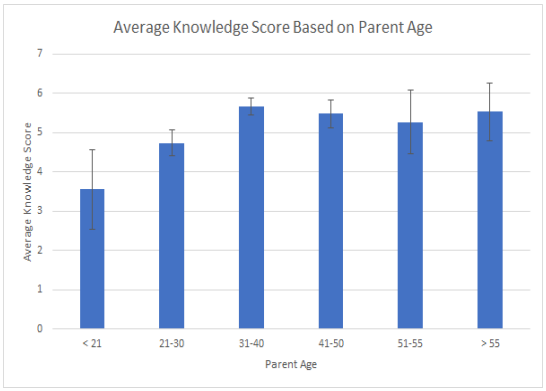
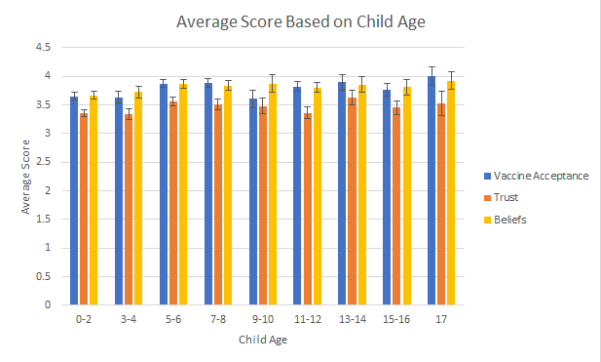


Figure C3 (Left) & *C4* (Right) - Average Score by Vaccine Acceptance, Beliefs, and Trust Scales based on parent's age; Average Score by Knowledge Scale based on parent's age. Error bars indicated ±1 SE

As an alternative way of approaching the role of age, the results of looking at scale by participants' children's ages may be found in Figures C5 and C6. While all parents were about average (value of 3), participants with children aged 3-4 years old had slightly more vaccine hesitant attitudes and slightly less trust in comparison to their older counterparts. Additionally, participants with children aged 0-2 had the lowest levels of knowledge and less positive vaccine beliefs. Interestingly, participants with older children ranked highest in vaccine acceptance, levels of knowledge, vaccine beliefs, and trust; the breakdown of this observation is as follows - participants with children aged 13-14 years old had the highest levels of knowledge and trust, while participants with children aged 17-18 had highest vaccine acceptance and vaccine beliefs (*Fig.* C5; *Fig.* C6).



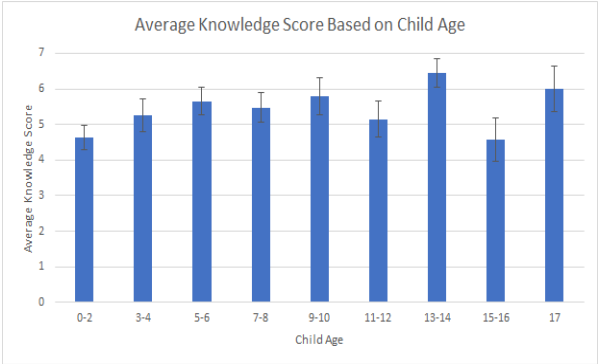
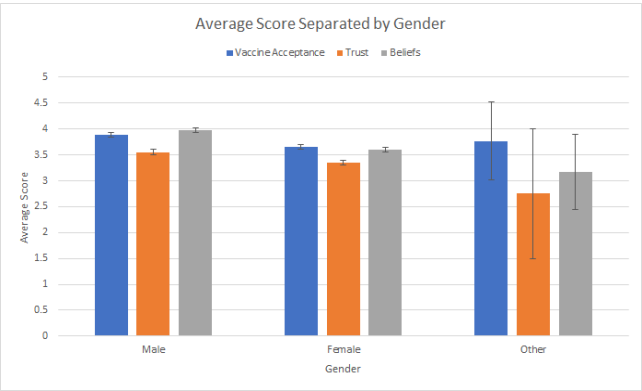


Figure C5 (Left) & *C6* (Right) - Average Score for Vaccine Acceptance, Beliefs, and Trust scales based on participant's child age; Average Score for Knowledge Scale based on participant's child age.

The results from the general descriptives test for gender identity by scale may be found in Figures C9 and C10; of the 507 participants, 255 individuals identified as "Female", 250 individuals identified as "Male", and 2 individuals identified as "Other". For beliefs, trust, and levels of vaccine acceptance, those who identify as male had the highest levels of vaccine acceptance, trust, and positive vaccine beliefs, while those who identified as "Other" reported the least positive vaccine beliefs and lowest levels of trust. Interestingly, those who identified as female reported more hesitant vaccine attitudes. Finally, in terms of knowledge, those who identified as "Other" had the highest levels of correct knowledge [*Fig. C9*, *Fig. C10*].



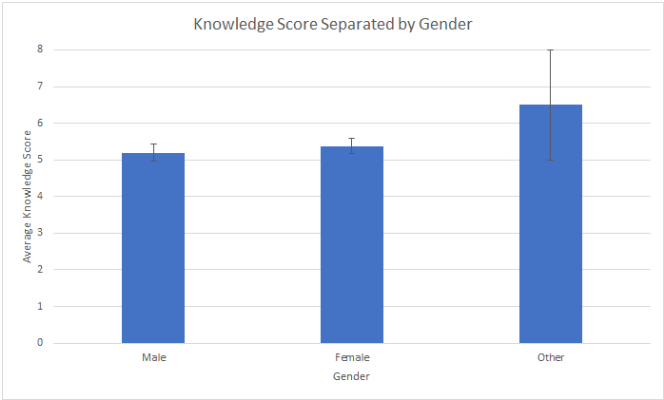


Figure C9 (Left) & *C10* (Right) - Average Score on Knowledge, Beliefs, Trust, and Vaccine Acceptance Scales Based on Parent Gender Identity. Error bars indicated ±1 SE

Information Sources

A bar graph was created to illustrate what participants recorded as their sources of vaccine information. This included friends, family, doctor, news, social media, and other. The most frequently reported response was "Doctor", followed by "Family", "Friends", the "News", "Social Media" and "Other", respectively [*Fig.* C7].

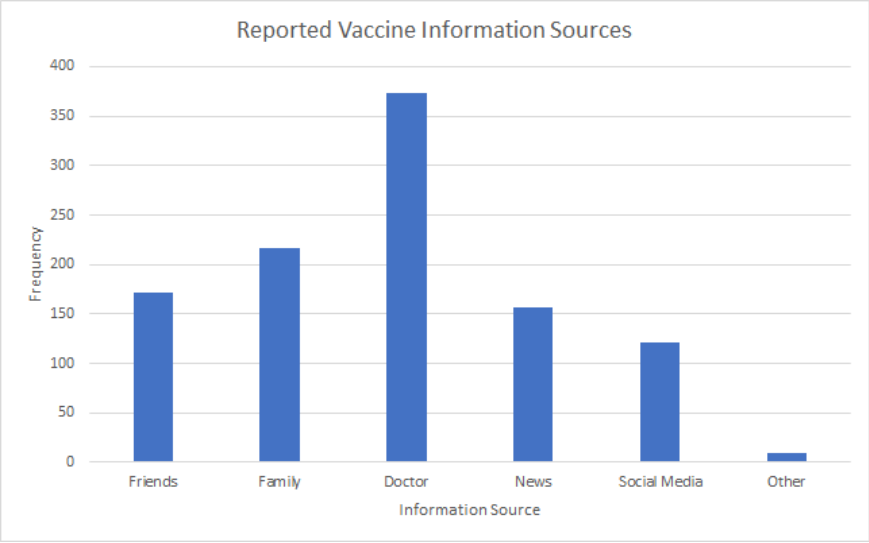


Figure C7 - Frequency bar graph of participants' reported vaccine information sources

COVID-19 Impact Report

A frequency graph was created to determine what COVID-19 impact participants most frequently reported. The most frequently reported response was "I, or someone I know, had the coronavirus" ("Sick"), followed by "My, or my child's, education was impacted" ("Education"), "I received a stimulus check" ("Stimulus"), "I, or someone I know, was an essential worker" ("Essential"), "I, or someone I know, lost my job and/or

lost a source of income" ("Income Loss"), "I teleworked" ("Teleworked"), and finally, "Other" [*Fig. C8*].

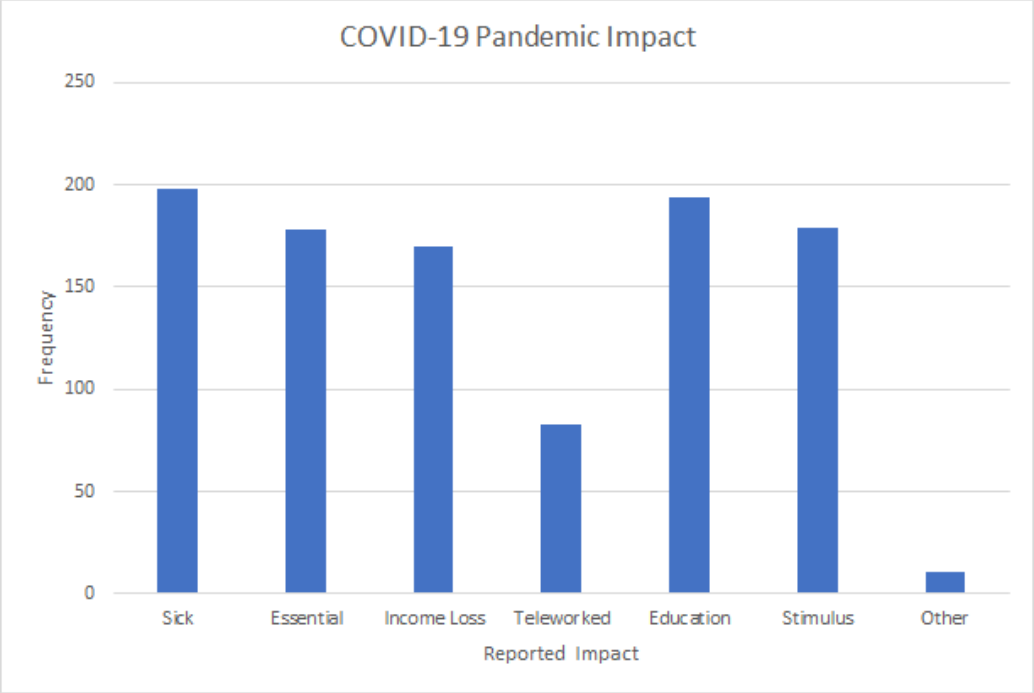


Figure C8 - Frequency bar graph of participants' reported COVID-19 Pandemic Impact

Chapter V: Discussion

Results

Our results for *levels of knowledge* appear to support our hypothesis; on average, for the influenza, parents ranked, on average, on the more knowledgeable side about the influenza disease, while for varicella, parents ranked, on average, more incorrect in their understanding or not knowledgeable about the varicella disease. On average, parents scored 4.04 for influenza knowledge, and 1.25 for varicella knowledge. Their combined mean knowledge score was 5.29. This is consistent with the literature: varicella is known to be a very common and highly contagious disease; however, studies have found that parents might underestimate its incidence and severity (Vezzosi et al., 2017). Team IPOV believes that this result follows logic - the influenza disease and vaccine are more salient in today's society in comparison to the varicella - it is understandable that parents had higher accurate levels of knowledge about the influenza. Further, we believe that the repeat nature of influenza vaccinations plays a role in explaining the higher levels of knowledge compared to the varicella vaccine.

The *beliefs* results partially support our hypothesis; on average, for influenza, parents scored 4.04 and therefore ranked on the more positive end of the vaccine belief spectrum. Alternatively, for varicella, parents scored 3.76, ranking them with more neutral beliefs about the varicella vaccine. Again, Team IPOV believes that this can be attributed to the prevalence of these respective vaccines and diseases.

The *trust* results partially support our hypothesis that parents will have low to moderate levels of trust, as based on literature indicating eroding levels of trust in scientists, doctors, and the government (Gauchat, 2011; Glanz et al., 2013; Nekola, 2017; Mesch & Schwirian, 2015).

Parents scored a 3.448 on average, ranking in the moderate range of the vaccine trust spectrum. This means that parents exhibited neither low nor high levels of trust in vaccines, scientists, government bodies, and the other asked about individuals.

Our Pearson's Correlation and hierarchical linear regression results provide support for our hypotheses in that they show a predictive relationship between *levels of knowledge*, *beliefs*, *trust,* and *vaccine hesitancy*. Our findings reveal that correct knowledge about vaccines and positive vaccine beliefs positively predicts higher levels of vaccine acceptance, as well as that higher levels of trust in scientists, doctors, and institutions also predict higher levels of vaccine acceptance. This is a result that follows both literature guidance and logic - it makes sense that those who fall into this category (those who understand vaccines and the risk of the disease; hold positive beliefs about vaccines; trust those who give out and make vaccines) are more accepting of vaccines.

Most interestingly, we find that trust accounts for approximately 38.9% of the incremental variance in vaccine acceptance after controlling for knowledge. Compared to incremental R^2 changes of 12.5% for knowledge and 10.6% for beliefs, it is clear that trust has the highest degree of explanatory power in our vaccine acceptance scale. This result is particularly important, as it adds an important implication in the current rise in trust in the COVID-19 vaccine (Mega, 2021). Although we hypothesized low levels of

trust, the outsized role of trust in vaccine hesitancy coupled with current developments indicating a rise in COVID-19 vaccine trust indicate a potential for a sustained increase in vaccination rates. Future data on varicella and influenza vaccination rates will indicate whether our finding - the outsized importance of trust to vaccine hesitancy - and this initial data on COVID-19 vaccine trust will result in higher vaccination rates for our vaccines of study and others.

Further, there have been numerous studies in the academic literature that examine how to structure clinical or public health interventions in order to increase vaccination rates (Betsch et al., 2018). Given our finding that trust has greater explanatory power in vaccine acceptance over knowledge and beliefs, we feel that there is strong potential in the success of interventions that target trust in vaccines, the healthcare system, and science.

Finally, our additional analysis results regarding the difference between the two vaccines both support our hypothesis and the above analysis - across the board, a significant difference between the influenza and varicella vaccines were found, with knowledge holding the largest effect. This could potentially be a product of familiarity; since influenza vaccines are available for administration to parents on an annual basis, parental familiarity with the influenza vaccine over the varicella vaccine, which is administered to an individual at a young age, may play an impactful role in the observed differences across all variables between the influenza and varicella vaccines.

Another interesting result from our analyses is found in our breakdown of our variables of interest by race [Table 6]. Across vaccine acceptance, beliefs, and trust, all

five racial categories we tracked scored within one point of each other. This indicates that for the most part, survey respondents of different races had relatively similar levels of vaccine acceptance, beliefs, and trust. However, in analyzing levels of knowledge, we can see that greater variance in scores across racial groups exists. African American respondents scored lower in comparison to all other racial identities. We hypothesize that this difference in knowledge is due to the long history of marginalization and discrimination in the health system that African Americans have experienced in the United States, and are aware that this is a finding and a sentiment echoed in other research (Byrd, 1992; Quinn et al., 2017). Potential future interventions to address inequities in vaccine knowledge would thus do well to consider the historical context that has fostered these inequities.

In breaking parents down by age group, we observed that younger parents, specifically those under the age of 21, showed lower levels of knowledge, beliefs, trust, and vaccine acceptance in regards to both the influenza and varicella vaccines. Team IPOV believes this also follows logic; there are cultural differences between different generations, and in addition, in the consideration that younger parents may not have been exposed to the same amount of interactions with the healthcare system as an older individual, on a personal level or in a parental capacity, it follows that younger parents would have lower levels of knowledge and less positive beliefs.

Additionally, in breaking parents down by the age group of their children, we observed that parents with older children rank highest in knowledge, beliefs, trust, and vaccine acceptance. We believe that this observation follows logically; parents with

children in their teenage years have likely already experienced much of the vaccination process with their older children. Consequently, not only have those parents had more opportunities to acquire knowledge about vaccines and the diseases that they prevent, but also those parents have observed first-hand both the benefits of vaccination and the relative lack of risk, allowing them to form positive beliefs about vaccines, build trust, and ultimately, become more vaccine accepting.

Finally, we observed that the male-identifying respondents exhibited the highest levels of vaccine acceptance, trust, and positive beliefs, while the female-identifying respondents exhibited more vaccine hesitant attitudes, and the respondents that identified as "Other" exhibited the least positive beliefs and the lowest levels of trust. Womens' elevated hesitancy levels compared to men does not have a single explanation. Women are not a homogeneous population, and their gender identity in the context of vaccine hesitancy should be interpreted in tandem with numerous other dimensions of identity and environment (Feletto and Sharkey, 2019). There is evidence in the literature to suggest that women are often the gatekeepers to health decisions of their families, which underscores the importance of further understanding their hesitancy levels (Lazarus et al., 2020).

Additionally, consistent with our finding that the element with the most explanatory power in vaccine hesitancy is trust, we hypothesize that respondents identifying as "Other" may have faced historical marginalization and mistrust in society and within the health care system, which over time may have resulted in higher levels of distrust in public health and the healthcare system (Liszewski et al., 2018). It is important

to note, however, that only two respondents identified as “other”, which indicates that this observation may be tempered by the small sample size.

Further, we asked survey respondents to indicate where they received their disease and vaccine information from. In order of most frequent response to least frequent response, respondents answered “Doctor”, followed by “Family”, “Friends”, the “News”, “Social Media” and “Other”, respectively [*Fig.* C7]. It is interesting to note that although we observed the most significant determinant of vaccine hesitancy and acceptance to be trust, the highest proportion of our respondents still obtained their vaccine information from their doctors. This suggests that potential future interventions could employ doctors as primary points of contact for vaccine hesitant parents, in order to best improve parental levels of trust.

Finally, it is important to note that the onset of the COVID-19 pandemic could have affected our survey results. When asked how COVID had affected them, our respondents answered, in order of highest frequency to lowest frequency, “I, or someone I know, had the coronavirus” (“Sick”), followed by “My, or my child’s, education was impacted” (“Education”), “I received a stimulus check” (“Stimulus”), “I, or someone I know, was an essential worker” (“Essential”), “I, or someone I know, lost my job and/or lost a source of income” (“Income Loss”), “I teleworked” (“Teleworked”), and finally, “Other” [*Fig. C8*]. Since the highest proportion of respondents indicated that they, or someone they know had the coronavirus, it is possible that such personal experiences with the virus affected their levels of knowledge, beliefs, and trust.

Limitations

This discussion would be incomplete without acknowledging the limitations of this analysis. First and foremost, the multiple choice question format for information sources introduced confounding effects in its analysis, and this, in combination with time constraints, limited the exploration of a potential effect. Furthermore, questions also had to be removed due to their effect on the scales' reliability, and as such, it is possible that something got missed with these questions removed. This may be acknowledged specifically for the knowledge scale, as some questions related to varicella and transmission were removed, and as such, there were more questions related to influenza than varicella in the scale. However, while this is something to acknowledge and consider, due to the robustness of our data and the fact that knowledge was treated as a unitary concept in our overall analysis, Team IPOV does not believe this to hold a negative impact on the validity of our study.

Moving forward, the format of survey dissemination must be acknowledged; as we made use of Qualtrics XM Software - an online survey dissemination package - our study was limited to only participants with internet access and those recruited by Qualtrics. As a result, we acknowledge that our results may not be wholly representative of all parents, and that overall, this study's results may not be generalizable to all parents in the United States, rather just our sample.

Finally, the effect of the COVID-19 pandemic must be acknowledged. Although effort was taken to ask detailed questions about the potential ways in which the participants were affected, this global issue's effects are all-encompassing and evolving,

and Team IPOV was able to only record, rather than control, for its potential effect due to 504 out of 507 participants all recording some degree of impact. As such, it is possible there is a greater effect than our research was able to detect. Despite these limitations, Team IPOV believes that our research contributes valuable information to the literature, and has been inspired by our limitations in recommending future ventures.

Future Research

In an effort to further understand parents' thoughts and behaviors relating to vaccinations, specifically the observed resistance or hesitancy towards vaccinations, Team IPOV had chosen to investigate potential influencing categories for vaccine hesitancy. We had initially hoped to look at the relationship between social networks' levels of knowledge and beliefs on the participants' levels of knowledge and beliefs, as well as to use the data we obtained to create an intervention that could potentially alleviate vaccine hesitancy. Alas, time did not permit such endeavors, and as such, Team IPOV believes these two to be valuable future directions. More specifically, Team IPOV encourages further research into interventions with a focus on the role of trust. Building trust is no easy feat and research needs to be done on effective ways of rebuilding trust, but Team IPOV believes the following to be potential promising and interconnected areas of focus: dissemination of scientific information in a manner understandable to the general public; taking effort to increase inclusivity in research, health care, and positions of authority; and finally, increasing transparency (Boele‐Woelki et al. 2018).

Additionally, Team IPOV encourages future research that focuses on and compares different vaccinations. This could also then lead to a more in depth intervention that reaches more parents; some are only hesitant to certain vaccines, whereas others are hesitant towards all.

Finally, Team IPOV advises a future direction of research that looks at the longitudinal effect of the COVID-19 pandemic on vaccine hesitancy. The COVID-19 pandemic has had unparalleled and unprecedented impacts on everyone's daily lives and beliefs, and as it is paramountly connected to the topic of vaccine and public health, its effect must be investigated.

General Implications

In analyzing the results of this survey, we have found that knowledge, beliefs, and trust influence parent's levels of vaccine hesitancy. Team IPOV initially set its sights on utilizing these results to craft an effective intervention for alleviating vaccine hesitancy and ultimately improving vaccination rates. While time did not allow us to carry out that final part of our project, the results at which we have arrived are very telling in regards to alleviating vaccine hesitancy. It is important to note that within the literature body, there is an observed focus on the importance of knowledge in both the discussion of vaccine hesitancy and in interventions. While coupling a strong, foundational knowledge of vaccines and their related diseases with positive beliefs about those vaccines will prove to be important in improving upon influenza and varicella vaccination rates, considering the explanatory power of trust in our model, building trust in vaccines, scientists and other

bodies is essential to alleviating vaccine hesitancy. As such, when future researchers attempt to construct impactful interventions related to vaccine hesitancy, trust should be a central focus.

Conclusion

In this study, Team IPOV sought to determine the underlying factors that influence vaccine hesitancy among parents. We selected to study the influenza and varicella vaccines, and specifically focused on parents' levels of knowledge about influenza and varicella, parents' beliefs about the vaccines, parents' levels of trust in the vaccines, and ultimately, the parents' levels of vaccine hesitancy. When conducting our study, we aimed at answering the following questions:

1. What are parents' levels of knowledge, beliefs, and trust toward the varicella (chickenpox) and influenza (flu) vaccinations?
2. What are the relations between parents' levels of knowledge, beliefs, and trust to their vaccine hesitancy?

Thus, we constructed and disseminated a national survey directed towards parents of children; within the survey, we asked respondents to answer specific questions related to both the influenza and varicella vaccines, each of which contributed to a scale measuring one of our variables of interest. We hypothesized that parents would have low levels of knowledge about the varicella disease and vaccine while possessing slightly higher levels of knowledge about the influenza disease and vaccine. Moreover, we hypothesized that parents would have relatively neutral beliefs about both vaccines and

that they would possess low levels of trust. Finally, we hypothesized that we would discover significant, positive relationships between parents' levels of knowledge, beliefs, trust, and vaccine hesitancy.

In analyzing the data received from our survey, we mostly found results that supported our initial hypotheses. For instance, we determined that on average, parents landed on the more knowledgeable side about the influenza disease and vaccine and the less knowledgeable side about the varicella disease and vaccine. In terms of beliefs, while we found parents to be on the more positive side of the vaccine belief continuum for influenza, we also found that parents were relatively neutral in regards to the varicella vaccine, in turn partially supporting our hypothesis. Additionally, our analysis of trust supported both prior literature, as well as our hypothesis, as parents ranked in the middle of the trust scale with moderate levels of trust.

Importantly, we found significant and meaningful positive relationships between knowledge, beliefs, trust, and vaccine hesitancy. While knowledge and beliefs both proved to have important influence over a parent's level of vaccine hesitancy, we determined that trust was the most significant predictor of a given parent's level of vaccine hesitancy. As such, as researchers continue to search for and construct new methods of improving upon vaccination rates and supporting herd immunity, the concept of trust is one that should be at the forefront of those researchers' minds. In helping to improve upon parents' attitudes and decision-making processes towards vaccination, analyzing methods for building trust is both an effective and necessary place to start.

Finally, our additional analysis provided some important insight of which to take note; for instance, individuals who identified as African Americans tended to be less knowledgeable in comparison to other racial identities, both younger parents and parents of younger children, tended to have higher levels of vaccine hesitancy, and those who identified as male had the highest levels of vaccine acceptance, trust, and positive beliefs. Finally, an observed difference was found among all of the variables between the influenza and varicella vaccines.

When Team IPOV embarked on its journey into uncovering important underlying factors that influence vaccine hesitancy, society had been seeing a noticeable, impactful drop in vaccination rates. Vaccines are important for the prevention of widespread outbreaks; with a minority of the population incapable of protecting themselves with vaccines because of medical conditions, the reduction in herd immunity resulting from an increase in non-medical exemptions has been a point of concern for society as a whole. Overall, in consideration of the implications of vaccine hesitancy and falling herd immunity, we found vaccine hesitancy to be a topic worthy of in-depth study, and we hope that our research has helped contribute to better understanding of vaccine hesitancy.

Appendix A

Equity Report

Team IPOV's research has always been centered around equity; our questions and goals for the future are related to this core component. Our team formed around the idea of creating a better and more widespread understanding of vaccinations, and had hopes for increasing vaccination rates to benefit those who are unable to get vaccinated for health-related reasons. We were all interested in herd immunity, which occurs when all those who are able to get vaccinated do in order to protect both themselves and those that physically cannot. Therefore, at the root of our project, we were interested in promoting, maintaining, and creating equity.

As a Team, we also had the goal of creating an intervention that would be distributed free of cost to hopefully inform more of the population and especially those who might not have equal access to this information. This includes those who may not be able to afford regular doctor visits, those who might not have access to the internet, and those who may not have had access to higher levels of education that would inform them about vaccinations. While COVID related setbacks did slow down the progress of our project and we were therefore unable to create an intervention as we originally wanted to, our intentions for the research and suggestions for future research reflect these goals.

Team IPOV also continued to think about equity as the COVID-19 pandemic reached the United States and has developed over the last year. We have seen the way that COVID has disproportionately affected certain communities, and the ways in which this

is related to the faults of public health informational paths and systems and biases within public health. This continued to prove the importance of our research and the push for equity in public health that is embedded within our endeavors.

Finally, Team IPOV attempted to embody this approach to equity within our research and its publication. Whenever using technical language specific to our project, we included the term in a glossary. We also discussed in great lengths how we would get this information into the hands of those who need it when it was turned into an intervention, which would include delivering our visual aids to common sources of news for people in many different areas. To make this as accessible as possible, we asked respondents which source they get their information from about vaccines. With this information, we would have been able to proportionately distribute our intervention.

Additionally, our entire Team unanimously agreed to include our entire copy of survey questions if published. While this will undoubtedly reach a more privileged group as it will be limited to those with internet access, this step was taken in an effort to freely share our findings and promote future research. We hope that by making this research and its survey accessible to those with internet access that others may be able to learn and continue from where we have left off.

Appendix B

Survey Questions

Vaccine Hesitancy: 6, 7, 8, 12, 13, 14, 15, 16, 17, 21, 22

Trust: 18, 23, 24, 40, 41

Belief: 27, 28, 29, 30, 31, 32, 38, 42, 43, 25, 26

Knowledge: 33, 34, 35, 36, 37, 39

Demographic: 36, 37, 38, 39, 40, 41

Screening Questions Block Options

Q61

Thank you for taking the time to complete this survey. Your responses will help inform research on the factors that influence vaccination rates in the United States. Your responses will be kept anonymous and stored on a password protected computer at the University of Maryland - College Park. Participation in this survey is completely voluntary, and you may stop at any time. You will be compensated the amount you agreed upon before you entered into the survey.

We ask that if you have multiple children, please base your answers on your **youngest child**. Thank you.

Q1 How many children do you have?

- 0
- 1
- 2
- 3
- 4
- 5
- 6+

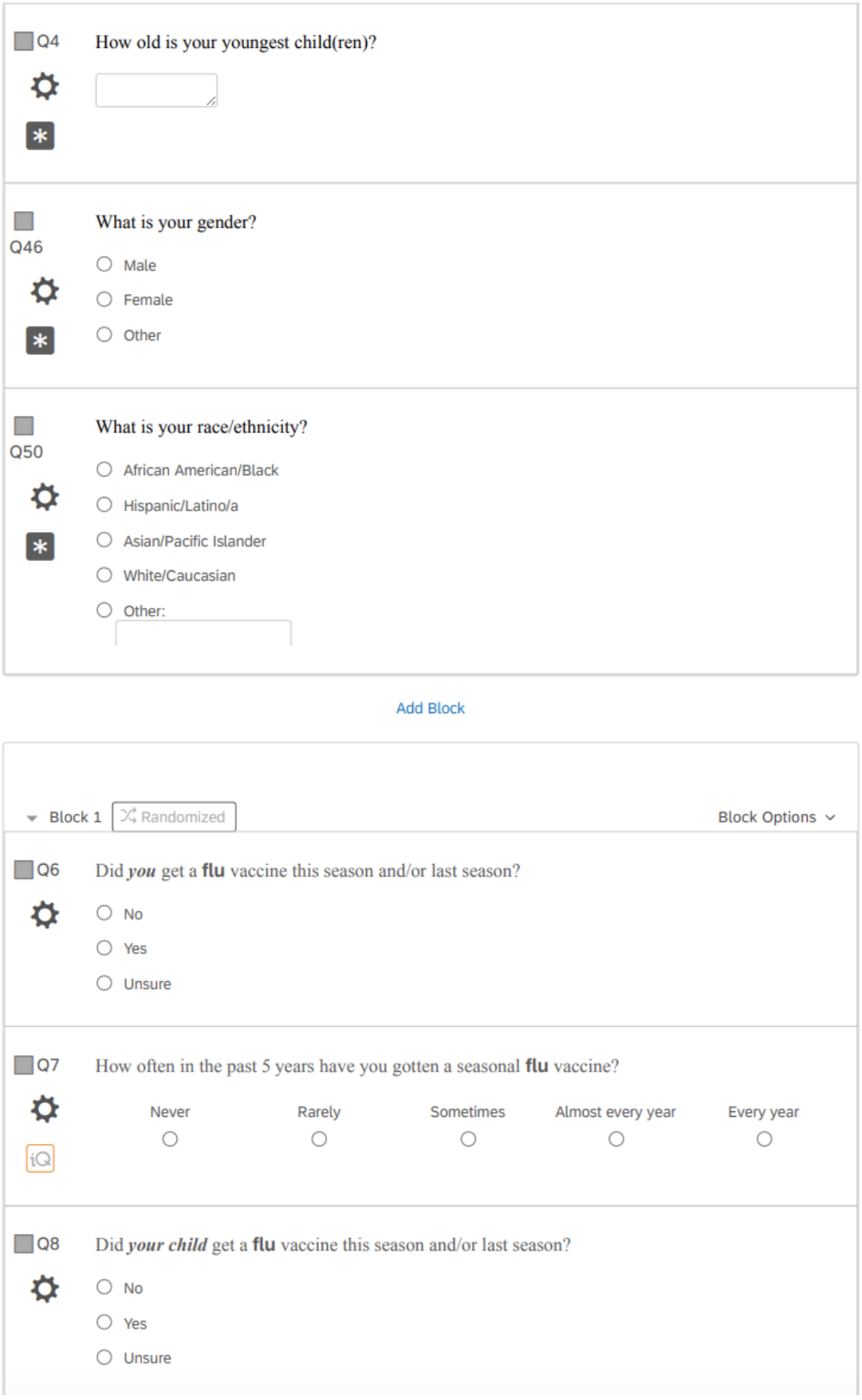
Q2 Are you 18 or older?

- Yes
- No

Q49 What is your age in years?

Q3 Do you currently reside in the United States?

- Yes
- No


Q4
How old is your youngest child(ren)?
Q46
What is your gender?
Male
Female
Other
Q50
What is your race/ethnicity?
African American/Black
Hispanic/Latino/a
Asian/Pacific Islander
White/Caucasian
Other:
Add Block
Block 1
Randomized
Block Options
Q6
Did *you* get a **flu** vaccine this season and/or last season?
No
Yes
Unsure
Q7
How often in the past 5 years have you gotten a seasonal **flu** vaccine?
Never
Rarely
Sometimes
Almost every year
Every year
Q8
Did *your child* get a **flu** vaccine this season and/or last season?
No
Yes
Unsure

Q12 How often in the past 5 years has your child gotten a seasonal **flu** vaccine?

Never	Rarely	Sometimes	Almost every year	Every year
○	○	○	○	○

Q13 Did ***you*** get the **chickenpox/varicella** vaccine?

- ○ No
- ○ Yes
- ○ Unsure

Q14 Did ***your child*** receive the **chickenpox/varicella** vaccine?

- ○ No
- ○ Yes
- ○ Unsure

Q15 If your doctor recommends a vaccine for your child, does your child usually get it?

Never	Rarely	Sometimes	Almost always	Always
○	○	○	○	○

Q16 How hesitant are you about your child getting vaccinations?

Not at all hesitant	Slightly hesitant	Hesitant	Very hesitant	Completely opposed
○	○	○	○	○

Q17 For any of the vaccines that your child hasn't received, if your doctor recommended it for your child tomorrow, how likely would they be to get it?

Very unlikely	Unlikely	Likely	Very likely	Certain
○	○	○	○	○

Q18 How much do you trust vaccines?

Not at all	Somewhat	Moderately	Mostly	Completely
○	○	○	○	○

Q23 Please rate your level of trust in each of the following items:

	Not at all	Somewhat	Moderate	Mostly	Completely
Scientists involved in developing and testing new vaccines.	○	○	○	○	○
Federal government agencies, such as the Food and Drug Administration (FDA) and the National Institutes of Health (NIH), responsible for monitoring the safety of recommended childhood vaccines.	○	○	○	○	○
Centers for Disease Control and Prevention (CDC), the federal government agency that makes recommendations about who should get licensed vaccines.	○	○	○	○	○

Q24 Please indicate your level of confidence in each item below about childhood vaccines for children aged 0 to 6 years

	I Don't Know	Not Confident At All	Somewhat Confident	Mostly Confident	Very Confident
My doctor or nurse is a trustworthy source for vaccine information	○	○	○	○	○
My doctor or nurse has my child(ren)'s best interest in mind when making vaccine recommendations	○	○	○	○	○

Q25 Do you know the recommended **flu** vaccine schedule?

- ○ No
- ○ Yes
- ○ Unsure

Q26 Do you know the recommended **chickenpox** vaccine schedule?

- ○ No
- ○ Yes
- ○ Unsure

Q27 Do you follow the recommended **flu** vaccine schedule?

- ○ No
- ○ Yes
- ○ Unsure

Q28

Do you follow the recommended **chickenpox** vaccine schedule?

- ○ No
- ○ Yes
- ○ Unsure

Q29

Many of the illnesses that vaccines prevent are severe.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
○	○	○	○	○

Q30

It is my role as a parent to research vaccines before administering them to my child(ren).

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
○	○	○	○	○

Q31

How concerned are you that your child might have a serious side effect from the **chickenpox** vaccination?

Not at all	Somewhat	Moderately	Mostly	Completely
○	○	○	○	○

Q32

What is the best way for your child to develop immunity?

- ○ Coming in contact with the disease
- ○ Receiving the vaccination
- ○ Other

Q33

The signs and symptoms of **chickenpox** include itchy, fluid-filled blisters, fever, tiredness, loss of appetite, and headache.

- ○ True
- ○ False

Q34

Chickenpox can be fatal.

- ○ True
- ○ False

Q35

Influenza is transmitted primarily by

	True	False	× I don't know
...Coughing and sneezing	○	○	○
...People, even if they are feeling well.	○	○	○
...People, after their symptoms appear.	○	○	○
...blood and body fluids.	○	○	○

Q36

The **flu** is more serious than a "common cold"

- ○ True
- ○ False
- ○ I don't know

Q37

The signs and symptoms of **influenza** include fever, headache, sore throat, cough, nasal congestion, and aches and pain.

- ○ True
- ○ False
- ○ I don't know

Q38

The **flu** vaccine may cause some people to get the flu.

- ○ True
- ○ False
- ○ I don't know

Q39

The **flu** can be fatal.

- ○ True
- ○ False
- ○ I don't know

Q40

I trust parents to give good advice about vaccines.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
○	○	○	○	○

Q41

I trust doctors to give good advice about vaccines.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
○	○	○	○	○

Q42 The opinions that my friends hold about vaccinations influence the decisions I hold about vaccinations.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
○	○	○	○	○

Q43 The opinions that my family holds about vaccinations influences the decisions I hold about vaccinations.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
○	○	○	○	○

Q44 Where do you get your information about vaccinations from (check all that apply):

- ☐ Friends
- ☐ Family
- ☐ Doctor
- ☐ News sources
- ☐ Social media
- ☐ Other:

Add Block

Block 4 Randomized Block Options

Q21 For the following statements, think specifically about the **flu** vaccine. Rate the degree to which you agree with the following statements, with 1 = Strongly disagree, 2 = Disagree, 3 = Agree, and 4 = Strongly agree.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
The flu vaccine is necessary for my child	○	○	○	○	○
The flu vaccine is important for my child	○	○	○	○	○
The flu vaccine is safe	○	○	○	○	○
The flu vaccine is effective	○	○	○	○	○
The flu vaccine is convenient	○	○	○	○	○
The flu vaccine is affordable	○	○	○	○	○

Q52

What is your annual household income range?

- Below $20,000
- $20,000 - $29,999
- $30,000 - $39,999
- $40,000 - $49,999
- $50,000 - $59,999
- $60,000 - $69,999
- $70,000 - $79,999
- $80,000 - $89,999
- $90,000 or more
- Prefer not to answer

Q55

Which region of the United States are you from?

Hawaii

Add Block

Block 3 Block Options

Q57

The following three questions are related to the COVID-19 (Coronavirus) outbreak. Please remember that your responses are voluntary and optional. Please do not answer the questions if they make you feel uncomfortable.

Q58

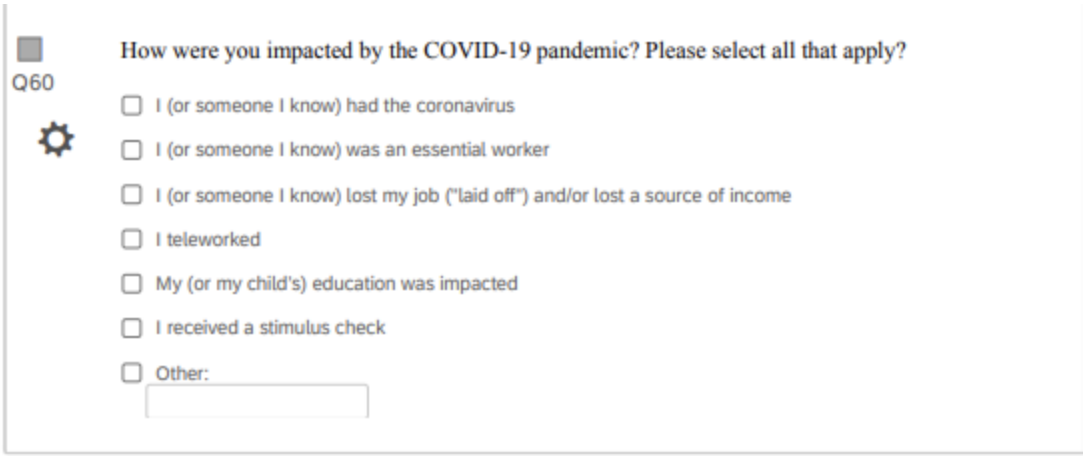
If there was a COVID-19 vaccine, would you get vaccinated?

- No
- Yes

Q59

If there was a COVID-19 vaccine, would you vaccinate your child with it?

- No
- Yes


Q60
How were you impacted by the COVID-19 pandemic? Please select all that apply?
I (or someone I know) had the coronavirus
I (or someone I know) was an essential worker
I (or someone I know) lost my job ("laid off") and/or lost a source of income
I teleworked
My (or my child's) education was impacted
I received a stimulus check
Other:

Appendix C

Figures

Figure 1

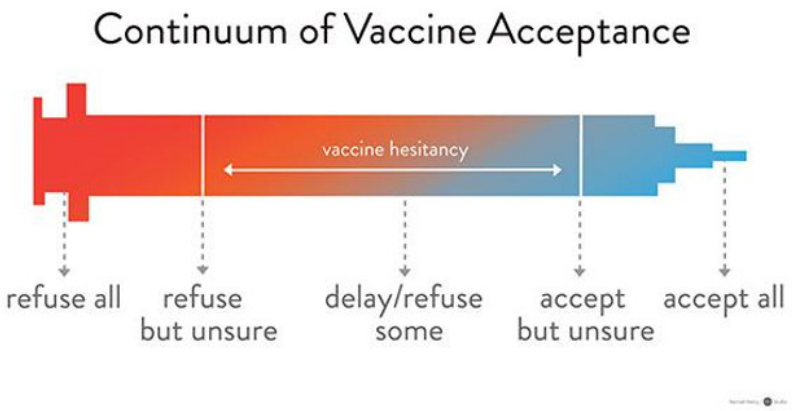


Figure C1. Visual representation of the "Continuum of Vaccine Acceptance" Attitudes. Graph referenced in Savoia et al. (2021).

Figure 2

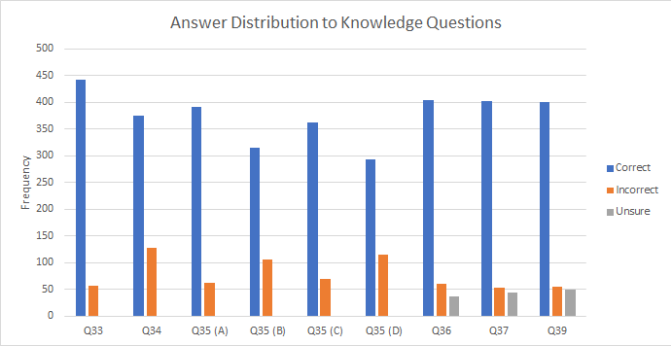


Figure C2. Frequency graph of answer distribution to Knowledge Scale Questions

Figure 3

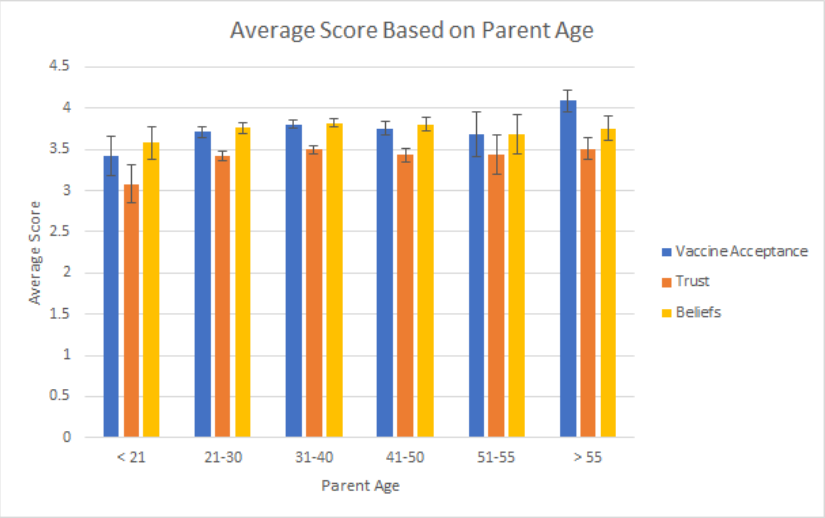


Figure C3 - Average Score by Vaccine Acceptance, Beliefs, and Trust Scales Based on Parent Age. Error bars indicated ±1 SE

Figure 4

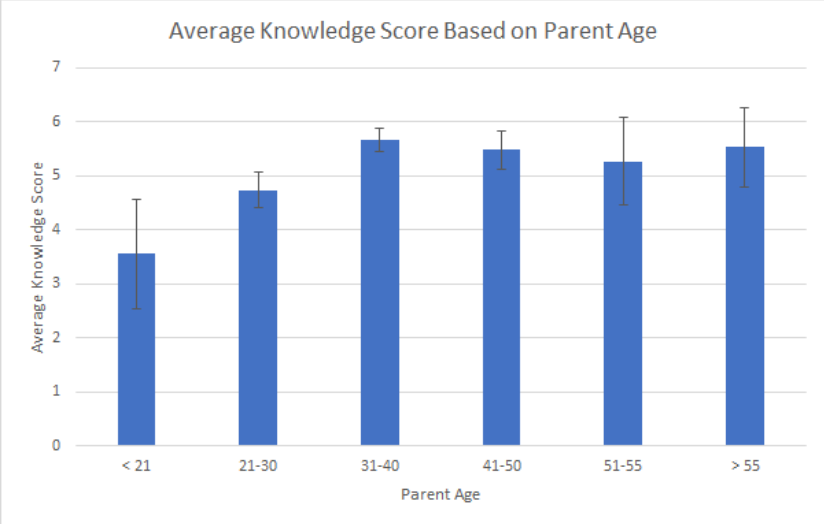


Figure C4 - Average Score by Knowledge Scale Based on Parent Age. Error bars indicated ±1 SE

Figure 5

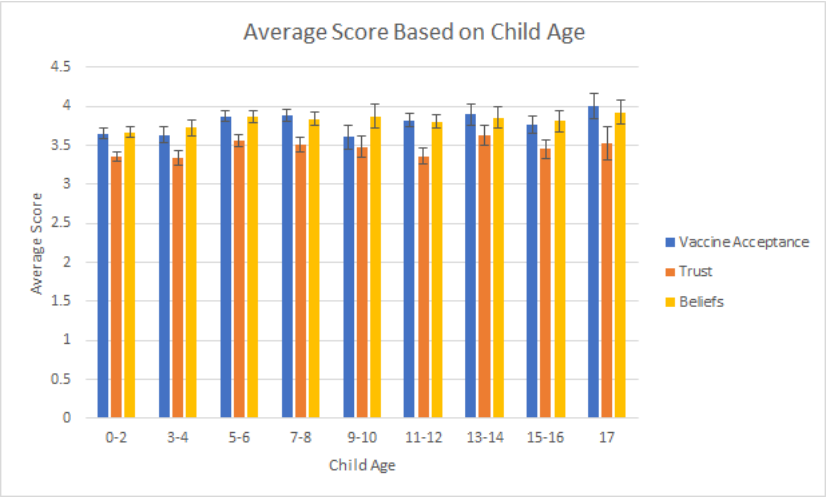


Figure C5 - Average Score for Vaccine Acceptance, Beliefs, and Trust scales based on participant's child age.

Figure 6

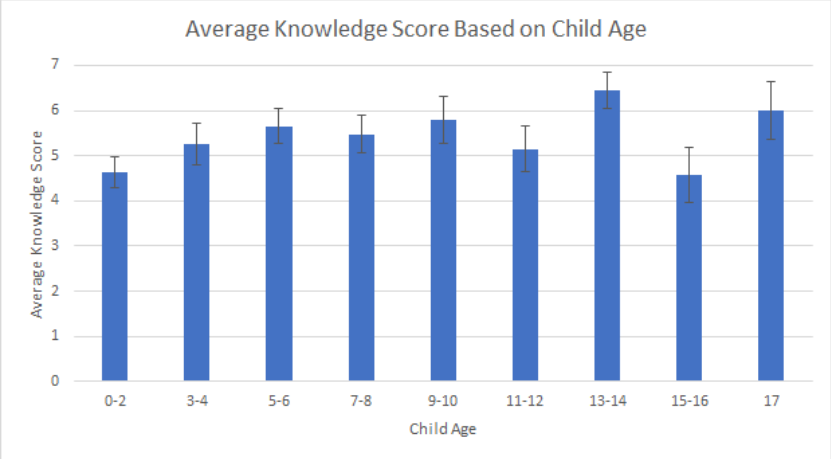


Figure C6 - Average Score for Knowledge scale based on participant's child age.

Figure 7

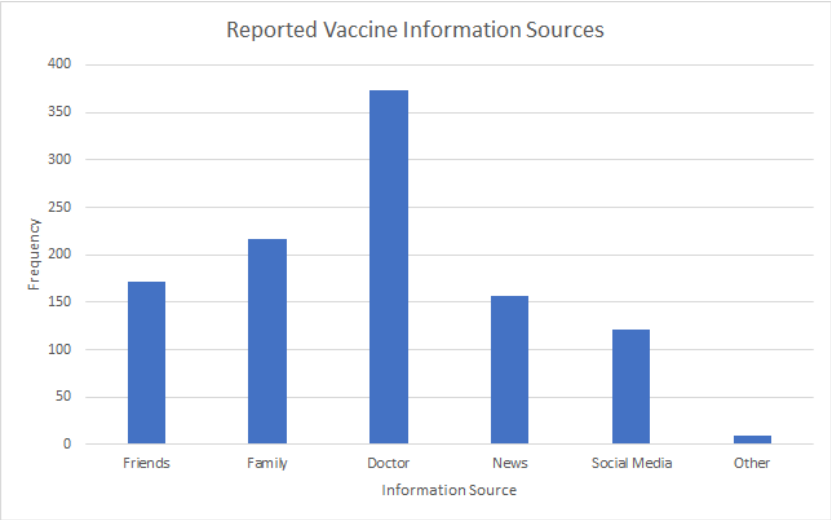


Figure C7 - Frequency bar graph of participants' reported vaccine information sources

Figure 8

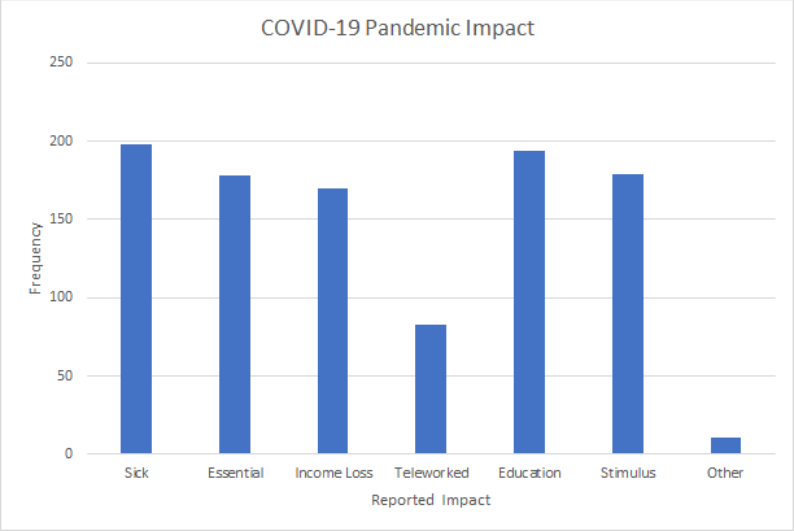


Figure C8 - Frequency bar graph of participants' reported COVID-19 Pandemic Impact

Figure 9

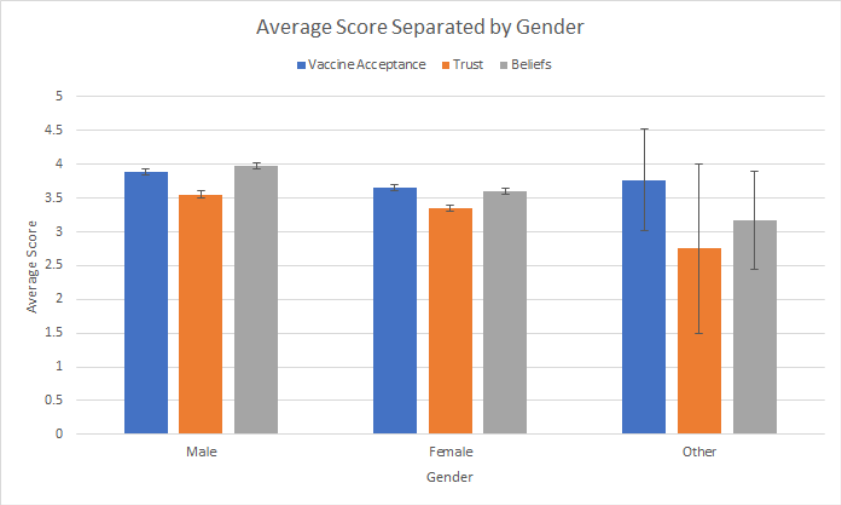


Figure C9 - Average Score by Vaccine Acceptance, Beliefs, and Trust Scales Based on Parent Gender Identity. Error bars indicated ±1 SE

Figure 10

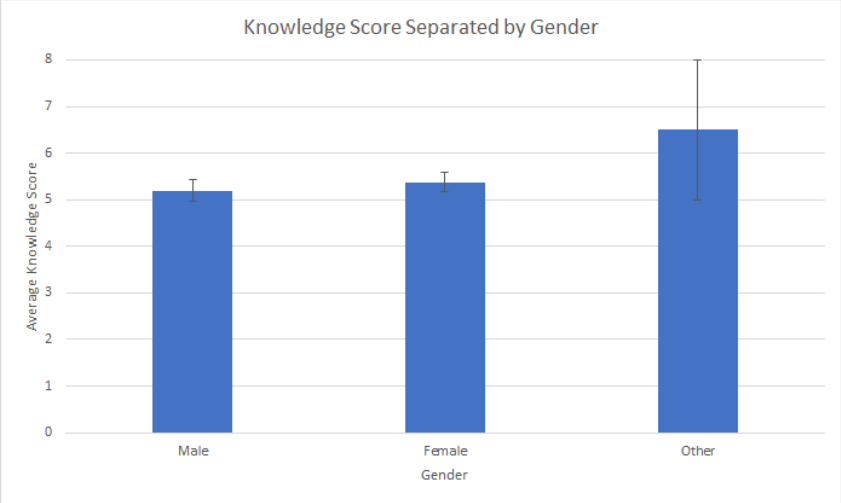


Figure C10 - Average Score on Knowledge Scale Based on Parent Gender Identity. Error bars indicated ±1 S

Figure 11

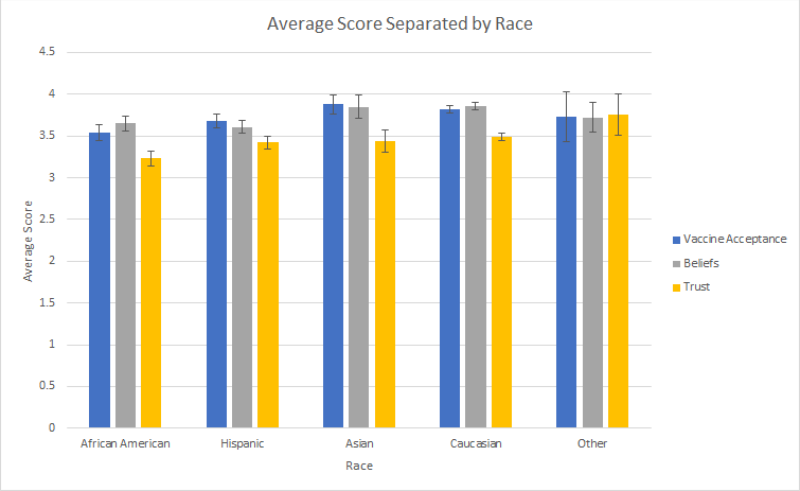


Figure C11 - Average Score on Vaccine Acceptance, Belief, and Trust Scales by Racial Identity. Error bars indicated ±1 S

Figure 12

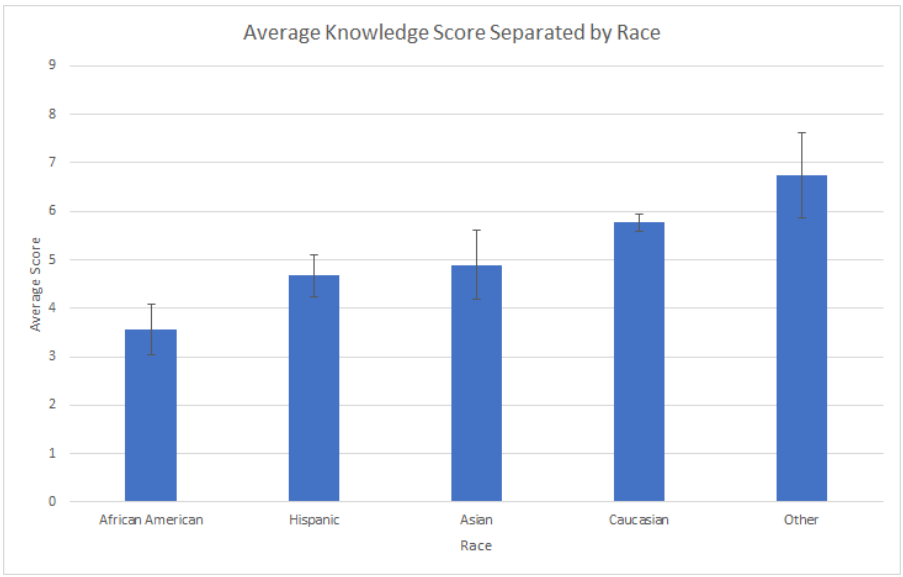


Figure C12 - Average Score on Vaccine Acceptance, Belief, and Trust Scales by Racial Identity. Error bars indicated ±1 S

Budget

We obtained money from several sources to fund our survey administration. We used the allotted money from Gemstone each semester, as well as funds raised through our Launch UMD campaign. Additionally, we applied for and received a $500 Do Good grant through the University of Maryland's Do Good program, an organization that helped fund research projects focusing on implementing positive change in the communities. Our main expense was Qualtrics Software. Qualtrics cost $5.15 per respondent for a total cost of $2,575.00 for 500 respondents, and we were able to fully fund this expense through the three aforementioned sources. A breakdown of our budget appears in the table below.

Item	Expected Price	Number of Items Needed
Qualtrics	$5.15 per respondent	$2,575.00 $5.15 per participant (due to specific population criteria) with 500 participants
Total Cost: $2,575.00		

Glossary

Alternative Vaccination Schedules: *parental modification of the recommended vaccination schedule, accomplished through delaying, reducing, or refusing certain vaccinations.*

Complacency*: describes individuals who "do not perceive a need for a vaccine, do not value the vaccine (Quinn et al, 2019, 1168-1169).*

Convenience*: access to vaccines (Quinn et al, 2019, 1168-1169).*

Confidence: *trust in the effectiveness and safety of vaccines, the system that delivers them, including the reliability and competence of the health services and health professionals and the motivations of policy-makers who decide on the needed vaccines (Quinn et al, 2019, 1168-1169)*

Herd Immunity: *collective immunity to contagious disease*

Influenza Vaccination: *a seasonal vaccine given yearly to children starting at the age of 6 months*

IPOV: Research team - acronym stands for "Investigating Parental Opinions of Vaccines"

Naturally inoculate*: exposure to an infected individual in hopes of catching the illness to develop an immunity*

Vaccine Hesitancy: *delay in acceptance or refusal of vaccines despite availability of vaccination services. Vaccine hesitancy is complex and context-specific[,] varying across*

time, place and vaccines. It includes factors such as complacency, convenience and confidence (SAGE, 2014)

Varicella Vaccination: *a vaccine given to children in two doses beginning at the age of 6 months*

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Footnotes

[1]On a similar note, while acknowledging the role of knowledge, the role of misinformation on vaccine hesitancy must be considered. Misinformation, otherwise known as false or inaccurate information, regarding the safety and necessity of vaccines has been spread through several sources, including the dissemination of anecdotal evidence, storytelling, and false ideas about infection and immunity. One of the most prominent figures credited for contributing to the modern anti-vaccination and vaccine hesitancy movements is Andrew Wakefield, a former British gastroenterologist who has since been removed from the UK medical register for his unethical behavior, misconduct, and fraud (Rao & Andrade, 2011). In 1998, Wakefield and a dozen of his colleagues published a series of scientifically flawed findings in *The Lancet*, a renowned, peer-reviewed general medical journal, that suggested a connection between the MMR (Measles-Mumps-Rubella) vaccine and autism. This publication drastically increased parental concern and reduced parental confidence in public health vaccination programs (Rao & Andrade, 2011).