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# A Systematic Review of the Rationale for Vaccine Hesitancy among American Parents

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**Abstract**

**Introduction:** Vaccines are one of the most successful interventions in the history of public health. They are largely responsible for the near eradication of several diseases. However, some people are vaccination averse which can lead to vaccine hesitancy. Vaccine hesitant parents are those that refuse or delay getting their children vaccinated despite the availability of vaccination services. This phenomenon often occurs despite parent's belief that vaccines are effective. The purpose of this review was to exam available literature to identify predictors of vaccine hesitancy among parents and parental rationale for vaccine hesitancy.

**Methods:** This literature review utilized the SCOPUS database to identify articles examining vaccine hesitancy among American parents, published from 1997 to 2020, inclusive. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) methodology was utilized to select articles used in the final literature review.

**Results:** Fifty-one articles were included in the final review. Predictors of vaccine hesitancy included demographics (income, education, marital status, race/ethnicity), healthcare practices (provider relationship, use of complementary or alternative medicine), and social-cultural factors. Parental rationale for vaccine hesitancy included concerns about the safety of vaccinations, not fearing diseases covered by vaccinations, and the belief that vaccines were not necessary. The most consistent and prevalent theme of vaccination hesitancy was the strength of the influence that the medical provider has on the parents.

**Conclusion:** Balanced communication with a trusted medical provider that addresses both the benefits and risk of vaccinations, along with parents' concerns about safety are important factors to reduce vaccine hesitancy among parents.

**Keywords:** vaccine hesitancy, parents, United States

## 1. Introduction

### *1.1 Introduction to the Problem*

In the history of public health, one of its most effective weapons in preventing disease is immunization. This has led to the passage of important legislation and the initiation of programs that have been affective at controlling many infectious diseases. One such intervention is the United States Immunization Program, which is a collection of legislation meant to require or encourage vaccination. It is considered to be one of the most important achievements of American public health and for good reason (Anderson, 2014). The immense power of immunization has resulted in the eradication of one, and the near eradication of other diseases. However, there remain pockets of underserved populations that have not experienced the full benefits of immunization. For example, measles outbreaks during the 1980's and early 1990's affecting mostly low-income children who were concentrated in inner cities (Whitney, Zhou, Singleton, & Schuchat, 2014). This highlighted the need to increase access to programs that educate and provide vaccination opportunities for such populations. The historic Vaccines for Children (VFC) program followed in 1993, which aimed to educate communities about vaccines, and to provide them at no cost to low-income, uninsured, and underinsured children (Fisk, 1993; Santoli, Rodewald, Maes, Battaglia, & Coronado, 1999).

The success of vaccines has allowed some to view preventable diseases as remnants of earlier times. The COVID 19 pandemic has proven this notion to be false. The governmental effort to facilitate the creation, manufacturing, and delivery of a vaccine to the American public has been extraordinary. It is now clear that the ability to quickly deliver vaccines to large portions of the population is an essential public health function. The challenge of getting vaccines into arms is complicated by recent data which indicates that approximately one-fourth of American parents hold serious reservations about vaccinating their children (Kempe et al., 2020). To that end, "vaccine hesitancy" has become the most visible threat to accomplishing the sought-after goal of herd immunity. Herd immunity is the circumstance in which a sufficiently large portion of the population of an area is immune to a specific disease, and thus, there are not enough susceptible hosts for disease transmission to continue (Fine, Eames, & Heymann, 2011). The beauty of herd immunity is that even those who for medical reasons cannot be vaccinated, and those who refuse, are still protected from the disease.

Vaccine hesitancy refers to the delay in acceptance or refusal of vaccination despite availability of vaccination services. Vaccine hesitancy has been found to be complex and is context specific across time, place, and vaccine. It is influenced by factors such as complacency, convenience, and confidence. To that end, the World Health Organization listed vaccine hesitancy as one of the top 10 threats to global health in 2019 (World Health Organization, 2019).

The history of vaccinating humans is long and replete with stops and starts. Public health officials have long struggled to convince lay communities to accept the safety and effectiveness of vaccines. Not unexpectedly, the American history of vaccine hesitancy largely parallels the history of the procedure itself. The anti-vaccine movement in the early days was persistent and often violent. There were two instances that define early American opposition to inoculation. The 1730 and 1774 smallpox riots in Marblehead, Massachusetts, represent some of the most violent opposition (Roads, 1880). In 1730, in response to the smallpox outbreak in Boston, the people of nearby Marblehead decided to ban the practice of variolation, which is the purposeful infection of people with what is believed to be a weak strain of smallpox, to produce subsequent immunity. When community members disobeyed the directive, there was rioting and attempts to burn the homes of those engaging in the practice. Some thirty years later, on the eve of the American Revolution, Marblehead residents again rioted when a local smallpox hospital attempted to immunize community members (Roads, 1880). Soon after anti-vaxxers organized, and in 1879 the Anti-Vaccination Society of America was founded in New York (Novak, 2018).

While vaccine hesitance is fueled by ignorance, some resistance to vaccinations is legitimate. Early methods used to variolate and vaccinate for smallpox involved arm to arm transfer of the pus from an infected person to a susceptible one. This led to some of those receiving vaccinations being exposed to bloodborne diseases, including syphilis. While no vaccine is without risk, modern medicine has tilted the risk-benefit relationship strongly in favor of the benefits (Vetter, Denizer, Friedland, Krishnan, & Shapiro, 2018).

However, the challenge to educate the public about the safety of vaccinations continues until today. In 1998, a publication by Dr. Andrew Wakefield and colleagues reignited the anti-vaccination movement. Wakefield proposed that there was a link between the MMR vaccine and autism (Wakefield et al., 1998). After subsequent review it was found that there were serious methodological and ethical concerns with the Wakefield study (Kolodziejski, 2014; Lindley & Milla, 1998). These issues ranged from sample selection, to epidemiological flaws, non-reproducibility, and the existence of undisclosed financial backing. However, damage had been done. From this bad science sprung an international rejection of the recommended vaccine schedule, particularly for the MMR vaccine (Callender, 2016).

### *1.2 Purpose Statement*

The need to understand the reasons for vaccine hesitancy in the United States is paramount to counter it and to increasing vaccination coverage rates. The purpose of this review was to exam available literature to identify predictors of vaccine hesitancy among parents and parental rationale for vaccine hesitancy.

## 2. Methods

### *2.1 Study Design*

A literature review of vaccine hesitancy among American parents was conducted. The SCOPUS database was used to search for articles. Primary and secondary search terms were used to identify these articles (Table 1).

Table 1. Primary and Secondary Search Terms

| | |
|---|---|
| Primary keywords | "Vaccines", "immunizations", "hesitancy", "hesitant", "vaccine-hesitant", "anti-vaccination", "parents", "children", and "United States" |
| Secondary Keywords | "under immunized", "refusal", "barrier", "attitudes", "beliefs", "demographics", "socioeconomic status", "race", "gender", "age", "education" |

The requirements for papers to be included in this review were articles written or translated into English about vaccine hesitancy among parents in the United States and published from 1997 to 2020 inclusive. The year 1997 was chosen as a starting point for two reasons. First, this was a year before Wakefield's study was published. Second, this was approximately four years after the measles epidemic hit American inner cities which resulted in the Vaccines For Children program. Filters were used in SCOPUS that allowed us to identify articles published in this time frame and to limit the search to the United States. All study designs were considered for inclusion.

*2.2Article Selection Methodology*

This search used Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) methodology to select articles used in the final literature review (Moher, Liberati, Tetzlaff, & Altman, 2010). In the initial phase, articles were retrieved and examined, and duplicate articles were removed. In step 1, titles and abstracts were reviewed and those that did not meet the inclusion criteria of (1) being conducted in the United States, (2) written or translated into English, and (3) focused on vaccine hesitancy among parents were removed. In step two, articles were read, and those that did not meet the above inclusion criteria after this deeper examination were removed (See Figure 1). To limit the risk of bias a reference librarian was consulted regarding our selected key words, and two researchers (J.L.F and J.F) had to agree to include all articles.

## 3. Results

Initially, 998 articles were identified. After removing duplicate titles 887 articles remained. Of these 887 articles, 811 were excluded in step 1, leaving, 76 articles to be read in full. Of these, 51 met all inclusion criteria (Figure 1). Table A1 includes information about the reviewed manuscripts with the year of the study publication, a description of the participants, the study design and results.

*3.1 Predictors of Vaccine Hesitancy among Parents*

Of the 51 articles reviewed, 44 discussed variables that correlated with vaccine hesitancy among parents. These factors clustered into three categories: Socio-demographics, Healthcare practices, and Social Cultural Factors (Table 2).

Table 2. Predictors in number and percent of selected articles

| | | n | % of topic | % of total articles |
|---|---|---|---|---|
| Total | | 44 | | 86.3% |
| Demographics | | 30 | 100% | 58.8% |
| | Socioeconomics | 12 | 40.0% | 23.5% |
| | Race/ethnicity | 6 | 10.0% | 11.8% |
| | Age | 3 | 7.5% | 5.9% |
| | Marital Status | 3 | 7.5% | 5.9% |
| | Language | 1 | 3.3% | 2.0% |
| | Country of birth | 1 | 3.3% | 2.0% |
| Healthcare Practices | | 25 | 100% | 49.0% |
| | Provider Relationship | 24 | 96.0% | 47.1% |
| | Complementary or Alternative Medicine | 5 | 20.0% | 9.8% |
| Social/Cultural | | 8 | 100% | 15.7% |
| | Social Clustering | 5 | 62.5% | 9.8% |
| | Knowledge of a severe reaction | 3 | 37.5% | 5.9% |

#### 3.1.1 Demographics

##### 3.1.1.1 Socioeconomics

There were 12 articles that included assessment of socioeconomic status, with 11 discussing income and 10 analyzing educational attainment. Seven articles mentioned that those with a high socioeconomic status were more likely to be hesitant about vaccines, four stated that those who with lower socioeconomic status were more likely to hesitate about vaccinations, and one article found that socioeconomic status did not impact their results.

Studies showed that parents were more likely to delay or refuse their children vaccinations if they had a household income greater than 400% of the Federal Poverty Line (P. J. Smith, et al., 2011), lived in wealthier census tracts (Hegde et al., 2019), were socially advantaged (Gilkey, McRee, & Brewer, 2013), or had an annual income over $75,000 (Luthy, Beckstrand, & Meyers, 2013). An ecological study found that vaccination hesitancy rates were higher in wealthier suburbs (Leib, Liberatos, & Edwards, 2011). Upper-middle class parents were also more likely to display vaccine hesitancy (Wang, Baras, & Buttenheim, 2015). For example, a California study found that expensive private kindergartens (tuitions of $10,000 or more) were two times as likely to have 20% or more of students' parents request vaccine exemptions than were lower cost kindergartens (McNutt et al., 2016). Parents with college educations (P. J. Smith, et al., 2011) were also more likely to delay or refuse vaccinations for their children (Leib et al., 2011). A study completed in Utah found that nearly half of the under-immunizing parents had some college education (as opposed to no college education or graduate school) (Luthy, Beckstrand, & Callister, 2010) while another study found that parents with private health insurance were more likely to be vaccine hesitant than were those without such coverage (P. J. Smith, et al., 2011).

In contrast, a 2005 study found that those who rated themselves as being "cautious" about vaccination were more likely to be lower income, and those who were considered "unconvinced" of the safety and effectiveness of vaccines had either some or no college education (Keane et al., 2005). Other studies found that mothers who were vaccine hesitant had lower levels of education and that lower income was associated with refusing some vaccines (Bardenheier et al., 2004). Additionally, those who had lower incomes were also two times more likely to believe that government information about vaccinations was unreliable (Lee, Whetten, Omer, Pan, & Salmon, 2016). Lastly, one study found no relationship between vaccine hesitancy and education or socioeconomic status (Fitch & Racine, 2004).

##### 3.1.1.2 Race/Ethnicity

Six studies analyzed findings based on race and ethnicity. Three of them indicated that race/ethnicity did not significantly impact hesitancy (Fitch & Racine, 2004; Keane et al., 2005; Orr & Beck, 2017), and three showed nuanced differences (Freed, Clark, Butchart, Singer, & Davis, 2010; Hirth, Fuchs, Chang, Fernandez, & Berenson, 2019; Lee et al., 2016). In one study nonwhite parents were less likely to trust government sources concerning vaccines (Lee et al., 2016). Interestingly, Hispanic parents were the most likely to be concerned about serious adverse effects and autism from vaccination, but were also the least likely to refuse a physician's direct recommendation to vaccinate (Freed et al., 2010).

##### 3.1.1.3 Age

Three studies found a relationship between the parental age and vaccine hesitancy with some discrepancies (Bardenheier et al., 2004; Gilkey et al., 2016; Smith, P. J. et al., 2011). The first study found that when combined with other variables, older, wealthier mothers with more children were more likely to refuse or delay vaccination (Smith, P. J. et al., 2011). Another found that younger mothers were less likely to question the safety of vaccines than were older mothers (Gilkey et al., 2016)and a third study found that mothers who delayed or refused vaccines tended to be younger than those who did not (Bardenheier et al., 2004).

##### 3.1.1.4 Marital Status

There were three studies reporting the relationship of marital status vaccine hesitancy (Gilkey et al., 2016; Keane et al., 2005; Smith, P. J. et al., 2011). While one study found that married mothers were more likely to be vaccine hesitant (Smith, P. J. et al., 2011), another found that single parents were more likely to be "unconvinced" of the safety and necessity of vaccines (Keane et al., 2005). A third investigation showed no relationship between marital status and parental vaccination beliefs (Gilkey et al., 2016).

#### 3.1.2 Healthcare Practices

The next set of predictors that were identified were the healthcare practices of the parents. These could be divided into two categories: relationship with a provider, and seeking complementary and alternative medical treatments.

#### 3.1.2.1 Provider Relationship

Provider relationships were found to be the most frequently acknowledged (n=24) predictor of whether a parent refused or delayed vaccinating their child, suggesting that doctors are a powerful source of vaccine information (Taylor & Newman, 2000). Physicians were frequently able to convince vaccine hesitant parents to change their minds about delaying vaccination of their children (Gust, Darling, Kennedy, & Schwartz, 2008). In one study, trust and satisfaction with pediatrician interaction was linked with vaccine hesitant parents ultimately immunizing their child on schedule (Benin, Wisler-Scher, Colson, Shapiro, & Holmboe, 2006). In other studies, vaccine hesitant parents cited a physician's recommendation as a motivating factor for changing their minds about vaccination (McCauley, Kennedy, Basket, & Sheedy, 2012; McCoy, Painter, & Jacobsen, 2019). Further, doctor's recommendations were considered to be the most important factor for those who vaccinated against the influenza every year (Flood et al., 2010), and that provider trust was key to vaccine confidence (Chung, Schamel, Fisher, & Frew, 2017; Orr & Beck, 2017; Zangger Eby, 2017).

Researchers also discovered that parents were less likely to trust physicians who lectured them (Fredrickson et al., 2004). Fredrickson and colleagues found that vaccine hesitant parents were not likely to care about social obligations that a physicians mentioned and wanted physicians to understand that their own children were what was the most important to them (Fredrickson et al., 2004). Some parents who believed that they were lectured to did not think that physicians provided "balanced information" (Glanz et al., 2013).

From the physicians' perspective, nearly one third said that they would dismiss families' who refused vaccines, and 28% said that they would dismiss vaccine hesitant families (Flanagan-Klygis, Sharp, & Frader, 2005). Many doctors also believed that nonconfrontational dialogue with hesitant parents at early stages of vaccine discussions which provided clear unambiguous answers with personal stories were effective in changing parent opinions about the potential adverse effects of vaccinations (Kempe et al., 2011).

While physicians were the most trusted source of vaccination information, parents who were unconvinced about vaccinating their child were less likely to trust their physician and less likely to request information from doctors than were parents without vaccine hesitancy (Keane et al., 2005). Vaccine hesitant parents were also more likely to be dissatisfied with their providers (Salmon et al., 2009), and were 2.64 times more likely to distrust doctor provided information on vaccines (Lee et al., 2016). As expected, those who distrusted the medical establishment were less likely to vaccinate their children (Gaudino & Robison, 2012), and even some parents who reported trusting their physician were still skeptical about whether they were being provided honest vaccine information (Glanz, Kraus, & Daley, 2015).

#### 3.1.2.2 Complementary and Alternative Medicine

Five studies identified a link between vaccine hesitancy and seeing a practitioner of complementary or alternative medicine (CAM), such as a homeopathy or chiropractic. A trusting relationship with a practitioner of a CAM was an inhibitor for getting children vaccinated (Benin et al., 2006). Vaccine hesitant parents were almost twice as likely to report being influenced by a CAM provider than were vaccine accepting parents (Smith, P. J. et al., 2011). Parents who were unconvinced about vaccines were more likely to seek care from a CAM provider than pro-vaccine parents (Keane et al., 2005), and vaccine hesitant parents trusted CAM providers more than physicians (Lee et al., 2016), and sought out vaccine information from those CAM providers (Salmon et al., 2009).

### 3.1.2 Social/Cultural

There were several social/cultural variables that were associated with vaccine hesitant individuals. Three studies mentioned that those who delayed or refused vaccines were more likely to know of someone who had an adverse reaction to a vaccine or believed had been injured by a vaccine (Chung et al., 2017; Gaudino & Robison, 2012; McCauley et al., 2012). Five studies mentioned that there was a social clustering aspect to vaccine hesitancy. Kennedy and colleagues mentioned that individuals who were vaccine hesitant were also more likely to live in states that allow philosophical exemptions to vaccination (Kennedy, Brown, & Gust, 2005), three studies mentioned that schools served as a clustering points for non-vaccinated or under vaccinated children (Brennan et al., 2017; Gaudino & Robison, 2012; McNutt et al., 2016), and one study reported that specific neighborhoods and communities were likely to exhibit vaccine hesitancy clustering (Hegde et al., 2019).

### *3.2 Parental Rationale for Vaccine Hesitancy*

Of the 51 articles reviewed in this study, 23 mentioned other reasons why parents chose to delay their children's vaccinations (Table 3). The most common rationale for delaying or refusing vaccination was over safety concerns, with 18 articles mentioning them (Bardenheier et al., 2004; Blaisdell, Gutheil, Hootsmans, & Han, 2016; Flood et al., 2010; Freed et al., 2010; Gaudino & Robison, 2012; Gilkey et al., 2013; Gust et al., 2008; Hirth et al., 2019;

Keane et al., 2005; Luthy et al., 2010; McCauley et al., 2012; Navin, Wasserman, Ahmad, & Bies, 2019; Salmon et al., 2009; Smith, M. J., Woods, & Marshall, 2009; Thorpe, Zimmerman, Steinhart, Lewis, & Michaels, 2012; Wheeler & Buttenheim, 2013; Zangger Eby, 2017; Zimmerman, Schlesselman, Baird, & Mieczkowski, 1997). Of those, seven discussed side effects (Blaisdell et al., 2016; Flood et al., 2010; Freed et al., 2010; McCauley et al., 2012; Salmon et al., 2009; Zangger Eby, 2017; Zimmerman et al., 1997), and four specifically mentioned fear of autism (Bardenheier et al., 2004; Freed et al., 2010; Luthy et al., 2010; Salmon et al., 2009). The next most common reason for vaccine hesitancy was the belief that, while vaccines were necessary and important, young children were given far too many vaccines which overtaxes children's developing immune systems (Fitch & Racine, 2004; Freed et al., 2010; Keane et al., 2005; Smith, M. J. et al., 2009; Zimmerman et al., 1997).

Table 3. Reasons for Delaying Vaccinations and Percent of Articles

| | n | % of articles |
|---|---|---|
| Total | 23 | 45.1% |
| Safety Concerns | 18 | 35.3% |
| Side Effects | 7 | 13.7% |
| Autism | 4 | 7.8% |
| Do not fear disease | 8 | 15.7% |
| Do not believe | 6 | 11.8% |
| Vaccines are necessary | | |
| Too many vaccines | 5 | 9.8% |
| Conflicting information | 5 | 9.8% |
| Prefer | 5 | 9.8% |
| "natural immunity" | | |
| Vaccine effectiveness | 2 | 3.9% |
| Sensitive to Pain | 1 | 2.0% |
| Cause illness | 1 | 2.0% |
| Social norms | 1 | 2.0% |

While most parents, both vaccine hesitant and not, have strong beliefs in vaccine effectiveness, two studies did mention that lack of confidence in vaccine effectiveness resulted in parents eschewing immunizations (Callaghan, Motta, Sylvester, Trujillo, & Blackburn, 2019; Kennedy et al., 2005). Another six studies reported that vaccine hesitant parents believed that the consequences of non-vaccination were not severe (Glanz et al., 2013; Hirth et al., 2019; Keane et al., 2005; LaVail & Kennedy, 2013; McCauley et al., 2012; Wang et al., 2015). Five papers mentioned that parents thought they received too much conflicting information which made it difficult for them to decipher what they should believe, causing them to reject the recommended vaccination schedule (Chung et al., 2017; Fredrickson et al., 2004; Salmon et al., 2009; Wang et al., 2015; Wheeler & Buttenheim, 2013). There were also four studies where parents reported rejecting vaccination because of their belief that the artificial nature of the immunization was inferior to the natural immunity afforded by surviving diseases (Amin et al., 2017; Luthy et al., 2013; McCoy et al., 2019; Reich, 2016).

## 4. Discussion

The most consistent and prevalent theme of vaccination hesitancy is the relationship with, and influence that the medical provider has on the parents. Parents who were originally vaccine hesitant were far more likely to change their minds about vaccination when their provider was willing to thoroughly explain the risks and benefits of vaccinations (Benin et al., 2006; Kempe et al., 2011). Even parents who espoused religious beliefs as a basis for refusal were willing to listen to a trusted medical provider. Parents were most likely to be convinced by providers who respected the authority of the parent (McCoy et al., 2019). However, one study found that vaccine hesitant parents chose to delay or refuse vaccination because they were swayed to do so by their physician (P. J. Smith et al., 2011), while other studies showed that those who did not trust their local providers were also much more likely to be vaccine hesitant. This speaks to the strength of this relationship and the importance of physicians taking the time

to explain the significance of vaccinations with parents (Gaudino & Robison, 2012; Keane et al., 2005; Lee et al., 2016; Salmon et al., 2009).

Interestingly, parents who were vaccine hesitant were generally open to dialogue, and one of the aspects that was important was that parents felt they were receiving "balanced" information (Glanz et al., 2013). This is vital because even when there was personal trust between the provider and parent, parents did not necessarily believe the provider was painting a balanced picture (Salmon et al., 2009; Wheeler & Buttenheim, 2013). However, in fairness to doctors, they may not present a balanced case for or against vaccination because they strongly believe in vaccine safety, effectiveness and its necessity. Thus, parents may perceive strong medical recommendations for vaccination as unbalanced, even though it is sound medical advice.

The importance of vaccinations to physicians is revealed by a study that found that almost a third of them had dismissed patients from their practices that were hesitant or had refused vaccination for their children (Leib et al., 2011). This series of steps has led to the clustering of parents in physicians' practices who are vaccine hesitant (Buttenheim, Cherng, & Asch, 2013). Other studies show that vaccine hesitant parents who chose to delay or refuse vaccinating their children were far more likely to be patients of physicians who support their beliefs (Kestenbaum & Feemster, 2015).

It seems likely that if providers are themselves vaccine hesitant, they would be more likely to support vaccine hesitant parents' views. In fact, one study showed that vaccine hesitant parents were likely to "shop around" and select their provider based on whether that provider would be willing to accept their vaccination choices (Chung et al., 2017). It appears that those who had the means to find a like-minded provider may explain why those who were socioeconomically advantaged (i.e. higher income and private health insurance) were more likely to refuse or delay vaccination. Less affluent vaccine hesitant parents may not have the same options of finding a provider who will allow them to choose their child's vaccine schedule.

Another interesting finding was that of the association between CAM practitioners and vaccine hesitancy. Those who placed less trust in traditional medical providers were more likely to utilize and trust CAM practitioners. This "holistic" or natural approach to health aligns with beliefs that vaccines are not natural and therefore inferior to natural approaches. In fact, pre-schools that stress these holistic principles were found to be clustering points for children with higher rates of personal belief vaccine exemption use in California (McNutt et al., 2016). However, because of the cross-sectional nature of most of these studies, researchers are precluded from determining whether doctors have influenced patients to be vaccine hesitant, or whether doctor shopping is the cause of vaccine hesitant patients landing in specific doctor's offices (Buttenheim et al., 2013; Kestenbaum & Feemster, 2015; Mergler et al., 2013).

The findings of socioeconomic predictors of vaccine hesitancy were mixed. Most articles mention that higher socioeconomic individuals were likely to be vaccine hesitant, yet others show that individuals from lower education and lower income were also likely to be hesitant about vaccines. More research is need on this topic, but it suggests that the wealthy and poor may have different reasons for being vaccine hesitant.

Beliefs concerning the efficacy of vaccines did not appear to differentiate vaccine hesitant or vaccine supportive parents. Studies showed that both groups of parents believed that vaccines were effective at preventing children from contracting disease. However, even the parents that were fully intending to vaccinate their children had concerns about the safety and potential side-effects of vaccines. Of the 23 articles that examined reasons for vaccine hesitancy, 78% mentioned safety concerns. The fear of their child having long-lasting side effects and the belief that their children were unlikely to get the disease in the first place played roles in their decisions (Smith, P. J. et al., 2011). Interestingly, one study found some hesitant parents argued that their children were already protected because these children's playmates had already been immunized (Salmon et al., 2009). Such an argument suggests that such parents believed that their own children were the beneficiaries of herd immunity, even though they saw no need to be responsible members of the herd.

The second most prevalent reason for vaccine refusal or delay was the belief that the immune system would be overtaxed if too many vaccines were given at once (Fitch & Racine, 2004; Freed et al., 2010; Keane et al., 2005; Smith, P. J. et al., 2011; Zimmerman et al., 1997). While parents who refused or delayed getting their children vaccinated may have believed that vaccines would prevent their child from getting sick, many did not believe vaccines were necessary to prevent disease. Some believed that the likelihood of the disease affecting their child was so low that immunization was not worth the risk (Smith, P. J. et al., 2011; Wang et al., 2015). Others believed that severity of the diseases covered by vaccine were not as threatening as the possible side-effects of the vaccines (McCauley et al., 2012), or believed that children should acquire their immunity naturally by contracting the disease (Luthy et al., 2013; McCoy et al., 2019; Reich, 2016; Salmon et al., 2009). Some parents were confused by

the information provided to them or thought the information was too ambiguous for them to decide (Wang et al., 2015). This led them to take the default route which is not vaccinating their children.

*4.1 Limitations*

This literature review utilized only the SCOPUS database to identify articles. However, it is the authors' belief that SCOPUS was the most relevant database given the topic and the timeliness of this review. The restriction of the articles to English language and the United States may have limited the range of vaccine hesitancy covered here. The authors also acknowledge that this review is synthesis of the works that met the eligibility criteria

*4.2 Conclusions*

The most important finding of this review was role of the medical provider as the leading factor influencing whether a vaccine hesitant parent accepts immunizations for their child. Having open and nonconfrontational discussions about vaccines was found to be an effective way to communicate with parents. Vaccine hesitancy does not stem from a disbelief in vaccine effectiveness. However, parents who refuse or delay vaccinations did perceptive that the risk posed by vaccinations was greater than that posed by the disease itself. Addressing this misperception should be the focus of future research assessing vaccine hesitancy.

**Competing Interests Statement**

The authors declare that there are no competing or potential conflicts of interest.

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Appendix A

Table A1: Description of Included Studies

| Authors | Date | Location | Participants | Study Design | Study Description | Results |
|---|---|---|---|---|---|---|
| Amin, Bednarczyk, Ray, Melchiori, Graham, Huntsinger, and Omer (Amin et al., 2017) | 2017 | United States | 1,471 parents recruited:<br>1,007 parents between 18 and 50 years of age with at least one child under 13 participated in online survey about moral foundations and vaccine attitudes.<br>464 subjects recruited from Amazon Mechanical Turk in a survey about moral foundations, attitudes towards vaccines, and beliefs taken from content analyses of anti-vaccine websites | Cross-Sectional Study | 2 independent studies were conducted to assess what moral values could be associated with vaccine hesitancy. They looked at six moral foundations used in decision making. 1) care vs harm, 2) authority vs subversion, 3) loyalty vs betrayal, 4) liberty vs oppression, 5) purity vs degradation natural vs unnatural, and 6) fairness vs cheating. | Medium vaccine-hesitancy more strongly valued purity when compared with low-hesitancy (2.08 AOR; 1.27-3.40 95% CI)<br>High hesitancy was twice as likely to value purity (AOR 2.15; 1.39-3.31 95% CI).<br>Less likely to place high emphasis on authority (AOR 0.43; 0.27-0.67 95% CI)<br>Concerns linked to purity and liberty moral foundations<br>Concerns for harm and fairness were not associated with vaccine hesitancy.<br>Loyalty vs betrayal foundation least related to vaccine beliefs. |

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Appendix A

Table A1: Description of Included Studies

| Authors | Date | Location | Participants | Study Design | Study Description | Results |
|---|---|---|---|---|---|---|
| Bardenheier, Yusuf, Schwartz, Gust, Barker, and Rodewald (Bardenheier et al., 2004) | 2004 | United States | 4,440 parents who were sampled in the 2000-2001 National Immunization Survey. There was a<br>2315 (52.1%) response rate. Parents with children aged 19 to 35 months qualified for the survey. | Case-Control Study | Parents were contacted following participating in the 2000-2001 NIS. 3 groups of cases (Refusal of MCV/MMR; Refusal of DTP/DTaP; refusal of hepatitis B) where paired with 3 groups of controls. The groups were not mutually exclusive, and some children were included in multiple groups. One interview was conducted for all questionnaires. | Most parents believed vaccines were important.<br>No significant difference in parents expressing general safety concerns.<br>Case parents more likely to ask child not to be vaccinated for reasons other than medical.<br>Case parents were more likely to have lower levels of education.<br>Lower income was associated with refusing MMR or Hepatitis B shots.<br>Mothers who delayed or refused vaccines were younger than those who were not.<br>Case parents more likely to believe in the association between vaccines and autism.<br>Case parents were less likely to report that if they had another baby, they would want them to get their recommended vaccines.<br>Most Respondents believed vaccines were important |

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Appendix A

Table A1: Description of Included Studies

| Authors | Date | Location | Participants | Study Design | Study Description | Results |
|---|---|---|---|---|---|---|
| Benin, Wisler-Scher, Colson, Shapiro, and Holmboe. (Benin et al., 2006) | 2006 | Connecticut, United States | 33 mothers who were 1-3 days postpartum were recruited. | Qualitative Open-ended interviews. | Participants were mothers who were 1 to 3 days postpartum. They were then again interviewed at 3 to 6 months postpartum. 3 topics were addressed. Attitudes about vaccination, knowledge about vaccination, and decision-making. | Mothers were grouped as "vaccinators," (25) and "nonvaccinators," (8)<br>Knowledge was considered poor among both groups.<br>Variables associated with vaccination were trusting the pediatrician, satisfaction with discussion about vaccines, and feeling obligated with the social contract.<br>Lacking trust in the pediatrician or feeling alienated by the pediatrician was prohibitive of vaccination.<br>Trusting a CAM practitioner was prohibitive of vaccination.<br>Not believing the severity or risk of vaccine preventable illness was large was also provided as an answer as to why mothers would not vaccinate. |

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Appendix A

Table A1: Description of Included Studies

| Authors | Date | Location | Participants | Study Design | Study Description | Results |
|---|---|---|---|---|---|---|
| Blaisdell, Gutheil, Hootsmans, Han (Blaisdell et al., 2016) | 2015 | Greater Portland, Maine, United States | 42 English-speaking vaccine hesitant parents of children 0-8. | Semi structured focus group interviews. | The study designed 8 focus groups with the vaccine-hesitant parents with 3-6 parents per group. 4 groups were selected for hesitant parents, and 4 groups were selected for refusing parents. Interview sessions were performed by a professional focus group facilitator. Open-ended questions and directed probes were used to study thought processes. | Most consistent theme was the unknown risk of vaccination and not vaccinating.<br>The parents reported that they could not rule out vaccines as the cause of bad outcomes and could not trust clinicians' reassurances about safety.<br>Some reported that they did not believe that there was enough information about long-term side-effects.<br>Also stated that they could not fully trust their providers for good vaccine information. |

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Appendix A

Table A1: Description of Included Studies

| Authors | Date | Location | Participants | Study Design | Study Description | Results |
|---|---|---|---|---|---|---|
| Brennan, Bednarczyk, Richards, Allen, Warraich, and Omer (Brennan et al., 2017) | 2017 | California, United States | 6,656 public schools, 147 Montessori schools, 20 Waldorf schools, and 35 holistic schools | Retrospective cohort study | The study acquired data on personal belief exemptions (PBE) for all California public and private schools for 2000-01 to 2014-15 school years. Religious and traditional private schools were not counted as alternative schools. PBE rates were counted as students with PBEs divided by the total enrollment for each year. | Montessori schools were the most represented amongst alternative schools.<br>Waldorf schools had PBE rate of 45.1% across study period.<br>Holistic schools had PBE of 7.4%.<br>Montessori schools had 3.9%.<br>Public schools had the lowest rate of 2.1%.<br>PBE rate for public schools increased from 0.9%-2.8%.<br>PBE rate for all alternative increased from 5.1%-10.8%.<br>PBE rate for Waldorf schools 19 times higher than public schools.<br>All alternative schools were 3.9 times higher than public schools.<br>Waldorf had the highest PBE rates but lowest change. |

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Appendix A

Table A1: Description of Included Studies

| Authors | Date | Location | Participants | Study Design | Study Description | Results |
|---|---|---|---|---|---|---|
| Buttenheim, Cherng, and Asch (Buttenheim et al., 2013) | 2013 | Philadelphia, Pennsylvania, United States | N/A | Agent-based modeling | An agent-based simulation was used to highlight the effect of patient dismissal policies that many pediatric providers have. The outcomes that were studied were the extent of clustering of vaccine-hesitant patients, exposure of vaccinated patients to unvaccinated patients, and proportion of patients who are unable to find a pediatrician. 84 experiments were running, and the proportion of zero-tolerance providers were set to increase. | As the proportion of zero-tolerance providers increases the vaccine hesitant parents continue to become more clustered until no-tolerance reaches 100%.<br>Hesitant parents will find it increasingly difficult to get any care at all for their children.<br>Interaction with vaccine accepting parents continues to decline.<br>There is minimal impact of provider tolerance at low levels of vaccine hesitancy.<br>At more real-life accurate levels, the system can still handle a substantial amount of zero-tolerance. |

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Appendix A

Table A1: Description of Included Studies

| Authors | Date | Location | Participants | Study Design | Study Description | Results |
|---|---|---|---|---|---|---|
| Cacciatore, Nowak, and Evans (Cacciatore, Nowak, & Evans, 2016) | 2016 | United States | 2,000 parents aged 18 and older with at least one child five or younger.<br>1,000 parents interviewed from November 2014-December 2014.<br>1,000 parents interviewed from May 2015 – June 2015. | Cross-sectional study | In late 2014 a survey was conducted revolving around vaccine beliefs and confidence. The Measles outbreak of 2014-2015 was used as an opportunity to take a follow-up interview of different respondents to determine if there was a correlation to the national outbreak and vaccine beliefs. Measures looked at four items of vaccine concern and six items of confidence regarding state immunization mandates. | 52.6 % parents in post-outbreak study were aware of cases of measles in the United States. 33.2% reported no knowledge, and 13.7% were excluded after responding “don’t know”.<br>Parents aware of outbreak more likely to be older, and more educated, otherwise groups were similar.<br>Respondents who claimed no awareness had significantly higher levels of concern than parents in pre-outbreak.<br>“high awareness” parents typically had higher confidence than low or no awareness parents.<br>State mandates had higher levels of support post-outbreak primarily among “high awareness” group. |

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Appendix A

Table A1: Description of Included Studies

| Authors | Date | Location | Participants | Study Design | Study Description | Results |
|---|---|---|---|---|---|---|
| Callaghan, Motta, Sylvester, Lunz-Trujillo, and Blackburn (Callaghan et al., 2019) | 2019 | United States | 4010 parents in the United States. | Cross-sectional study | A study on the psychological factors associated with delaying vaccination. Parents in survey were asked six yes/no questions about vaccine behavior. Two questions focused on HPV. The first four questions were on general vaccine behaviors and used to determine the measure of vaccine delay attitudes. Study examined conspiratorial thinking, needle sensitivity, and moral purity. | Those who scored highest on conspiratorial thinking were more likely to report delayed vaccination, more likely to choose their doctors based on willingness to delay.<br>Individuals most sensitive to pain of needles were 14-16% more likely than those without sensitivity to display hesitant behavior.<br>Conspiratorial thinking and moral purity associated with delay in HPV vaccination.<br>Moral purity did not predict doctor choice. |
| Chung, Schamel, Fisher, and Frew (Chung et al., 2017) | 2017 | United States | 5,121 parents' children under 7 in the United States.<br>2,603 in 2012 survey, 2518 in 2014 survey. | Cross-sectional study | Two web surveys were conducted. One survey in 2012 and another survey conducted in 2014. Vaccine decision-making typology was established. | Delayers and refusers were more likely to know someone whose child experienced severe reaction to a vaccine or delayed/refused vaccine(s).<br>High proportions of vaccine hesitant parents choose their healthcare provider based on whether they would allow them to delay vaccines.<br>Difficulty was reported in finding trusted sources of information.<br>Trust in healthcare provider most common reason for reversal in decision. |

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Appendix A

Table A1: Description of Included Studies

| Authors | Date | Location | Participants | Study Design | Study Description | Results |
|---|---|---|---|---|---|---|
| Fitch and Racine (Fitch & Racine, 2004) | 2004 | The Bronx, New York,<br>United States | 102 parents and legal guardians of patients of an ambulatory pediatric practice. | Cross-sectional study | Over an 8-week period from December 2001-January 2002, structured telephone interviews were given to 102 primary caretakers of ethnically diverse backgrounds about their beliefs regarding immunizing their children against influenza. | 98% of parents felt that their children should be immunized in general.<br>Significant amount believed that children were given more shots than were necessary.<br>Socioeconomic status had no impact on beliefs regarding vaccination.<br>36% believed that immunizations could weaken the child's immune system.<br>Race/ethnicity was found to have no impact on the vaccine beliefs.<br>Parents of high-risk children were less likely to have those concerns. |
| Flanagan-Kylis, Sharp, and Frader (Flanagan-Klygis et al., 2005) | 2005 | United States | 1003 physicians randomly chosen from the 2002 American Academy of Pediatrics directory. | Cross sectional study. | Over a 4-month period, pediatricians were mailed a 16-item survey asking if they provide routine vaccinations, and, if they did, their encounters and attitudes regarding parental vaccine refusal. | 302 physicians were included in the final analysis.<br>Overwhelming number of pediatricians found traditional vaccines "extremely important".<br>Many rated newer vaccines only as "somewhat important".<br>Small portion thought of some vaccines as "optional"<br>54% of pediatricians encountered vaccine refusal.<br>28% would dismiss a family for refusing vaccines.<br>Dismissers were more likely to believe that vaccines were "extremely important" than nondismissers. |

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Appendix A

Table A1: Description of Included Studies

| Authors | Date | Location | Participants | Study Design | Study Description | Results |
|---|---|---|---|---|---|---|
| Flood, Rousculp, Ryan, Beusterien, Divino, Toback, Sasane, Block, Hall, and Mahadevia (Flood et al., 2010) | 2010 | United States | 500 American parents with children from 2-12 years were selected to be representative of the general US population. | Cross-sectional study. | Web-based survey from a nationwide panel. Random-digit dialing, and address-based sampling were used. Survey instrument developed to assess parents' experiences and perceptions of influenza illness and influenza vaccination. | Main reason parents vaccinated against influenza was to prevent illness.<br>Next major reason was doctor's recommendation.<br>Barriers were low perceived risk of influenza and side effects caused by influenza.<br>High likelihood of vaccination perceived greater threat of influenza.<br>Health belief model a good tool for describing factors of influenced a parents' decision about vaccination. |

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Appendix A

Table A1: Description of Included Studies

| Authors | Date | Location | Participants | Study Design | Study Description | Results |
|---|---|---|---|---|---|---|
| Fredrickson, Davis, Arnold, Kennen, Humiston, Cross, and Bocchini (Fredrickson et al., 2004) | 2004 | Albuquerque, NM; Cleveland, OH; Shreveport, LA; Rochester, NY; Santa Fe, NM; Wichita, KS<br>United States. | 32 Focus groups of family physicians, pediatricians, family medicine and pediatric nurses, public health immunization nurses, parents, and parents who had refused vaccines.<br>3 groups were surveyed; private family physicians, private pediatricians, and public health nurses. | Focus group and cross-sectional survey | The study was conducted in two phases. The first phase were in-person qualitative focus groups. The second phase was a national survey of immunization providers. The first group had moderators discuss the reasons behind vaccine hesitancy and experiences with vaccine hesitant parents. The survey was sent out to providers and asked about number of immunizations and the number of refusals as well as the reasons for refusal. | Parents were likely to listen to practitioners who had a similar view of parenting.<br>Outright refusal is rare.<br>Reasons vary.<br>Providers found that vaccine-hesitant parents wanted to have providers that knew that their child was the most important person to them.<br>Vaccine-hesitant parents were likely to ask physicians about their own practices in vaccinating their children.<br>Parents wanted honest risk/benefit assessment personalized to their child.<br>Conflicting sources of information might lead to refusal. |

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Table A1: Description of Included Studies

| Authors | Date | Location | Participants | Study Design | Study Description | Results |
|---|---|---|---|---|---|---|
| Freed, Clark, Butchart, Singer, and Davis (Freed et al., 2010) | 2010 | United States | 1552 parents of children 17 or younger in the United States. | Cross sectional survey | Survey was sent to a nationally representative sample of parents in the US. Survey topics were about opinions on vaccine safety, history of vaccine refusal, and questions concerns that the parents on vaccines in general and specific vaccines. | Parents overwhelmingly agree that vaccines are good at preventing diseases.<br>Most common reason for refusal is the safety of vaccines.<br>Women were more likely to be concerned about safety concerns.<br>Hispanic parents are less likely to refuse, but more likely to be concerned about serious adverse effects and autism.<br>Vaccine hesitant parents had concerns over the amount of shots.<br>Concerns more common about newer vaccines. |
| Gaudino and Robison (Gaudino & Robison, 2012) | 2012 | Oregon, United States | 2900 parents of Oregon elementary school children in the 2004-05 school year. | Retrospective cohort study | Used multi-staged, population-proportionate sampling. Parent directories were obtained from school officials in the area. Parents who claimed exemption were oversampled approximately 1-3.5 non-exemptors. Parents were mailed 43 questions in 2 rounds of surveys. | Parents using the exemptions were more likely to have strong vaccine concerns.<br>Exemption parents were more likely to have had more than one childbirth in a non-hospital setting.<br>Exemption parents were more likely to distrust local doctors.<br>Exemption parents were more likely to use chiropractors for their school-age children.<br>Were more likely to know someone with a vaccine-hurt child.<br>Areas with high exemption rates were clustered. |

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Table A1: Description of Included Studies

| Authors | Date | Location | Participants | Study Design | Study Description | Results |
|---|---|---|---|---|---|---|
| Gilkey, McRee, Magnus, Reiter, Dempsey, and Brewer (Gilkey et al., 2016) | 2016 | United States | 9,354 parents in the United States who completed the 2011 National Immunization Survey. | Cross-sectional study | Used data from the 2011 National Immunization survey. Providers verified the immunization history provided by parents of 19-35-month-old children. Logistic regression models were used to assess associations between vaccine confidence and vaccine refusal, delay, and status | 15% and 27% of parents reported a history of refusal or delay, respectively.<br>Younger parents were less likely to be hesitant.<br>Marital status of parent did not have an impact on vaccine status.<br>Vaccine confidence was consistent across multiple vaccine types.<br>Vaccine confidence was positively associated with vaccine uptake and negatively associated with vaccine refusal and delay. |
| Gilkey, McRee, and Brewer (Gilkey et al., 2013) | 2013 | North Carolina, United States | 1.847 North Carolina parents with children ages 1-17 | Cross-sectional study | Data was used from two linked telephone surveys conducted in 2010. The North Carolina BRFSS and North Carolina Child Health Assessment and Monitoring Program (CHAMP) survey. The answer to the question "Has you ever postponed o refused to get a vaccine shot for your child?" was assessed. | 12% of parents reported having refused or delayed a vaccine for their child.<br>Forgone vaccination was more common for younger children as opposed to teenagers.<br>Parents who scored high on the healthy feeding index were more likely to report forgone vaccination.<br>Most common reason for forgoing vaccines was concern about safety.<br>Another reason was the belief that vaccines were not needed. |

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Table A1: Description of Included Studies

| Authors | Date | Location | Participants | Study Design | Study Description | Results |
|---|---|---|---|---|---|---|
| Glanz, Kraus, and Daley (Glanz et al., 2015) | 2015 | United States | 44 studies | Perspective Review | A perspective article from PLoS Biology commenting on timing, balance, and engaging vaccine hesitant parents to build a framework for web-based intervention. | Parents want balanced information regarding vaccine safety.<br>Vaccine hesitant parents likely have their decisions made regarding their vaccination behavior prior to their child's birth.<br>Parents think that physicians will not give them unbiased information regarding vaccinations. |
| Glanz, Wagner, Narwaney, Shoup, McClure, McCormick, and Daley (Glanz et al., 2013) | 2013 | Colorado, United States | 854 parents with children younger than 4 who were members of Kaiser Permanente Colorado health plan. | Mixed Methods Study | From 2008-2011 seven focus groups were conducted with vaccine-hesitant parents. The findings of the focus groups were developed into a survey that was sent to 854 parents. | Vaccine decision-making begins prenatally.<br>Vaccine hesitant parents trust their pediatrician, but do not trust what they say about vaccines.<br>Parents who refused were twice as likely to report that they had thought about their decision before the birth of their child.<br>Parents who refused or delayed vaccines were 8 times more likely to report that they reevaluate their decisions. |
| Gust, Darling, Kennedy, and Schwartz (Gust et al., 2008) | 2008 | United States | 3924 interviews with parents in the United States. | Cross-sectional study | Data was obtained from the 2003-2004 National Immunization Survey. Data was analyzed to obtain an estimate of proportion of parents with "vaccine doubt", identify factors associated with those parents, identify specific vaccines of concern, and describe main reasons for changing their mind. | 28% of parents responded yes to experiencing vaccine hesitancy.<br>Vaccine safety was considered the main reason for unsure, refused, and delayed parents.<br>Unsure and refused parents chose the varicella vaccine.<br>Delayed parents did not report a specific vaccine of concern.<br>The largest proportion of parents who changed their mind did so because of "information or assurances from healthcare provider." |

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Table A1: Description of Included Studies

| Authors | Date | Location | Participants | Study Design | Study Description | Results |
|---|---|---|---|---|---|---|
| Healy and Pickering (Healy & Pickering, 2011) | 2011 | United States | NA | Perspective Review | Commentary and non-systematic review discussing successful methods for discussing vaccine concerns with vaccine hesitant parents. | Open nonconfrontational dialogue with vaccine-hesitant parents at early stage.<br>Provide clear answers and acknowledge possibility of adverse events.<br>Use personal stories and reports of outbreaks. |
| Hegde, Wagner, Clarke, Potter, Swanson, and Boulton (Hegde et al., 2019) | 2019 | Michigan, United States | 542,159 children aged 2-7 | Cross-sectional study | Used vaccine records for children born April 1, 2007- March 31, 2012 in the Michigan Care Improvement Registry and analyzed the socio-economic factors at census block and tract level to analyze association between socioeconomic factors and DTaP uptake. | Uptake of all four doses of DTaP was 88.6% in Michigan.<br>On Census tract level affluence and socio-economic disadvantage were the two factors.<br>On Census block level only affluence related.<br>High affluence tracts had statistically lower vaccination coverage than low affluence tracts.<br>Low socio-economic disadvantage tracts had higher coverage than high disadvantage tracts. |

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Table A1: Description of Included Studies

| Authors | Date | Location | Participants | Study Design | Study Description | Results |
|---|---|---|---|---|---|---|
| Hirth, Fuchs, Chang, Fernandez, and Berenson (Hirth et al., 2019) | 2019 | United States | 143,721 parents of teenagers aged 13-17. | Time-trend study. | Ecological study using data from 13-17-year-old adolescents collected from the national immunization survey. Evaluated the trends over the 8 years regarding parents who did not intend to vaccinate their child for the HPV vaccine and compared it with region and race/ethnicity. | Non-intenders decreased from 72% of the study population in 2010 to 58% in 2016.<br>Most frequent reason for hesitancy was feeling that vaccination was not necessary.<br>Black Parents that did not intend to vaccine their children for HPV and were less likely to report safety concerns as their reason than were white and Hispanic parents.<br>Hispanic parents were more likely to associate lack of knowledge/requirement as their reason for not vaccinating their teen against HPV.<br>Recommended increased provider recommendation. |

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Table A1: Description of Included Studies

| Authors | Date | Location | Participants | Study Design | Study Description | Results |
|---|---|---|---|---|---|---|
| Keane, Walter, Patel, Moorthy, Stevens, Bender, Bradley, Buford, Anderson, Anderson, Tibbals, and Vernon (Keane et al., 2005) | 2005 | United States | 2,018 American parents of children under the age of 16 drawn from a sample designed to be representative of the US population | Cross-sectional study | An analysis of a mail-in survey answers that were sent to parents by the Ipsos Health Marketing group. Questions addressed attitude and belief statements regarding vaccines. | Parents who were cautious had a high emotional investment in children.<br>"Relaxed" view on vaccines was associated with a less involved parenting style.<br>"Unconvinced" parents had a higher distrust of vaccines.<br>"Vaccine-believer" had a higher education than other groups.<br>Cautious parents were more likely to have a lower income.<br>Single parents were more likely to be unconvinced.<br>"Unconvinced" parents were more likely to home-school and use CAM provider.<br>"Unconvinced" parents had less trust in government and physicians.<br>"Unconvinced" less likely to believe vaccines are safe or necessary, and more likely to believe children had too many shots.<br>No significant differences in attitude by race/ethnicity |

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Table A1: Description of Included Studies

| Authors | Date | Location | Participants | Study Design | Study Description | Results |
|---|---|---|---|---|---|---|
| Kempe, Daley, McCauley, Crane, Suh, Kennedy, Basket, Stokley, Dong, Babbel, Seewald, and Dickinson (Kempe et al., 2011) | 2011 | United States | 619 physicians in the United States.<br>357 pediatricians and 262 family practitioners. | Cross-sectional study | From February-May 2009 surveys were sent to two groups of physicians. Survey was developed with the CDC. Physicians were surveyed by internet or mail and the responses were subsequently analyzed. | No significant differences seen across provider demographics, region, or practice-type.<br>43% of physicians thought that level of concern from parents had increased.<br>Less than 10% of parents refuse vaccines.<br>64% of providers surveyed agreed to spread out vaccines on request.<br>Were most asked for personal statements from vaccine-hesitant parents.<br>Vaccine-hesitant parents were more likely to ask providers what vaccines they would give their own children. |
| Kennedy, Brown, and Gust (Kennedy et al., 2005) | 2005 | United States | 1,540 parents of children 18 years or younger. | Cross-sectional study | Data was taken from the 2002 HealthStyles survey. Survey data were weighted to the 2000 US population. Outcome variable that was selected on a five-point Likert scale was whether students should be allowed to go to school if they are not vaccinated. | 12% respondents opposed compulsory vaccination.<br>Belief in compulsory vaccination was significantly tied to the belief in safety and utility of vaccines.<br>Residence of states that permit philosophical exemptions to vaccines in school were significantly associated with opposition to compulsory vaccination by state law. |

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Table A1: Description of Included Studies

| Authors | Date | Location | Participants | Study Design | Study Description | Results |
|---|---|---|---|---|---|---|
| Kestenbaum and Feemster (Kestenbaum & Feemster, 2015) | 2016 | Philadelphia, United States | 35 Articles | Review | 35 articles non-systematically reviewed to provide insight into the complex reasons behind vaccine-hesitancy and addressing it. | Reasons for hesitancy vary.<br>Vaccine hesitant parents were more likely to trust individuals rather than institutions.<br>Vaccine hesitant providers were less likely to encourage vaccines themselves.<br>Vaccine-hesitant parents had more trust in "natural" remedies.<br>Parents influenced by social norms of their community both for and against vaccine. |
| LaVail and Kennedy (LaVail & Kennedy, 2013) | 2013 | United States | 376 parents in the United states with at least one child younger than 6 years old | Cross-sectional study. | Data was collected from the HealthStyles 2010 survey. Survey was mail in and answers to the questions were analyzed to create three confidence constructs were created as value, safety, and efficacy. Outcome variable used was the answer to the question "indicate the answer that best described your plans for vaccinating your youngest child." | The best predictor of the constructs that were evaluated was the value of vaccines.<br>Value of vaccines was the belief that vaccines are important and it is the right thing to do.<br>Confidence in safety of vaccines failed to account for significant variance in vaccination behavior.<br>Efficacy of vaccines also failed to account for significant variance in vaccination behavior. |

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Table A1: Description of Included Studies

| Authors | Date | Location | Participants | Study Design | Study Description | Results |
|---|---|---|---|---|---|---|
| Lee, Whetten, Omer, Pan, and Salmon (Lee et al., 2016) | 2016 | Colorado, Massachusetts, Missouri, and Washington, United States | 1,253 parents of children schools in Colorado, Massachusetts, Missouri, and Washington. | Case-Control study | Surveys were sent to parents in private and public schools in the selected states. Parents from children who had non-medical exemptions were selected as cases and those who were fully vaccinated were controls. Likert scales were used into surveys measuring trust in healthcare professionals and trust in government, respectively. | Parents who distrust government were 2.11 times more likely to trust CAM on vaccines.<br>Parents who distrust government had increased odds on distrusting vaccine information acquired at healthcare providers' offices.<br>2.39 times more likely to believe that government sources were unreliable.<br>Distrustful parents were more likely to be nonwhite.<br>Distrustful parents were more likely to have lower incomes. |
| Leib, Liberatos, and Edwards (Leib et al., 2011) | 2011 | Connecticut, United States | 133 pediatricians in Connecticut | Cross-sectional study. | Study was a quantitative survey. Physicians were asked about the number of vaccine concerns and refusals, impact on vaccine safety refusals on pediatricians, and the estimates of the socioeconomic characteristics of the families in their practices. | Most physicians found that there was an increase in concern and refusals among their patients.<br>More than 30% of providers have dismissed families because of their refusal to immunize.<br>Vaccine refusals were reported more by physicians caring for wealthier, better educated families, and were more likely to report dismissing patients.<br>More than a third of pediatricians reported that refusals had a personal negative impact on them. |

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Table A1: Description of Included Studies

| Authors | Date | Location | Participants | Study Design | Study Description | Results |
|---|---|---|---|---|---|---|
| Luthy, Beckstrand, and Meyers (Luthy et al., 2013) | 2013 | Utah, United States | 801 parents in Utah that exempted their parents from vaccines. | Cross-sectional study. | A convenience sample of parents who exempted from vaccines were given a 16-question survey regarding their choice to exempt their child from vaccines. | Those who exempted largely did not use the internet to do their research on vaccines.<br>They preferred natural immunity for their children.<br>Most had incomes of over $75,000.<br>Most frequently mentioned reason was conflicting belief in the philosophy behind vaccines. |
| Luthy, Beckstrand, and Callister (Luthy et al., 2010) | 2010 | Utah, United States | 86 parents of under-immunized children in Utah. | Cross-sectional study. | A convenience sample of parents from the county health department and local physicians was taken. Those who participated were asked to complete a survey with questions about their hesitancy to immunize their children and what advice they'd give friends or family. | 2 major themes; concern regarding vaccine safety and lack of perceived need.<br>Autism was the most cited concern among parents.<br>Most common income range was from $30,001-$45,000.<br>Most parents in the study were white non-Hispanic.<br>47.8% had "some" college education. |

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Table A1: Description of Included Studies

| Authors | Date | Location | Participants | Study Design | Study Description | Results |
|---|---|---|---|---|---|---|
| McCauley, Kennedy, Basket, and Sheedy (McCauley et al., 2012) | 2012 | United States | 1500 parents ages 6 to 23 months old. | Cross-sectional study. | Study was decided on participants who in the Healthways study from 2009-2010 survey and agreed to be contacted again with a child younger than 2 years in the household. Survey gathered information on respondent demographics and vaccination choices. | Vaccine-hesitant parents that chose to eventually vaccinate cited physician's recommendations as the reason for vaccinating their child.<br>Side effects of the vaccines were the top concerns.<br>Vaccine hesitant parents were more likely to have known a child who they believe was vaccine injured.<br>Vaccine-hesitant parents are less likely to believe that diseases are serious.<br>Vaccine-hesitant parents are less likely to believe that vaccines are important. |
| McCoy, Painter, and Jacobsen (McCoy et al., 2019) | 2019 | South-Central Pennsylvania,<br>United States | 14 Christian parents who homeschool their children. | Qualitative focus-group | Four small focus groups occurred from November to December 2017. A semi-structured interview was used to get responses about their families and how their family approached their vaccine decision. Thematic code was then used to analyze the data. | Two religious themes emerged: God provided their body with natural immune system and strong belief in the parental role as main decision maker.<br>Were willing to change decision and have open communication with physician who respected their ultimate parental authority.<br>Beliefs generally aligned with US population in every other respect regarding vaccination. |

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Table A1: Description of Included Studies

| Authors | Date | Location | Participants | Study Design | Study Description | Results |
|---|---|---|---|---|---|---|
| McNutt, Desemone, DeNicola, Chebib, Nadeau, Bednarczyk, and Shaw (McNutt et al., 2016) | 2016 | California, United States | 565 Kindergartens randomly sampled in California. | Time-trend study. | Study used annual school immunization survey data obtained from the California Department of Public Health with 10 or more students. 15 academic years were analyzed separately for public and private schools. Proportions of vaccine exempt students was compared with tuition and religious affiliation. | There was no significant difference between Roman Catholic, Jewish, and Islamic schools with Public schools.<br>Secular and non-Catholic Christian private schools were likely to have higher Personal Belief Exemptions.<br>Annual tuition of $10,000 or more were more than twice as likely to have 20% or more children with personal belief exemptions than those with lower tuitions. |
| Mergler, Omer, Pan, Navar-Boggan, Orenstein, Marcuse, Taylor, DeHart, Carter, Damico, Halsey, and Salmon (Mergler et al., 2013) | 2013 | Colorado, Massachusetts, Missouri, and Washington, United States | 705 parents linked to 551 unique providers across the four described states in the US. | Case-Control study | Case parents of unvaccinated children and control parents of vaccinated children were asked to give their provider during their child's years of vaccination. The identified providers were given a survey. Both surveys were about immunization beliefs including the beliefs and perceived risks/benefits. Associations were measured with odds ratios. | Viewpoints regarding disease severity were not associated.<br>Parents who had high confidence were much more likely (4.6 OR) to have a physician who believed similarly.<br>Provider beliefs in safety and utility of vaccines were associated with parent beliefs.<br>Parents may selectively choose providers who have similar beliefs to their own. |

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Table A1: Description of Included Studies

| Authors | Date | Location | Participants | Study Design | Study Description | Results |
|---|---|---|---|---|---|---|
| Navin, Wasserman, Ahmad, and Bies (Navin et al., 2019) | 2019 | Michigan, United States | 4,098 parents of children in Michigan | Retrospective Cohort study | This study aimed to look at the effect of vaccine education sessions had on parents who had committed to an alternative immunization schedule. They looked through medical records of parents who attended an immunization education session and compared it to the August 2016 report of Michigan Care Improvement Registry and matched the records. They subsequently analyzed the results. | Vaccine hesitant parents who attended a session were much more likely to give their child a vaccine than were those who did not.<br>Highest reason for those who did not receive a vaccine was the belief that vaccines provide little benefit (10.5%).<br>The next highest reason was that parents had concerns about the risks of vaccines (8.1%).<br>Those who committed to an alternative schedule were far more likely to subsequently get their child vaccinated than they were those parents who were going to refuse vaccines. |

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Table A1: Description of Included Studies

| Authors | Date | Location | Participants | Study Design | Study Description | Results |
|---|---|---|---|---|---|---|
| Orr and Beck (Orr & Beck, 2017) | 2017 | Cincinnati, Ohio, United States | 86 surveys were completed by parents with children from 6 months to 7 years and spoke English. | Cross-sectional study | Survey used the PACV tool addressing 3 elements of vaccine hesitancy. Primary outcome was to find out if the parent intended on getting the child the influenza vaccine. | 73% of parents intended on getting their child the influenza vaccine.<br>Families who did not intend on getting the influenza vaccine for their child scored higher on the PACV.<br>Race/ethnicity had no impact on vaccine-hesitancy.<br>Marital status had no impact on vaccine-hesitancy.<br>Socioeconomic status had no impact.<br>Chronic medical conditions not associated.<br>Trust in provider of vaccine was most important issue. |
| Reich (Reich, 2016) | 2016 | United States | 57 Articles | Literature Review | Non-systematic literature review that goes over Parental beliefs and attitudes regarding natural and artificial immunity. | Vaccine hesitant parents were more likely to believe that natural illness provides superior immunity.<br>Parents concerns had roots in large anxieties regarding health.<br>Vaccine-hesitant parents were more likely to believe that manmade interventions were worse and dangerous when compared to things that occur naturally. |

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Table A1: Description of Included Studies

| Authors | Date | Location | Participants | Study Design | Study Description | Results |
|---|---|---|---|---|---|---|
| Robison and Osborn (Robison & Osborn, 2017) | 2017 | Oregon, United States | 450,687 parent-child pairs were examined with the child being between 9 months and 17 years old. | Retrospective cohort study | Using Oregon's ALERT system for tracking immunizations, parent-child pairs were identified. They were then followed from 2010-2011 through 2014-2015 influenza seasons to watch if influenza vaccine in adults was a predictor for influenza in their children. | Children of immunized adults were 2.77 times more likely to be immunized against the seasonal influenza.<br>Children of adults who were immunized for seasonal influenza were more likely to be immunized for non-influenza diseases.<br>When adults improved their own immunization behavior their children's likelihood to become immunized increased dramatically.<br>Encouraging parental immunization is a potential tool for increasing immunization rates in children. |
| | | | | | | (continued) |
| Salmon, Sotir, Pan, Berg, Omer, Tokley, Hopfensperger, Davis, and Halsey (Salmon et al., 2009) | 2009 | Wisconsin, United States | 780 parents of children with nonmedical exemptions and 1491 parents of up-to-date children. | Case-Control Study | Schools provided Wisconsin Department of Health with names and addresses of parents of the selected children. Self-administered surveys were mailed to parents of children with nonmedical exemptions for one or more vaccines and the controls. | Chief belief among case parents was the belief that vaccines might cause harm.<br>Cases more likely to report concerns for vaccine safety, question the need for immunization.<br>Cases were more likely to consult nonmedical sources for information.<br>More likely to consult CAM providers.<br>Cases less likely to believe their children were at risk for getting a vaccine-preventable disease. |
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Table A1: Description of Included Studies

| Authors | Date | Location | Participants | Study Design | Study Description | Results |
|---|---|---|---|---|---|---|
| Smith, Woods, and Marshall (Smith, M. J. et al., 2009) | 2009 | Kentucky, United States | 121 parents and pediatricians in Kentucky | Cross-sectional study | Internet based survey about the parental fear and concerns of vaccines in Kentucky. | 85% of respondents reported concern about MMR vaccine.<br>46% of parents had skepticism of vaccines in general.<br>70% of pediatricians reported that autism was the most prevalent concern.<br>Physicians reported that reliable vaccine information material was most helpful to them. |
| Smith, Humiston, Marcuse, Zhao, Dorell, Howes, and Hibbs (Smith, P. J. et al., 2011) | 2011 | United States | 11,206 parents of children aged 24-35 months. | Cross-sectional study | Data was collected from the 2009 National Immunization survey interview. Vaccine status at 24 months was determined. Questions were asked about their vaccine decision, and questions were read 11 statements to provide on a scale of zero to ten. Responses were then analyzed. | 25.8% of respondents delayed, 8.2% of respondents refused, and 5.8% both delayed and refused vaccination.<br>Those who refused and/or delayed were more likely to say that they were influenced by their provider. Did not say whether this was a positive or a negative influence.<br>Vaccine delayers were more likely to report the influence of a CAM provider.<br>Vaccine hesitant parents had higher socioeconomic status.<br>Married mothers over 30 years old were most likely to refuse or delay vaccination.<br>English speaking college graduates were more likely to be vaccine hesitant.<br>Most likely to have more children under the age of 18.<br>Vaccine hesitant parents more likely to be non-Hispanic white parents.<br>Believe that their children had too many shots. |

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Table A1: Description of Included Studies

| Authors | Date | Location | Participants | Study Design | Study Description | Results |
|---|---|---|---|---|---|---|
| Taylor and Newman (Taylor & Newman, 2000) | 2000 | Seattle, Washington, United States | 598 parents whose children went to pediatric practices of Puget Sound Pediatric Research Network | Cross-sectional study | Parents were asked to complete a survey on varicella vaccine while they were in an office visit. A 6-point Likert scale was used. Health scores for each respondent were computed to indicate level of influence pediatrician had on decision. | Parents believed that vaccine was worth getting if the only benefit was the prevention of rare complications.<br>Parents would not get the vaccine if the only benefit was to save lost time from work.<br>Parents believed that their pediatrician was the most important influence on their decision to get the varicella vaccination. |
| Thorpe, Zimmerman, Steinhart, Lewis, and Michaels (Thorpe et al., 2012) | 2012 | Western Pennsylvania,<br>United States | 396 Parents of homeschooled children in Western Pennsylvania with children 18 or under. | Cross-sectional study | 707 parents were sent an interview of which 18% responded. The interview was done online, and collected demographics, vaccine status, and attitudes regarding immunization. | 95% of study population believed that education about vaccines was important.<br>38% had fully vaccinated children.<br>56% of study population reported partial vaccination and 6% reported no vaccines.<br>Parents of fully vaccinated children were more likely to agree that vaccination was important.<br>Parents of fully vaccinated children were more likely to believe their health care provider and believe that vaccines were safe. |

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Table A1: Description of Included Studies

| Authors | Date | Location | Participants | Study Design | Study Description | Results |
|---|---|---|---|---|---|---|
| Wang, Baras, and Buttenheim (Wang et al., 2015) | 2015 | Philadelphia, Pennsylvania, United States | 23 upper middle-class parents with young children in the Philadelphia metropolitan area. | Qualitative study. | Parents of children in a pediatric practice in Philadelphia were given in-depth open-ended interviews about immunization decisions in parents who self-report as pro-vaccine. Interview data was coded to identify key themes. | Parents were overwhelmed by the ambiguity and quantity of the information that was presented to them.<br>Parents who described themselves as pro-vaccines frequently delayed or spaced vaccines.<br>Parents were sympathetic to vaccine hesitant parents.<br>Parents did not believe there were severe consequences for deviating from schedule. |
| Wheeler and Buttenheim (Wheeler & Buttenheim, 2013) | 2013 | Large Northeastern city in the United States | 237 unique medical records for clinical encounters between December 2009 and April 2011. | Cross-sectional study. | Data from initial vaccine counseling sessions were taken from a private pediatric practice in a large northeastern city. The outcome that was studied was the vaccination intent of the parents and measured against predictor variables using logistic regression. | Parents who received information from doctor were less likely to report specific concerns with vaccines.<br>The number of concerns about safety, utility, or necessity of the vaccine was associated with intentions to follow an alternate vaccine schedule.<br>Non-physician sources of information played in important role in the decision to delay vaccinations.<br>Most common belief in those who followed alternative schedule was overtaxing of child's immune system. |

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Table A1: Description of Included Studies

| Authors | Date | Location | Participants | Study Design | Study Description | Results |
|---|---|---|---|---|---|---|
| Wilson, Taylor, Knowles, Blyth, Laux, Lohr, and Jhaveri (Wilson et al., 2019) | 2019 | North Carolina, United States | 1436 infants born at North Carolina Women's Hospital in 2011 | Retrospective cohort study | Study was conducted at North Carolina Women's hospital. The end of the study was to compare the rate of completion of the primary vaccine series among infants who did and did not receive the Hepatitis B vaccine at birth. | 20.8% of infants born in 2011 did not receive HepB vaccine.<br>44% of infants who had the vaccine at birth were up to date compared to 23% of those who were not.<br>At 24 months there were overall increases, but consistently different.<br>Infants in the Not vaccinated group were much more likely to have no recorded vaccinations.<br>The birth dose of HepB was a predictor of completing vaccines.<br>Indicates that vaccine choices were made prenatally. |
| Wolf, Rowhani, Rahbar, Tasslimi, Matheson, and DeBolt. (Wolf, Rowhani-Rahbar, Tasslimi, Matheson, & DeBolt, 2016) | 2016 | Washington, United States | 277,098 children; 65,466 of total had foreign born parents. | Retrospective cohort study | From January 1, 2008 and May 1, 2013 data from children were examined from the Washington State Immunization Information System. Receipt of vaccines in children with 1 or more parents born in a foreign country was compared with children who were born to 2 parents born in the United States. | Somali born parents less likely to immunize their children against measles compared to US-born parents.<br>No other disparity was found in foreign born parents compared to US born parents.<br>Mexican and Indian born parents were more likely to have fully immunized children compared to Ukrainian and Russian born parents. |

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Table A1: Description of Included Studies

| Authors | Date | Location | Participants | Study Design | Study Description | Results |
|---|---|---|---|---|---|---|
| Zangger (Zangger Eby, 2017) | 2017 | Phoenix, Arizona, United States | 23 parents with children at one of two offices of a suburban pediatric private practice. | Quasi-experimental study | Examine the impact of a presentation on vaccine education and the subsequent decision making by vaccine-hesitant parents in a pediatric primary care clinic in the United States. | Mothers tended to be more vaccine hesitant than fathers.<br>Parents main concern was vaccine side effects.<br>Trust in medical provider was high.<br>82.6% of parents agreed or strongly agreed that vaccines prevent illnesses.<br>Parents of firstborn children were typically more accepting. |
| Zimmerman, Schlesselman, Baird, and Mieczkowski (Zimmerman et al., 1997) | 1997 | United States | 1,241 primary care physicians across the United States | Cross-sectional study | Interview designed to determine physicians' likelihood of recommending vaccination. A stratified random sample was taken of family practitioners, pediatricians, and general practitioners younger than 65 were asked to take a standardized telephone survey by trained interviewers. | 11% believed that too many shots at once would have side effects and would not administer them.<br>4% of physicians said that they believed the risk of side effects increased by upper respiratory tract infection.<br>55% of physicians thought there would be no increased risk.<br>8% of physicians thought the efficacy would decrease.<br>47% were less likely to vaccinate a child with a URI as opposed to a well-child. |