How Misinformation Regarding COVID-19 Caused a Decline in Childhood Vaccination Rates in the United States

Authors:

Sophia Chrisco* (corresponding author)

Department of Political Science and Public Service
University of Tennessee at Chattanooga
zjf946@mocs.utc.edu

Muhammad Hassan Bin Afzal, Ph.D.

Visiting Assistant Professor
Department of Political Science and Public Service
University of Tennessee at Chattanooga
Hassan-Afzal@utc.edu

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Abstract

Globally, over 25 million children did not receive immunizations in 2022, a significant increase compared to 2019's rate of 3.7 million. Initially, such statistics were attributed to COVID-19-related medical backlogging; however, as these numbers fail to recover, the question becomes: Did COVID-19 have an even more significant impact on childhood vaccination rates? As we remain in the early hours of social media communications, the COVID-19 pandemic brought about an unprecedented outbreak of misinformation. A problem is new and unmanageable; unregulated and unsupported claims ran rampant without end, spilling doubt of vaccine safety and viral severity into immunization. From the advent of COVID-19's spread, expert opinion was cast into doubt by United States political leaders. Today, public health matters are no longer in state agencies' hands; they are finding their future uncertain in our House chambers and Senate floors. Our research article thoroughly explores the origin of vaccine hesitancy recently and how political rhetoric and misinformation exacerbate the situation. After that, our study examines the role of education, income, and partisan identity and how they shape the rhetoric and perception of vaccine hesitancy among parents. Most specifically, as of March 26, 2024, within the span of the first three months of 2024, the total number of measles cases (64) in the USA surpasses that of reported cases(58) in 2023 (CDC, 2024). Utilizing 2022 GSS data, our study explores how the attained level of education, income, and partisan identity affects parents' decision to vaccinate MMR their children. Our study finds that increased levels of education, higher income, and partisanship strongly influence parents' level of MMR vaccination acceptance for their children.

Keywords: Educational Attainment, MMR Vaccination, Vaccination Hesitancy, Partisan identity, Socioeconomic Status

Introduction

It was on a small English farm in 1796 where physician Edward Jenner first inoculated a young boy from smallpox (World Health Organization, 2023). Taking fluids from a sore off the hand of a milkmaid suffering from cowpox, the child was able to ward off the far more lethal, smallpox, a viral infection that has claimed over five hundred million lives (Henderson, 2009). From an animal, we gained the technology to protect ourselves from our world's tiniest yet most prolific killers, and animals, we have caught and spread viruses as vicious as their predecessors, viruses such as COVID-19 (National Institute of Allergy and Infectious Diseases, 2021). Life-saving vaccines, the factual science embraced by American administrations under Thomas Jefferson and Dwight Eisenhower, have had their safety questioned by more recent Presidents, notably Donald Trump (Hornsey, 2020). Much like a virus, information spreads uncontrollably regardless of its validity when given an avenue to jump from person to person. In nature, this is human contact. However, even isolation cannot prevent the spread of misinformation following the development of social media. Once this has taken hold, there is more than one victim, virus, or political figure, but millions of individuals are infected. Infected with harmful viruses, as well as harmful information. Like a virus, misinformation works from the ground up, starting from one. One misinformed individual, who spreads their inaccurate information to millions over the internet, will then spread this information into policy, as those who run appeal to what gains the vote of the masses. When the masses are mistaken, policy itself becomes just as misguided. We know misinformation has negatively affected COVID-19 rates. However, another question presents itself. Did the spread of COVID-19 misinformation contribute to the plummet in childhood immunization rates following 2020?

Inaccurate opinions regarding public health crises severely affected the success of its vaccine counterpart. However, statistics have revealed that the spread of misinformation devastated the containment of COVID-19 and the field of immunology. What was already a century hallmarked by the historic backsliding of childhood vaccination rates saw these effects amplified in the advent of the 2020 decade. 2022 marked the most significant decline in immunizations, with over 25 million eligible children failing to receive their yearly shots, 21.3 million more than the 3.7 million in 2019 (World Health Organization, 2023). The question is, did anything occur in the years between to cause a puncture in the equilibrium? Are inaccurate sentiments surrounding COVID-19 immunization creating childhood vaccine hesitancy? Is it possible to prove a link between these two events? Moreover, how can we prevent misinformation's effect on individuals and policy?

COVID-19, or in its entirety, SARS-CoV-2, emerged in December 2019 as a respiratory virus of zoonotic origin (Centers for Disease Control, 2023). The strain belongs to the coronaviridae family, which accounts for everything from the SARS epidemic of 2002 to the variants of the common cold (Liu, 2021). As an RNA virus, which lacks the replicating qualities that ensure an identical copy in every duplicate, the classification of coronavirus has the evolutionary advantage of quick and strategic advancement. This creates a diverse array of strains that range in severity, making them far more dangerous. One reason immunization is highly critical is that most viruses can adapt to their conditions based on their RNA makeup, and COVID-19 is no exception. With this ability, it can develop characteristics that make it different enough from its original strand that a vaccine can no longer prevent the evolved version. This capability is often so advanced that it allows the virus to adapt to infecting multiple species, hence the zoonotic origin of COVID-19. Bats have historically been the ecological reservoir of

coronavirus strains, with over four hundred known variants evolving from this species[1] (Olival et al., 2015). Based on the first patient's location, sources confirm that the virus most likely originated in the local bat population of Hubei province, China. Subsequently, the bats likely transferred the disease to civet cads, badgers, and raccoon dogs that were slaughtered and sold for fur in what are known as "wet markets," outlets that sell fresh meats and animal products (Hao, 2022). Identifying the source of COVID-19 is crucial to public health, not only because it aids in our understanding of viral prevention but also to address the epicenter, the origin, and the most prominent source of COVID-19 misinformation.

As false claims of COVID-19's source, characteristics, and treatments are cyclonic in their spread, identifying the genesis of the misinformation is challenging yet necessary to understand its progression. Questions surrounding the source of the virus' emergence initially sparked the suspension of official information in early 2020 (Bolsen & Palm 2020). When the populous trust eroded in even the earliest facts regarding the pandemic, every following development was met with circumspection. Further damaging, the voices of those who share opinions of mistrust become the sources trusted by the already misguided population. Eventually, these sentiments are muddled between legitimate data, misguiding the remainder of those trying to follow the facts. These erroneous beliefs came in phases, beginning with baseless lab leak conspiracy, downplaying the severity, and then onto mistrust in the vaccine's safety. While there are numerous false ideas surrounding COVID-19, including everything from blaming 5G telecommunications, wealthy elites, and the so-called "deep state" to the virus being a hoax, have all been rampant since the start of the pandemic, it is the three phases as mentioned above that

[1] Bats are one of the most common natural reservoirs of zoonotic viruses. Influenza, Human Immunodeficiency Virus (HIV), Ebola virus, Nipah virus, Hendra virus, and more, are all attributable to various bat species.

have been most devastating to rates of childhood vaccination (Romer & Jamison, 2020). Each has a significant connection to the procedures, whether by being the catalyst to suspicion, the negligent concern for viral precautions, and finally, claims of bad faith towards the vaccine industry. These phases each have a genesis, a beginning, and a creator.

Nevertheless, not every phase shares the exact origin. The catalysts ' aftereffects and evolution can be revealed by analyzing each conspiracy's source and spread. From there, the source of the spillover of suspicion into routine vaccines may be identified and circumvented. COVID-19 misinformation is linked to the decline in childhood vaccinations.

Theoretical Framework

Knowledge, notwithstanding its validity, is presented through frames of communication. Like the viral capsid binds that allow the infection to enter the host cell, how information is presented determines the passing of misinformation (Elrick, 2021). Communication is the common denominator and catalyst that ties people and policy together in this problem. When people are exposed to a manipulatively framed belief, they are more likely to prioritize and emphasize specific details in the way the conspirator designed, known as the "emphasis framing effect" (Druckman, 2004). From there, these manipulated or even blatantly false beliefs enter the body of people they come into contact with, creating further confusion, likely to be misrepresented as it travels from person to person. We know this theory applies to COVID-19, as a recent study determined that accentuating the personal health benefits of transmission prevention increased the likelihood that those exposed to this belief would manifest this behavior

(Jordan, 2020). The probability of this increases when the information is provided through a figure of authority, in this scenario, a politician (Silvester, 2021).

Each conspiracy regarding COVID-19 negatively impacted the prevention of both COVID-19 and, by extension, public attitudes toward all immunizations. It is, however, three specific false dialogues, i.e., the question of the virus' origin, misrepresentation of the dangers of contracting communicable diseases, as well as the illegitimate claims surrounding pharmaceutical companies such as Pfizer, Moderna, and BioNTech, that extended the damage to the field of immunology as a whole. Even before COVID-19 was defined as a "pandemic" in March 2020, prevention attempts were circumvented. In February of that year, Botoa and Lei Xiao of the South China University of Technology published a paper claiming the virus was leaked outside of the laboratory (Xiao, 2020), sparking U.S. politicians, such as Arkansas Senator Tom Cotton to perpetuate claims of may have been artificially created (Stevenson, 2020). This unsupported belief was then further exacerbated by Donald Trump, the sitting president of the U.S. at the time of his claim. Here, Trump framed this idea with racial and political undertones, designating it by a name he coined "China Virus" that has no official ties to the virus classification[2] (Zheng, 2020). Officials from multiple U.S. states reiterated these false hypotheses even after Xiao's research was redacted.

Identifying the origin of why COVID-19 was questioned and misconstrued at a far higher rate than previous pandemics further explains the following conspiracies. Supporters of these Republican politicians were continually misrepresenting the severity of COVID-19. Advice from health officials, primarily Anthoney Fauci, who was the director of the National Institute of

[2] Covid-19 was also offensively referred to by some as "Wuhan Flu," negatively emphasizing its place of origin and downplaying its severity by comparing it to another virus.

Allergy and Infectious Diseases throughout the pandemic, was disregarded and criticized by Republican politicians (Rutledge, 2020). Trump actively ignored the World Health Organization's demand for national lockdowns, citing low case numbers. The Central Intelligence Agency and even Trump's economic advisor missed other active warning signs (Rutledge, 2020). Instead, Trump fired the CDC's chief analyst on viral respiratory disease, Dr. Nancy Messonnier (Goodman & Shulkin, 2020).

Publicly, Trump stated that the virus would likely disappear by summer, that the virus was comparable in strength to the flu, cases were decreasing, and that citizens should continue to go to work, summing his thoughts up as "unconcerned" (Doggett, 2023). At the state level, politicians from Alabama, Arizona, Florida, South Carolina, and Texas all actively made claims to minimize the threat of COVID-19[3] (Tyson, 2020). Often, these individuals compared COVID-19 to influenza, framing the virus as non-dangerous. The following year, flu vaccination rates decreased by only 51.4% of the population (Centers for Disease Control, 2023). As elected officials, each individual held immense, authoritative power in framing facts regarding COVID-19. Further, their placement in office originates from their broad supporting audience who trusts their abilities and opinions.

However, most devastating to the field of immunology was the negative connotations of its vaccine by those in positions of power. Reports from the House of Representatives Subcommittee on COVID-19 discovered a minimum of forty-seven instances of an elected official intentionally hindering vaccination efforts (Bolson & Palm, 2022). While larger figureheads, such as Donald Trump, did receive and support the vaccine, according to research, it was far little too late. Surveys report that supporters of Trump were 35% less likely to receive a

[3] Alabama, Arizona, Florida, South Carolina, and Texas are all traditionally Republican strongholds.

vaccine for COVID-19 (Callaghan & Moghtaderi, 2021). As of 2021, only 52% of Republicans have received a vaccine compared to nearly 90% of Democrats (Hamel & Lopes, 2021).

To what end does this affect immunology as a whole? Is there a correlation between those mentioned above and the 21.3 million difference in childhood vaccines following the advent of the pandemic? Further analysis of public opinion suggests a connection. This connection is the center of my theory, as COVID-19 misinformation negatively affected childhood vaccination rates. Research has confirmed widespread negative attitudes towards Johnson and Johnson, Pfizer, and Moderna, developers of COVID-19, as well as many of the childhood vaccines scheduled for parents (Baumel, 2022). Concerningly, before COVID-19, the anti-vaccine movement relied nearly exclusively on health and safety, and however proponent this remains, a new, broader opinion has become a hallmark of this demographic: freedom and liberty. It is now not only a private medical decision to vaccinate but also a method of proving your autonomy from the government. Indicators of vaccine hesitancy regarding COVID-19 include strong religious affiliation and partisanship, the same ideals conservatives share (Milligan, 2022). There are non-related explanations for this gap in immunization, such as a medical backlog. However, this anti-childhood vaccine trend has begun seeping into several U.S. states' public policy. Unless immediate action towards negative beliefs surrounding vaccines is taken, these policies will continue to be enacted, crippling public health.

Role of Misinformation in Public Health Crises

It is well understood that COVID-19 misinformation was not only prevalent but influential. Indeed, health professionals have concluded that such rhetoric significantly harmed

the populous' trust in their field. Dr. Salman Bin Naeem and Dr. Maged N. Kamel-Boulos of The Islamia University of Bahawalpur have entitled this "health literacy," which they determined was directly correlated to exposure to misinformation online (Naeem & Kamel-Boulos, 2021). Pillars of "health literacy" include where an individual's information originates, their ability to understand, and how they will later apply it to their health circumstances (Naeem & Kamel-Boulos, 2021). False sentiments surrounding COVID-19 are known to cause negative connotations towards public health resources and anxiety overall. An analysis of 80 million tweets from 76,985 accounts over 18.5 months produced results indicating a causal relationship between heightened levels of stress, anxiety, and even suicidal ideation surrounding posts that shared unconfirmed information concerning COVID-19 (Verma et al., 2022).

Another research team tested misinformation's impact on vaccine impact directly by isolating 8,001 individuals from both the U.K. and the U.S., exposing 3,000 from each country to unfiltered tweets concerning COVID-19 and 1,000 tweets verified as factual. The results revealed that those in the experimental groups changed their initial survey answers to "no" regarding receiving the COVID-19 vaccine by several percentage points (Loomba et al., 2021).

With social media's measured impact on public health, experts across the globe recognized that action needed to be taken. In particular, Twitter (now known as X) became the epicenter of false COVID-19 narratives, with over 1.12 billion related tweets generated in a single year (Banda, et al., 2022). Literature about COVID-19 is primarily concerned with Twitter as a variable in public health attitudes, with eight scholars of human behavior currently urging for Artificial Intelligence scripts to be implemented on social media platforms to combat false claims contributing to negative beliefs. In the United States, 23,612 of 98,385 users, all exposed to untrue statements, held a lack of optimism in COVID-19 inoculation (Hussain et al., 2020).

Other research, such as that conducted at the University of Leicester, encourages world leaders to discuss COVID-19 on their platforms. The figureheads of the nations within the intergovernmental Group Seven alone account for 85.7 million followers (Rufai & Bunce, 2020). Two hundred three of their posts have gone viral, according to the script analysis employed by the study. Many of these tweets were positive, 166 considered "informative," and 48 included links to governmental sources on disease prevention (Rufai & Bunce, 2020). The only tweets flagged as "political" were sourced from then-U.S. President Donald Trump, who unfortunately had a disproportionately high percentage of the total following (Rufai & Bunce, 2020). These negative and unfounded sentiments have been proven to matter to the overall conversation, as research conducted by the Cornell Alliance for Science at Cornell University determined that Trump was mentioned in 37.9% of 38 million media posts and sources flagged as misinformation (Evangea et al., 2023). Participants in this study even suggest this number may be higher indirectly, as the second highest subject in the sample was "miracle cures," of which Trump was the majority proponent (Evangea et al., 2023). The pillars of a significant portion of an individual's health literacy have been collected, with social media as the origin; a lack of ability to discern legitimacy has been identified, and the application proves to be a minimization of vaccination. Herein, we have established that misinformation has a measurably negative effect on public health opinions; these opinions, by extension, have a poor influence on their respective community, and these opinions have the greatest power when perpetuated by a public official.

Can literature support this phenomenon's extension to annual and childhood vaccines? To answer this, understanding the second pillar of health literacy, i.e., how individuals interpret available information, should be evaluated. A Canadian team analyzed tweets discussing COVID-19-specific vaccine hesitancy and discovered the three most significant percentages of

the stated reservations stem from a lack of trust in its safety, political skepticism, and finally, a lack of understanding of the severity of disease spread (Griffith et al., 2021). These reasonings mirror the conspiracies I predicted would cause the most disparagement. Specifically, the tweets discussed a lack of "big pharma," pharmaceutical companies that also manufacture vaccines for yearly and children's use (Griffith et al., 2021). This term was mentioned in 173,452 tweets concerning vaccines in the U.K. from January 2020 to November 2021 (Erokhin et al., 2022). The conspiracy surrounding vaccine manufacturers is central to many challenges in immunology and has increased exponentially in the advent of the most recent pandemic. It holds all the hallmarks of a traditional subterfuge: a small group of people are harming a larger group, only a minimum amount of the majority understand what's "truly going on," and the lack of credible evidence becomes the evidence for the conspiracy itself (Blaskiewicz, 2013). Similar to many others of its kind, the belief is layered with some truth. For example, vaccines can have dangerous side effects (Miller et al., 2015). However, these risks are exaggerated and misframed to fit a designed narrative.

Childhood vaccine misinformation originates in "big pharma," with its genesis credited to now-disgraced British physician Andrew Wakefield (Rao & Andrade, 2011). In 1998, Wakefield completed a now redacted *Lancet* study, which proposed a link between Merck & Co. Inc's Measles, Mumps, and Rubella (MMR) vaccine manufacturing and autism spectrum disorder (Jolley & Douglas, 2017). It is evidenced that this belief increased exponentially in the years following the pandemic. According to research from The University of Toronto, big pharma was mentioned in a staggering 48.3% of sampled tweets that discussed vaccines (Griffith et al., 2021). A survey in the U.K. revealed that 10% of adults believed in bureaucratic involvement in vaccine production, and a quarter suspected a World Health Organization agenda (McManus et

al., 2020). Within the anti-vaccination community is a new age group known as the "indigo parents," who believe physicians purposefully give certain "indigo" children autism to make them less intuitive (Singler, 2015). American actress and model Jenny McCarthy popularized this movement during the early 2000s. Dr. Beth Singler, a professor from the University of Zurich, discussed this concept in a recently published book, where followers of the movement generalize Attention Deficit Hyperactive Disorder (ADHD) as either a fictitious or gift designated as a "disease" that ultimately, big pharma is using as an excuse to develop for social control. Vaccines are then administered to these "high vibrational" or "angelic children with a higher purpose to aid humanity" to poison them with autism, ensuring they cannot reach these "goals" (Singler, 2015).

The premise that politicians and public figures most effectively spread misinformation is also supported by literature. According to the previously mentioned Griffith study, it is the second most common theme in anti-vaccination tweets, making up 32.4% of the conversation (Griffith et al., 2021). Dr. Katrin Weigmann agrees, noting that the 300,000 acquired immunodeficiency virus (AIDs) related deaths are attributed to former South African president Thabo Mbek's policy, which advised against antiviral care on the baseless premise that the disease was harmless (Weigmann, 2017). Today, rates of polio infection are significantly high in Pakistan, and many, such as social psychologist Dr. Gabriel Andrade, link to the 1990s political theory that the CIA developed the vaccine to sterilize Muslim men (Andrade, 2020). Weigmann hypothesizes that myside bias, the propensity to believe new information if it aligns with your previously held beliefs, is the primary reason why conspiracy theories spread by public figures are so effective (Weigmann, 2017). Andrade proposes "paranoid style" American politics, an idea from Dr. Richard Hoftsader in the 1960s that created a defensive and mistrustful Western

culture in which information is believed without question or denied without reason (Andrade, 2020). Considering these prior public health disasters, the link between the growing relationship between anti-vaccination and U.S. politics becomes clearer.

Medical misunderstanding was found to be the third most common sentiment shared on Twitter regarding anti-vaccination (Griffith et al., 2021). Variations of this include high survival rates and mild symptoms of communicable disease, a lack of vaccine for noncommunicable diseases (such as heart disease and cancer), or for those who have not had one developed yet, and most frequently, a lack of understanding of herd immunity (Griffith et al., 2021). Herd immunity is the phenomenon of low rates of disease spread following a high number of vaccinated people in a given area. This is vital to the survival of those unable to receive vaccinations and the community as a whole due to the ability of viruses to evolve outside of preventive measures (Fine et al., 2011). Furthermore, the vaccine's effectiveness may also be why many individuals fail to receive them. Dr. Gregory Poland and Dr. Robert Jacobson hypothesized that the lack of witnessing effects creates a cognitive dissonance from the realities of disease exposure (Poland & Jacobson, 2001). When the crippling effects of communicable diseases are not seen, they are therefore not known, leaving a significant portion of the population unaware of the dangers. A 2003 survey by a team of Canadian scientists suggests that Western culture and curriculum urgently need more common immunological knowledge (Riveto et al., 2003). While widespread support for vaccines was high, the survey concluded that most of the sample could not answer many of the questions regarding immunization mechanisms (Riveto et al., 2003).

Examining the mechanisms behind conspiracy genesis may provide a link between hesitancy in both COVID-19 and childhood vaccination. Social psychologist Ted Goertzel theorized that conspiracies "stick together," meaning one's internal monological belief system

recognizes a pattern of similar ideas that each marginally supports one another and affirm previous beliefs, the likelihood of which is increased the more when slightly distinct yet similar ideas are spoken of in frequent (Goertzel, 1994). An environment conducive to this is social media, where the enormous spike in conversation regarding COVID-19 vaccination likely intersected with other fields of immunology. Research has also suggested that conspiracy is at its highest in areas of uncertainty, indicating that the previously mentioned systemic lack of knowledge of epidemiology is causing this issue (Prooijen & Jostmann, 2013). Similarly, unsupported beliefs can also be linked to a cognitive desire for closure when an explanation isn't clear (Marchlewska et al., 2018). The same team also recognized that when individuals perceive random patterns, conspiratorial theories are more likely to arise (Van Prooijen & Jostmann, 2013). Here is where questions of safety become favorable to mistruth conception. For instance, adverse side effects, while rare, can appear prevalent as a pattern when the population fails to consider the number of vaccinations. This is especially conducive in the post-COVID-19 era, as those anxious about the COVID-19 vaccine will be more aware of adverse effects. The final most commonly considered conductor of conspiracy is the theory that such beliefs arise when small-scale explanations are given for significant world events, undoubtedly applicable to COVID-19 and many of the communicable diseases now eradicated by childhood vaccines (Brotherton & Eser, 2015).

Now that literature has established the first two pillars of health literacy; the final one is how recognized and understood information is being applied, which can be reviewed through available work. Objectively, vaccination rates will decline during regional or global disruption. A Greek team recently evaluated immunization rates in each of the world's continents, each seeing a significant decrease in vaccination. Historically, this has been commonplace, as they

discussed similar numbers recorded during the Syrian civil war and the Ebola virus outbreak in West Africa (Maltezou, 2022). However, vaccination rates declined significantly in weight due to the limited amount of months they were not administered in the U.S. A team of sixteen physicians discovered that only 57% of eighteen-month-olds became immunized in the U.S. during 2021, and an even more dramatic decrease for children over four years (DeSilva, 2023).

Specific states with literature surrounding vaccination trends in children during this period also universally reveal declines. Colorado saw a drop of 31% for under two years, 78% for children three to nine years, and 82% for those 10-17 (O'Leary et al., 2021). Texas, the state already battling the country's highest vaccination exemption rates, still saw a 47% decrease in immunizations under five months and a 58% decline in children over 16 months (Nuzeth et al., 2021). Furthermore, these numbers fail to recover to normal levels, ruling out the brief administration period halts as the sole factor. A 2022 study reported that over a quarter of parents with children eligible for immunizations reported being vaccine-hesitant (Nguyen et al., 2022). Such percentages highly contrast from those taken in 2019, reflecting over 90% coverage for all scheduled vaccines (Hill et al., 2023). We aim to test the following hypotheses based on our detailed literature review and context analysis.

H1: A higher level of attained education lowers MMR vaccine hesitancy among parents for their children.

H2: A higher income level lowers MMR vaccine hesitancy among parents for their children.

H3: Partisanship strongly influences MMR vaccine hesitancy among parents for their children.

Data and Methods

This study utilizes data from the General Society Survey (GSS) of the National Opinion Research Center (NORC) at the University of Chicago. GSS is a two-step continuous interview-based survey conducted at the household level, which is cross-sectional, covering the United States through urban, suburban, and rural areas. Data is collected yearly. Therefore, the figures within this research are up to date and are not limited by opinions previous to the COVID-19 outbreak. The independent variables (IV) analyzed in this scholarship are education, income, and political party alignment. The summary statistics (Table 1) outline the makeup and range of each variable used in the current study.

Each measures opinions as related to the likelihood of actions concerning vaccination. The original data pool included 1,234 respondents, and the dependent variable is divided into five response ranges: strongly agree, agree, neither agree nor disagree, disagree, and strongly disagree. To gain a more accurate reading of DV, the center value, neither agree nor disagree, must be eliminated as it yields no information as to whether or not the respondent would or would not vaccinate their children, adding any indication for either spectrum. Finally, in all our models (9M1, M2, M3), we have a consistent number of 952 participants.

Results and Analysis

Model 1: the bivariate ordered logistic model finds that one unit increase in education level decreases the vaccine hesitancy among parents regarding MMR vaccination for their children by 46.5%, which is statistically significant. The second model looks at the effects of

education and annual income level and how that impacts vaccine hesitancy. In model 2, we observe that a unit increase in education reduces vaccine hesitancy among parents regarding MMR vaccination for their children by 48.6%. Again, it is statistically significant and holds everything else equal in the model. Also, in model 2, we find that a one-unit increase in family income is associated with a 9.1% decrease in vaccine hesitancy among parents and is also statistically significant (see more in Table 2). In model 3, we use independent and others combined as a reference category and wanted to see the effects of being Democrat or Republican regarding vaccine hesitancy. In model 3, being a Democrat compared to being independent and others reduces vaccine hesitancy by 97.8%, which is statistically significant, holding all else equal.

On the other hand, being a Republican compared to being independent and others increases vaccine hesitancy by 44.9%, which is statistically significant. Our model 3 also shows that a unit increase in education reduces this vaccine hesitancy by 34.8%, and it is statistically significant, holding everything else equal. Similarly, a unit increase in family income reduces vaccine hesitancy by 11.5%, and it is also statistically significant, holding everything else equal.

Virology, the larger field encompassing immunology and viral behavior, is not included in primary or secondary-level education in the U.S. Moreover, the subject consists of only 10% of courses taught at the university level (Kusher & Pekoz, 2021). The more significant portion of the general public is mainly illiterate towards the study, as reflected in the opinions gathered regarding vaccination. Levels of education are highly correlated with personal attitudes and decisions made towards immunizations. The grossly limited avenues for public members to become informed on preventable disease and medical prevention provide a reason for the correlation of generalized vaccine hesitancy with the IV of the education (Educ) variable, which

represents years of schooling. Sixteen years of schooling, or bachelor-level education, was the mean education level in the 2022 GSS survey. At the post-secondary level of schooling, the difference between those who chose to or did not receive the COVID-19 vaccine was as high as 213 of 269 households in the total survey. The contrast was even more significant, following those who have received education at the Master's, Juris Doctorate, and Ph.D. benchmarks. For instance, those with twenty years of schooling saw seventy-one submissions of "getting the COVID-19 vaccine" in the GSS 2022 survey compared to only five that recorded no, amounting to only 7.042% of the sample. Vaccine hesitancy is exceptionally high amongst those with an education up to high school (seven years), to which seven and five years were the only categories to reach the maximum score of a mean of 5. Here, the mean begins to drop off consistently at 15. Vaccination rates for children by household is strongly correlated with educational attainment.

GSS asked a myriad of questions regarding immunizations. According to GSS survey data, which asked, "Are vaccines important for children," results reflected that beyond post-secondary education, vaccine hesitancy for children is nearly nonexistent; furthermore, the highest rates of disagreement are from the associate to the high school level. Disagreement peaked at twelve years of high school or graduate level schooling without attendance at university or community college equivalent institutions. In contrast, individuals who showed the highest agreement completed a minimum of a Bachelor's degree. In large, the variable of education is the furthest limited. With state statutes requiring schooling to a minimum age of fifteen, however often up to 18, depending on state law, opinions from below the high school level are nearly nonexistent (National Center for Education Statistics, 2023).

Nevertheless, the differences between the likelihood of receiving a vaccine and personal attitudes towards their safety increase with the year of education; the years we have adequate

data for are minimal. Additionally, the results of COVID-19 hesitancy and childhood vaccines are similar. For example, those educated up to the high school level alone refuse the COVID-19 vaccine by 41.14%.

As mentioned above, the research recognizes the COVID-19 conspiracy theory's Republican origin and its budding cornerstone within the party. From its conception in conservative discourse three years ago to our first anti-vaccination presidential candidate, immunological hesitancy is evolving into a beacon of GOP values (Piper, 2023). COVID-19 vaccine acceptance has seen the highest contrast between parties, with the independent parties illustrating the highest rejection levels. Currently, the largest third party is the Libertarian party, which characterizes itself on its values of civil liberties, non-interventionism, laissez-faire capitalism, and minimizing governmental scope, precisely the motivation of much of the resistance of the COVID-19 vaccine (Redpath & Winger, 2022). On average, Democrats show a standard deviation difference between Republicans and Independents. Concerning the idea that vaccines do "more harm than good," strong Democrats registered 111 votes in disagreement compared to only 25 vital Republican survey participants. Regarding whether vaccines are safe, large, strong Democrats counted a vote of 130 in the category of strongly agree, whereas Republicans only garnered 21-24 households that agreed.

However, even within the independent parties that lean to either binary, there are significant differences in responses, a difference of seventy-one people. Of those who responded "strongly agree," the response included 106 independents that affiliated with democrats, and only 35 independents that affiliated with republicans. When evaluating the information, it becomes apparent where the gap in immunization coverage is coming from. More broadly, Republicans

also feel vaccines are more likely to harm a patient rather than aid their health, according to another GSS survey.

The political party affiliation responses are arranged into eight categories: strong democrat, not very strong democrat, independent close to democrat, independent (neither no response), independent close to republican, not very strong republican, strong republican, and other party. The responses indicating no response will remain its own category. It is impossible to indicate what system of beliefs would be included in nondescript minor partisan affiliations, to which are not included in this study which focuses on the relationship between Democrats and Republicans. Furthermore, independent responses that indicate the values of either party are organized within them, as they self-represent identifiable traits within that affiliation that showed staggering differences in opinion, affiliating with their indicated party's voting patterns under the previous tests. Therefore, in this new binary, 0 becomes: other party/independent with no indicated affiliation, 1 becomes: democrat and democratically affiliated independents, and 2 becomes: Republican and Republican affiliated independents.

Such results found within the variables of education and partisanship may be correlated with data gathered regionally. The Eastern region of the U.S., the states with the highest number of Republicans and lowest rates of education saw the highest rates of belief that vaccines are harmful; however, the southern sector was leading in this respect. Additionally, vaccine hesitancy is highest in the West South Central, East North Central, Mountain, and South Atlantic regions, to which reflected the highest numbers. The same states saw the lowest rates of COVID-19 immunizations as well. Supplemental research integrated within public school curriculum would better guard the population against misinformation, preventing it from becoming a partisan platform, which would ultimately minimize its regional stronghold.

My ordinal logistic regression model is defined by three independent variables: education, education and income, and education, income, and party affiliation, and is tested by the dependent variable: "Parents should be able to refuse to vaccinate their children against measles, mumps, and rubella." While GSS asks many questions concerning immunizations, I focused on the survey specifically regarding the measles, mumps, and rubella (MMR) shot in my ordinal logistic regression model for multiple purposes. First, vaccine hesitancy primarily originates from the MMR shot, as Andrew Wakefield's original paper propelling a now-debunked link between vaccines and autism was focused on MMR (Rao & Andare, 2011). This is not only one of the most commonly held conspiracy beliefs about vaccines but also the basis for the extending belief that pharmaceutical companies will inevitably harm others through their products (Goldberg & Richey, 2020). Additionally, the MMR's exigence is of great concern.

When writing, a declared measles outbreak affects seventeen U.S. states (Centers for Disease Control, 2024). Measles is highly contagious, infecting nine of ten people who come into contact with the virus. Infection is characterized by fever up to 105°F, cough, coryza, conjunctivitis of the eyes, Koplik spot rash, followed by a maculopapular rash (Centers for Disease Control, 2024). Furthermore, measles can cause complications such as encephalitis, otitis media, bronchopneumonia, laryngotracheobronchitis, and diarrhea, all of which can result in death (Centers for Disease Control, 2024). One of the most severe complications, subacute sclerosing panencephalitis (SSPE), occurs seven to ten years after infection and is a severe neurological degenerative disease that causes blindness, paralysis, behavioral and intellectual deterioration along with seizures, and is always fatal (National Institute of Neurological Disorders, 2024). Patients usually enter a vegetative, comatose state before death, and death occurs on average three years following diagnosis (National Institute of Neurological Disorders,

2024). Since 2013, measles cases have been reported in the U.S. yearly, and the U.S. has already surpassed its total of 2023 cases in the first three months of 2024 (Centers for Disease Control 2024). This is after measles increased thirty-fold in 2023 (The World Health Organization, 2023).

To understand further, we conduct predictive modeling (margins plot) for models 1-3. Figure 1 shows the outcome of all four ordinal levels of vaccine hesitancy MMR for their children among parents, and it shows that one unit increase in four years of education significantly decreases vaccine hesitancy among parents. Most interestingly, figure 1 also shows that the maximum vaccine hesitancy substantially decreases when the level of acting education increases. Simultaneously, the lower vaccine hesitancy intensifies (it becomes lower, which means increased support for the MMR vaccine) with an incremental added level of education (See Figure 1).

We delve deeper to understand the nuance around the strongest vaccine hesitancy (pr: outcome =0). Therefore, figure 2 shows that increased education significantly decreases maximum vaccine hesitancy among participants (**see Figure 2**). Similarly, we explore the level of income and vaccine hesitancy among parents. Again, we stratified and focused only on the maximum vaccine hesitancy among parents (pr: outcome =0). We observe that a higher income level lowers vaccine hesitancy among parents regarding MMR vaccination to their children (**see Figure 3**).

Overall, the unique contribution of this study shows that each unit of four years attained education significantly contributes to the reduction of vaccine hesitancy (MMR) among parents. This is significant seeing as the highest point of disagreement occurs before the university level, where individuals are first potentially exposed to education on subject. Similarly, while students

who major in primarily STEM (science, technology, engineering, and mathematics) related fields have this exposure, other research suggest those who have attended university possess stronger critical thinking skills; skills that are particularly high in liberal arts students (Düşünme & İlişki, 2016).This implies the majority of university students learn the skills to approach issues of public health by various methods. As of the 2022 Census, only 23.1% of those under 25 have attained a Bachelor's degree, suggesting a significant portion of our population do not possess these skills (US Census, 2022). Moreover, my research affirms existing literature identifying Republican affiliation as an indicator of vaccine hesitancy (Jones & McDermott, 2022 ; Milligan, 2022 ; Motta, 2021). Therefore, because each variable is shown to have a relationship MMR vaccine hesitancy, we can accept hypotheses 1-3.

Study Limitations

As the advent of COVID-19 only began four years ago, the time the study covers is limited here, and even further so by the emergence of conspiracies in varying periods within this timeframe. Indeed, this research does not, nor has the current ability to extensively track long-period effects of misinformation concerning COVID-19 and childhood immunization regression as the year of 2024 begins. While enough time has passed to suggest other factors, namely, backlogging of the immunization schedules within clinics in the U.S. is likely not the issue, we still have yet to understand how this trend will continue long term. This would be especially important in an analysis of emerging epidemics of preventable, or mutated strains of preventable disease among the U.S. population.

The exigence of this issue also minimizes the amount of available related research. As of March of 2024, scholarship concerning the relationship between COVID-19 misinformation and the decline of childhood vaccination is virtually nonexistent. Therefore, discussing variables within the issue are what make up the study's evidence exclusively. Each is relative to their respective constant, however, together they draw a new, non-existing conclusion.

Research included in this study is limited by surveys and existing data derived from other sources. All surveys are collected through GSS from the year 2022. Additionally, the region of focus of my study is exclusively the U.S.; nevertheless, some outside research includes data from outside the U.S., all of which are marked as global. At the state level, survey data and outbreak statistics are skewed by population size and urbaness.

Discussion and Conclusions

MMR vaccine hesitancy possesses a significant relationship with the common American socio-demographic attributes: education, socioeconomic status, and partisanship. When surveyed through the lens of new and emerging political and public health contexts, supplemented by existing literature, it becomes apparent that COVID-19 misinformation had an exacerbating effect on vaccine hesitancy. Fallacious COVID-19 related-sentiments and MMR hesitancy share features that identify this connection. The furtherance of the belief that experts should not be trusted in 2020, whether that be through the firing of the US chief analyst on respiratory disease, the dispelling of statements and advice made by experts like Dr. Anthony Fauci as well those from CDC, WHO, mirror the beliefs encouraged by the larger anti-vaccination community (Goldberg & Richey, 2020). Distrust in authority as in indicator of vaccine hesitancy, coupled

with elected officials who propel this lack of confidence, plays on individuals in a variety of ways. Not only through the affirmation of their original belief through myside bias, however because these officials are the very authority Republican individuals *do* trust, because they elected them to office. The stage to suggest this was already set as the alternative, the "lab leak conspiracy" gave individuals a tangible problem that is being "covered up" that was then affirmed by the politicians they elected. Trump himself supported Wakefield's claims about MMR and autism spectrum disorder, tweeting "healthy young child goes to doctor, gets pumped with massive shot of many vaccines, doesn't feel good and changes - AUTISM. Many such cases!" (@realDonaldTrump, 2014). These explain the severe disparity in vaccination opinions between Republican and Democratic voters. Furthermore, the notions surrounding COVID-19 that suggest: 1) COVID-19 is not a severe disease and 2) COVID-19 vaccine manufacturers create harmful products are both applicable to vaccines as a whole. A hallmark of those within the greater anti-vaccination community argue naturally immunity is preferable to immunizations, and don't believe their children are at severe risk (Fredrickson et al. 2004 ; Harmenson et al. 2013). However the most common reason parents resist vaccination is due to their fear of the vaccine safety, primarily due to the ingredients; the same ingredients used in the COVID-19 vaccine (Mckee & Bohannon, 2016 ; Centers for Disease Control, 2023 ; Food and Drug Administration, 2023). Consequently, its reasonable that someone who adopted these beliefs during the COVID Era would extend them to all vaccines as they are also applicable. Literature establishes the extent of this authority bias; the stronger likelihood and greater power figureheads have in the opinions of the general public. Script analysis from the University of Leicester determines some 88.7 million collective Twitter following of Trump, over a quarter of the U.S. population (Rufai & Bunce, 2020).

These issues are also intensified by education due to the related cognitive skills that come with university (Düşünme & İlişki, 2016). The emphasis framing effect, which again, increases the probability of an individual believing a statement if the statement's wording and phrasing is emphasized through agenda setting, is heightened further by a lack of education (Bullock and Velditz, 2017). Furthermore, health literacy's second pillar's basis is in the individual's ability to understand the information given (Naeem & Kamel-Boulos, 2021). Education is correlated with higher cognitive complexity; the ability to isolate source nuances, and consciously consider such subtleties. Therefore, educated individuals are less likely to accept simple solutions to complicated matters (Van Proojian, 2017). Emphasis framing is most often formed by promoting a positive gain or negative loss, nuanced details educated individuals are less likely to miss (Druckman, 2001). In 1997, researchers determined the effect is reduced when participants engage in "detailed mental processing" (Goldstien et al., 2005); results corroborated by a similar 2010 study that revealed one's involvement within said issue reduced the likelihood of the emphasis framing effect (Cheng & Whu, 2010). Widespread ignorance about viral behavior, herd immunity, and immunization has eliminated these mitigated effects; which furthermore helps to give reason to the survey discrepancies between educated classes.

These issue in tandem produce tangible results. The sentiments towards the validity of the origins and dangers of COVID-19 have been shared throughout the Republican and Libertarian parties at a disproportionate rate to other sectors. Regionally, this study's data correlates with states that often elect Republican officials, are the most vaccine hesitant, and have the highest rates of preventable disease outbreaks, excluding California and New York; which is likely attributable to their exceeding population rates (John Hopkins University, 2023). In 2019, an outbreak of measles spread between thirty-one states, with slightly lower reported rates in 2018,

2014, and 2013 (Center for Disease Control, 2023). Pertussis (whooping cough) and rotavirus epidemics report highest case counts in the Eastern United States, specifically Appalachia (Centers for Disease Control, 2023). Mumps has followed a similar regional pattern in the U.S. since 2000, yet is more widespread with lower discrepancies between states (Center for Disease Control, 2023). Most recently, in 2022, varicella (chicken-pox) outbreaks were highest on the East Coast and Texas (Center for Disease Control, 2023).

Regional and partisan-aligned vaccine hesitancy not only has a feedback effect into viral contraction, but state policy. It could be argued Republican politicians only create such a policy because their voters themselves are already vaccine hesitant, however, the context of COVID-19 makes this impossible. COVID-19 was a global emergency; natural disasters are often unprecedented, and not traditionally left open for optional response through election cycles. The first to respond were politicians, not constituents. The first to speak against COVID-19 prevention were Republican politicians, ending any "chicken or the egg" arguments that anti vaccination as a true policy issue, not simply internet anecdotes, originated through citizens. Because they were the first to raise concern, politicians situate themselves as the influencing, not influenced opinion. An opinion which holds immense power through the vehicle of authority bias. While incremental in progress, states have begun to introduce non-religious or medical exemptions for vaccinations in public school districts. States with the weakest medical exemptions have the highest rates of the spread of preventable disease (Ocasio et al., 2023). According to policy observations from the University of California College of Law: San Francisco, state bills challenging vaccine related-law, whether they be related to COVID-19 or another virus, have increased at the highest historical rate since the pandemic (Rosenthal, 2023). Exemptions in Texas have increased over 500% from 2010 to 2022 (Balch, 2023). Austin, Texas

saw school immunization exemption rates as high as 52.9%, several times exceeding the CDC herd immunity threshold (Texas Department of Health, 2023).

Thirty states total reported exponential declines in immunization coverage (Seither, 2023). Nationally, over 250,000 kindergarteners are currently unprotected from the measles virus, and while this number may appear low, considering nine out of ten unvaccinated people who are exposed to the virus will become infected, the results may be catastrophic (Rosenthal, 2023). This risk does not only extend to the unvaccinated, but considering viral evolution, the potential for measles to adapt and infect vaccinated people is not outside the realm of possibility (Muloz-Alia et al., 2015). Economically, a measles epidemic may have devastating consequences, as each case in a recent outbreak in Washington state cost $3.4 million dollars (Pike et al., 2021). Considering measles is only one of nineteen routinely scheduled vaccines for children, the weakening of multiple strains has the potential to cripple global health and economic stability. According to the data at hand, Republican states of the middle south and eastern central regions, states with the lowest rates of education, pose the greatest risk. Because there are many variables affecting immunization coverage, even if the greatest impact is localized, a multi-faceted approach is necessary. In Kansas, the state legislature stripped the authority of their state health department to "control the spread of infectious or contagious diseases," which House members have attributed to COVID-19 (HB 2285). Both Idaho (SB1130) and Utah have removed the right of private entities to require vaccination for employment (HB 131). Montana prohibits hospitals, hospice, and other care facilities from requiring visitors to receive immunizations before visiting patients (SB 308).

The 2024 U.S. presidential seat now sees its first candidate using anti-vaccination as a platform. Robert F. Kennedy Jr., chair of Children's Health Defense, profits over $10 million

dollars per year and primarily focuses on state-level anti-vaccine litigation and legislative funding for the cause (Piper, 2023). Previously, he's published three books concerning immunization conspiracy and promotes scientifically unfounded claims from vaccination's link to autism spectrum disorder (Kennedy, 2021). In his own online campaign statement, Kennedy considers vaccines as a civil liberties crisis, particularly within the scope of the First Amendment right to assembly and worship, as well as the Seventh Amendment's right to trial by jury (Kennedy, 2023), disregarding the judiciary's long history of state police and emergency powers (Galva et al., 2005). Trump offered Kennedy a position as chair of a Vaccine Safety Task Force (Weeks, 2017). Notwithstanding this committees' failure to emerge, it marks the beginning of vaccines' place in our House chambers and Senate floors; never mind their often decades of use and safety. Our post COVID-19 era has benchmarked a shift from state agency regulation of public health into the hands of non-licensed legislature domination.

COVID-19 misinformation, arising from the mouths of politicians in 2020, helped to generate a four-year fight for public safety. A fight fought between an unprepared populus, only to be once again fed back into the legislature, and ultimately, back into the power of fatal preventable disease. Through survey analysis, it becomes arguable that the near consensus of vaccine effectiveness and safety has springboarded from the advice and research of professionals into fractured discourse woven as a mosaic of truth and fiction. The genesis of doubt seeded by Republicans in 2020 was the catalyst for half-truths becoming lies, where Twitter became a game of telephone, and where the populous lost their trust in true research. COVID-19 misinformation, like its viral counterpart, could not be contained, spreading to all people of the U.S., and into the field of immunology as a whole. Through the avenue of the lab leak conspiracy, came childhood immunization's regression through underestimation of viral severity

and unsupported fear of vaccine manufacturers; the manufacturers of all immunizations. As we proceed into the uncharted territory of extreme immunization backsliding, we must prepare ourselves for epidemics to come in the case of failed recovery.

As education has a relationship with vaccine hesitancy, it's important to look at public school curriculums closely and determine whether they're teaching necessary skills on public health, as well as critical analysis. In the same respect, those in positions of power, especially as the legislature becomes increasingly involved in communicable disease regulation, need to consider further accountability towards their own knowledge, as well of their own dialogue on immunizations and disease spread. Maintaining herd immunity is imperative to the health and safety of the US. Breaking the chain of transmission by limiting the pool of susceptible individuals and hindering the spread and evolution of disease is essential to preserving life and health of our populus. In future work, other geosocial attributes may be explored, testing MMR vaccine hesitancy by variables such as religion, sex, region, etc. Other common identifying qualities of the American populus may change results at different rates. In addition, the factor of the pandemic is yet to be observed long-term, which may yield new information regarding COVID-19's relationship with emerging outbreaks in the 2020s.

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Table 1: Summary Statistics

Appendix 1: Summary Statistics

Variable	Type	Categories	Mean	Std. Dev.	Min	Max	Total
DV: vax_opinion Please tell us the extent to which you agree or disagree with the following statement: "Parents should be able to refuse to vaccinate their children against MMR."	Ordinal	Strongly Agree (0), Agree (1), Disagree (2), Strongly Disagree (3)	1.875	0.951	0	3	952
IV: educ_group	Ordinal	Various categories (0-4)	2.985	0.734	0	4	952
IV: Income	Ordinal	Various categories (1-12)	11.41	1.73	1	12	872
IV: Democrats	Binary	No (0), Yes (1)	0.460	0.499	0	1	952
IV: Independent and others (reference category)	Binary	No (0), Yes (1)	0.195	0.397	0	1	952
IV: Republicans	Binary	No (0)	0.299	0.458	0	1	952

Table 2: Ordered Logistic Models (Odds ratio)

Variable	Model 1 (Education Only)	Model 2 (Education & Income)	Model 3 (Education, Income, & Political Affiliation)
DV: MMR Vaccine Hesitancy			
Educational Group	1.465*** (0.12)	1.486*** (0.13)	1.348*** (0.12)
Total Family Income	-	1.091* (0.04)	1.115** (0.04)
Democrats	-	-	1.978*** (0.32)
Republicans	-	-	0.551*** (0.10)
Threshold 1 (cut1)	0.348*** (0.09)	0.987 (0.45)	0.972 (0.45)
Threshold 2 (cut2)	1.425 (0.35)	4.009** (1.82)	4.223** (1.94)
Threshold 3 (cut3)	7.633*** (1.96)	22.673*** (10.53)	26.879*** (12.62)
AIC	2443.042	2226.544	2156.427
BIC	2462	2250	2190

Significance levels: *p < 0.05, **p < 0.01, ***p < 0.001

Figure 1:

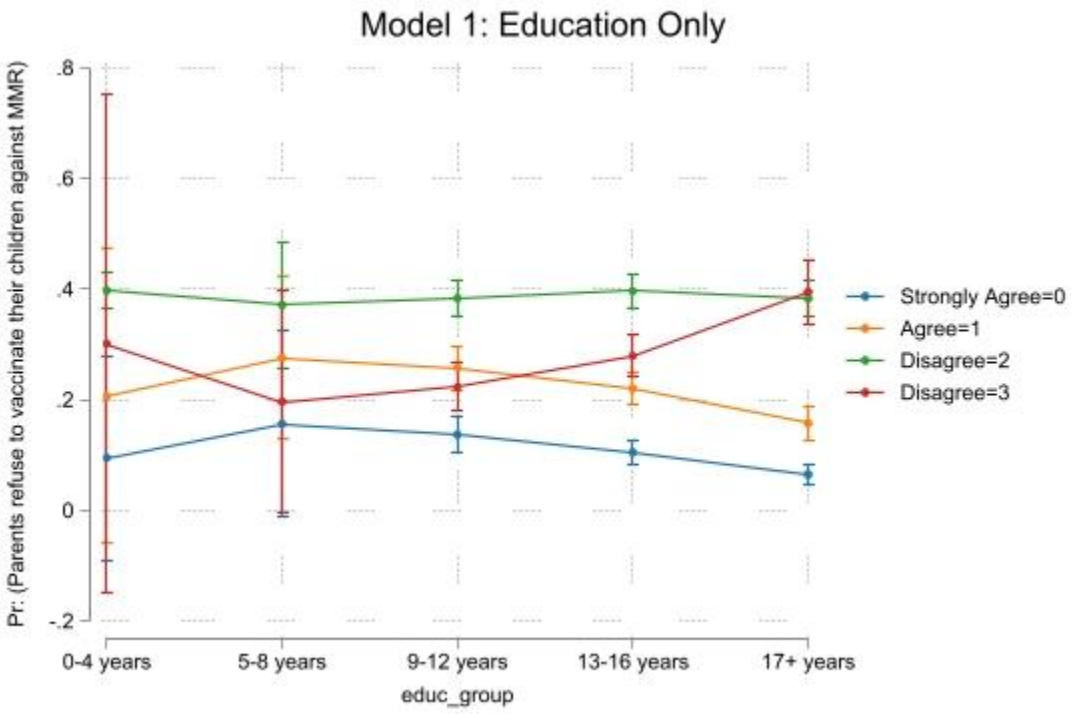

Figure 1: Predictive Modeling (Effects of attained education on MMR Vaccine Hesitancy among parents)

Figure 2:

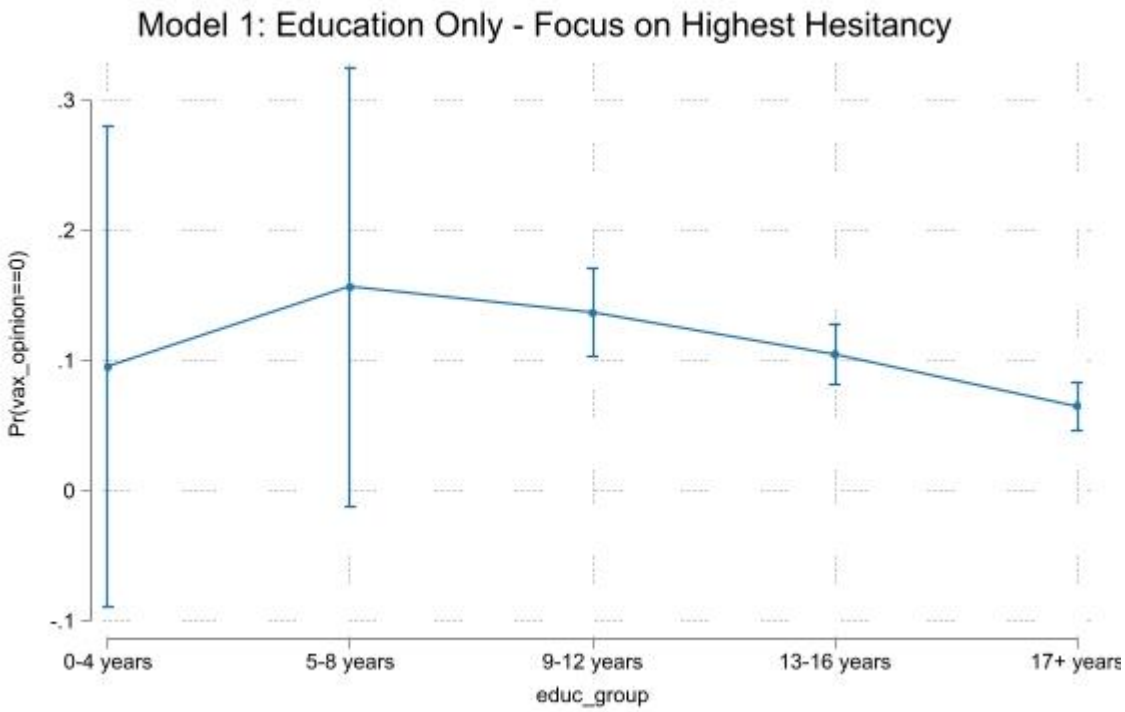

Figure 2: The predictive modeling of maximum vaccine hesitancy based on attained education level (Pr: Outcome = 0). The participants strongly agree, "Parents should be able to refuse to vaccinate their children against measles, mumps, and rubella."

Figure 3:

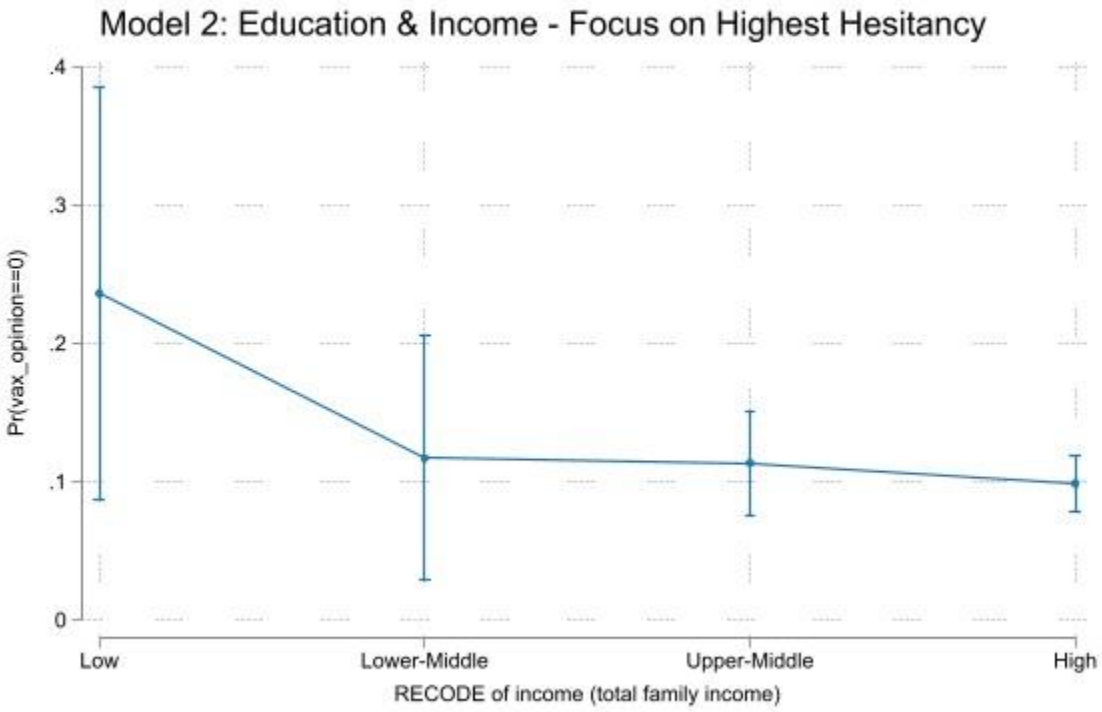

Figure 3: The predictive modeling of maximum vaccine hesitancy based on income level (Pr: Outcome = 0). The participants strongly agree, "Parents should be able to refuse to vaccinate their children against measles, mumps, and rubella."