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Vaccine Hesitancy: Factors in the Pathways to Pediatric Immunization Decision Making among U.S. Parents of Children ages 0-6

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Master of Public Health

Global Epidemiology

_____

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By

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Bachelors of Science

Virginia Polytechnic Institute and State University

2010

Thesis Committee Chair: Saad Omer, PhD

An abstract of

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Abstract

Vaccine Hesitancy: Factors in the Pathways to Pediatric Immunization Decision Making among U.S. Parents of Children ages 0-6

By Samantha C. Benedict

Background: Parents who delay or refuse vaccines for their children create gaps in herd immunity that leave their children and others vulnerable to infection. School vaccination mandates that have enabled the current high levels of vaccine coverage are circumvented in many states through religious or personal belief exemptions. These often cluster, in schools, neighborhoods, and communities. Sociodemographic characteristics of parents and parent knowledge, attitudes, and beliefs about childhood vaccination play an interconnected role in vaccine decision outcomes. Understanding vaccine hesitant parents can facilitate new methods for improving vaccination coverage.

Objective: This research aims to examine the relationships between parent sociodemographic characteristics and parent knowledge, attitudes, and beliefs about pediatric immunization, with each other and with parental vaccine decision-making. Also, if and to what extent sociodemographic characteristics effect on parental vaccine decision-making is mediated by knowledge, attitudes, and beliefs. By elucidating these relationships we hope to develop a pathway framework.

Methods: Analysis was conducted on two pooled samples from nationally representative online poll of parent opinions about pediatric immunizations. The survey was completed by 2,603 parents ≥18 years with a child 0-6 years in 2012, and by 2,518 in 2014. This study modeled mediating and moderating sociodemographic factors, and persuasive influences on vaccine decisions.

Results: Those influenced by a doctor or nurse had lower odds of choosing to delay (OR=0.55; 95% CI: 0.40, 0.78) or refuse (OR=0.30; 95% CI: 0.16, 0.54), and also less likely to choose to refuse than delay (OR=0.53; 95% CI: 0.29, 0.98), adjusting for KABs. The odds of delaying for those aged 30-44 were higher compared to those 18-29 (OR=2.38; 95% CI: 1.57, 3.61). The West was more likely to delay, and the Midwest more likely to refuse than the South.

Conclusion: Several sociodemographic characteristics exhibited an indirect effect on vaccine decisions; parent knowledge, attitudes, and beliefs mediated the effect. Parent age has a relationship with vaccine decision independent of included KABs variables. Our findings indicate the effectiveness of doctors in promoting immunization uptake. This study also reveals that sociodemographic factors could be used to target practices in geographic areas where vaccine hesitant behavior is more common.

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Chapter I: Introduction

Context of Project

With the vanishing visibility of the threat vaccine preventable diseases (VPDs) pose, alternative vaccine schedules and vaccine refusal have become a risk to the protective effect of herd immunity. The 2020 Healthy People goals to maintain or achieve 95% or higher coverage among kindergarteners with the MMR, DTaP, Polio, Hepatitis B, and Varicella vaccines is threatened by the number of parents choosing to delay or refuse vaccines for their children. This vaccine hesitant behavior increases the risk of infection and the time children remain susceptible to vaccine preventable diseases, but it also escalates the risk of infection for others. Those with medical contraindication to vaccination, those too young to be vaccinated, and those with low immune function are made more vulnerable because of these parent's choices. For example, earlier this year, an outbreak of measles began at Disney theme parks in California. 125 cases of measles were confirmed in U.S. residents as of February 11th. Among the cases in California residents, 45% were unvaccinated. Of these 12 were infants too young to be vaccinated, 28 were intentionally unvaccinated, and 1 was on an alternative plan for vaccination[1].

The school mandates that achieved wide vaccination coverage in the United States are being circumvented in many states with personal belief exemptions or religious exemptions. Though overall vaccination coverage in the United States has remained high, exemptions tend to cluster[2]. These gaps in coverage have been associated with outbreaks of vaccine preventable diseases including pertussis and measles[3-7]. In 2014 alone, there were over 600 reported cases of measles in the

United States, the largest number of cases since 2000 when measles was declared eliminated there[8]. The California outbreak was highly publicized, and resulted in legislative backlash. Personal belief exemptions will no longer be allowed in California starting in July 2016. California will be the third state to only allow medical exemptions.

Problem Statement

The success of vaccines has decreased cases of vaccine preventable diseases (VPDs) dramatically, to the point that much of the population has not seen them in their lifetimes, which allows misconceptions about both vaccines and VPDs to proliferate. Availability of exemptions and the ease or difficulty of obtaining them are variable across the country, which plays a role in clustering at the state level, and is likely interrelated with parent attitudes. Parents are responsible for making health care decisions for their children. Some parents remain convinced that vaccines are more dangerous than the diseases they prevent. Understanding who these parents are and the reasoning they are using to make this risky choice is necessary to improve vaccination coverage.

Exemptions would not be such a threat to herd immunity if they did not cluster in schools, neighborhoods, and communities. Many studies have examined the associations between sociodemographic factors and vaccine decision-making. Private schools tend to have more exemptions than public schools[9, 10]. A 2015 study in California and a 2013 study in Arizona found that higher numbers of exemptions were clustered in suburban catchment areas where students came from families with a higher socioeconomic status, had a higher percentage of white

students, and a lower percentage of students receiving a subsidized lunch[11, 12]. White parents are more likely to be vaccine hesitant, while Hispanic and black parents are less likely to delay or refuse vaccines for their children [13-15]. Higher education attainment and more children in a household have been associated with vaccine hesitant behavior[14-18]. Parent age and income have been associated with vaccine decision-making [13, 14, 16, 19]. Negative vaccine beliefs are linked both with trusting their doctor less and with vaccine delay or refusal behavior [14, 16, 20, 21].

Purpose of Project

This study will examine the relationships between parent sociodemographic characteristics and parent knowledge, attitudes, and beliefs about pediatric immunization, with each other and with parental vaccine decision-making. It will also investigate if and to what extent the relationship between sociodemographic characteristics and parental vaccine decision-making is mediated by knowledge, attitudes, and beliefs. This study seeks to elucidate the relationships between these concepts in a potential causal framework. Multiple multivariable models will be built, which taken together will assess the components of a pathway model.

Chapter II: Literature Review

A short history of vaccines, the early anti-vaccination movement, and vaccine impact

Vaccine preventable diseases caused a high burden of morbidity and mortality prior to the introduction and pervasive implementation of various immunization programs. Smallpox, the first human disease to be eradicated—went from a U.S. reported annual peak in cases in 1920 of 110,672 to being completely eliminated from the United States in 1949 (there is a lack of reported information prior to 1900)[22, 23]. Worldwide eradication of smallpox was declared in 1980[22]. Measles, which at its annual U.S. peak in 1958 caused 763,094 cases and 552 deaths, only had 55 cases in 2006[22]. Polio, a terrifying disease, had its number of U.S. cases peak in 1949 with 42,033. Polio deaths in the U.S. peaked at 3,145 in 1952. Thanks to the various forms of polio vaccine, it has been eliminated from the United States and most of the world and remains a target of eradication campaigns[22].

Vaccination and anti-vaccination movements came into existence together, with the first widespread use of the smallpox vaccine, when it was made compulsory in Britain in 1853. At the beginning, vaccination was a much more arduous and risky procedure. The practice of variolation proceeded vaccination and was essential to its invention. Variolation, also commonly called inoculation, was a process in which either powdered smallpox scabs or fluid from a pustule from a person with a mild case of smallpox was applied to a shallow scratch of the skin. The practice was done in order to induce a mild case of smallpox and therefore acquire immunity[24]. Variolation had a long history in India and China. Lady Mary Wortley

Montagu introduced it to Britain in the 1720s from Turkey, and it soon became widespread there[24].

The smallpox vaccine was developed in 1796 in Britain, well before the development of germ theory, when Edward Jenner substituted cowpox for smallpox in variolation[24]. Cowpox was a milder illness that did not spread from person to person, but still conferred immunity to smallpox. Early vaccination was a painful procedure where a lancet was used to cut a scored pattern on the arm in as many as four places, and then the vaccination material, lymph, was applied to the wounds. The lymph came either from calves, or often from arm to arm transfer[24]. Vaccinated individuals, most often infants, had to return eight days after being vaccinated so that the lymph from their blisters could be applied to another person's arm. Vaccination did prevent smallpox, but it came with its own risks. Blood-borne infections including tetanus, erysipelas, septicemia, and even syphilis could be passed along[25]. Blisters could easily become infected in the unsanitary conditions of 19th century cities resulting in gangrene or other infections. Malnutrition among working class children could result in adverse reactions to vaccination without any contamination[24].

Vaccination became mandatory in 1853, and penalties for not vaccinating became enforceable in 1867. Families prosecuted for failing to vaccinate their child could be fined repeatedly up to 20 shillings plus court costs[24]. When parents couldn't pay, their belongings could be seized and sold to generate the money, and a parent imprisoned for up to two weeks if the sale did not generate enough to pay the fine[24]. These laws were targeted at the poor and working class and

exacerbated existing class tensions. The procedure was still medically risky and went against widely held Victorian beliefs that health was dependent on bodily integrity[24]. Religious figures published pamphlets of sermons where they condemned the practice of vaccination. The vaccination laws marked a new invasiveness by the government on individual health practices. Anti-vaccination societies were founded, and there were widespread protests and acts of civil disobedience. Through these protest movements, the people of Britain eventually won the right to be conscientious objectors, technically in 1898 and realistically in 1907. The anti-vaccination movement both currently and historically has been fought as a legislative battle between personal freedom and the public good.

The early anti-vaccination movement was introduced to the United States from Britain. Compulsory vaccination laws were passed and overturned in patchwork across the country. Smallpox vaccine was not widely used in the United States until after 1900[26]; universal smallpox vaccination of infants did not occur until the 1920s[22]. Vaccination was not regulated on a national scale; it has remained in the hands of state and local governments. The emergence of germ theory, the field of bacteriology, and numerous other scientific advancements transformed vaccination into a much safer process, and numerous other vaccines to prevent other diseases were developed. National vaccination programs in the United States began with the introduction of the inactivated polio vaccine in 1955, when funds were appropriated for the purchase and distribution of the vaccine[26]. The national government has continued in this role since then, working with state

and local governments, and private partners to purchase, stockpile, and distribute vaccines[22].

Vaccine Coverage and Regulations in the United States

Vaccines have proven to be a very successful preventative public health measure through dramatic reductions in cases. However, this success is predicated on the wide coverage necessary to achieve herd immunity; this interrupts disease transmission and protects the vulnerable and those who cannot be vaccinated. In the United States wide vaccine coverage has been made possible by mandating vaccines as a requirement for attending school[23]. Additionally, there are specific vaccine schedules recommended by the Advisory Committee on Immunization Practices (ACIP) and the Centers for Disease Control and Prevention (CDC)[27].

The childhood immunization schedule in the United States is determined by the Centers for Disease Control and Prevention (CDC) through the recommendations developed by the Advisory Committee on Immunization Practices (ACIP)[22]. The ACIP reviews the relevant scientific research on vaccines to create an evidence-based vaccination schedule. The American Academy of Family Physicians (AAFP) and the American Academy of Pediatrics (AAP) also approve the childhood vaccination schedule. The current childhood vaccine schedule vaccinates against 14 different diseases with 10 vaccine series'. Diseases vaccinated against include: chicken pox, diphtheria, tetanus, pertussis, hepatitis A, hepatitis B, measles, mumps, rubella, polio, pneumococcus, *Haemophilus influenzae* type b, rotavirus, and influenza[28].

School vaccination mandates are utilized as a strategy for maintaining high vaccine coverage in the United States. There is no national legislation, instead individual states have their own varied regulations on school vaccination mandates. Mandates have demonstrated their effectiveness in promoting immunization coverage. In a recent example, the live attenuated varicella vaccine was recommended for children 12-18 months old in 1995, and mandates were implemented starting in 1997. By 2002, 33 states and D.C. had school and/or daycare mandates for varicella vaccine[29]. Using data from the 2002 National Immunization Survey (NIS) Davis, et al. compared up-to-date (UTD) status of children in states with and without school or daycare entry mandates for varicella. They found that 84.9% (95% confidence interval: 83.9, 85.9) of children living in states with a mandate for varicella vaccine were UTD, compared to 76.8% (95% CI: 75.3, 78.4) of children in states without a mandate for varicella vaccine[29]. This difference remained significant in multivariate analysis when individual and household characteristics were controlled for.

Availability of exemptions to school entry vaccination mandates vary across the United States. All states allow medical exemptions[23]. Currently only West Virginia and Mississippi do not allow either religious or philosophical exemptions, but they will be joined by California in July of 2016[30]. An additional 20 states currently allow philosophical exemptions, though Vermont will no longer allow them as of July 2016[30]. Non-medical exemptions are much more common than medical exemptions – an estimated 80% of exemptions in the 2011-2012 school year were non-medical[31]. Since 1998, states that allow philosophical exemptions

increased from 15 to 20[23]. Several states with only religious exemptions interpret them broadly enough to encompass secular beliefs, so in most states there is some kind of exemption available if parents choose to pursue it. However, states that allow both philosophical and religious exemptions have overall higher frequencies of exemptions[31, 32]. From 2005-2011 states that allowed philosophical and religious exemptions had a 2.54 (95% CI: 1.68, 3.83) times higher incidence rate ratio (IRR) of exemptions compared to states with only religious exemptions available[32]. In the 2011-2012 school year, the mean exemption rate for states with both philosophical and religious exemptions was 2.8%, compared to 1.5% for states with only religious exemptions[31].

The difficulty of obtaining exemptions from vaccine mandates also varies dramatically across states. The process can be as simple as a form from the school that only requires a parental signature, to as complicated as notarized forms obtained from the health department with a written letter. For the purpose of comparison, regulations are often divided into three categories of complexity based on the time and effort required. The rate of exemptions has been shown to be higher in states where it is easier to obtain an exemption[23, 31, 32]. Rota, et al. compared complexity levels of regulations to frequency of exemptions in 1998 and found that five states with the lowest level complexity and three with medium complexity had the highest frequency of exemptions (defined as more than 1.0%). None of the states with highly complex regulations were categorized as having high exemption frequencies[23]. In a more recent study Omer, et al. found that states with easy

exemption policies had an exemption IRR 2.31 (95% CI: 1.31, 3.85) times as high as states with difficult exemption policies[32].

There are other important differences in state regulations. Currently 25 states do not require immunizations for homeschooled children. An additional 12 states do not require proof of immunization, and nine states have conflicting regulations for different homeschool options. Only four states require parents of homeschooled children to submit proof of immunization[33]. Whether vaccine hesitancy is a problem among parents of homeschooled children is difficult to glean from currently available data; regardless, an estimated 1.7 million children in the U.S. were homeschooled in 2011, 3.4% of all school-age children, who could potentially be at risk[34]. The procedures for accepting or denying exemptions are often loose. Many states accept all requested exemptions; Rota, et al. found that only 16 states reported that exemption requests were ever denied[23]. Another degree of convenience or complexity is in whether exemptions have to be renewed or not. Only five states require that they be renewed every year, nine only require renewal when transferring schools, and 34 do not require renewal of exemptions at all[23]. Requiring that vaccine exemptions be renewed may be a deterrent to parents, and could offer schools and health departments an opportunity to revisit the decision with parents. For example, most school districts in D.C., Rhode Island, and Kansas have implemented yearly discussions between parents that claimed exemptions and school nurses[31].

Location can play a role in vaccine decision-making, as a result of these diverse state regulations. Opposing mandatory vaccination was more common

among parents that live in states where personal or philosophical exemptions are available (OR=1.7; 95% CI: 1.2, 2.4)[19]. Examining larger census regions across the country in a study using NIS data from 2003 and 2004, there was a significant association between the west region and unsure parents when the south was used as a reference (OR=2.39; 95% CI: 1.22, 4.65). The authors speculated that it is probably due to the disproportionate number of states that have personal/philosophical exemptions available there[14]. It is impossible to ascertain whether location has an independent association with vaccine decision-making from state law, or if state law is driven by location specific attitudes.

National Vaccine Coverage, Use of Exemptions, and Associated Outbreaks

The 2020 healthy people goals set target vaccination coverage at ≥95% for MMR, diphtheria, tetanus toxoid, pertussis, polio, hepatitis B, and varicella for kindergarteners[35]. For the 2011-2012 school year (the first survey used in this analysis), median coverage levels for DTaP (vaccine covering diphtheria, tetanus, and pertussis), and Hep B were at or above this goal. Median coverage for MMR was 94.8%, with a range from 86.8% in Colorado to 99.3% in Texas in the 47 reporting states and D.C.[35]. Four states reported coverage less than 90.0%. Only 33 reporting areas gave information about varicella coverage. Median coverage with two doses of varicella was 93.2% with a range of 84% in Colorado and 99.2% in Texas and Mississippi. Regarding exemptions, ten states reported less than one percent of kindergartners had exemptions and nine states reported having greater than 4%[35]. Alaska had the highest percentage of exemptions with 7.0%, and

Mississippi had the lowest with only 0.1%. The median exemption rate was 1.5% across DC and the 49 reporting states.

For the 2013-2014 school year (the second survey), coverage remained similar, with national median vaccine coverage for MMR at 94.7%, and 93.3% for varicella[2]. A higher number of states reported, with 49 states and DC reporting for MMR, and 36 states reporting for varicella. Colorado again reported the lowest coverage of MMR, with only 81.7% coverage, even lower than the 2011-2012 school year. Mississippi reported the highest coverage with 99.7%[2]. Eight states reported <90.0% coverage, four more than in 2011-2012. The median exemption rate increased from 1.5% to 1.8% across the 46 states and DC reporting. Oregon had the highest exemption rate of 7.1% and Mississippi again had the lowest with <0.1%. Only eight states had exemption rates <1%, two less than 2011/2012; and 11 had >4% exemptions, two more than 2011-2012 school year.

Vaccine coverage has remained high on a national scale. However, the frequency of non-medical exemptions to kindergarten entry immunization requirements has increased in the United States over the past two decades. The increases have been most pronounced in states that allow personal belief exemptions (PBE). Exemptions can accumulate at a local level to create gaps in herd immunity that result in outbreaks[2, 35]. For example, private schools have been shown to have higher exemption rates than public schools[9, 10]. During the 2009-2010 school year, the mean exemption rates for all types of exemptions was 4.25% in private schools compared to 1.91% in public schools in DC and the 35 states that reported. In fact, the exemption rate for each type of exemption was higher for

private schools than public schools: for medical exemptions 0.58% vs. 0.34%, for religious exemptions 2.09% vs. 0.83%, and for PBE 6.10% vs. 2.79%[9]. Private schools had more exemptions than public schools regardless of whether states allowed PBE. In New York, this trend was examined from 2003-2012 by Lai et al., who found exemption rate ratios of 1.39 (95% CI: 1.15, 1.68) for medical exemptions and 3.94 (95% CI: 3.20, 4.86) for religious exemptions when private schools were compared to public schools while controlling for year[10].

Though 80% of private school students attend schools with some kind of religious orientation, it seems unlikely that this is only the result of religious beliefs[9]. Most religions promote the use of vaccines[10, 36]. Only Christian Scientists have specific anti-vaccine doctrine, though the Amish and Mennonite communities have been associated with low vaccination rates[10, 36]. In 2012, 76% of Amish and Mennonite schools had religious exemptions for more than 30% of their students in New York State[10]. However, even the Amish may be using religious exemptions because of concerns about vaccine safety, rather than for religious reasons[10].

Vaccine exemptions cluster within states. Examining spatial trends of exemptions in California revealed associations between higher socioeconomic statuses, higher percentages of white students, suburban catchment areas, and low percentages of students offered subsidized school lunch with higher exemption rates[12]. During the 2014-2015 school year, 800 or more schools had exemption rates exceeding 10%, dipping vaccine coverage below the threshold for maintaining protective herd immunity against measles[12]. Schools with high exemption rates

were clustered in the areas surrounding Sacramento, San Francisco, and Las Angeles[12]. Another study found similar results in Arizona, also associating high rates of PBE with charter schools, higher percentages of white students, and lower numbers of students who qualify for subsidized school lunches. Personal belief exemptions clustered in the north central region of the state[11]. Aggregates of children with vaccine exemptions create a pool of susceptible individuals where outbreaks of vaccine preventable disease can occur.

Refusing or delaying vaccines dramatically increases individual risk for contracting a vaccine preventable disease. Several matched case-control studies conducted using people covered by Kaiser Permanente health plans in Colorado (KPCO) investigated individual and population risks for varicella, pneumococcal disease, and pertussis. In 2010, varicella was the most commonly refused vaccine; both parents and providers viewed it as a less serious VPD. Researchers found that children whose parents had refused vaccination for varicella were 8.6 times more likely to contract varicella than vaccinated children using KPCO data from 1998-2008 (95% CI: 2.2, 33.3, P =0.004)[5]. In a study conducted between 1996 and 2007 on pertussis, the children of parents who refused vaccines had odds of contracting pertussis 22.8 times the odds of vaccine acceptors (95% CI: 6.7, 77.5; P <0.001)[4]. Children with parents who refused the pneumococcal vaccine were found to be 6.5 times more likely to be hospitalized for pneumococcal disease or lobar pneumonia using data from 2004-2009 (95% CI: 1.7, 24.5)[7]. The risk of hospitalization rose, though the serotypes protected against by the pneumococcal vaccine have become more rare.

It is not only individual risk that increases when parents refuse or delay vaccines for their children. These parents are also burdening those too young to be vaccinated and those with a medical contraindication to vaccination. Measles is one of the most infectious viruses that affect humans; it can cause serious complications that can lead to death including pneumonia and encephalitis. High vaccination coverage is required to maintain protective herd immunity against measles. High coverage with 2-dose MMR ended endemic transmission of measles in the United States in 2000[6], but outbreaks continue through imported cases. For example, in 2008 an intentionally unvaccinated seven-year-old child returned home to San Diego from Switzerland infected with measles. At least 839 people were exposed to the virus. There were eleven additional cases that resulted, with 1 hospitalization of an infant too young to be vaccinated. All 12 cases were unvaccinated, nine parents had PBEs, and three were too young to be vaccinated[6]. The index case was misdiagnosed twice, once with an upper respiratory infection and once with scarlet fever. Out of the 839 people exposed, 106 were children that had no proof of measles immunity. Of those, 38 had parents who had chosen to delay or refuse the vaccine, of which 32 were eligible to receive post-exposure prophylaxis, but only 13 accepted. Among the children exposed to the virus without proof of measles immunity, 48 were too young to be vaccinated[6]. In San Diego, coverage among kindergarteners with the first dose of MMR was at 97%, and 95% for the second dose. Yet out of 643 schools surveyed, 56 had <90% coverage with the first dose of MMR, and 19 schools had <70% coverage[6]. The school districts with high refusal rates tended to cluster. There were four connected school districts with significantly

higher exemption rates than the rest of the county, ranging from 5% to more than 20%. The index case attended a charter school where 30% of the kindergarteners had personal belief exemptions, but the overall district had an exemption rate of just 2.2%. High exemption rates in public schools were significantly associated with higher median income based on zip code and census tract information.

Parent Factors

Parents are responsible for making health care decisions for their children, and some parents remain convinced that vaccines are dangerous. Understanding the associations between sociodemographic descriptors and parent knowledge, attitudes, and beliefs about vaccination with each other and with vaccine decision outcomes is crucial to improving vaccine coverage. Sociodemographic factors related to vaccine decision-making behavior are examined here.

A majority of exempt children have received at least some vaccines; though many parents have doubts about vaccines, only a very small proportion of parents refuse all vaccines for their children. For example, a case-control study that took place across four states found that 75.5% of elementary school children with vaccine exemptions had received at least one vaccine. At the time, varicella was the most common vaccine exemption[16]. The population delaying and refusing vaccines is only a fraction of those who have concern about the issue, in a study using 2003-2004 national immunization survey data (NIS) researchers found that 28.3% of parents responded yes to at least one of three vaccine doubt indicator questions. Within this group 8.9% of parents accepted despite uncertainty, 13.4% delayed a vaccination, and 6% refused a vaccination[14].

The relationship of income to vaccine decision-making is variable, appearing to shift with time and location. Cost was previously a barrier to on-time up-to-date vaccination status. Since, unlike some other countries that require compulsory vaccination, vaccines are not provided free of cost[23]. Government programs to cover the cost of childhood vaccination for low-income families were implemented in the 90s. Additionally, since 2008 the Affordable Care Act ensures that all private health care plans must cover the cost of childhood vaccinations among other preventative health care measures[37]. In a study using data from the 2003 NIS, 16.6% (12.0, 21.2) of respondents below 100% of the federal poverty line said they were likely to delay, less than the 29.7% (21.3, 38.1) among those with household incomes >$75,000[13]. Another study using the 2003 NIS found no association between income, using an income to poverty ratio, with Up-to-date vaccination status for the 4:3:1:3 series[15]. Yet, in a study using data from a 2002 Health Styles survey, those making <$25,000 were 2.3 (1.3, 4.0) times more likely to oppose compulsory vaccination compared to those making $75,000 or more[19]. The question in the second survey did not specifically ask about parents personal intention to vaccinate their own child; it asked whether or not they would support allowing children to go to public school if they were not vaccinated, a belief which has a less clear-cut relationship with intent to vaccinate. However, parents planning to have their child receive only some, or no vaccines, were 4.3 times more likely among those opposed to compulsory vaccination (95% CI: 1.8, 10.3) [19]. A study conducted in Oregon, a state with consistently high number of exemptions and lower vaccine coverage, using data from 2004-2005, found that Exemptors were

more likely to be below the federal poverty line (35.4% vs. 22.2%)[20]. The same study also found that Exemptors were more likely to be stay-at-home parents (51.1% vs. 31.3%), and that they were less likely to be working full time (29.8% vs. 45.9%)[20].

Higher education attainment levels are often associated with vaccine exemptions or vaccine hesitant behavior. In a case-control study conducted across four states between 2002 and 2003, 57.6% of parents of exempt children had more than some college compared to 47.2% of parents of fully vaccinated children ($p<0.02$)[16]. The Oregon study from 2004-2005 found no significant association between education categories and vaccine exemptions[20]. Kim, et al., found that mothers with less than a high school education were more likely up-to-date on their child's vaccines compared to mothers that had college degrees (Hazard Ratio (HR)=1.16; 95% CI: 1.01, 1.33)[15]. In a survey of Washington state pediatricians, where practices were comprised of 50% or more of patients with parents with college degrees, alternative immunization schedules were requested significantly more frequently (P =0.02)[17].

Race and ethnicity have a generally consistent relationship with vaccine hesitant behavior. In general, white parents are more likely to refuse or delay than other groups. Hispanic and non-Hispanic black parents are less likely to refuse. In a quantitative study using data from the 2003-2004 NIS survey white parents had the highest proportion that refused vaccines (9.7%)[14]. Hispanic and non-Hispanic black parents were less likely to refuse compared to white parents (Hispanic OR=0.15; 95% CI: 0.04, 0.49) (Black OR=0.12; 95% CI: 0.04, 0.39). Only Hispanic

parents' were less likely to be unsure (OR=0.36; 95% CI: 0.15, 0.85)[14]. Smith, et al., used data from the 2003 NIS to specifically look at associations with intentional delay. The authors found that 14.5% of Hispanic (95% CI: 10.5, 18.5) and 12.4% of non-Hispanic black (95% CI: 7.9, 16.9) parents would delay immunizations for any reason, significantly less than white parents, 28.1% of whom would choose to delay (95% CI: 23.7, 32.5)[13]. A study using the same data found that Hispanic children were more likely to be up to date (UTD) on immunizations compared to non-Hispanic white children (OR=1.11; 95% CI: 1.01, 1.22)[15].

The relationship of marital status to vaccine decision-making is confusing. Several studies using NIS data from 2003, and another that included data from 2004 got different results. Using 2003 and 2004 NIS data, Gust, et al., found that mothers who had never married were 2.14 times more likely to delay than mothers that were married (95% CI: 1.08, 4.26)[14]. Yet Smith et al., found that unmarried mothers delayed 16.8% (95% CI: 11.7, 21.9), less than the 23.2% (95% CI: 19.7, 26.7) that chose to delay among married mothers[13]. Another study found that marital status was not associated with differences between unvaccinated and fully vaccinated children, though being young, widowed, divorced, or separated was associated with differences between under vaccinated and fully vaccinated status[18]. A relationship between marital status and choosing to delay vaccines is possible; it is not likely to be related to choosing to refuse based on current evidence.

Increasing numbers of children under 18 in the household was significantly associated with a higher likelihood of deciding to delay immunizations. Having 2-3

children increased the odds of delay to 3.46 (95% CI: 1.41, 8.48) times that of households with a single child. The odds of delay increase to 5.18 (95% CI: 1.66, 16.20) times that of an only child for those with four or more children[14]. Smith et al., found that having four or more children was associated with under vaccination when compared to UTD children, associated with unvaccinated children when compared to under vaccinated children, and unvaccinated children when compared to fully vaccinated children[18]. So, more children within a household may have associations with decisions to delay or to refuse childhood immunizations.

Age appears to have a strong relationship with parental vaccine decisions, but comparison is difficult between studies with different age brackets. Several studies found that parents thirty or older were more likely to delay than parents from younger age groups. In a case control study conducted across four states, Colorado, Massachusetts, Washington, and Missouri, parents of exempt children were compared to parents of fully vaccinated children. They found a significant difference between groups, 44.0% of parents of children with exemptions were older than the median age group (36-40) compared to the 35.9% of parents with fully vaccinated children (P =0.02)[16]. Gust et al., using data from the 2003-2004 NIS comparing unsure parents, parents who delayed, and parents who refused with vaccine accepting parents. They found that mothers older than thirty were 2.82 times more likely to be unsure compared to younger parents (95% CI: 1.46, 5.47)[14]. Unsure was defined as having answered yes to vaccine doubt questions but still accepting vaccinations for their child. Information or reassurances from their health care provider was the main reason listed by unsure parents for

changing their mind[14]. Smith et al., found that 19.1% of parents aged 20-29 (95% CI: 15.2, 23.0) compared to 24.5% of parents thirty or older (95% CI: 20.4, 28.6) were significantly (P <0.05) less likely to delay vaccines for their child for any reason[13].

The attitudes and beliefs that parents hold about vaccination have continued to be strikingly different between parents that vaccinate, delay, or refuse vaccines for their children. In a case-control study among parents who obtained exemptions for their child, only 47.0% of parents believed full vaccination status benefited children, and 47.3% believed that fully vaccinated children benefited the community. Whereas 95.5% of parents of fully vaccinated children believed that being fully vaccinated benefited children, and 89.6% believed that it benefited the community[16]. In a study that compared the attitudes of parents who supported or opposed compulsory vaccination, opposed parents were much more likely to have negative or incorrect beliefs about vaccines. For instance, 24% of opposed parents believed "the body can protect itself without vaccines," vs. 10% of supportive parents (OR=2.3; 95% CI: 1.4, 3.6)[19]. Other beliefs significantly different between groups (p<0.001) included: "vaccines are not very important for a child's health," "vaccines are not necessary to prevent certain diseases," "the diseases vaccines prevent are not serious," "children are not likely to get the diseases vaccines prevent," "children receive too many vaccines"[19]. An Oregon study from 2004-2005 that compared the parents of children with exemptions to parents with fully vaccinated children found similar results. Parents of exempt children were less likely to believe that benefits outweigh the risks (39.5% vs. 84.9%) then parents of

fully vaccinated children[20]. They were also more likely to believe that too many vaccines overwhelm a child's immune system (77.9% vs. 17.5%), vaccines are given at too young an age (77.9% vs. 28.9%)[20]. Beliefs about other parents behavior were also different, with 44.4% of Exemptors believing that some or many parents in the community are not vaccinating their children compared to only 22.0% among parents of fully vaccinated children[20]. It's important to note that negative vaccine beliefs do not only exist among vaccine hesitant parents, many vaccine-accepting parents also have doubts.

Position of Health Care Workers

Doctors are in the best position to talk to parents about childhood vaccinations. The majority of parents still identify their health care provider as their most trusted source of vaccine information. Three variables in the analysis address the relationship between parents and health care providers: if parents' choice of health care provider was influenced by if they would be allowed to refuse or delay a vaccine for their child; if a doctor or nurse influenced their decision to vaccinate; and how parents approach the subject of childhood vaccines with their doctors. Information on how doctors interact with parents and respond to questions about childhood vaccines is important to put these variables into context.

One of the most alarming facts that showed up in the literature was how many doctors are willing to provide parents with a medical exemption to vaccines if the parent did not want to vaccinate when there was no medical contraindication to vaccination. This study compared the health care providers of vaccinated children to exempt children from a previous case-control study conducted in Washington,

Missouri, Massachusetts, and Colorado. The authors found that 24.5% of providers of exempt children and 14.6% among providers of vaccinated children would do this[38]. Significant differences were found in the types of medical degrees providers had, where providers of vaccinated children were more often MDs (87.9% vs. 74.1% p=0.01) and less often DOs (5.3% vs. 13.0% p<0.01)[38]. Doctors also significantly differed in their beliefs about vaccines and vaccine safety. The providers identified by exempt children were less likely to report high-perceived vaccine safety (OR=0.37; 95% CI: 0.19, 0.72)[38]. Doctors of exempt children were also 2.28 times more likely to believe that children get more vaccines than is good for them (95% CI: 1.56, 5.10), and 4.03 times more likely to believe that a child's immune system could be weakened by too many vaccines (95% CI: 2.06, 7.86)[38]. Additional statistically significant associations between doctors of exempt children and misinformed vaccine beliefs included: Health care providers of exempt children were more likely to believe that a good diet is more important than vaccines for preventing infectious disease (OR=3.68; 95% CI: 1.61, 8.38), that its better to get the disease than to be vaccinated (OR=4.08; 95% CI: 1.90, 8.76), and that the CDC/ACIP underestimate the frequency of vaccine side effects (OR=2.86; 95% CI: 1.65, 4.97), compared to providers of vaccinated children[38]. These providers were also less likely to believe that vaccines strengthen the immune system (OR=0.55; 95% CI: 0.36, 0.85) or that immunizations are getting safer (OR=0.47; 95% CI: 0.27, 0.82)[38]. It's disquieting to find that vaccine hesitant beliefs are present even among some health care providers. A follow up to the previously mentioned study by Salmon et al.,[38] examined the association of vaccine attitudes and beliefs

between parents and health care providers. The authors found that a majority of all responding parents trusted their health care provider. Health care providers were identified as parents' most used resource for vaccine information among 90% of respondents[39]. Though parents that agreed to the statement 'a child's immune system could be weakened by too many vaccines,' had 4.6 (95% CI: 2.2, 9.3) times higher odds of having a provider with the same belief[39]. Parents may gravitate towards doctors that share similar beliefs to their own, either by design, or because parents may be dismissed from other practices.

Similar results were found in a study of Washington state pediatricians attitudes about alternative vaccination schedules. Among all respondents, 60% were comfortable using alternative vaccine schedules when they were requested[17]. The proportion of pediatricians that agreed with the statement 'Too many vaccines are given in one visit' was 8%[17]. More seriously, 6% agreed that too many vaccines were given overall[17].

Many health care providers do not know how to react when parents refuse vaccinations for their child. In a study of Connecticut pediatricians from 2007-2008, out of the 128 practices included in the study, 62% noticed an increase in vaccine concerns or refusal in the previous 5 years. Among these doctors, 28% said that the increased concern over vaccines had a negative effect on them, compared to 45% who merely found it annoying. More seriously, 31.3% reported dismissing families for refusing vaccines, though the American Academy of Pediatrics discourages doctors from doing this[40]. More than 40% of respondents (25.6% strongly agreed,

15.5% agreed) agreed that dismissing parents was the right thing to do when families refused all vaccines[40].

In a 2009 study that sampled doctors from the national organizations American Academy of Pediatrics and the American Academy of Family Physicians, per month, 79% of respondents experienced at least one refusal, and 89% reported a request to use an alternative vaccination schedule[41]. Yet, 81% of physicians said that they never or rarely sent out information to parents about vaccines prior to doctor appointments[41]. Common barriers to vaccination discussion were asked about. Time was the number one barrier to vaccine discussions with parents, reported by 62% of physicians (95% CI: 58, 66). Other reasons included: doubt about ability to convince parents, lack of enough knowledge about vaccine safety evidence to confidently discuss, and doubts that parents will understand the risk/benefit information[41]. A majority of responding doctors noticed that the prevalence of vaccine hesitant behavior among parents had increased in the five years prior to the survey (2004-2009). Only 29% (95% CI: 26, 33) thought vaccine concerns had decreased or stayed the same, while 43% (95% CI: 39, 47) thought it had increased greatly, and 28% (95% CI: 24, 32) thought it had increased moderately[41].

Trust in Health Care Workers and Other Factors in Vaccine Decision-making

Doctors are noticing the increasing prevalence of vaccine hesitant behavior among parents, and they are frustrated and doubt their ability to convince parents that vaccinating their children is the right thing to do. Some health care providers are starting to doubt vaccines themselves. Many are comfortable using alternative

vaccine schedules. Yet doctors are still the most trusted source of information about vaccines for parents, and unsure parents who decided to vaccinate most often cite the advice of their doctor for changing their minds. However, vaccine hesitant parents are less likely to trust their doctor or to trust the information provided by their doctor alone.

In a study using NIS data from 2001-2002, parents who believed that vaccines were not safe, but were influenced by a health care provider (HCP), had an estimated vaccination coverage rate that was significantly higher (74.4%) than among children with parents who were not influenced by their doctor (50.3%); there was an estimated difference of 24.1% (95% CI: 9.3, 38.9) between groups[21]. However, only 20.7% of parents who believed vaccines were not safe admitted to being influenced by a HCP compared to 35.5% of parents who believed in the safety of vaccines. Sociodemographic factors may also play a role in how much parents trust their health care provider[21]. Non-Hispanic white parents and mothers with 12 years of education were more likely to not be influenced by HCPs and to believe vaccines are not safe, compared to Hispanic parents and mothers with college degrees respectively. This was also true for households with four or more children less than 18 years of age[21].

In a survey of school personnel involved in the review of student immunization status, nurses and a variety of other school personnel were asked about their training as well as knowledge, attitudes, and beliefs about vaccination. Associations were found between vaccine beliefs of staff and the presence of student exemptions. Vaccine misconceptions were fairly common, with 19% of participants

concerned that too many vaccines could weaken the immune system[42]. Though 95.6% of respondents believed that children benefit, and 96.1% believed that society benefits, when all children are immunized[42]. Only 69% of respondents were nurses. Attending a school with a respondent who was a nurse, or who had at least a moderate trust in local or state health departments reduced the likelihood of children having vaccine exemptions[42].

In a small but interesting study that examined the structure of doctor visits, the authors found that some communication strategies worked better than others, and some areas for potential improvement in engaging with patients. In this qualitative study, 111 doctor visits were recorded, including 16 health care providers from nine practices. There were 55 discussions with vaccine hesitant parents. The majority of subjects were white mothers with household incomes of $75,000 or more a year. When discussions were initiated in a participatory format, 80% of parents resisted the HCP's recommendation, compared to 17% of presumptive initiations[43]. If the initial recommendation was rejected, about half of HCPs pursued recommending immunization. They were more likely to pursue it if the parent's refusal was direct than when parents used a less explicit response. An example would be something like "not today," compared to a more direct "no". Out of 19 interactions where doctors pursued their recommendation, in nine of them parents accepted immediately after[43]. Of these, 11 discussions were with vaccine hesitant parents, who were convinced in three cases, compared to eight discussions with non-VHPs, with six successful interactions[43]. Many of the observed providers did not provide rationale for the recommended vaccines and did not discuss

potential side effects. These results suggest that doctors have more potential influence than they realize, and possible opportunities for interventions.

The qualitative portion of a mixed methods study examined parent's decision-making process in more detail. They conducted 7 focus groups, four were comprised of 13 parents that denied all vaccinations, and 3 made up of 11 parents that delayed vaccines. Five themes emerged from these discussions: vaccination decisions were made during pregnancy or when making a birth plan, this decision was continuously reevaluated, multiple sources were sought out for vaccine information, there was a distinction between trusting a doctor and trusting the vaccine information they provided, and it was thought that doctors did not know enough about vaccination and that the vaccination information they presented was one sided[44]. One mother said, "They don't give vaccine information I think I would like"[44]. These parents appear to be treating vaccines as separate from other medical decisions. In the quantitative portion of this study, a survey asked questions determined from the results of the focus groups. All respondents were surveyed from within a health insurance network, which resulted in a skew in demographics. For instance, few individuals in the sample had a household income less than $30,000 per year. Parents who refused were 3.2 times more likely to think about vaccination before the birth of their child (95% CI: 1.3, 8.0; P =0.01) compared to acceptors; parents who delayed were 2.3 times (95% CI: 1.4, 4.0; P <0.002) more likely to do so[44]. Both refusing (OR=35.1; p<0.0001) and delaying parents (OR=8.4; P =0.0006) strongly disagreed with their doctor's advice ((95% CI: 10.7, 119.3) & (95% CI: 2.5, 28.0) respectively)[44]. Delayers were significantly less

confident (OR=0.5; 95% CI: 0.3, 0.8; *P* =0.007) that they had sufficient information to make a decision about vaccination compared to acceptors[44]. The association between choosing to refuse and a lack of confidence in available vaccine information was not significant.

Similar findings emerged from a qualitative study in north Texas. The researchers interviewed individuals that had children or were pregnant and had already made a decision to refuse or delay vaccination for their child. The two main themes that emerged from these interviews were a distrust of the medical community and a desire to collect information on vaccines from multiple sources. These parents wanted a 'balanced' source of information on vaccines, about both risks and benefits[45].

Another qualitative study in King county of Washington state investigated the process by which parents make decisions about vaccination. They found that a major influencing factor was seeing vaccination as a social norm[46]. Factors that caused parents to reassess their decision towards vaccination included: pro-vaccination discussion with others, finding new information about vaccines or vaccine preventable diseases, or changing risks like school entry or travel abroad[46]. Other factors could influence parents to change their decision away from vaccination. These included learning about school exemptions to vaccine requirements, concern about the number of vaccines, or a child having a bad reaction to a vaccine. [46]

Parents and Information Sources

As mentioned above, in multiple studies vaccine hesitant parents are more likely to pursue more information about vaccines from multiple sources. Also, message framing about childhood vaccines can affect parent intentions to vaccinate. A few variables in this analysis address sources other than doctors that parents may turn to for information; indirectly, the vaccine attitude score may be influenced by information found online, and directly through personal contact with other parents who have delayed or refused vaccines, or who have a vaccine injured child.

Parents use multiple sources for vaccine information. Doctors are used the most frequently and by the most people, and tend to be the most trusted. What other sources do people use? In a 2002 survey, 79.6% of respondents reported using between two to six sources[47]. Only 4.4% reported using only one source. Doctors, as seen elsewhere, were the most used, with a child's health care provider reported as a source for 91.7% of parents[47]. Additionally, 84% reported using VIS statements or other printed materials from their health care provider. Other sources did not have as much support. Friends and family were used by only 53.8%, and 39.9% rated the Internet as a good or excellent source of vaccine information[47]. The odds ratio adjusted for vaccine decision characterized parents who utilized the internet as a resource as 1.49 times (1.12, 2.0) more likely to have attained at least a college degree and 1.41 times (1.04, 1.91) more likely to have a household income greater than or equal to $70,000 compared to parents who did not utilize the internet as a resource for vaccine information[47]. Most importantly, Internet users

were 3.53 (2.61, 4.76) times more likely to have at least one child with a vaccine exemption compared to non-internet utilizers.

A study that examined the perceived credibility of potential sources of vaccine information found that parents trusted their child's physician the most (76%), followed by other health care providers (26%)[48]. Government related vaccine experts or officials were only highly trusted for 23%[48]. Parents trusted family and friends only 15%. Very few respondents rated parents claiming a vaccine-harmed child as trustworthy, and even fewer regarded celebrities as credible (8%, and 2% respectively). Women were more likely to trust parents who claimed a vaccine harmed child or celebrities compared to men[48].

Emphasizing the facts behind certain benefits of vaccination may do more to assuage parent fears than others. Evidence from a 2014 study shows that parents respond better to messaging that emphasizes the benefits of immunization directly to their child[49]. Messaging that emphasized benefits to society, which has previously been demonstrated to improve adult intentions to vaccinate themselves, did not improve or detract from parent intent to vaccinate their children[49]. VIS statements were provided to all parents, with the VIS statement alone as the control. The intervention groups received additional promotional materials with messages that emphasized benefits to the child or benefits to society. One intervention group received all three.

The Internet is a vast space filled with both credible and misleading information. Search terms influence the retrieved results of search engines. One study found that search criteria could impact the quality and the viewpoint of

retrieved websites on childhood vaccine information. Pre-existing attitudes could have a significant impact on the information parents who choose to rely on the Internet receive. In 2013, searching using the 'negative' search term 'vaccine risks,' resulted in 3.6 times more myths per website compared to searching with neutral terms, and 4.8 times more myths than searching with vaccine positive terms[50]. The most common myth found was "childhood vaccines cause autism," which was also the most commonly countered myth. Out of the total 84 websites analyzed, only 15 websites made an explicit recommendation towards vaccination, four websites recommended against, and 65 made no recommendation at all[50]. This study did not include discussion boards or other social media in its analysis, so the personal element of story sharing from parents claiming that vaccines hurt their child is not as present. A media surveillance study that took place from early 2011- 2012, examined government reports, blogs, and online articles related to information on vaccines, vaccination programs, and vaccine preventable diseases. Of the 10,380 reports from 144 countries analyzed, 69% contained either positive or neutral content, and 31% contained negative content[50]. With nearly a third of collected reports classified as negative, this shows that information available online is dramatically variable in outlook.

Global Context

Vaccine hesitancy is not just a problem in the U.S, its international in scale. Though localized circumstances surround each instance, trust, whether in vaccines, vaccine providers, or government, is at the root of the issue. The halt of polio vaccination for 11 months in northern Nigeria in 2003-2004 was in part politically

and religiously driven, and caused large setbacks to the global polio eradication efforts[51]. The health workers in rural regions of Pakistan are under threat, a situation not improved by the CIA using a vaccine campaign as a front for intelligence gathering in 2011. Parents refuse vaccines on religious grounds, an additional barrier to the already difficult geographical and geopolitical situation. In 2014 there were 306 cases of polio in Pakistan, 85.2% of total cases worldwide[52]. The UK only recovered vaccine coverage to pre-Wakefield levels in 2012[51]. Vaccine confidence has largely outstripped convenience of access as a chief threat to vaccine coverage. Meanwhile, outbreaks of vaccine preventable disease continue across the world. Cases of measles reached 34,250 in the EU in 2011. Outbreaks due to under-vaccination also occurred in Ukraine, Russia, and the UK in 2012. There were high numbers of cases in U.S., Canada, Australia, New Zealand, Kenya, Somalia, India, and Mozambique. In the majority of these countries, infrastructure is not the primary barrier to vaccine coverage[53].

Chapter III: Methods

We conducted a quantitative cross-sectional study to examine the impact of the relationships between the socio-demographic characteristics of parents and parental knowledge, attitudes, and beliefs about childhood vaccination on pediatric immunization decision-making. This study was performed using data from a national online poll of parents' opinions, attitudes, and beliefs about childhood vaccination administered by Gfk in 2012 and 2014. The Centers for Disease Control and Prevention contracted FHI360 in 2012 and Westat in 2014 to develop and administer the survey, which was subcontracted to Gfk.

The original survey was approved by the FHI360 Institutional Review Board. This study was determined to be exempt from review by Emory University's IRB, because it does not qualify as 'human subjects research.' The study examines only de-identified data and cannot be linked to the individual human subjects by anyone.

Study Settings and Participants

The target population for this survey included non-institutionalized adults 18 and older, residing in the United States, who are parents or caretakers of children aged 0 to 6 years old. The sample came from KnowledgePanel®, an assembled panel of online survey takers recruited through random digit dialing from 1999 until 2009, when recruitment switched to address-based sampling. Invited panelists who do not have Internet access are provided with a laptop and free Internet service. Participants complete a demographic survey when they accept the invitation to become part of the panel and update this demographic information each year that they are an active panel member. These demographic characteristics are used to

establish weights for panel sampling. For each survey conducted using KnowledgePanel®, a random sample is drawn from among active panel members using probability-proportional-to-size selection incorporating the panel demographic weights and the weights accounting for under and oversampling due to panel recruitment strategies. Depending on study requirements, eligibility criteria can be applied prior to sampling or the sample can be screened during selection.

Data Collection

In 2012 a pre-test to screen for study eligibility was conducted between January 29th and February 7th. Participants completed the main survey between March 9th and March 26th. A total of 4,933 people were sampled for the screener and 2,792 (56.6%) completed it. The main survey was completed by 2,603 (93.2%). In 2014 the pre-test was completed between June 2nd and June 6th 2014. The main survey was administered between July 11th and July 28th. A total of 4,803 were sampled for the initial screening, and 2,618 (54.5%) completed it, and of those 2,518 (96.2%) qualified for and completed the main survey.

Participants were contacted with a notification email when selected for the survey and non-responders were contacted again with a reminder email three days later. All survey respondents received a $5 equivalent incentive for participation.

Analysis

Outcome Variables

The primary outcome variable of interest was the parent's decision to accept, refuse, or delay vaccination for their youngest child. All vaccination behaviors were

self-reported and could not be verified. Acceptance was defined as accepting all recommended childhood vaccines (excluding the influenza vaccine) at the time they were recommended by a care provider. Though influenza vaccination is recommended for children, the influenza vaccine must be renewed on a yearly basis and the uptake rate for the flu vaccine is usually much lower than for other childhood vaccines. The acceptance category also included those who were actively trying to catch up on all vaccines.

Refusal was defined as those parents who refused at least one non-influenza recommended vaccine. If a parent refused some and delayed some immunizations, they were classified with parents who refused for the purpose of this analysis.

The delay category included parents who delayed at least one of the non-influenza recommended vaccines, unless they had also refused vaccines. This category did not include unintentional delays caused by illness, missed appointments, or lack of vaccine stock. It was meant to include parents that were pursuing alternative vaccine schedules, not parents that were in the process of actively trying to catch up to the ACIP recommended schedule or those who could not vaccinate due to health or structural concerns. Some parents were recoded into a decision category based on individual vaccine questions, which were only asked of parents that indicated they had delayed or refused a vaccine. Parents who responded that they had delayed or refused, but had only done so for the influenza vaccine were moved to the acceptance category.

Year

Sample data was pooled from both survey years when the samples were shown to be very similar with only minimal differences in descriptive analysis.

Exposure Variables: Socio-demographics

Socio-demographic characteristics to be included in analysis were chosen based on a comprehensive literature review conducted prior to quantitative analysis. These variables include age, gender, income, education attainment, geographic region, race/ethnicity, and childcare type. Age was categorized into three age brackets: 18-29, 30-44, and 45+. Household income was defined in three categories: low (<$20,000), mid ($20,000-$99,999), and high ($100,000+). Education was compressed into three categories: high school or less, some college/associate's degree, and Bachelor's degree or higher. Geographic region uses four defined census regions including: Northeast, South, Midwest, and West. Childcare type was in four categories. The reference category was stay-at-home parent. Other categories were daycare, family member/neighbor/friend/nanny inside the home on a regular schedule, or outside the home on a regular schedule.

Information on race and ethnicity was collected in the survey with a question that had respondents 'check all that apply'. In univariate and bivariate analysis to aid interpretation, race and ethnicity were kept as separate variables. Those who identified as more than one race were categorized as 'multi-racial'. However for the multivariate models, race and ethnicity were combined into one variable, so that those who identified as multi-racial were given an index variable for each race or ethnicity they identified with. These index variables were weighted by equally

splitting the effect of race/ethnicity across all selected categories. For example, if someone responded that they were Hispanic, white, and American Indian/Alaska Native, the indicator variable for each of these would be 1/3. This weighting strategy allows the effect of race/ethnicity to be divided amongst the different groups with which the participant identifies.

Exposure Variables: Knowledge, Attitudes, and Beliefs

Using exploratory factor analysis in SPSS, a vaccine attitude score variable was created from seven questions concerned with parental beliefs about the need for vaccines, the danger of vaccine preventable diseases, and the safety and efficacy of vaccines. All the questions were measured on a five-point Likert scale. All of the questions were originally coded so that 1 indicated positive attitudes or beliefs towards vaccines while 5 indicated negative attitudes or beliefs. After factor analysis verified that the items measured a single latent factor with high internal consistency (Cronbach's $\alpha > 0.7$), a construct mean index was constructed from the mean of each participant's responses. Index scores were not constructed for participants who answered three or less of the questions. The questions were reverse-coded prior to variable creation so that a higher mean would indicate a more positive attitude towards vaccines.

A dichotomous variable was included based on the question “When you were selecting a doctor or health care provider for your child, was one of your considerations whether they would allow you to delay or refuse vaccines for your youngest child?”

The survey included three questions addressing whether health care providers had influenced the parents' decision to vaccinate. A separate question was included for doctors, nurses, and other health care workers. We combined the questions about doctors and nurses into one dichotomous variable indicating whether a doctor or nurse had influenced that participant's decision to vaccinate.

Two questions in the survey addressed how parents think they approach vaccination and how they think other parents approach vaccination. These two variables have three responses: "I tend not to ask questions…", "I tend to ask basic questions (i.e. about side effects)…", and "I tend to ask serious questions about a vaccine/or whether my child really needs it".

Three questions in the survey that were included in analysis addressed knowing other parents whose child had been severely injured by vaccines, or other parents who had deliberately chosen to delay or refuse a vaccine for their child.

Modeling

All analysis was conducted in SPSS version 22.0 (IBM SPSS Inc., Chicago, IL, USA), using the Complex Samples module to account for the sampling design used in the survey. Descriptive statistics were generated for variables of interest, and bivariate cross-tabulations were used to examine key relationships. Rao and Scott's Survey adjusted Pearson χ^2 tests were used in bivariate analysis to test for associations between parent's vaccine decisions and socio-demographic (SD) and knowledge, attitudes, and belief (KABs) variables. Bivariate analysis was also conducted between the SD variables and each of the KABs variables. Relationships were evaluated for significance at $\alpha = 0.05$ with 95% Confidence Intervals.

Survey-weighted multiple multivariable models were developed and compared to assess for and quantify mediation between the different categories of the variables. By using nested regression, SD variables were tested independently of KABs variables with the outcome (model 2). The same was done for KABs variables independent of socio-demographics (model 1). Then SD characteristics were tested together against each KABs variable included in analysis (models 4-11). The Full Model tested KABs and SD variables together against the vaccine decision outcome in a multivariable logistic regression. This was to verify the presence and direction of mediation or any other unaccounted for direct effects when compared to the other models.

Model 1 examined the direct effect of included KABs variables alone on vaccine decision-making in a multivariable logistic model. Model 2 looked at the direct effects of socio-demographics on the outcome.

Models 3 – 10 tested the relationship between each knowledge, attitude, and belief variable on all the socio-demographic predictors. 'Was your doctor choice affected by whether they would allow you to refuse or delay a vaccination for your child?' and 'Was your decision to vaccinate your child influenced by a doctor or nurse?' were considered with logistic regression in Model 3 and Model 4 respectively.

Ordinal regression was considered for both 'Statement that best describes your approach to vaccines,' and 'Statement that best describes how you think other parents approach vaccines,' because the responses were ordinal in nature. They escalated from 'Asking no questions,' 'asking basic questions (i.e. about side effects),'

to ‘asking serious questions and/or whether their child really needs the vaccine.’ For Model 5, testing parent’s own approach to vaccines, the test of parallel lines run by SPSS to test the proportional odds assumption found that the assumption held, so ordinal logistic regression could be used. The proportional odds assumption requires that the difference in log odds between the response levels is the same in every case. We failed to reject the null hypothesis, since p=.179, which is > .05. For Model 6, testing how respondents think other parents approach vaccines, the test of parallel lines was <.001, so ordinal logistic regression was not a valid approach. Multivariable logistic regression was used instead.

The outcome for model 7, ‘Personally knowing someone whose child has been severely injured by a vaccine,’ was dichotomized for logistic regression, combining the categories: ‘yes, someone else’s child’, ‘yes, my child’, and ‘yes, both my and someone else’s child’. This simplified possible responses to just yes and no. Models 8 and 9 used logistic regression to test the relationship between, ‘Do you know a parent who has delayed a vaccination for their child,’ and ‘Do you know a parent who refused a vaccination for their child,’ respectively, to the selected socio-demographic predictors.

Model 10 used linear regression to examine the relationship between socio-demographic variables and the continuous variable Vaccine Attitude Score, which was created in SPSS using factor analysis.

Adjusted Wald tests were conducted on each of the models with the categorical version of the variables of interest to test for overall significance in the model. The models were run previously with indicator versions of the variables so

reference categories could be selected; however using that method examines the significance of the specific levels compared to the reference category in the model but not the overall variable.

Multicollinearity was assessed for socio-demographics and knowledge, attitude, and belief variables both together and separately. No variance inflation factors were > 5.

Chapter IV: Results

Description of Sample

The sample was pooled from the 2012 and 2014 surveys for a total sample size of 5,121 parents or guardians ≥ 18 of a child <7 years old. The un-weighted descriptive statistics for sociodemographics (Table 1.1), un-weighted and weighted KABs (Table 1.2, 1.3), and factor analysis (Table 1.4) remain split by year. Respondents of the survey were 72.3% female and 27.7% male. The majority of participants were white, making up 80% of respondents. Black participants made up 9.7% of the sample. None of the other racial groups comprised more than 5% of the sample. Hispanic individuals made up 13.8% of participants, 86.2% of the sample identified as non-Hispanic. A majority of the parents surveyed were within the 30-44 age group. There was a wide range of education levels and household income levels. Weighted population estimates of parents' vaccine decisions from the overall sample comprised 90.0% (95% CI: 88.8, 91.0) who accepted all non-influenza vaccines, 5.6% (95% CI: 4.8, 6.4) who delayed at least one vaccine without refusing any, and 4.5% (95% CI: 3.7, 5.4) who refused at least one vaccine.

Factor Analysis

A vaccine attitude score was constructed based on questions that addressed beliefs about vaccine safety, necessity, and efficacy. The mean answers of the sample were high overall, ranging from 4.2-4.7, with a maximum possible value of five, indicating positive attitudes and beliefs about vaccines. Internal reliability was estimated by Cronbach's α, found to be 0.924. Therefore, reliability was high, exceeding the accepted cut-off of 0.7.More details about the vaccine attitude score

can be found in Table 1.3, which describes the individual items, item means, and factor loadings for the vaccine attitude score.

Bivariate Associations with Vaccine Decision

Almost all the variables included in bivariate analysis had statistically significant associations with respondents' vaccine decision (Table 2.1). The only exceptions were gender and the number of children in the household. All knowledge, attitude, and belief variables were significantly associated (Table 2.2).

Middle-aged parents chose to delay the most often, while older parents chose to refuse the most. Of the middle-aged parents, aged 30-44, 7.1% delayed non-influenza vaccines for their youngest child, compared to 2.9% of parents in the youngest age group from 18-29, or 4.0% among older parents 45+ years in age. The oldest age group had 5.2% refuse, while both young and middle-aged parents had 4.4% who chose to refuse.

Consistent with previous research, Hispanic parents continue to be more likely to accept vaccines, especially compared to white parents. More participants who identified as Hispanic accepted vaccines (94.2% vs. 88.8%) and fewer delayed (3.7% vs. 6.0%) or refused (2.1% vs. 5.1%) compared to those who did not identify as Hispanic. Participants who specifically identified as white had only 87.9% choose to accept all vaccines.

A higher frequency of parents' with a bachelor's degree or higher chose to delay vaccines for their youngest child then those with some college or those with high school or less (8.1% vs. 5.4% and 3.2% respectively).

In categories of employment, those who identified themselves as not working but not retired, disabled, or unemployed, had the highest frequency that delayed (6.9%) and refused (6.8%) compared to all other categories. Self-identified stay-at-home parents also had the highest proportion that chose to delay (6.5%) or refuse (5.9%) compared to other types of childcare.

A smaller proportion of those who never married chose to delay (2.2%) or refuse (2.7%) than either those who were currently married (6.0%, 4.6%) or divorced/separated (3.3%, 5.4%).

Unsurprisingly, more parents who delayed or refused vaccines for their child factored in whether a doctor would allow them to refuse or delay into their choice of doctor (table 2.2). Only 9.7% (95% CI: 8.0, 10.8) of acceptors answered yes to this question, compared to 33.6% of delayers (95% CI: 27.4, 40.5), and 53.0% of refusers (95% CI: 43.4, 62.4). Participants who chose to delay or refuse non-influenza vaccines for their children had still had a large proportion say that their doctor or nurse influenced their decision. A doctor or nurse influenced the vaccination decision of 31.0% (95% CI: 25.2, 37.4) delayers, and 20.8% (95% CI: 14.7, 28.5) of refusers. In these cases, doctors may be ameliorating parents' decisions, from a refusal to delay, or refusing some vaccines instead of all vaccines. For comparison, a doctor or nurse influenced the vaccination decision of 37.4% of acceptors (95% CI: 35.3, 39.5).

The majority of parents who refused vaccines for their child approached vaccines with serious questions. Only 2.2% (95% CI: 1.0, 4.6) asked no questions, 16.9% (95% CI: 10.2, 26.7) asked basic questions, and 80.9% (95% CI: 71.3, 87.9)

asked serious questions or questioned the necessity of vaccines (Table 2.2). Parents who delayed were almost evenly split, with 44.3% (95% CI: 37.2, 51.7) asking basic questions, and 44.9% (95% CI: 38.0, 52.1) asking serious questions, and 10.7 (95% CI: 6.2, 18.0) asking no questions. Most acceptors had basic questions about things like side effects, with 65.3% (95% CI: 16.3, 19.7). However, 17.9% (95% CI: 16.3, 19.7) of acceptors had serious questions or questioned the necessity of vaccines. This suggests that even parents with serious concerns about vaccines can be convinced of their safety and public health importance. Interestingly, 62.7% (95% CI: 52.8, 71.6) of parents who refused vaccines for their child thought that in general other parents did not ask any questions. These are the same parents that asked the most questions. Out of the parents who delayed, 57.3% (95% CI: 50.1, 64.2) thought other parents asked no questions. While 57.8% (95% CI: 55.6, 59.9) of parents who accepted all vaccines believed that in general, other parents asked basic questions about vaccines. These numbers paint an unflattering picture, where parents who choose to refuse or delay vaccines for their children doubt that other parents are as concerned for their own child's safety.

Parents who chose to refuse or delay vaccines for their child were much more likely to know someone else who had delayed or refused vaccines for their child. 84.2% (95% CI: 78.8, 88.4) of delayers and 89.5% (95% CI: 84.2, 93.1) of refusers knew someone who delayed. A personal connection to a parent that refused vaccines was present for 59.4% (95% CI: 52.1, 66.3) of delayers and 87.0% (95% CI: 80.3, 91.7) of refusers. Among acceptors, 37.4% (95% CI: 35.4, 39.4) said they knew someone who delayed, and 27.6% (95% CI: 25.8, 29.5) said they knew someone

who refused. Knowing someone who delayed or refused a vaccine for their child is not necessarily motivation to do the same, but it may increase the possibility.

Bivariate Associations between KABs and SD variables

Bivariate associations between sociodemographic and KABs variables can be found in more detail in Tables 2.3, 2.4, and 2.5. Among the lowest income category, <$20,000, 'Was your choice of doctor influenced by whether they would allow you to delay or refuse vaccines for your youngest child?,' 20.3% (95% CI: 15.6, 26.0) responded yes. Compared to the 11.9% (95% CI: 10.3, 13.6) of the $20,000-$99,999 income bracket and 8.8% (95% CI: 6.9, 11.1) of the $100,000+ income bracket that also answered yes, it stands out. Those who never married also answered yes slightly more often than other groups, with 18.3% (95% CI: 12.5, 26.1) who answered yes compared to 12.3% (95% CI: 10.9, 13.8) among married respondents and 8.1% (95% CI: 5.0, 12.7) among divorced or separated respondents. Using survey weighted chi-square we found the choice of a provider tolerant of delay or refusal was significantly associated with education (P =0.008), employment (P=0.048), household income (P <.001), and marital status (P =0.025). The categories with the highest proportion of people choosing doctors tolerant of vaccine hesitant behavior were those with high school or less education (15.5%), those with a household income less than $20,000 (20.3%), people not-working for unspecified reasons (15.9%), and the never married (18.3%). Doctor or nurse influence on vaccination decision was significantly associated with race (P=0.004) and education (P =0.012). White respondents were slightly less likely to report that their vaccination decision influenced by a doctor or nurse 33.6% (95% CI: 31.5,

35.9). Among other racial groups a range of 44.7%-49.5% were influenced by a doctor or nurse, though the confidence intervals are fairly large considering the small sample sizes of these groups. The details of the relationships of these two KABs variables and SD factors are in Table 2.3.

Table 2.4 examines the bivariate relationships between sociodemographics and the respondent's approach to asking questions about vaccines and how the respondent thinks other parents approach and question vaccines. Those who self-described approaching vaccination with questions were associated with education (P <0.001) and income (P =0.001). The highest proportion of individuals who felt that they asked serious questions about vaccines compared between education categories was 27.7% (95% CI: 25.0, 30.7) among those with some college or an associate's degree. A smaller proportion of those with high school or less education, 22.0% (95% CI: 18.4, 25.9) and those with a bachelor's degree or more 17.3% (95% CI: 15.5, 19.3) felt they questioned the necessity of vaccines or asked other serious questions. Those in the highest income bracket, making $100,000 or more were much less likely, only 14.4% (95% CI: 12.0, 17.2) to question the necessity of vaccines or ask serious questions about vaccination compared to 25.8% (95% CI: 21.1, 31.2) of the lowest income category and 23.4% (95% CI: 23.4, 25.6) of the middle income category. Perceived approach of other parents to vaccination was significantly associated with gender (P =0.006), age (P =0.018), ethnicity (P =0.023), race (P =0.010), education (P =0.002), employment (P =0.004), and household income (P =0.001). A smaller proportion of those with a bachelor's degree or more think other parents question the necessity of vaccines; only 7.0% (95% CI: 5.8, 8.5)

compared to 11.5% (95% CI: 9.6, 13.7) among those with some college and 12.9% (95% CI: 10.2, 16.3) among those with high school or less.

Table 2.4 displays the associations between sociodemographic variables and social network features related to vaccination, including acquaintance with others with a vaccine injured child, who have delayed vaccines for their child, or who have refused vaccines for their child. Personal connection to a vaccine-related injury was associated with gender (P =0.025), ethnicity (P <0.001), race (P =0.008), education (P =0.032), employment (P =0.012), income (P <0.001), and childcare type (P=0.016). Personal connection to a parent who chose to delay was associated with gender (P =0.002), ethnicity (P <0.001), race (P <0.001), education (P <0.001), employment (P <0.001), income (P <0.001), region (P =0.009), marital status (P<0.001), and childcare type (P =0.019). Personal connection to a parent that chose to refuse was significantly associated with gender (P =0.003), ethnicity (P =0.001), race (P <0.001), education (P <0.001), employment (P <0.001), income (P <0.001), marital status (P <0.001), region (P <0.001), number of children (P =0.007), and childcare type (P =0.001). A smaller proportion of those in the lowest income bracket personally knew someone who delayed (29.4%; 95% CI: 24.5, 34.8) or refused (22.7%; 95% CI: 18.5, 27.6) at least one vaccination for their child compared to 44.6% (delay; 95% CI: 42.2, 47.0) and 34.4% (refuse; 95% CI; 32.1, 36.7) of middle income parents, and 44.2% (delay; 95% CI: 40.3, 48.3) and 31.0% (refuse; 95% CI: 27.4, 34.8) lower income parents.

Multivariable Models

Model 1: Vaccine Decision Outcomes and Parent Knowledge, Attitudes, and Beliefs

Model 1 examines knowledge, attitude, and belief variables in relation to pediatric vaccine decisions in a multivariable multinomial regression. All KABs variables had a significant association with the outcome, which can be found in Table 3.2. Some associations of interest are discussed below.

Delay vs. Accept: Those that chose a doctor in part by whether they would allow vaccine refusal or delay had higher odds of choosing to delay a vaccination for their child compared to acceptors OR=2.11 (95% CI: 1.43, 3.13; *P* <0.001), after adjusting for other KABs variables. Parent or guardians who had their vaccine decision influenced by a doctor or nurse had much lower odds of choosing to delay a vaccine for their child, OR=0.55 (95% CI: 0.40, 0.78; *P* =0.001). Those who approach childhood vaccines with serious questions had 2.56 (95% CI: 1.28, 5.15) times the odds of delay. Respondents who thought others approached childhood vaccines with basic (OR=0.49; 95% CI: 0.34, 0.69) or serious questions (OR=0.25; 95% CI: 0.12, 0.49) were much less likely to delay vaccines themselves. Participants who knew a parent with a vaccine-injured child had increased odds of delaying a vaccination, OR=2.44 (95% CI: 1.69, 3.53). Similarly, parents who personally knew someone who had delayed a vaccine had increased odds of delay vs. acceptance, compared to parents who did not (OR=6.35; 95% CI: 4.00, 10.09; *P* <0.001).

Refuse vs. Accept: When adjusting for other KABs variables, having doctor choice influenced by the ability to choose to delay or refuse vaccines was associated with higher odds of choosing to refuse, OR=2.40 (95% CI: 1.42, 4.05). If a doctor or nurse influenced one's vaccination decision, the odds of choosing to refuse were reduced, OR=0.30 (95% CI: 0.16, 0.54). Asking either basic or serious questions was

associated with a higher likelihood of refusal (basic; OR=4.74 95% CI: 1.19, 18.85) (serious; OR=21.43 95% CI: 5.79, 79.32). However, the odds of refusing for those who think *others* approach vaccination with serious questions were reduced, OR=0.35 (95% CI: 0.17, 0.70). The odds of refusing a vaccine were higher for parents who knew someone who refused a vaccine OR=3.78 (95% CI: 1.58, 9.05).

Refuse vs. Delay: There were fewer strong associations when comparing parents who delayed to parents who refused across most knowledge, attitude, and belief variables. Having a more positive vaccine attitude score had a significant protective effect, OR=0.44 (95% CI: 0.34, 0.55). Respondents who were influenced by a doctor or nurse in their vaccination decision were less likely to choose to refuse than delay, OR=0.53 (95% CI: 0.29, 0.98). Knowing a parent that chose to refuse a vaccine for their child increased the odds of refusing a vaccine, OR=3.98 (95% CI: 1.68, 9.45).

Model 2: Vaccine Decision Outcomes and Parent Sociodemographic Characteristics

Model 2 examined the relationships between all the sociodemographic factors and pediatric vaccine decisions, in a multivariable logistic regression. More detailed results can be found in Table 3.2. The model was run twice, once using acceptors as the reference group, and once using delay as the reference to elucidate a comparison between delay and refuse categories. Gender was significant: the odds of women reporting delay of vaccination was 1.45 (95% CI: 1.02, 2.08) times higher than the odds of men reporting delay. This may be misleading, since only one parent per household was surveyed. Age appears to be an important variable; the odds of delaying for those 30-44 were 2.38 (95% CI: 1.57, 3.61) times higher compared to

parents 18-29. Hispanic, Black, and Asian/Pacific Islander respondents were all less likely than white respondents to choose to delay vaccines for their child. Education was also significant in the model; those with a bachelor's degree or more had 2.21 (95% CI: 1.22, 4.01) times greater odds of delaying vaccination compared to those with high school or less. The odds of delaying among respondents from the West census region were 1.64 (95% CI: 1.11, 2.43) times higher compared to the reference region, South. Childcare type was also important. Parents of children in daycare were less likely than stay-at-home parents to choose to delay a vaccine for their child (OR=0.62; 95% CI: 0.39, 0.98). Participants for whom a neighbor, family member, friend, or nanny care for the child inside the home on a regular schedule were also less likely than stay-at-home parents to choose to delay a vaccine for their child (OR=0.55; 95% CI: 0.33, 0.92).

Fewer relationships were statistically significant when looking at refusal vs. acceptance, or refusal vs. delay. Hispanic and Asian/Pacific Islander respondents were less likely to refuse vaccines than those identifying as white. Asian/Pacific Islanders were also less likely to choose refusal over delay, compared to white participants. In the Midwest, parents were more likely to refuse instead of accept compared to parents in the South. Those with a bachelor's degree or higher were less likely to refuse than to delay compared to those that graduated high school or less.

Models 3-10: The Relationship of Sociodemographic Descriptors to Vaccine Knowledge, Attitudes, and Beliefs

Detailed results from Models 3-4 and 7-10 can be found in Table 3.3. Models 5 and 6 can be found in Table 3.4. Models 3 and 4 examine the associations of key sociodemographic characteristics to doctor choice and doctor/nurse influence respectively. Models 5 and 6 address the type of questions parents asked about vaccines, and how respondents think other parents ask questions about vaccines. Models 7-9 address personal connections to people with a vaccine injured child, who delayed a vaccine, or who refused a vaccine for their child. Model 10 is a linear regression with the vaccine attitude score made through factor analysis.

Model 3: "Was your choice of doctor affected by if they would allow you to refuse or delay a vaccine for your child?"

Income and region were the only two significant variables in the model after adjustment for other socio-demographic factors. Those making $20,000-$99,999 were less likely than the lowest income category (<$20,000) to have their choice of doctor influenced by the ability to delay or refuse immunization for their child (OR=0.55; 95% CI: 0.36, 0.82). Those making $100,000 or more a year were even less likely than the lowest income level to choose a delay or refusal tolerant doctor (OR=0.41; 95% CI: 0.25, 0.68; p=0.001). Respondents from the Northeast census region were more likely to factor possible vaccine options into doctor choice compared to those in the south, OR=1.56 (95% CI: 1.03, 2.36).

Model 4: "Did a doctor or nurse influence your decision to vaccinate your child?"

Education and race/ethnicity had significant associations in this model. Hispanic, Black, and Asian/Pacific Islander respondents were more likely to have their vaccine decision influenced by a doctor or nurse compared to white

participants, (Hispanic; OR=1.73 95% CI: 1.16, 2.59) (Black; OR=1.51 95% CI: 1.11, 2.06) (Asian and Pacific Islander; OR=2.16 95% CI: 1.45, 3.22). Those with some college or an associate's degree were less likely than those with less education to be influenced by a doctor or nurse in their decision, OR=0.76 (95% CI: 0.60, 0.96; *P*=0.022).

Model 5: "Statement that best describes your approach to vaccines:

1. *I tend not to ask any questions about a vaccine before it is given to my child.*
2. *I tend to ask basic questions about a vaccine (i.e. side effects) before it is given to my child.*
3. *I tend to ask serious questions about a vaccine and/or whether my child really needs it."*

This model used ordinal logistic regression. Race/ethnicity, education, household income, and childcare type were significant in the model. The odds of those with some college or an associate's degree not asking questions were lower than for those with less education, compared with asking basic or serious questions. Additionally, the middle education category of respondents was less likely to ask no or basic questions than to ask serious questions compared to the lowest education category (OR=0.73; 95% CI: 0.57, 0.93). Respondents in the highest income bracket were 1.55 (95% CI: 1.07, 2.23) times more likely to ask no questions then to ask basic or serious questions compared to those in the lowest income bracket. The same odds ratio applies to how likely the highest income bracket was to ask no questions or basic questions instead of serious questions. Respondents utilizing daycare outside the home were 1.38 (95% CI: 1.11, 1.71) times more likely to ask no

questions then to ask basic or serious questions; and 1.38 times more likely to ask no questions or basic questions then to ask serious questions in comparison to stay-at-home parents. Those who identified as Asian or as Pacific islanders were also more likely to ask no questions then to ask basic or serious questions, and more likely to ask no questions or basic questions then to ask serious questions compared to those who identify as white (OR=1.90; 95% CI: 1.37, 2.65).

Model 6: "Statement that best describes how you think others approach childhood vaccines:

1. *They tend to not ask any questions about a vaccine before it is given to their child.*
2. *They tend to ask basic questions (i.e. side effects) about a vaccine before it is given to their child.*
3. *They tend to ask serious questions about a vaccine or whether their child really needs it."*

This question could not be modeled with ordinal regression, so multivariable logistic regression was used. Gender, race/ethnicity, education, and income were significant in the model. Women had odds of asking serious questions 1.52 (95% CI: 1.08, 2.14) times higher then asking basic questions compared to men. Those who identified as Hispanic were less likely than white respondents to ask basic questions compared to no questions (OR=0.49; 95% CI: 0.33, 0.75). Among those with a bachelor's degree or higher, the odds of asking serious questions compared to basic questions were 0.59 (95% CI: 0.38, 0.92) times lower than those in the lowest education category. Those making $100,000 or more were less likely to ask serious

questions then to ask basic questions compared to the lowest income bracket (OR=0.51; 95% CI: 0.27, 0.97).

Model 7: "Do you personally know anyone, including yourself, whose child has experienced a severe reaction to a vaccine? By severe reaction, we mean having a reaction to a vaccine that required medical attention and could not be treated at home."

Gender, income, race/ethnicity, and childcare type were significant in Model 7. Women were slightly more likely to know someone with a vaccine-injured child then men (OR=1.40; 95% CI: 1.06, 1.86; *P* =0.019). Respondents identifying as Asian or Pacific Islander were slightly less likely to know a parent with a vaccine-injured child compared to white respondents (OR=0.39; 95% CI: 0.15, 0.99; *P* =0.047). Those in the highest income bracket were also less likely to know someone whose child had a severe reaction to a vaccine compared to the lowest income bracket (OR=0.51; 95% CI: 0.31, 0.85; *P* =0.009). Additionally, compared to stay-at-home parents, those who utilize a family member, friend, neighbor, or nanny inside the home on a regular schedule were also less likely to know anyone with a vaccine-injured child (OR=0.49; 95% CI: 0.32, 0.76).

Model 8: "Do you personally know anyone who has chosen to delay their child's vaccinations?" & Model 9: "Do you personally know anyone who has chosen to refuse their child's vaccinations?"

Both Models 8 and 9 had significant associations with gender, race/ethnicity, education, region, and childcare type. In Model 8, income was also significant.

Women were more likely to know a parent that had chosen to delay or refuse then men (Delay; OR=1.50 95% CI: 1.25, 1.81; *P* <0.001) (Refuse; OR=1.47 95% CI: 1.20, 1.79; *P* <0.001). Hispanic, black, and Asian/Pacific Islander respondents were less likely to know someone who chose to delay or refuse any vaccinations for their child compared to white participants. Both of the higher education categories were more likely to know someone who chose to delay or refuse vaccines for their child. Among those with some college or an associate's degree, the odds of knowing someone who delayed was 1.80 (95% CI: 1.41, 2.30) times higher than a respondent who graduated high school or less, and 1.70 (95% CI: 1.32, 2.20) times higher for knowing a parent who refused. Among those with a bachelor's degree or more, the odds of knowing a parent who delayed were 2.08 (95% CI: 1.61, 2.68) times higher than the reference group, and 1.81 (95% CI: 1.38, 2.87) times higher for knowing a parent that chose to refuse. Compared to those living in the South census region, those living in the West had odds 1.49 (95% CI: 1.20, 1.86) times higher of knowing a parent that delayed a vaccination and 1.62 (95% CI: 1.29, 2.04) times higher of knowing a parent that refused. The Midwest census region respondents only had significantly higher odds of knowing a parent who refused, OR=1.35 (95% CI: 1.08, 1.65; *P* =0.008). Parent or guardians that utilize daycare outside of the home were less likely to know parents who delayed (OR=0.76; 95% CI: 0.61, 0.93) or refused (OR=0.68; 95% CI: 0.55, 0.85) vaccinations for their child. This could be related to the fact that many daycare centers have their own immunization mandates.

Model 10: Vaccine Attitude Score

Race/ethnicity, education, income, region, and childcare type were significantly associated with vaccine attitude score. Hispanic and black respondents were more likely to have slightly higher scores, or more positive vaccine attitudes than white respondents (P =0.009 and P =0.041 respectively). Compared to those with high school or less education, those with a bachelor's degree or more had significantly more positive vaccine attitudes (P =0.001). Those making $100,000 or more a year also had higher vaccine attitude scores than the lowest income category (P =0.028). Those from the Midwest census region were more likely to have slightly lower vaccine attitude scores compared to respondents from the south (P =0.043). Compared to stay-at-home parents, both those who use daycare (P =0.016) or have a family member, friend, neighbor or nannies, inside the home (P =0.012) were more likely to have higher vaccine attitude scores.

Full Model:

The Full Model examined both KABs and SD variables together against parent's vaccine decisions. According to our hypothesized model, KABs are mediating the effect of socio-demographics on the outcome of pediatric vaccination decisions. The results of this model supply evidence toward our hypothesis, since the effects of almost all sociodemographic predictors became insignificant in the model when included with knowledge, attitude, and belief variables. Together with models 4-11 that examined the specific relationships of all SD variables with each of the individual KABs variables, we found that age seems to have a relationship with childhood vaccine decisions independent of KABs. The variables race/ethnicity, education, and region appear to only be only partially mediated by KABs, and

appear to have remaining direct effects that are not accounted for by the hypothesized mediating variables. Detailed results can be found in Table 3.1.

Chapter V: Discussion

Childhood vaccines are very important for public health. Previously undiscovered benefits have recently come to light. Childhood vaccines can play a role in lowering the risk of childhood stroke, and vaccinating against measles can protect against other infections[54, 55]. High immunization coverage has enabled dramatic reduction in cases for diseases like rubella and polio; yet as these threats have lost immediacy, public doubt can grow. Vaccine knowledge, attitudes, and beliefs are linked to parent sociodemographic characteristics. They cluster in communities made up of similar income levels, education levels, and racial/ethnic makeups. Doubt spreads easily. Parents trust their doctor, but doctors lack the time and resources to answer all possible questions, and many doctors lack understanding behind how vaccines and the human immune system work.

This quantitative study on pediatric vaccine decision making split parents into three possible decision outcomes: accept (accept all), delay (delayed at least one, but no refusals), and refuse (refused at least one). Yearly influenza vaccination was not included. The association of sociodemographic (SD) characteristics of parents and parent knowledge, attitudes, and beliefs (KABs) toward pediatric immunization was evaluated with bivariate analysis and multivariable logistic models. In total, eleven multivariable models were built to explore any mediating effects of KABs variables on the relationship of sociodemographic factors to vaccine decision-making. First, sociodemographic factors were modeled independently with vaccine decision. Second, KABs variables were modeled independently with vaccine decision. Then the associations between each of the KABs variables with all parent

sociodemographic characteristics were examined. The full or saturated model adjusted for all SD and KABs variable effects on vaccine decision. Almost all of the demonstrated effects of sociodemographic characteristics on vaccine decision were mediated by KABs variables. Age was the only SD variable that appeared to have a relationship with vaccine decision independent of KABs variables included in the analysis. These results can aid our understanding of the pathway to vaccination decision-making and present possible points for intervention: to improve vaccination coverage and overall trust in vaccines.

The proportion of acceptors, delayers, and refusers is fairly consistent for the available vaccine coverage numbers. For the 2011-2012 school year, as previously discussed, median MMR coverage was 94.8%, with a range of 86.3%-99.3% across areas reporting. For the 2013-2014 school year, median MMR coverage was 94.7% with a range of 81.7%-99.7%. Within our sample, 90.0% (95% CI: 88.8, 91.0) accepted all vaccines, 5.6% (95% CI: 3.7, 5.4) delayed at least one vaccine without refusing any, and 4.5% (95% CI: 3.7, 5.4) refused at least one vaccine.

Parent Sociodemographic Characteristics

Sociodemographic associations with vaccine decision were generally consistent with past findings where previously studied [13-21]. Previous studies have also examined associations between childhood vaccine decision and similar parent knowledge, attitude, and belief variables to those examined in this analysis [16-17, 19-21, 38, 40, 44, 47-48].

Women were more likely than men to know someone with a vaccine injured child, a parent who delayed, or a parent who refused; a possible reflection of current trends in caregiving and society.

Income continues to have an inconsistent relationship to vaccine decision outcomes. Income was significantly associated with vaccine decision in bivariate analysis, but it was not significant when included in model 2, which adjusted for all sociodemographic variables. Past studies have associated household income >$75,000 with increased likelihood of vaccine delay than those below the federal poverty line, while similar studies have found the opposite, or no significant association [13]. In associations with KABs variables, low-income status was linked to considering whether a doctor would allow a parent to refuse or delay childhood vaccines in their choice of doctor, but this group chose less frequently to delay or refuse vaccines for their child. This was also true for those who never married, compared to those married, divorced, or widowed. This could be a result of vagueness in the wording of the question, or it could be important for those parents that other children using the same doctor were not refusing or delaying vaccines, so as to protect their own kids from potential exposure. It could also be that it was important for these parents to have the option available, even if they were less likely to choose it.

Parents who enrolled their children in daycare were less likely to delay or refuse when compared to stay-at-home parents. This makes sense considering that daycare often has its own mandates on vaccine coverage for enrollees [29]. This is consistent with past findings showing Exemptors to consist of a majority of stay-at-

home parents [20]. Our results also suggest that parents utilizing childcare consisting of a family member, neighbor, or friend inside the home on a regular basis is less likely to delay when compared to stay-at-home parents. Childcare type is by its nature linked to employment status. Previous work has shown Exemptors to be less likely to be working fulltime compared to parents of vaccinated children [20]. Bivariate analysis of employment shows evidence that a higher frequency of parents who described themselves as not-working (but also not retired, disabled, or unemployed) decided to delay or refuse at least one vaccine for their child. This is a group that undoubtedly overlaps with stay-at-home parents.

Participants with a bachelor's degree or higher were significantly more likely to delay compared to participants with 12 years or less education, with other sociodemographic factors adjusted for. This finding is consistent with past studies: mothers with less than high school were more likely to be up-to-date in comparison to mothers with college degrees [15], doctor practices where 50% or more of patients had college degrees reported alternate vaccination schedules were requested more frequently [17]. Higher education (>12 years) is also associated with lower trust in doctors or nurses, and trust in HCPs is associated with higher vaccine acceptance [21]. Those with some college or a bachelor's degree+ were more likely to know someone who chose to delay vaccines for their child than those in the lowest education attainment category, and those who knew someone who delayed more often chose to delay vaccines for their child.

The census region West was associated with larger numbers of parents choosing to delay vaccines. Several states in that region have had consistently lower

vaccination coverage, including Oregon and Colorado, plus California's recent outbreaks of measles [1, 2]. The South region includes states with consistently high vaccination coverage like Texas and Mississippi, and also includes the two states that only allow medical exemptions for vaccines: Mississippi and West Virginia [2, 23, 35]. The Midwest region was associated with higher numbers of refusal and had statistically significant less positive vaccine attitudes than parents in the south. Unsurprisingly, those in the west were more likely to know someone who delayed compared to the south. Parents from both the Midwest and West were more likely to know someone who had refused than parents from the South. The Northeast was more likely than the South to have doctor choice influenced by whether a doctor would allow parents to refuse or delay vaccines for their child. (knowing someone who delayed or refused – more likely to delay or refuse).

White parents were consistently more likely than other racial or ethnic groups to choose to delay or refuse vaccines for their child. Hispanic, Black, and Asian/Native Hawaiian/Pacific Islander parents were statistically significantly more likely to accept than delay when compared to white identifying parents. Hispanic and Asian/Native Hawaiian/Pacific Islander parents were also more likely to accept than refuse, and Asian/Native Hawaiian/Pacific Islander parents were more likely to delay than refuse when compared to white parents. Ample amounts of previous research has exhibited that Hispanic and Non-Hispanic Black parents to be less vaccine hesitant compared to white parents [13-15]. Non-Hispanic white parents are less likely to be influenced by their doctor, and more likely to know someone

with a vaccine injured child, someone who delayed, or someone who refused. They also have more negative attitudes about childhood vaccines.

We divided age into three age groups: 18-29, 30-44, and 45+. Age group divisions were not consistent in the literature; the most common was to split age group at age thirty. We found that parents aged 30-44 were significantly more likely to delay than accept when compared to 18-29 year olds in both the saturated model and when only adjusted for other sociodemographic characteristics. Age did not have any significant associations with included KABs variables, only with vaccine decision. Elsewhere, parents >30 were shown to be more likely to be unsure than younger parents [16]. Another study found that those older than 36-40 were more likely to delay [14], an age group that overlaps with our results.

Parent Vaccine Knowledge, Attitudes, and Beliefs

Doctors have the power to influence their patients. Evidence here indicates that parents that were influenced by doctors were more likely to accept than to delay, more likely to accept than refuse, and more likely to delay instead of refuse. It suggests that doctors can persuade parents to delay vaccines instead of outright refusal. Previous studies show that doctors are the most used resource for vaccine information, but many doubt their ability to convince parents to follow vaccine recommendations. Gust et al., found that the most listed reason for unsure parents to change their mind was reassurance from health care providers (HCPs) [14]. Multiple studies show 90% or more parents list their HCP as a source for vaccine information [39, 47]. VIS statements or other printed materials from a doctor were used by 84% of parents [47]. Vaccine coverage is higher among parents who said

they were influenced by a HCP [21]. In a study examining doctor behavior and barriers to vaccine discussion, 81% of physicians said they never or rarely sent out information to parents prior to doctor appointments. Yet 62% said that time was a barrier to vaccine discussion. Additionally, many doctors doubted their ability to convince parents, their own ability to confidently discuss vaccines, and parent ability to understand risk and benefit information [41]. A small observational study of doctor visits found that pursuing original vaccine recommendations was likely to pay off, but that many doctors did not always do this [43]. These facts together suggest an opportunity to improve vaccine coverage by helping doctors, with resources and communication strategies.

Parents who considered whether they would be allowed to delay or refuse vaccines for their child when choosing a doctor were more likely to delay or refuse vaccines compared to those who did not. This was true when adjusting for all other KABs variables and in the saturated model additionally adjusted for sociodemographic characteristics. Vaccine hesitant parents may gravitate towards providers with similar beliefs to their own by design or because they were dismissed from other practices. In a study of Connecticut pediatricians, 31.3% said they had dismissed families for refusing vaccines. Salmon et al., found that doctors of exempt children are more likely to harbor vaccine hesitant beliefs including that children get more vaccines then are good for them, or that a child's immune system could be weakened by too many vaccines [38]. Working to improve doctor attitudes and beliefs toward childhood vaccinations may be another opportunity for intervention.

In model 1, adjusted for all KABs variables, parents approaching vaccination with serious questions were more likely to delay or refuse vaccines compared to those asking no questions. Other studies have shown that doubting parents seek information from many sources; they want information on both risks and benefits of vaccination. The Internet was used more often by those with higher household income (>$70,000) and/or with a college degree [47]. However, thinking that other parents asked basic or serious questions was associated with higher numbers accepting vaccines for their children. It may say something about a difference in trust in society, when the parents who think others are not asking any questions are choosing to delay or refuse vaccines.

In model 1, adjusted for all KABs variables, knowing someone with a vaccine injured child, a parent who delayed a vaccine for their child, or a parent who refused a vaccine for their child was associated with refusing vaccines. Knowing someone with a vaccine injured child or who delayed vaccines was also associated with choosing to delay vaccines. This shows that social connections matter, and doubt can spread within social networks. Knowing a vaccine delaying or refusing parent was associated with several sociodemographic factors, which play a role in forming social networks. It was more likely to know a delayer if a woman, if white, if >12 years of education, if household income $20,000-$99,999, if from West census region, or if a stay-at-home parent. Associations for knowing a refusing parent were only different in that income was not significant, and both Midwest and West regions were significant. Oddly, knowing someone with a vaccine injured child was

more likely in the Northeast census region, and was less likely for those making $100,000 or more compared to those making <$20,000.

Pathway Evaluation

Though parent age groups can be linked to vaccine decision outcomes, they did not have any associations with the knowledge, attitude and belief variables tested in this analysis. The West census region continued to be more likely to delay, statistically significant when compared to the South. Those with a bachelor's degree or higher were still more likely to delay when compared to those who graduated high school or less. Respondents who identified as Hispanic were less likely to refuse compared to white identifying parents. All other sociodemographic variables were no longer significant when the model was adjusted for KABs variables. This model hypothesizes a possible pathway for vaccine decision-making, and found that several sociodemographic variable effects on vaccine decision were mediated by parent knowledge, attitudes and beliefs.

Strengths and Limitations

There were several limitations to this study. Our study was cross-sectional in design, and therefore we cannot demonstrate as causal relationship, we can only hypothesize. Receipt of vaccination could not be confirmed for participants. It is also unclear whether respondents answered with past action or future intentions. Since the age of children included was 0-6, either or both are possible.

There were also numerous strengths. The sampling method utilized gave us a nationally representative sample specific to parents aged 18 or older with children aged 0-6. Since the sample is nationally representative, our results should be

generalizable. The age range for children covers the time period of infancy through kindergarten, so vaccination decisions are recent. SPSS allowed us to account for the complex sample design in our analysis. Our analysis examined the nuances of the relationships between sociodemographic descriptors, parent knowledge, attitudes, and beliefs about childhood vaccines, and the outcomes of parent vaccine decisions.

Conclusions

Key messages from the results presented and discussed here include: (1) Several sociodemographic characteristics effect on vaccine decision was mediated by parent knowledge, attitude and belief variables; (2) Parent age has a relationship with vaccine decision that is not mediated by any of the KABs variables we investigated; (3) Doctors play an important role in parent vaccine decision making, and have the potential to improve vaccination coverage among their patients. Programs focused on doctors have the potential to improve vaccine coverage and vaccine knowledge. Since doctors are generally the most frequently used and most trusted source for vaccine information, if doctors make information resources available to parents before doctor visits, parent concerns can be more effectively appeased. Sociodemographic factors could be used to target practices in areas where delaying and refusing vaccines for children is more common.

Future Recommendations

Future studies on the subject of vaccine hesitancy should include longitudinal data collection, so as to strengthen causal evidence. There currently is a gap in knowledge of the vaccination status of most home schooled children, which should be investigated. Upcoming changes to vaccination mandate laws in Vermont and

California should track changes to vaccination coverage as the new laws are implemented. Intervention studies on improving the resources doctors can make available to patients, or improving communication between doctors and parents should be a priority.

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Table 1.1 Sociodemographics by survey year

	Frequency (%)	
	2012	2014
Gender		
Male	719 (27.6%)	699 (27.8%)
Female	1884 (72.4%)	1819 (72.2%)
Age		
18-29	812 (31.2%)	776 (30.8%)
30-44	1899 (61.4%)	1563 (62.1%)
45-59	184 (7.1%)	165 (6.6%)
60+	8 (0.3%)	14 (0.6%)
Ethnicity		
Hispanic	363 (14.0%)	337 (13.5%)
Non-Hispanic	2224 (85.4%)	2165 (86.0%)
Race		
White	2059 (80.1%)	1989 (80.3%)
Black	260 (10.1%)	238 (9.6%)
American Indian/Alaskan Native	20 (0.8%)	17 (0.7%)
Asian	91 (3.5%)	85 (3.4%)
Native Hawaiian/Pacific Islander	17 (0.7%)	9 (0.4%)
Other Single Race	65 (2.5%)	56 (2.3%)
Multi-racial	55 (2.1%)	84 (3.4%)
Education		
< High School Graduate	109 (4.2%	59 (2.3%)
High School Graduate	359 (13.8%)	326 (12.9%)
Some College/Associate's degree	916 (35.2%)	871 (34.6%)
Bachelor's degree	797 (30.6%)	818 (32.5%)
Master or Doctoral degree	422 (16.2%)	444 (17.6%)
Employment		
Employed	1618 (62.2%)	1675 (66.5%)
Unemployed	290 (11.1%)	183 (7.3%)
Retired or Disabled	56 (2.2%)	57 (2.3%)
Not-working, other	639 (24.5%)	603 (23.9%)
Household Income		
< $10,000	206 (7.9%)	151 (6.0%)
$10,000-$19,999	204 (7.8%)	154 (6.1%)
$20,000-$39,999	561 (21.6%)	505 (20.1%)
$40,000-$59,999	463 (17.8%)	450 (17.9%)
$60,000-$99,999	714 (27.4%)	757 (30.1%)
$100,000-$149,999	313 (12.0%)	347 (13.8%)
$150,000 or more	142 (5.5%)	154 (6.1%)

Table 1.1 Continued Sociodemographics by survey year

	Frequency (%)	
	2012	2014
Region		
Northeast	357 (13.7%)	351 (13.9%)
Midwest	730 (28.0%)	673 (26.7%)
South	869 (33.4%)	840 (33.4%)
West	647 (24.9%)	654 (26.0%)
Marital Status		
Married	1956 (75.1%)	1948 (77.4%)
Widowed	6 (0.2%)	4 (0.2%)
Divorced	97 (3.7%)	99 (3.9%)
Separated	47 (1.8%)	26 (1.0%)
Never Married	228 (8.8%)	210 (8.3%)
Living with Partner	269 (10.3%)	231 (9.2%)
Number of Children in Household		
One	826 (31.7%)	929 (36.9%)
Two - Three	1507 (57.9%)	1339 (53.2%)
Four+	270 (10.4%)	250 (9.9%)
Childcare Type		
Daycare outside home	707 (27.5%)	657 (26.3%)
Familly member, friend, nanny, or neighbor outside home on a regular schedule	351 (13.6%)	351 (14.1%)
Familly member, friend, nanny, or neighbor inside home on a regular schedule	200 (7.8%)	257 (10.3%)
Stay-at-home parent/guardian	1317 (51.1%)	1233 (49.4%)

Table 1.2 Descriptive Statistics of Parental Knowledge, Attitudes, and Beliefs (unweighted n=5121)

	Frequency (%)	
	2012	2014
When choosing a doctor was one of your considerations whether they would allow you to delay or refuse vaccines for your youngest child?		
Yes	352 (13.5%)	281 (11.2%)
No	2246 (86.5%)	2223 (88.8%)
Did a doctor or nurse influence your decision to vaccinate?		
Yes	946 (36.6%)	821 (32.9%)
No	1642 (63.4%)	1675 (67.1%)
Statement that best describes how your approach childhood vaccines		
I tend not to ask any questions about a vaccine before it is given to my child	364 (14.0%)	382 (15.3%)
I tend to ask basic questions about a vaccine (i.e. side effects) before it is given to my child	1620 (62.5%)	1587 (63.4%)
I tend to ask serious questions about a vaccine and/or whether my child really needs it	607 (23.4%)	533 (21.1%)
Statement that best describes how you think other parent's approach childhood vaccines		
I tend not to ask any questions about a vaccine before it is given to my child	916 (35.6%)	833 (33.6%)
I tend to ask basic questions about a vaccine (i.e. side effects) before it is given to my child	1426 (55.4%)	1393 (56.1%)
I tend to ask serious questions about a vaccine and/or whether my child really needs it	234 (9.1%)	255 (10.3%)
Do you personally know anyone, including yourself, whose child has experienced a severe reaction to a vaccine? By severe reaction, we mean having a reaction to a vaccine that required medical attention and could not be treated at home.		
Yes, someone else's child	260 (10.1%)	268 (10.7%)
Yes, my child	58 (2.2%)	31 (1.2%)
Yes, both my child and someone else's child	15 (0.6%)	14 (0.6%)
No	2254 (87.1%)	2187 (87.5%)
Do you personally know anyone who has chosen to delay their child's vaccinations?		
Yes	1226 (47.3%)	1240 (49.5%)
No	1365 (52.7%)	1264 (50.5%)
Do you personally know anyone who has chosen to refuse any of the recommended vaccines for their child?		
Yes	936 (36.1%)	966 (38.5%)
No	1656 (63.9%)	1541 (61.5%)

Table 1.3 Weighted Descriptive Parental Knowledge, Attitudes, and Beliefs (n=5121)

	Weighted % (95% CI)	
	2012	2014
When choosing a doctor or for your child, was one of your considerations whether they would allow you to delay or refuse vaccines for your youngest child?		
Yes	13.7% (11.7-16.0)	11.4% (9.8-13.2)
No	86.3% (84.0-88.3)	88.6% (86.8-90.2)
Did a doctor or nurse influence your decision to vaccinate?		
Yes	36.8% (33.9-39.8)	35.8% (33.2-38.4)
No	63.2% (60.2-66.1)	64.2% (61.6-66.8)
Statement that best describes how your approach childhood vaccines		
I tend not to ask any questions about a vaccine before it is given to my child	16.0% (13.8-18.4)	15.7% (13.8-17.8)
I tend to ask basic questions about a vaccine (i.e. side effects) before it is given to my child	61.4% (58.4-64.4)	62.6% (59.9-65.1)
I tend to ask serious questions about a vaccine and/or whether my child really needs it	22.6% (20.2-25.3)	21.8% (19.6-24.1)
Statement that best describes how you think other parent's approach childhood vaccines		
I tend not to ask any questions about a vaccine before it is given to my child	35.2% (32.4-38.2)	33.2% (30.7-35.8)
I tend to ask basic questions about a vaccine (i.e. side effects) before it is given to my child	54.8% (51.7-57.8)	55.8% (53.1-58.5)
I tend to ask serious questions about a vaccine and/or whether my child really needs it	10.0% (8.2-12.1)	11.0% (9.4-12.9)
Do you personally know anyone, including yourself, whose child has experienced a severe reaction to a vaccine? By severe reaction, we mean having a reaction to a vaccine that required medical attention and could not be treated at home.		
Yes, someone else's child	9.5% (7.9-11.5)	8.7% (7.5-10.1)
Yes, my child	3.1% (2.1-4.5)	1.4% (0.8-2.4)
Yes, both my child and someone else's child	0.8% (0.4-1.7)	0.5% (0.3-1.0)
No	86.6% (84.3-88.6)	89.3% (87.7-90.8)
Do you personally know anyone who has chosen to delay their child's vaccinations?		
Yes	42.3% (39.3-45.3)	42.4% (39.8-45.0)
No	57.7% (54.7-60.7)	57.6% (55.0-60.2)
Do you personally know anyone who has chosen to refuse any of the recommended vaccines for their child?		
Yes	31.7% (29.0-34.5)	32.5% (30.1-34.9)
No	68.3% (65.5-71.0)	67.5% (65.1-69.9)

Table 1.4 Descriptive statistics for Vaccine Attitude Score (n=5121; case-wise deleted=286)

	2012		2014		
Factor	**Mean**	**SD**	**Mean**	**SD**	**Factor Loading**
Vaccine Attitudes ($\alpha = 0.924$, 7 items)					
KABS3: In general, how important do you think vaccines are for keeping children healthy?*	4.60	0.023	4.61	0.022	0.852
KABS4A: To what extent do you agree or disagree with this statement: Getting my child immunized is the right thing to do.**	4.50	0.028	4.55	0.023	0.876
KABS4B: How confident are you in the safety of routine childhood immunizations? ***	4.35	0.031	4.35	0.024	0.832
KABS5: In general, how serious are the diseases that vaccines can prevent?****	4.68	0.019	4.70	0.017	0.674
KABS7: To what extent do you agree or disagree with this statement: the risks associated with vaccines are small; and the risks associated with the diseases vaccines prevent are big?**	4.22	0.030	4.22	0.027	0.722
KABS11: How confident are you that the vaccines you get your youngest child will prevent diseases?***	4.42	0.028	4.44	0.021	0.816
KABS12: How confident are you that vaccines are valuable in protecting the general public through disease prevention?***	4.46	0.026	4.48	0.021	0.853
Items removed from analysis					
KABS6: How likely is it that if U.S. children are not vaccinated, they will get the diseases that vaccines can prevent?†	3.80	0.030	3.82	0.024	

*5=very important; 1=not at all important

**5=strongly agree; 1=strongly disagree

***5=very confident; 1=not at all confident

****5=very serious; 1=not at all serious

†5=very likely; 1=not at all likely

Table 1.5 Variable Descriptions

Variable Name	*Variable Type*	*Level*	*Description*
Social Demographics (SD)			
Age	Categorical	1	(18-29), (30-44), (45+)
Race/Ethnicity (check all that apply)	Weighted indicators	1	Ethnicity: Hispanic/not Hispanic Race: White, Black, American Indian/Alas Native, Asian/Native Hawaiian/Pacific Islander
Income	Categorical	1	Low: <$20,000; Mid: $20,000-$99,999; High: ≥$100,000
Gender	Categorical	1	male or female
Education Attainment	Categorical	1	High school or less, some college, Bachelor's degree or higher
Geographic Region	Categorical	1	Northeast, Midwest, South, West (based o census)
Childcare	Categorical	1	• daycare • family/friend/nanny outside home on a regular schedule • " " inside home on a regular schedule • stay at home parent
Knowledge, Attitudes and Behaviors (KABs)			
Vaccine Attitude Score	Continuous (scale)	2	Score of vaccine attitudes (derived from 7 items)
Dr. Decision	Categorical (dichotomous)	2	When selecting a doctor, was whether they would allow you to refuse or delay part of your decision?
Doctor/Nurse Influence	Categorical (dichotomous)	2	Did a doctor or nurse influence your decision? (yes/no)
Personal Approach to vaccines	Categorical (ordinal)	2	How do you approach childhood vaccination? ask no questions, ask basic q's ask serious q's
Perceived Approach of others to vaccines	Categorical	2	How do you think others approach vaccination? ask no questions, ask basic q's ask serious q's
Personal connection to vaccine injury	Categorical (d)	2	Know child injured by vaccine?
Personal connection to parent that delayed	Categorical (d)	2	Know parent that delayed v. for child?
Personal connection to parent that refused	Categorical (d)	2	Know parent that refused v. for child?
Outcome			
Childhood Vaccine Decision	Categorical	3	Not including flu vaccine, or those actively working to catch up, did you intentionally refuse or delay any of the recommended childhood vaccinations? Accept, Delay, Refuse

Table 2.1 Bivariate analysis of sociodemographics vs. vaccine decision outcome column% (95% CI) N=5121

	Population Estimate (95% CI)				(Pearson)
	Accept	Delay	Refuse	$\chi 2$	p-value
Gender				$\chi 2 = 5.0$	$p = 0.297$
Male	91.0% (89.0-92.7)	4.8% (3.7-6.4)	4.1% (3.0-5.6)		
Female	89.2% (87.7-90.5)	6.1% (5.2-7.1)	4.7% (3.8-5.9)		
Age				**$\chi 2 = 37.4$**	**$p = 0.001$**
18-29	92.7% (90.4-94.5)	2.9% (2.1-3.9)	4.4% (2.9-6.6)		
30-44	88.5% (86.9-89.9)	7.1% (6.0-8.3)	4.4% (3.6-5.5)		
45+	90.8% (86.8-93.7)	4.0% (2.3-6.7)	5.2% (3.0-8.8)		
Ethnicity *listwise deleted=33*				**$\chi 2 = 26.0$**	**$p = 0.002$**
Hispanic	94.2% (91.6-96.0)	3.7% (2.2-6.2)	2.1% (1.3-3.4)		
Not Hispanic	88.9% (87.5-90.1)	6.0% (5.2-6.9)	5.1% (4.2-6.2)		
Race *listwise deleted=77*				**$\chi 2 = 82.8$**	**$p = 0.000$**
White	87.9% (86.4-89.2)	6.6% (5.7-7.7)	5.5% (4.5-6.6)		
Black	96.2% (92.9-98.0)	2.0% (0.8-4.6)	1.9% (0.7-4.7)		
American Indian/Alaskan Native	97.5% (83.9-99.7)	2.5% (0.3-16.1)	-		
Asian	97.1% (93.0-98.9)	2.5% (0.9-6.8)	0.3% (0.0-2.3)		
Native Hawaiian/Pacific Islander	94.8% (80.7-98.8)	5.2% (1.2-19.3)	-		
Other Single Race	99.1% (96.5-99.8)	0.5% (0.1-3.6)	0.3% (0.3-2.4)		
Multi-racial	89.2% (80.2-94.4)	7.3% (3.1-16.4)	3.4% (1.3-8.5)		
Education				**$\chi 2 = 44.7$**	**$p = 0.001$**
High School Graduate or less	92.4% (89.7-94.4)	3.2% (2.0-5.0)	4.4% (2.9-6.7)		
Some College/Associate's degree	89.3% (87.3-91.0)	5.4% (4.3-6.8)	5.3% (4.1-6.9)		
Bachelor's degree or higher	88.1% (86.5-89.6)	8.1% (6.9-9.6)	3.8% (3.0-4.7)		
Employment				**$\chi 2 = 33.7$**	**$p = 0.002$**
Employed	90.4% (89.0-91.7)	5.6% (4.7-6.6)	4.0% (3.1-5.1)		
Unemployed	93.7% (90.1-96.1)	3.3% (1.8-6.2)	2.9% (1.4-6.0)		
Retired or Disabled	95.2% (89.6-97.8)	1.9% (0.6-6.3)	2.9% (1.0-7.9)		
Not-working, other	86.3% (83.3-88.8)	6.9% (5.2-9.0)	6.8% (5.0-9.3)		

Table 2.1 Continued

	Population Estimate (95% CI)				(Pearson)
	Accept	Delay	Refuse	$\chi2$	p-value
Household Income				**$\chi2 = 43.6$**	**p = 0.000**
< $20,000	94.7% (92.0-96.5)	2.5% (1.3-4.6)	2.8% (1.6-5.0)		
$20,000-$99,999	88.7% (87.1-90.1)	5.9% (4.9-6.9)	5.5% (5.5-6.7)		
$100,000 or more	91.0% (88.5-93.0)	7.0% (5.1-9.4)	2.0% (1.3-3.1)		
Region				**$\chi2 = 29.2$**	**p = 0.020**
Northeast	90.4% (90.4-93.0)	6.1% (4.0-9.1)	3.5% (2.1-6.0)		
Midwest	87.6% (85.0-89.7)	5.8% (4.3-7.6)	6.7% (5.1-8.7)		
South	92.1% (90.1-93.7)	4.3% (3.3-5.6)	3.6% (2.4-5.3)		
West	88.6% (86.1-90.7)	6.9% (5.4-8.9)	4.5% (3.1-6.4)		
Marital Status				**$\chi2 = 17.3$**	**p = 0.042**
Married, Widowed, or Living with Partner	89.4% (88.1-90.6)	6.0% (5.2-7.0)	4.6% (3.8-5.6)		
Divorced or Separated	91.3% (85.9-94.7)	3.3% (1.8-5.8)	5.4% (2.6-10.9)		
Never Married	95.1% (91.1-97.3)	2.2% (1.0-4.7)	2.7% (1.1-6.6)		
Number of Children in Household				$\chi2 = 17.5$	p = 0.051
One	89.8% (87.6-91.7)	5.8% (4.5-7.5)	4.3% (3.1-6.1)		
Two - Three	90.9% (89.4-92.2)	5.0% (4.2-6.0)	4.1% (3.1-5.3)		
Four+	85.1% (80.7-88.7)	7.7% (5.1-11.3)	7.2% (5.0-10.3)		
Childcare Type *listwise deleted=49*				**$\chi2 = 42.6$**	**p = 0.001**
Daycare outside home	93.3% (91.2-95.0)	4.5% (3.2-6.4)	2.1% (1.3-3.5)		
Family member, friend, nanny, or neighbor outside home on a regular schedule	91.6% (87.9-94.2)	4.8% (3.2-7.2)	3.6% (1.8-7.1)		
Family member, friend, nanny, or neighbor inside home on a regular schedule	92.3% (89.3-94.5)	4.1% (2.6-6.3)	3.7% (2.2-6.0)		
Stay-at-home parent/guardian	87.6% (85.8-89.2)	6.5% (5.4-7.7)	5.9% (4.7-7.4)		

Table 2.2 Bivariate analysis of KABs predictor variables vs. vaccine decision outcome

	Population estimate Row % (95% CI)				Pearson
	Accept	**Delay**	**Refuse**	**χ2**	**p-value**
When choosing a doctor or for your child, was one of your considerations whether they would allow you to delay or refuse vaccines for your youngest child?				χ2 = 496.3	p = 0.000
Yes	9.3% (8.0-10.8)	33.6% (27.4-40.5)	53.0% (43.4-62.4)		
No	90.7% (89.2-92.0)	66.4% (59.5-72.6)	47.0% (37.6-56.6)		
Did a doctor or nurse influence your decision to vaccinate?				χ2 = 29.6	p = 0.000
Yes	37.4% (35.3-39.5)	31.0% (25.2-37.4)	20.8% (14.7-28.5)		
No	62.6% (60.5-64.7)	69.0% (62.6-74.8)	79.2% (71.5-85.3)		
Statement that best describes how your approach childhood vaccines				χ2 = 582.6	p = 0.000
I tend not to ask any questions about a vaccine before it is given to my child	16.8% (15.2-18.5)	10.7% (6.2-18.0)	2.2% (1.0-4.6)		
I tend to ask basic questions about a vaccine (i.e. side effects) before it is given to my child	65.3% (63.1-67.3)	44.3% (37.2-51.7)	16.9% (10.2-26.7)		
I tend to ask serious questions about a vaccine and/or whether my child really needs it	17.9% (16.3-19.7)	44.9% (38.0-52.1)	80.9% (71.3-87.9)		
Statement that best describes how you think other parent's approach childhood vaccines				χ2 = 166.8	p = 0.000
They tend not to ask any questions about a vaccine before it is given to my child	31.4% (29.4-33.4)	57.3% (50.1-64.2)	62.7% (52.8-71.6)		
They tend to ask basic questions about a vaccine (i.e. side effects) before it is given to my child	57.8% (55.6-59.9)	36.6% (30.1-43.5)	28.4% (20.6-37.8)		
They tend to ask serious questions about a vaccine and/or whether my child really needs it	10.8% (9.5-12.3)	6.1% (3.5-10.5)	8.9% (4.0-18.5)		
Do you personally know anyone, including yourself, whose child has experienced a severe reaction to a vaccine? By severe reaction, we mean having a reaction to a vaccine that required medical attention and could not be treated at home.				χ2 = 567.7	p = 0.000
No	91.2% (89.9-92.4)	66.8% (59.8-73.1)	49.1% (39.8-58.5)		
Yes, someone else's child	6.1% (5.2-7.1)	29.9% (23.8-36.8)	44.8% (35.4-54.5)		
Yes, my child	2.7% (2.0-3.7)	3.3% (1.8-6.0)	6.1% (3.2-11.4)		

Table 2.2 Continued

	Population estimate Row % (95% CI)				**Pearson**
	Accept	**Delay**	**Refuse**	**$\chi 2$**	**p-value**
Do you personally know anyone who has chosen to delay their child's vaccinations?				$\chi 2 = 455.8$	$p = 0.000$
Yes	37.4% (35.4-39.4)	84.2% (78.8-88.4)	89.5% (84.2-93.1)		
No	62.6% (60.6-64.6)	15.8% (11.6-21.2)	10.5% (6.9-15.8)		
Do you personally know anyone who has chosen to refuse any of the recommended vaccines for their child?				$\chi 2 = 456.5$	$p = 0.000$
Yes	27.6% (25.8-29.5)	59.4% (52.1-66.3)	87.0% (80.3-91.7)		
No	72.4% (70.5-74.2)	40.6% (33.7-47.9)	13.0% (8.3-19.7)		

Table 2.3 SD vs. KABs: Doctor choice (95% CI)

	When choosing a doctor was one of your considerations whether they would allow you to delay or refuse vaccines for your child?*			Pearson
	No	**Yes**	$\chi 2$	p-value
Gender			$\chi 2 = 6.4$	$p = 0.109$
Male	88.8% (86.4-90.8)	11.2% (9.2-13.6)		
Female	86.4% (84.5-88.1)	13.6% (11.9-15.5)		
Age			$\chi 2 = 9.1$	$p = 0.151$
18-29	85.6% (82.4-88.4)	14.4% (11.6-17.6)		
30-44	87.9% (86.2-89.4)	12.1% (10.6-13.8)		
45+	90.7% (85.7-94.1)	9.3% (5.9-14.3)		
Ethnicity	*listwise deleted=46*		$\chi 2 = 9.6$	$p = 0.072$
Hispanic	84.7% (80.2-88.3)	15.3% (11.7-19.8)		
Not Hispanic	88.3% (86.8-89.6)	11.7% (10.4-13.2)		
Race	*listwise deleted=90*		$\chi 2 = 8.1$	$p = 0.719$
White	87.4% (85.8-88.9)	12.6% (11.1-14.2)		
Black	87.2% (82.0-91.1)	12.8% (8.9-18.0)		
American Indian/Alaskan Native	85.4% (65.4-94.8)	14.6% (5.2-34.6)		
Asian	93.4% (89.2-96.1)	6.6% (3.9-10.8)		
Native Hawaiian/Pacific Islander	83.8% (59.4-94.8)	16.2% (5.2-40.6)		
Other Single Race	86.5% (73.7-93.6)	13.5% (6.4-26.3)		
Multi-racial	86.1% (75.3-92.7)	13.9% (7.3-24.7)		
Education			**$\chi 2 = 21.0$**	**$p = 0.008$**
High School Graduate or less	84.5% (80.9-87.5)	15.5% (12.5-19.1)		
Some College/Associate's degree	88.9% (86.9-90.5)	11.1% (9.5-13.1)		
Bachelor's degree or higher	89.1% (87.3-90.6)	10.9% (9.4-12.7)		
Employment			**$\chi 2 = 18.4$**	**$p = 0.048$**
Employed	88.8% (87.1-90.3)	11.2% (9.7-12.9)		
Unemployed	85.7% (79.5-90.2)	14.3% (9.8-20.5)		
Retired or Disabled	88.6% (80.1-93.8)	11.4% (6.2-19.9)		
Not-working, other	84.1% (80.5-87.1)	15.9% (12.9-19.5)		
Household Income			**$\chi 2 = 54.5$**	**$p = 0.000$**
< $20,000	79.7% (74.0-84.4)	20.3% (15.6-26.0)		
$20,000-$99,999	88.1% (86.4-89.7)	11.9% (10.3-13.6)		
$100,000 or more	91.2% (88.9-93.1)	8.8% (6.9-11.1)		

Table 2.3 Continued (95% CI)

				Pearson
	No	**Yes**	$\chi 2$	p-value
Region			$\chi 2 = 12.4$	$p = 0.158$
Northeast	85.1% (85.1-88.8)	14.9% (11.2-19.6)		
Midwest	87.0% (84.1-89.4)	13.0% (10.6-15.9)		
South	89.4% (87.1-91.2)	10.6% (8.8-12.9)		
West	86.3% (82.9-89.1)	13.7% (10.9-17.1)		
Marital Status			**$\chi 2 = 17.6$**	**$p = 0.025$**
Married, Widowed, or Living with Partner	87.7% (86.2-89.1)	12.3% (10.9-13.8)		
Divorced or Separated	91.9% (87.3-95.0)	8.1% (5.0-12.7)		
Never Married	81.7% (73.9-87.5)	18.3% (12.5-26.1)		
Number of Children in Household			$\chi 2 = 12.1$	$p = 0.054$
One	85.3% (82.3-87.7)	14.7% (12.3-17.7)		
Two - Three	88.8% (86.9-90.4)	11.2% (9.6-13.1)		
Four+	87.0% (83.1-90.2)	13.0% (9.8-16.9)		
Childcare Type	*listwise deleted=62*		$\chi 2 = 16.1$	$p = 0.065$
Daycare outside home	90.5% (87.8-92.6)	9.5% (7.4-12.2)		
Family member, friend, nanny, or neighbor outside home on a regular schedule	84.8% (79.7-88.8)	15.2% (11.2-20.3)		
Family member, friend, nanny, or neighbor inside home on a regular schedule	87.9% (83.7-91.1)	12.1% (8.9-16.3)		
Stay-at-home parent/guardian	87.0% (84.9-88.8)	13.0% (11.2-15.1)		

*listwise deleted=19; the numbers in the columns are the total listwise deleted for that variable, including the 19

Table 2.4 SD vs. KABs: doctor or nurse influence on vaccination decision (CI)

	Did a doctor or nurse influence your decision to vaccinate?**			Pearson
	No	**Yes**	$\chi 2$	p-value
Gender			$\chi 2 = 0.4$	$p = 0.665$
Male	63.2% (59.8-66.4)	36.8% (33.6-40.2)		
Female	64.1% (61.7-66.5)	35.9% (33.5-38.3)		
Age			$\chi 2 = 4.4$	$p = 0.369$
18-29	61.6% (57.6-65.4)	38.4% (34.6-42.4)		
30-44	64.6% (62.1-66.9)	35.4% (33.1-37.9)		
45+	65.2% (58.5-71.4)	34.8% (28.6-41.5)		
Ethnicity	*listwise deleted=62*		$\chi 2 = 9.9$	$p = 0.053$
Hispanic	59.5% (54.3-64.4)	40.5% (35.6-45.7)		
Not Hispanic	64.8% (62.6-66.9)	35.2% (33.1-37.4)		
Race	*listwise deleted=106*		**$\chi 2 = 49.5$**	**$p = 0.004$**
White	66.4% (64.1-68.5)	33.6% (31.5-35.9)		
Black	58.1% (51.5-64.4)	49.5% (25.5-73.7)		
American Indian/Alaskan Native	50.5% (26.3-74.5)	49.5% (25.5-73.7)		
Asian	51.6% (41.6-61.5)	48.4% (38.5-58.4)		
Native Hawaiian/Pacific Islander	54.8% (31.3-76.2)	45.2% (23.8-68.7)		
Other Single Race	55.3% (43.4-66.6)	44.7% (33.4-56.6)		
Multi-racial	54.9% (42.8-66.4)	45.1% (33.6-57.2)		
Education			**$\chi 2 = 20.0$**	**$p = 0.012$**
High School Graduate or less	59.7% (55.3-64.0)	40.3% (36.0-44.7)		
Some College/Associate's degree	66.9% (63.9-69.8)	33.1% (30.2-36.1)		
Bachelor's degree or higher	64.7% (62.2-67.2)	35.3% (32.8-37.8)		
Employment			$\chi 2 = 5.8$	$p = 0.507$
Employed	63.7% (61.2-66.0)	36.3% (34.0-38.8)		
Unemployed	60.1% (52.7-66.9)	39.9% (33.1-47.3)		
Retired or Disabled	60.2% (46.2-72.7)	39.8% (27.3-53.8)		
Not-working, other	65.9% (61.7-69.8)	34.1% (30.2-38.3)		
Household Income			$\chi 2 = 12.0$	$p = 0.072$
< $20,000	59.0% (52.9-64.8)	41.0% (35.2-47.1)		
$20,000-$99,999	65.2% (62.8-67.5)	34.8% (32.5-37.2)		
$100,000 or more	61.7% (57.6-65.7)	38.3% (34.3-42.4)		

Table 2.4 Continued (95% CI)

				Pearson
	No	**Yes**	$\chi 2$	p-value
Region			$\chi 2 = 7.4$	$p = 0.340$
Northeast	60.7% (60.7-66.0)	39.3% (34.0-44.8)		
Midwest	63.7% (59.9-67.4)	36.3% (32.6-40.1)		
South	63.1% (59.7-66.4)	36.9% (33.6-40.3)		
West	66.5% (62.6-70.2)	33.5% (29.8-37.4)		
Marital Status			$\chi 2 = 12.3$	$p = 0.071$
Married, Widowed, or Living with Partner	64.5% (62.4-66.6)	35.5% (33.4-37.6)		
Divorced or Separated	61.9% (52.9-70.1)	38.1% (29.9-47.1)		
Never Married	56.0% (48.2-63.5)	44.0% (36.5-51.8)		
Number of Children in Household			$\chi 2 = 7.0$	$p = 0.214$
One	61.7% (58.3-65.1)	38.3% (34.9-41.7)		
Two - Three	65.3% (62.6-67.8)	34.7% (32.2-37.4)		
Four+	61.4% (54.9-67.6)	38.6% (32.4-45.1)		
Childcare Type	*listwise deleted=77*		$\chi 2 = 11.7$	$p = 0.140$
Daycare outside home	65.8% (61.9-69.5)	34.2% (30.5-38.1)		
Familly member, friend, nanny, or neighbor outside home on a regular schedule	60.4% (54.8-65.7)	39.6% (34.3-45.2)		
Familly member, friend, nanny, or neighbor inside home on a regular schedule	58.5% (51.9-64.7)	41.5% (35.3-48.1)		
Stay-at-home parent/guardian	64.6% (61.8-67.4)	35.4% (32.6-38.2)		

**listwise deleted=37; the numbers in the columns are the total listwise deleted for that variable, including the 37

Table 2.5 SD vs. KABs: How parents approach vaccines

	Statement that best describes how you approach childhood vaccines*				Pearson
	No Questions	**Basic Questions**	**Question Necessity**	$\chi 2$	p-value
Gender				$\chi 2 = 3.8$	$p = 0.451$
Male	16.6% (14.2-19.3)	62.4% (59.0-65.7)	21.0% (18.3-24.0)		
Female	15.3% (13.5-17.3)	61.6% (59.2-64.0)	23.1% (21.1-25.2)		
Age				$\chi 2 = 6.7$	$p = 0.568$
18-29	16.7% (13.8-20.1)	59.6% (55.6-63.5)	23.7% (20.5-27.2)		
30-44	15.7% (13.9-17.6)	63.0% (60.5-65.4)	21.3% (19.3-23.5)		
45+	13.6% (9.3-19.5)	63.2% (56.4-69.5)	23.1% (18.0-29.3)		
Ethnicity	*listwise deleted=49*			$\chi 2 = 0.3$	$p = 0.955$
Hispanic	15.8% (12.4-19.9)	61.5% (56.2-66.4)	22.7% (18.5-27.7)		
Not Hispanic	15.9% (14.3-17.7)	62.1% (59.9-64.2)	22.0% (20.3-23.9)		
Race	*listwise deleted=91*			$\chi 2 = 39.8$	$p = 0.217$
White	15.1% (13.5-16.9)	62.5% (60.3-64.8)	22.3% (20.4-24.3)		
Black	15.8% (11.6-21.1)	60.5% (54.1-66.5)	23.8% (19.0-29.2)		
American Indian/Alaskan Native	25.5% (8.0-57.3)	67.4% (39.1-86.9)	7.1% (2.5-18.9)		
Asian	23.5% (16.3-32.7)	65.7% (55.5-74.7)	10.7% (5.3-20.7)		
Native Hawaiian/Pacific Islander	28.9% (11.5-55.7)	49.5% (27.5-71.8)	21.6% (7.7-47.7)		
Other Single Race	15.9% (9.4-25.7)	56.7% (44.7-68.0)	27.3% (27.3-40.0)		
Multi-racial	14.8% (7.0-28.6)	59.6% (47.5-70.7)	25.6% (17.5-35.8)		
Education				**$\chi 2 = 54.2$**	**$p = 0.000$**
High School Graduate or less	16.3% (13.2-20.0)	61.7% (57.2-66.0)	22.0% (18.4-25.9)		
Some College/Associate's degree	13.8% (11.6-16.2)	58.5% (55.3-61.6)	27.7% (25.0-30.7)		
Bachelor's degree or higher	17.2% (15.3-19.3)	65.5% (63.0-67.9)	17.3% (15.5-19.3)		
Employment				$\chi 2 = 10.6$	$p = 0.617$
Employed	16.0% (14.2-18.0)	62.7% (60.2-65.0)	21.3% (19.3-23.5)		
Unemployed	15.4% (10.8-21.6)	59.0% (51.7-65.9)	25.6% (20.0-32.2)		
Retired or Disabled	9.2% (4.4-18.2)	64.2% (51.0-75.6)	26.6% (16.6-39.6)		
Not-working, other	16.3% (13.2-20.0)	60.9% (56.6-65.1)	22.7% (19.3-26.6)		

Table 2.1 Bivariate analysis of sociodemographics vs. vaccine decision outcome column% (95% CI) N=5121

	Population Estimate (95% CI)				(Pearson)
	Accept	Delay	Refuse	$\chi 2$	p-value
Gender				$\chi 2 = 5.0$	$p = 0.297$
Male	91.0% (89.0-92.7)	4.8% (3.7-6.4)	4.1% (3.0-5.6)		
Female	89.2% (87.7-90.5)	6.1% (5.2-7.1)	4.7% (3.8-5.9)		
Age				**$\chi 2 = 37.4$**	**$p = 0.001$**
18-29	92.7% (90.4-94.5)	2.9% (2.1-3.9)	4.4% (2.9-6.6)		
30-44	88.5% (86.9-89.9)	7.1% (6.0-8.3)	4.4% (3.6-5.5)		
45+	90.8% (86.8-93.7)	4.0% (2.3-6.7)	5.2% (3.0-8.8)		
Ethnicity *listwise deleted=33*				**$\chi 2 = 26.0$**	**$p = 0.002$**
Hispanic	94.2% (91.6-96.0)	3.7% (2.2-6.2)	2.1% (1.3-3.4)		
Not Hispanic	88.9% (87.5-90.1)	6.0% (5.2-6.9)	5.1% (4.2-6.2)		
Race *listwise deleted=77*				**$\chi 2 = 82.8$**	**$p = 0.000$**
White	87.9% (86.4-89.2)	6.6% (5.7-7.7)	5.5% (4.5-6.6)		
Black	96.2% (92.9-98.0)	2.0% (0.8-4.6)	1.9% (0.7-4.7)		
American Indian/Alaskan Native	97.5% (83.9-99.7)	2.5% (0.3-16.1)	-		
Asian	97.1% (93.0-98.9)	2.5% (0.9-6.8)	0.3% (0.0-2.3)		
Native Hawaiian/Pacific Islander	94.8% (80.7-98.8)	5.2% (1.2-19.3)	-		
Other Single Race	99.1% (96.5-99.8)	0.5% (0.1-3.6)	0.3% (0.3-2.4)		
Multi-racial	89.2% (80.2-94.4)	7.3% (3.1-16.4)	3.4% (1.3-8.5)		
Education				**$\chi 2 = 44.7$**	**$p = 0.001$**
High School Graduate or less	92.4% (89.7-94.4)	3.2% (2.0-5.0)	4.4% (2.9-6.7)		
Some College/Associate's degree	89.3% (87.3-91.0)	5.4% (4.3-6.8)	5.3% (4.1-6.9)		
Bachelor's degree or higher	88.1% (86.5-89.6)	8.1% (6.9-9.6)	3.8% (3.0-4.7)		
Employment				**$\chi 2 = 33.7$**	**$p = 0.002$**
Employed	90.4% (89.0-91.7)	5.6% (4.7-6.6)	4.0% (3.1-5.1)		
Unemployed	93.7% (90.1-96.1)	3.3% (1.8-6.2)	2.9% (1.4-6.0)		
Retired or Disabled	95.2% (89.6-97.8)	1.9% (0.6-6.3)	2.9% (1.0-7.9)		
Not-working, other	86.3% (83.3-88.8)	6.9% (5.2-9.0)	6.8% (5.0-9.3)		

Table 2.1 Continued

	Population Estimate (95% CI)				(Pearson)
	Accept	Delay	Refuse	$\chi2$	p-value
Household Income				**$\chi2 = 43.6$**	**p = 0.000**
< $20,000	94.7% (92.0-96.5)	2.5% (1.3-4.6)	2.8% (1.6-5.0)		
$20,000-$99,999	88.7% (87.1-90.1)	5.9% (4.9-6.9)	5.5% (5.5-6.7)		
$100,000 or more	91.0% (88.5-93.0)	7.0% (5.1-9.4)	2.0% (1.3-3.1)		
Region				**$\chi2 = 29.2$**	**p = 0.020**
Northeast	90.4% (90.4-93.0)	6.1% (4.0-9.1)	3.5% (2.1-6.0)		
Midwest	87.6% (85.0-89.7)	5.8% (4.3-7.6)	6.7% (5.1-8.7)		
South	92.1% (90.1-93.7)	4.3% (3.3-5.6)	3.6% (2.4-5.3)		
West	88.6% (86.1-90.7)	6.9% (5.4-8.9)	4.5% (3.1-6.4)		
Marital Status				**$\chi2 = 17.3$**	**p = 0.042**
Married, Widowed, or Living with Partner	89.4% (88.1-90.6)	6.0% (5.2-7.0)	4.6% (3.8-5.6)		
Divorced or Separated	91.3% (85.9-94.7)	3.3% (1.8-5.8)	5.4% (2.6-10.9)		
Never Married	95.1% (91.1-97.3)	2.2% (1.0-4.7)	2.7% (1.1-6.6)		
Number of Children in Household				$\chi2 = 17.5$	p = 0.051
One	89.8% (87.6-91.7)	5.8% (4.5-7.5)	4.3% (3.1-6.1)		
Two - Three	90.9% (89.4-92.2)	5.0% (4.2-6.0)	4.1% (3.1-5.3)		
Four+	85.1% (80.7-88.7)	7.7% (5.1-11.3)	7.2% (5.0-10.3)		
Childcare Type *listwise deleted=49*				**$\chi2 = 42.6$**	**p = 0.001**
Daycare outside home	93.3% (91.2-95.0)	4.5% (3.2-6.4)	2.1% (1.3-3.5)		
Family member, friend, nanny, or neighbor outside home on a regular schedule	91.6% (87.9-94.2)	4.8% (3.2-7.2)	3.6% (1.8-7.1)		
Family member, friend, nanny, or neighbor inside home on a regular schedule	92.3% (89.3-94.5)	4.1% (2.6-6.3)	3.7% (2.2-6.0)		
Stay-at-home parent/guardian	87.6% (85.8-89.2)	6.5% (5.4-7.7)	5.9% (4.7-7.4)		

Table 2.2 Bivariate analysis of KABs predictor variables vs. vaccine decision outcome

	Population estimate Row % (95% CI)				Pearson
	Accept	**Delay**	**Refuse**	**χ2**	**p-value**
When choosing a doctor or for your child, was one of your considerations whether they would allow you to delay or refuse vaccines for your youngest child?				χ2 = 496.3	p = 0.000
Yes	9.3% (8.0-10.8)	33.6% (27.4-40.5)	53.0% (43.4-62.4)		
No	90.7% (89.2-92.0)	66.4% (59.5-72.6)	47.0% (37.6-56.6)		
Did a doctor or nurse influence your decision to vaccinate?				χ2 = 29.6	p = 0.000
Yes	37.4% (35.3-39.5)	31.0% (25.2-37.4)	20.8% (14.7-28.5)		
No	62.6% (60.5-64.7)	69.0% (62.6-74.8)	79.2% (71.5-85.3)		
Statement that best describes how your approach childhood vaccines				χ2 = 582.6	p = 0.000
I tend not to ask any questions about a vaccine before it is given to my child	16.8% (15.2-18.5)	10.7% (6.2-18.0)	2.2% (1.0-4.6)		
I tend to ask basic questions about a vaccine (i.e. side effects) before it is given to my child	65.3% (63.1-67.3)	44.3% (37.2-51.7)	16.9% (10.2-26.7)		
I tend to ask serious questions about a vaccine and/or whether my child really needs it	17.9% (16.3-19.7)	44.9% (38.0-52.1)	80.9% (71.3-87.9)		
Statement that best describes how you think other parent's approach childhood vaccines				χ2 = 166.8	p = 0.000
They tend not to ask any questions about a vaccine before it is given to my child	31.4% (29.4-33.4)	57.3% (50.1-64.2)	62.7% (52.8-71.6)		
They tend to ask basic questions about a vaccine (i.e. side effects) before it is given to my child	57.8% (55.6-59.9)	36.6% (30.1-43.5)	28.4% (20.6-37.8)		
They tend to ask serious questions about a vaccine and/or whether my child really needs it	10.8% (9.5-12.3)	6.1% (3.5-10.5)	8.9% (4.0-18.5)		
Do you personally know anyone, including yourself, whose child has experienced a severe reaction to a vaccine? By severe reaction, we mean having a reaction to a vaccine that required medical attention and could not be treated at home.				χ2 = 567.7	p = 0.000
No	91.2% (89.9-92.4)	66.8% (59.8-73.1)	49.1% (39.8-58.5)		
Yes, someone else's child	6.1% (5.2-7.1)	29.9% (23.8-36.8)	44.8% (35.4-54.5)		
Yes, my child	2.7% (2.0-3.7)	3.3% (1.8-6.0)	6.1% (3.2-11.4)		

Table 2.2 Continued

	Population estimate Row % (95% CI)				**Pearson**
	Accept	**Delay**	**Refuse**	**$\chi 2$**	**p-value**
Do you personally know anyone who has chosen to delay their child's vaccinations?				$\chi 2 = 455.8$	$p = 0.000$
Yes	37.4% (35.4-39.4)	84.2% (78.8-88.4)	89.5% (84.2-93.1)		
No	62.6% (60.6-64.6)	15.8% (11.6-21.2)	10.5% (6.9-15.8)		
Do you personally know anyone who has chosen to refuse any of the recommended vaccines for their child?				$\chi 2 = 456.5$	$p = 0.000$
Yes	27.6% (25.8-29.5)	59.4% (52.1-66.3)	87.0% (80.3-91.7)		
No	72.4% (70.5-74.2)	40.6% (33.7-47.9)	13.0% (8.3-19.7)		

Table 2.3 SD vs. KABs: Doctor choice (95% CI)

	When choosing a doctor was one of your considerations whether they would allow you to delay or refuse vaccines for your child?*			Pearson
	No	**Yes**	$\chi 2$	p-value
Gender			$\chi 2 = 6.4$	$p = 0.109$
Male	88.8% (86.4-90.8)	11.2% (9.2-13.6)		
Female	86.4% (84.5-88.1)	13.6% (11.9-15.5)		
Age			$\chi 2 = 9.1$	$p = 0.151$
18-29	85.6% (82.4-88.4)	14.4% (11.6-17.6)		
30-44	87.9% (86.2-89.4)	12.1% (10.6-13.8)		
45+	90.7% (85.7-94.1)	9.3% (5.9-14.3)		
Ethnicity	*listwise deleted=46*		$\chi 2 = 9.6$	$p = 0.072$
Hispanic	84.7% (80.2-88.3)	15.3% (11.7-19.8)		
Not Hispanic	88.3% (86.8-89.6)	11.7% (10.4-13.2)		
Race	*listwise deleted=90*		$\chi 2 = 8.1$	$p = 0.719$
White	87.4% (85.8-88.9)	12.6% (11.1-14.2)		
Black	87.2% (82.0-91.1)	12.8% (8.9-18.0)		
American Indian/Alaskan Native	85.4% (65.4-94.8)	14.6% (5.2-34.6)		
Asian	93.4% (89.2-96.1)	6.6% (3.9-10.8)		
Native Hawaiian/Pacific Islander	83.8% (59.4-94.8)	16.2% (5.2-40.6)		
Other Single Race	86.5% (73.7-93.6)	13.5% (6.4-26.3)		
Multi-racial	86.1% (75.3-92.7)	13.9% (7.3-24.7)		
Education			**$\chi 2 = 21.0$**	**$p = 0.008$**
High School Graduate or less	84.5% (80.9-87.5)	15.5% (12.5-19.1)		
Some College/Associate's degree	88.9% (86.9-90.5)	11.1% (9.5-13.1)		
Bachelor's degree or higher	89.1% (87.3-90.6)	10.9% (9.4-12.7)		
Employment			**$\chi 2 = 18.4$**	**$p = 0.048$**
Employed	88.8% (87.1-90.3)	11.2% (9.7-12.9)		
Unemployed	85.7% (79.5-90.2)	14.3% (9.8-20.5)		
Retired or Disabled	88.6% (80.1-93.8)	11.4% (6.2-19.9)		
Not-working, other	84.1% (80.5-87.1)	15.9% (12.9-19.5)		
Household Income			**$\chi 2 = 54.5$**	**$p = 0.000$**
< $20,000	79.7% (74.0-84.4)	20.3% (15.6-26.0)		
$20,000-$99,999	88.1% (86.4-89.7)	11.9% (10.3-13.6)		
$100,000 or more	91.2% (88.9-93.1)	8.8% (6.9-11.1)		

Table 2.3 Continued (95% CI)

				Pearson
	No	**Yes**	$\chi 2$	p-value
Region			$\chi 2 = 12.4$	$p = 0.158$
Northeast	85.1% (85.1-88.8)	14.9% (11.2-19.6)		
Midwest	87.0% (84.1-89.4)	13.0% (10.6-15.9)		
South	89.4% (87.1-91.2)	10.6% (8.8-12.9)		
West	86.3% (82.9-89.1)	13.7% (10.9-17.1)		
Marital Status			**$\chi 2 = 17.6$**	**$p = 0.025$**
Married, Widowed, or Living with Partner	87.7% (86.2-89.1)	12.3% (10.9-13.8)		
Divorced or Separated	91.9% (87.3-95.0)	8.1% (5.0-12.7)		
Never Married	81.7% (73.9-87.5)	18.3% (12.5-26.1)		
Number of Children in Household			$\chi 2 = 12.1$	$p = 0.054$
One	85.3% (82.3-87.7)	14.7% (12.3-17.7)		
Two - Three	88.8% (86.9-90.4)	11.2% (9.6-13.1)		
Four+	87.0% (83.1-90.2)	13.0% (9.8-16.9)		
Childcare Type	*listwise deleted=62*		$\chi 2 = 16.1$	$p = 0.065$
Daycare outside home	90.5% (87.8-92.6)	9.5% (7.4-12.2)		
Family member, friend, nanny, or neighbor outside home on a regular schedule	84.8% (79.7-88.8)	15.2% (11.2-20.3)		
Family member, friend, nanny, or neighbor inside home on a regular schedule	87.9% (83.7-91.1)	12.1% (8.9-16.3)		
Stay-at-home parent/guardian	87.0% (84.9-88.8)	13.0% (11.2-15.1)		

*listwise deleted=19; the numbers in the columns are the total listwise deleted for that variable, including the 19

Table 2.4 SD vs. KABs: doctor or nurse influence on vaccination decision (CI)

	Did a doctor or nurse influence your decision to vaccinate?**			Pearson
	No	**Yes**	$\chi 2$	p-value
Gender			$\chi 2 = 0.4$	$p = 0.665$
Male	63.2% (59.8-66.4)	36.8% (33.6-40.2)		
Female	64.1% (61.7-66.5)	35.9% (33.5-38.3)		
Age			$\chi 2 = 4.4$	$p = 0.369$
18-29	61.6% (57.6-65.4)	38.4% (34.6-42.4)		
30-44	64.6% (62.1-66.9)	35.4% (33.1-37.9)		
45+	65.2% (58.5-71.4)	34.8% (28.6-41.5)		
Ethnicity	*listwise deleted=62*		$\chi 2 = 9.9$	$p = 0.053$
Hispanic	59.5% (54.3-64.4)	40.5% (35.6-45.7)		
Not Hispanic	64.8% (62.6-66.9)	35.2% (33.1-37.4)		
Race	*listwise deleted=106*		**$\chi 2 = 49.5$**	**$p = 0.004$**
White	66.4% (64.1-68.5)	33.6% (31.5-35.9)		
Black	58.1% (51.5-64.4)	49.5% (25.5-73.7)		
American Indian/Alaskan Native	50.5% (26.3-74.5)	49.5% (25.5-73.7)		
Asian	51.6% (41.6-61.5)	48.4% (38.5-58.4)		
Native Hawaiian/Pacific Islander	54.8% (31.3-76.2)	45.2% (23.8-68.7)		
Other Single Race	55.3% (43.4-66.6)	44.7% (33.4-56.6)		
Multi-racial	54.9% (42.8-66.4)	45.1% (33.6-57.2)		
Education			**$\chi 2 = 20.0$**	**$p = 0.012$**
High School Graduate or less	59.7% (55.3-64.0)	40.3% (36.0-44.7)		
Some College/Associate's degree	66.9% (63.9-69.8)	33.1% (30.2-36.1)		
Bachelor's degree or higher	64.7% (62.2-67.2)	35.3% (32.8-37.8)		
Employment			$\chi 2 = 5.8$	$p = 0.507$
Employed	63.7% (61.2-66.0)	36.3% (34.0-38.8)		
Unemployed	60.1% (52.7-66.9)	39.9% (33.1-47.3)		
Retired or Disabled	60.2% (46.2-72.7)	39.8% (27.3-53.8)		
Not-working, other	65.9% (61.7-69.8)	34.1% (30.2-38.3)		
Household Income			$\chi 2 = 12.0$	$p = 0.072$
< $20,000	59.0% (52.9-64.8)	41.0% (35.2-47.1)		
$20,000-$99,999	65.2% (62.8-67.5)	34.8% (32.5-37.2)		
$100,000 or more	61.7% (57.6-65.7)	38.3% (34.3-42.4)		

Table 2.4 Continued (95% CI)

				Pearson
	No	**Yes**	$\chi 2$	p-value
Region			$\chi 2 = 7.4$	$p = 0.340$
Northeast	60.7% (60.7-66.0)	39.3% (34.0-44.8)		
Midwest	63.7% (59.9-67.4)	36.3% (32.6-40.1)		
South	63.1% (59.7-66.4)	36.9% (33.6-40.3)		
West	66.5% (62.6-70.2)	33.5% (29.8-37.4)		
Marital Status			$\chi 2 = 12.3$	$p = 0.071$
Married, Widowed, or Living with Partner	64.5% (62.4-66.6)	35.5% (33.4-37.6)		
Divorced or Separated	61.9% (52.9-70.1)	38.1% (29.9-47.1)		
Never Married	56.0% (48.2-63.5)	44.0% (36.5-51.8)		
Number of Children in Household			$\chi 2 = 7.0$	$p = 0.214$
One	61.7% (58.3-65.1)	38.3% (34.9-41.7)		
Two - Three	65.3% (62.6-67.8)	34.7% (32.2-37.4)		
Four+	61.4% (54.9-67.6)	38.6% (32.4-45.1)		
Childcare Type	*listwise deleted=77*		$\chi 2 = 11.7$	$p = 0.140$
Daycare outside home	65.8% (61.9-69.5)	34.2% (30.5-38.1)		
Familly member, friend, nanny, or neighbor outside home on a regular schedule	60.4% (54.8-65.7)	39.6% (34.3-45.2)		
Familly member, friend, nanny, or neighbor inside home on a regular schedule	58.5% (51.9-64.7)	41.5% (35.3-48.1)		
Stay-at-home parent/guardian	64.6% (61.8-67.4)	35.4% (32.6-38.2)		

**listwise deleted=37; the numbers in the columns are the total listwise deleted for that variable, including the 37

Table 2.5 SD vs. KABs: How parents approach vaccines

	Statement that best describes how you approach childhood vaccines*				Pearson
	No Questions	**Basic Questions**	**Question Necessity**	$\chi 2$	p-value
Gender				$\chi 2 = 3.8$	$p = 0.451$
Male	16.6% (14.2-19.3)	62.4% (59.0-65.7)	21.0% (18.3-24.0)		
Female	15.3% (13.5-17.3)	61.6% (59.2-64.0)	23.1% (21.1-25.2)		
Age				$\chi 2 = 6.7$	$p = 0.568$
18-29	16.7% (13.8-20.1)	59.6% (55.6-63.5)	23.7% (20.5-27.2)		
30-44	15.7% (13.9-17.6)	63.0% (60.5-65.4)	21.3% (19.3-23.5)		
45+	13.6% (9.3-19.5)	63.2% (56.4-69.5)	23.1% (18.0-29.3)		
Ethnicity	*listwise deleted=49*			$\chi 2 = 0.3$	$p = 0.955$
Hispanic	15.8% (12.4-19.9)	61.5% (56.2-66.4)	22.7% (18.5-27.7)		
Not Hispanic	15.9% (14.3-17.7)	62.1% (59.9-64.2)	22.0% (20.3-23.9)		
Race	*listwise deleted=91*			$\chi 2 = 39.8$	$p = 0.217$
White	15.1% (13.5-16.9)	62.5% (60.3-64.8)	22.3% (20.4-24.3)		
Black	15.8% (11.6-21.1)	60.5% (54.1-66.5)	23.8% (19.0-29.2)		
American Indian/Alaskan Native	25.5% (8.0-57.3)	67.4% (39.1-86.9)	7.1% (2.5-18.9)		
Asian	23.5% (16.3-32.7)	65.7% (55.5-74.7)	10.7% (5.3-20.7)		
Native Hawaiian/Pacific Islander	28.9% (11.5-55.7)	49.5% (27.5-71.8)	21.6% (7.7-47.7)		
Other Single Race	15.9% (9.4-25.7)	56.7% (44.7-68.0)	27.3% (27.3-40.0)		
Multi-racial	14.8% (7.0-28.6)	59.6% (47.5-70.7)	25.6% (17.5-35.8)		
Education				**$\chi 2 = 54.2$**	**$p = 0.000$**
High School Graduate or less	16.3% (13.2-20.0)	61.7% (57.2-66.0)	22.0% (18.4-25.9)		
Some College/Associate's degree	13.8% (11.6-16.2)	58.5% (55.3-61.6)	27.7% (25.0-30.7)		
Bachelor's degree or higher	17.2% (15.3-19.3)	65.5% (63.0-67.9)	17.3% (15.5-19.3)		
Employment				$\chi 2 = 10.6$	$p = 0.617$
Employed	16.0% (14.2-18.0)	62.7% (60.2-65.0)	21.3% (19.3-23.5)		
Unemployed	15.4% (10.8-21.6)	59.0% (51.7-65.9)	25.6% (20.0-32.2)		
Retired or Disabled	9.2% (4.4-18.2)	64.2% (51.0-75.6)	26.6% (16.6-39.6)		
Not-working, other	16.3% (13.2-20.0)	60.9% (56.6-65.1)	22.7% (19.3-26.6)		

Table 2.5 Continued

	Statement that best describes how you approach childhood vaccines*				Pearson
	No Questions	**Basic Questions**	**Question Necessity**	$\chi 2$	p-value
Household Income				**$\chi 2 = 41.8$**	**p = 0.001**
< $20,000	16.3% (12.0-21.7)	57.9% (51.9-63.7)	25.8% (21.1-31.2)		
$20,000-$99,999	15.1% (13.3-16.9)	61.6% (59.1-64.0)	23.4% (23.4-25.6)		
$100,000 or more	18.5% (15.3-22.2)	67.1% (63.1-70.8)	14.4% (12.0-17.2)		
Region				$\chi 2 = 15.1$	p = 0.350
Northeast	18.0% (18.0-22.9)	58.3% (52.7-63.7)	23.7% (19.2-28.9)		
Midwest	15.1% (12.6-18.0)	60.1% (56.3-63.8)	24.8% (21.6-28.3)		
South	16.3% (13.8-19.1)	63.3% (59.8-66.6)	20.5% (17.8-23.4)		
West	14.5% (11.8-17.6)	63.9% (60.0-67.7)	21.6% (18.5-25.1)		
Marital Status				$\chi 2 = 12.7$	p = 0.188
Married, Widowed, or Living with Partner	16.2% (14.6-18.0)	62.2% (60.0-64.3)	21.6% (19.8-23.5)		
Divorced or Separated	12.2% (7.6-18.9)	65.0% (56.6-72.5)	22.8% (16.9-30.1)		
Never Married	14.0% (9.8-19.7)	57.7% (50.2-64.9)	28.3% (22.1-35.4)		
Number of Children in Household				$\chi 2 = 3.4$	p = 0.821
One	15.6% (13.1-18.4)	61.4% (57.9-64.7)	23.1% (20.3-26.1)		
Two - Three	15.7% (13.8-17.8)	62.8% (60.1-65.4)	21.5% (19.2-23.9)		
Four+	17.4% (12.4-23.9)	59.3% (52.9-65.5)	23.3% (19.0-28.2)		
Childcare Type	*listwise deleted=66*			$\chi 2 = 26.7$	p = 0.055
Daycare outside home	18.8% (15.9-22.1)	63.4% (59.5-67.1)	17.8% (14.9-21.1)		
Family member, friend, nanny, or neighbor outside home on a regular schedule	15.1% (11.5-19.5)	61.8% (56.2-67.1)	23.1% (18.7-28.2)		
Family member, friend, nanny, or neighbor inside home on a regular schedule	13.0% (9.2-18.1)	64.0% (57.5-70.0)	22.9% (17.9-28.9)		
Stay-at-home parent/guardian	15.0% (12.9-17.3)	61.2% (58.4-64.0)	23.8% (21.4-26.3)		

*listwise deleted=28; the numbers in the columns are the total listwise deleted for that variable, including the 28

Table 2.6 SD vs. KABs: How parents think others approach vaccines

	Statement that best describes how you think other parents approach childhood vaccines**				Pearson
	No Questions	**Basic Questions**	**Question Necessity**	$\chi 2$	p-value
Gender				**$\chi 2 = 25.0$**	**p = 0.006**
Male	33.8% (30.7-37.1)	58.1% (54.6-61.4)	8.1% (6.4-10.4)		
Female	34.5% (32.1-36.9)	53.3% (50.8-55.7)	12.2% (10.6-14.1)		
Age				**$\chi 2 = 25.8$**	**p = 0.018**
18-29	35.3% (31.6-39.3)	51.6% (47.6-55.6)	13.1% (10.6-16.0)		
30-44	33.1% (30.8-35.4)	57.6% (55.1-60.1)	9.3% (7.9-11.1)		
45+	38.7% (32.4-45.5)	51.6% (44.9-58.3)	9.6% (6.6-13.9)		
Ethnicity	*listwise deleted=86*			**$\chi 2 = 20.3$**	**p = 0.023**
Hispanic	39.9% (34.8-45.2)	49.1% (43.9-54.3)	11.0% (8.2-14.7)		
Not Hispanic	32.9% (30.9-34.9)	56.8% (54.6-59.0)	10.3% (9.0-11.8)		
Race	*listwise deleted=128*			**$\chi 2 = 60.5$**	**p = 0.010**
White	34.3% (32.1-36.5)	56.0% (53.7-58.2)	9.8% (8.4-11.4)		
Black	29.7% (24.2-35.9)	56.0% (49.5-62.2)	14.3% (10.6-19.0)		
American Indian/Alaskan Native	20.1% (9.0-39.0)	78.1% (58.9-89.9)	1.8% (0.4-7.7)		
Asian	28.6% (20.0-39.0)	59.8% (49.5-69.3)	11.6% (7.0-18.5)		
Native Hawaiian/Pacific Islander	20.2% (5.9-50.7)	60.7% (35.7-81.2)	19.1% (6.4-44.7)		
Other Single Race	45.6% (34.2-57.6)	45.0% (33.5-57.1)	9.3% (9.3-18.0)		
Multi-racial	48.5% (36.7-60.4)	39.6% (29.1-51.1)	12.0% (5.2-25.4)		
Education				**$\chi 2 = 37.8$**	**p = 0.002**
High School Graduate or less	32.7% (28.6-37.0)	54.4% (49.9-58.8)	12.9% (10.2-16.3)		
Some College/Associate's degree	35.5% (32.4-38.7)	53.0% (49.8-56.2)	11.5% (9.6-13.7)		
Bachelor's degree or higher	34.6% (32.2-37.1)	58.3% (55.8-60.9)	7.0% (5.8-8.5)		
Employment				**$\chi 2 = 48.4$**	**p = 0.004**
Employed	32.9% (30.6-35.2)	58.3% (55.8-60.7)	8.9% (7.5-10.4)		
Unemployed	37.0% (30.1-44.4)	50.6% (43.2-57.8)	12.5% (8.6-17.7)		
Retired or Disabled	30.6% (19.9-43.9)	54.0% (40.6-66.8)	15.4% (8.2-26.9)		
Not-working, other	37.4% (33.3-41.7)	48.7% (44.5-52.9)	13.9% (10.7-17.7)		

Table 2.6 Continued

	Statement that best describes how you think other parents approach childhood vaccines**				Pearson
	No Questions	**Basic Questions**	**Question Necessity**	$\chi 2$	p-value
Household Income				**$\chi 2 = 40.5$**	**p = 0.001**
< $20,000	33.3% (28.0-39.1)	51.2% (45.2-57.2)	15.4% (11.5-20.3)		
$20,000-$99,999	34.7% (32.3-37.1)	54.8% (52.3-57.2)	10.5% (10.5-12.2)		
$100,000 or more	33.0% (29.3-36.9)	60.8% (56.8-64.7)	6.2% (4.5-8.5)		
Region				$\chi 2 = 11.5$	p = 0.530
Northeast	37.5% (37.5-43.2)	51.5% (46.0-57.0)	11.0% (8.0-14.9)		
Midwest	36.3% (32.7-40.1)	54.3% (50.4-58.1)	9.4% (7.2-12.2)		
South	32.4% (29.3-35.6)	57.1% (53.6-60.5)	10.5% (8.4-13.0)		
West	33.1% (29.5-37.0)	55.8% (51.7-59.7)	11.1% (8.8-13.9)		
Marital Status				$\chi 2 = 17.9$	p = 0.117
Married, Widowed, or Living with Partner	34.2% (32.2-36.3)	55.9% (53.7-58.1)	9.9% (8.6-11.3)		
Divorced or Separated	31.4% (23.9-40.1)	55.1% (46.0-63.8)	13.5% (8.0-21.9)		
Never Married	35.9% (28.9-43.5)	48.7% (41.1-56.3)	15.4% (10.6-21.9)		
Number of Children in Household				$\chi 2 = 6.2$	p = 0.625
One	35.5% (32.2-39.0)	54.1% (50.6-57.6)	10.4% (8.4-12.8)		
Two - Three	33.0% (30.5-35.7)	56.6% (53.9-59.3)	10.3% (8.7-12.2)		
Four+	36.4% (30.6-42.6)	51.8% (45.3-58.2)	11.8% (7.8-17.5)		
Childcare Type	*listwise deleted=103*			$\chi 2 = 3.8$	p = 0.943
Daycare outside home	33.4% (29.8-37.2)	57.0% (53.1-60.8)	9.6% (7.6-11.9)		
Family member, friend, nanny, or neighbor outside home on a regular schedule	33.3% (28.2-38.8)	55.9% (50.2-61.4)	10.9% (7.6-15.4)		
Family member, friend, nanny, or neighbor inside home on a regular schedule	32.5% (26.5-39.0)	56.9% (50.2-63.4)	10.6% (6.9-15.9)		
Stay-at-home parent/guardian	35.0% (32.3-37.8)	54.3% (51.4-57.2)	10.6% (8.8-12.7)		

**listwise deleted=64; the numbers in the columns are the total listwise deleted for that variable, including the 64

Table 2.7 SD vs. KABs: Do you know someone injured by a vaccine? Do you know someone who delayed or refused a vaccine?

	Do you personally know anyone, including yourself, whose child has experienced a severe reaction to a vaccine? By severe reaction, we mean having a reaction to a vaccine that required medical attention and could not be treated at home.*				
	No	**Yes, but not my child**	**Yes, my child**	**χ2**	**p-value**
Gender				**χ2 = 18.5**	**p = 0.025**
Male	89.9% (87.8-91.7)	7.1% (5.7-8.9)	3.0% (2.0-4.5)		
Female	86.5% (84.6-88.2)	10.6% (9.2-12.3)	2.9% (2.0-4.1)		
Age				χ2 = 14.9	p = 0.191
18-29	85.8% (82.6-88.5)	10.5% (8.3-13.2)	3.7% (2.2-6.0)		
30-44	89.1% (87.6-90.5)	8.5% (7.3-9.9)	2.4% (1.7-3.3)		
45+	87.1% (81.8-91.1)	8.6% (5.5-13.0)	4.3% (2.1-8.6)		
Ethnicity	*Listwise deleted=55*			**χ2 = 44.3**	**p = 0.000**
Hispanic	87.5% (83.7-90.5)	6.7% (4.8-9.2)	5.9% (3.6-9.3)		
Not Hispanic	88.1% (86.6-89.4)	9.7% (8.5-11.1)	2.2% (1.6-3.1)		
Race	*Listwise deleted=100*			**χ2 = 64.9**	**p = 0.008**
White	87.4% (85.9-88.9)	10.1% (8.9-11.6)	2.4% (1.8-3.3)		
Black	87.2% (81.7-91.2)	7.1% (4.5-11.0)	5.8% (3.0-10.9)		
American Indian/Alaskan Native	89.9% (71.2-97.0)	2.8% (0.4-18.0)	7.3% (1.7-26.1)		
Asian	95.6% (87.2-98.6)	1.4% (0.4-4.1)	3.1% (0.6-13.3)		
Native Hawaiian/Pacific Islander	89.2% (68.9-96.8)	10.8% (3.2-31.1)	-		
Other Single Race	92.7% (83.6-96.9)	3.5% (1.2-9.6)	3.8% (3.8-14.0)		
Multi-racial	84.0% (72.4-91.3)	14.7% (7.6-26.5)	1.2% (0.3-4.5)		
Education				**χ2 = 24.8**	**p = 0.032**
High School Graduate or less	88.2% (84.8-90.8)	7.9% (5.7-10.7)	4.0% (2.5-6.4)		
Some College/Associate's degree	86.1% (83.9-88.1)	11.4% (9.6-13.4)	2.5% (1.7-3.6)		
Bachelor's degree or higher	89.4% (87.8-90.9)	8.3% (7.1-9.7)	2.3% (1.5-3.5)		
Employment				**χ2 = 38.9**	**p = 0.012**
Employed	89.1% (87.5-90.5)	8.8% (7.6-10.3)	2.0% (1.4-2.9)		
Unemployed	86.8% (81.2-90.9)	7.2% (4.7-10.8)	6.0% (3.1-11.4)		
Retired or Disabled	86.8% (77.3-92.7)	9.0% (4.3-17.8)	4.2% (1.6-10.7)		
Not-working, other	85.0% (81.4-88.1)	10.8% (8.4-13.8)	4.1% (2.4-7.0)		

Table 2.7 Continued

	Do you personally know anyone, including yourself, whose child has experienced a severe reaction to a vaccine? By severe reaction, we mean having a reaction to a vaccine that required medical attention and could not be treated at home.*				
	No	**Yes, but not my child**	**Yes, my child**	**χ2**	**p-value**
Household Income				**χ2 = 57.3**	**p = 0.000**
< $20,000	84.7% (79.2-88.9)	8.6% (5.8-12.4)	6.8% (3.7-12.0)		
$20,000-$99,999	87.7% (86.0-89.1)	9.7% (8.4-11.3)	2.6% (2.6-3.4)		
$100,000 or more	91.8% (89.7-93.5)	7.2% (5.6-9.1)	1.0% (0.5-2.2)		
Region				χ2 = 14.1	p = 0.378
Northeast	88.7% (88.7-91.6)	8.5% (6.2-11.7)	2.8% (1.3-5.7)		
Midwest	88.3% (85.9-90.4)	10.2% (8.2-12.6)	1.5% (1.0-2.3)		
South	88.2% (85.7-90.3)	8.6% (6.9-10.7)	3.2% (2.1-4.9)		
West	86.8% (83.6-89.4)	9.4% (7.3-11.9)	3.8% (2.3-6.3)		
Marital Status				χ2 = 4.3	p = 0.751
Married, Widowed, or Living with Partner	88.0% (86.5-89.3)	9.2% (8.0-10.4)	2.9% (2.2-3.8)		
Divorced or Separated	89.9% (84.4-93.6)	8.1% (5.1-12.7)	2.0% (0.5-7.3)		
Never Married	86.2% (79.7-90.9)	9.4% (6.2-14.1)	4.4% (1.6-11.4)		
Number of Children in Household				χ2 = 18.5	p = 0.100
One	89.2% (86.8-91.2)	9.2% (7.4-11.4)	1.7% (0.9-3.0)		
Two - Three	87.8% (85.9-89.5)	8.8% (7.5-10.3)	3.4% (2.4-4.8)		
Four+	84.7% (79.6-88.7)	10.8% (7.6-15.2)	4.4% (2.4-8.2)		
Childcare Type	*Listwise deleted=72*			**χ2 = 32.0**	**p = 0.016**
Daycare outside home	90.6% (88.0-92.7)	6.9% (5.3-8.9)	2.5% (1.3-4.7)		
Familly member, friend, nanny, or neighbor outside home on a regular schedule	84.8% (80.5-88.3)	12.1% (9.0-16.1)	3.1% (1.6-5.7)		
Familly member, friend, nanny, or neighbor inside home on a regular schedule	92.8% (89.8-95.0)	6.7% (4.6-9.7)	0.5% (0.2-1.3)		
Stay-at-home parent/guardian	87.0% (84.9-88.8)	9.7% (8.2-11.5)	3.3% (2.4-4.7)		

*listwise deleted=34; the numbers in the columns are the total listwise deleted for that variable, including the 34

Table 2.8 SD vs. KABs: Do you know someone who delayed a vaccine for their child?

	Do you personally know anyone who has chosen to delay their child's vaccinations?**			
	Yes	**No**	**χ2**	**p-value**
Gender			**χ2 = 22.3**	**p = 0.002**
Male	38.5% (35.3-41.9)	61.5% (58.1-64.7)		
Female	45.1% (42.7-47.5)	54.9% (52.5-57.3)		
Age			χ2 = 3.5	p = 0.440
18-29	40.4% (36.5-44.3)	59.6% (55.7-63.5)		
30-44	43.2% (40.8-45.6)	56.8% (54.4-59.2)		
45+	43.1% (36.6-49.8)	56.9% (50.2-63.4)		
Ethnicity	*Listwise deleted=47*		**χ2 = 46.2**	**p = 0.000**
Hispanic	32.9% (28.4-37.8)	67.1% (62.2-71.6)		
Not Hispanic	44.7% (42.6-46.9)	55.3% (53.1-57.4)		
Race	*Listwise deleted=92*		**χ2 = 188.7**	**p = 0.000**
White	47.1% (44.9-49.4)	52.9% (50.6-55.1)		
Black	26.9% (21.5-33.0)	73.1% (67.0-78.5)		
American Indian/Alaskan Native	19.5% (8.6-38.4)	80.5% (61.6-91.4)		
Asian	29.9% (21.9-39.3)	70.1% (60.7-78.1)		
Native Hawaiian/Pacific Islander	32.5% (15.1-56.5)	67.5% (43.5-84.9)		
Other Single Race	14.8% (9.4-22.7)	85.2% (77.3-90.6)		
Multi-racial	49.4% (37.5-61.3)	50.6% (38.7-62.5)		
Education			**χ2 = 117.7**	**p = 0.000**
High School Graduate or less	32.2% (28.2-36.4)	67.8% (63.6-71.8)		
Some College/Associate's degree	45.9% (42.7-49.1)	54.1% (50.9-57.3)		
Bachelor's degree or higher	49.3% (46.8-51.9)	50.7% (48.1-53.2)		
Employment			**χ2 = 78.5**	**p = 0.000**
Employed	42.5% (40.1-44.9)	57.5% (55.1-59.9)		
Unemployed	28.1% (22.6-34.3)	71.9% (65.7-77.4)		
Retired or Disabled	27.6% (18.3-39.4)	72.4% (60.6-81.7)		
Not-working, other	49.8% (45.6-54.1)	50.2% (45.9-54.4)		

Table 2.8 Continued

	Do you personally know anyone who has chosen to delay their child's vaccinations?**			
	Yes	**No**	**χ2**	**p-value**
Household Income			**χ2 = 59.4**	**p = 0.000**
< $20,000	29.4% (24.5-34.8)	70.6% (65.2-75.5)		
$20,000-$99,999	44.6% (42.2-47.0)	55.4% (53.0-57.8)		
$100,000 or more	44.2% (40.3-48.3)	55.8% (51.7-59.7)		
Region			**χ2 = 24.3**	**p = 0.009**
Northeast	42.5% (42.5-47.9)	57.5% (52.1-62.7)		
Midwest	45.1% (41.4-48.9)	54.9% (51.1-58.6)		
South	38.2% (35.0-41.5)	61.8% (58.5-65.0)		
West	46.1% (42.1-50.1)	53.9% (49.9-57.9)		
Marital Status			**χ2 = 49.1**	**p = 0.000**
Married, Widowed, or Living with Partner	44.1% (42.0-46.3)	55.9% (53.7-58.0)		
Divorced or Separated	34.4% (27.0-42.7)	65.6% (57.3-73.0)		
Never Married	27.6% (21.6-34.5)	72.4% (65.5-78.4)		
Number of Children in Household			χ2 = 6.0	p = 0.248
One	42.6% (39.2-46.0)	57.4% (54.0-60.8)		
Two - Three	41.3% (38.7-43.9)	58.7% (56.1-61.3)		
Four+	47.0% (40.7-53.4)	53.0% (46.6-59.3)		
Childcare Type	*Listwise deleted=65*		**χ2 = 20.3**	**p = 0.019**
Daycare outside home	37.5% (34.0-41.2)	62.5% (58.8-66.0)		
Family member, friend, nanny, or neighbor outside home on a regular schedule	40.6% (35.3-46.0)	59.4% (54.0-64.7)		
Family member, friend, nanny, or neighbor inside home on a regular schedule	42.9% (36.6-49.4)	57.1% (50.6-63.4)		
Stay-at-home parent/guardian	44.9% (42.1-47.8)	55.1% (52.2-57.9)		

**listwise deleted=26; the numbers in the columns are the total listwise deleted for that variable, including the 26

Table 2.9 SD vs. KABs: Do you know someone who refused a vaccine for their child?

	Do you personally know anyone who has chosen to delay their child's vaccinations?***			
	Yes	**No**	**χ2**	p-value
Gender			**χ2 = 19.4**	**p = 0.003**
Male	28.7% (25.8-31.9)	71.3% (68.1-74.2)		
Female	34.5% (32.3-36.8)	65.5% (63.2-67.7)		
Age			χ2 = 3.3	p = 0.447
18-29	30.3% (26.9-34.0)	69.7% (66.0-73.1)		
30-44	32.8% (30.6-35.0)	67.2% (65.0-69.4)		
45+	33.6% (27.7-40.1)	66.4% (59.9-72.3)		
Ethnicity	*Listwise deleted=42*		**χ2 = 26.7**	**p = 0.001**
Hispanic	25.3% (21.2-29.9)	74.7% (70.1-78.8)		
Not Hispanic	33.8% (31.8-35.9)	66.2% (64.1-68.2)		
Race	*Listwise deleted=85*		**χ2 = 138.1**	**p = 0.000**
White	36.0% (33.9-38.1)	64.0% (61.9-66.1)		
Black	19.7% (14.9-25.6)	80.3% (74.4-85.1)		
American Indian/Alaskan Native	18.4% (7.4-38.7)	81.6% (61.3-92.6)		
Asian	21.9% (14.5-31.7)	78.1% (68.3-85.5)		
Native Hawaiian/Pacific Islander	34.4% (15.9-59.2)	65.6% (40.8-84.1)		
Other Single Race	8.5% (4.9-14.2)	91.5% (85.8-95.1)		
Multi-racial	35.8% (25.2-47.9)	64.2% (52.1-74.8)		
Education			**χ2 = 67.0**	**p = 0.000**
High School Graduate or less	24.7% (21.2-28.7)	75.3% (71.3-78.8)		
Some College/Associate's degree	35.9% (32.9-39.0)	64.1% (61.0-67.1)		
Bachelor's degree or higher	36.0% (33.7-38.4)	64.0% (61.6-66.3)		
Employment			**χ2 = 58.7**	**p = 0.000**
Employed	31.2% (29.0-33.4)	68.8% (66.6-71.0)		
Unemployed	23.2% (18.1-29.2)	76.8% (70.8-81.9)		
Retired or Disabled	21.6% (13.8-32.0)	78.4% (68.0-86.2)		
Not-working, other	40.0% (36.0-44.1)	60.0% (55.9-64.0)		

Table 2.9 Continued

	Do you personally know anyone who has chosen to delay their child's vaccinations?*			
	Yes	**No**	**χ2**	p-value
Household Income			**χ2 = 38.8**	**p = 0.000**
< $20,000	22.7% (18.5-27.6)	77.3% (72.4-81.5)		
$20,000-$99,999	34.4% (32.1-36.7)	65.6% (63.3-67.9)		
$100,000 or more	31.0% (27.4-34.8)	69.0% (65.2-72.6)		
Region			**χ2 = 41.4**	**p = 0.000**
Northeast	32.7% (32.7-37.9)	67.3% (62.1-72.1)		
Midwest	36.2% (32.7-39.8)	63.8% (60.2-67.3)		
South	27.0% (24.1-30.0)	73.0% (70.0-75.9)		
West	36.1% (32.4-39.9)	63.9% (60.1-67.6)		
Marital Status			**χ2 = 53.7**	**p = 0.000**
Married, Widowed, or Living with Partner	33.9% (31.9-35.9)	66.1% (64.1-68.1)		
Divorced or Separated	23.3% (17.6-30.3)	76.7% (69.7-82.4)		
Never Married	17.9% (13.6-23.3)	82.1% (76.7-86.4)		
Number of Children in Household			**χ2 = 20.8**	**p = 0.007**
One	29.5% (26.5-32.7)	70.5% (67.3-73.5)		
Two - Three	32.1% (29.7-34.6)	67.9% (65.4-70.3)		
Four+	40.1% (34.2-46.3)	59.9% (53.7-65.8)		
Childcare Type	*Listwise deleted=59*		**χ2 = 31.1**	**p = 0.001**
Daycare outside home	25.8% (22.8-29.1)	74.2% (70.9-77.2)		
Family member, friend, nanny, or neighbor outside home on a regular schedule	34.4% (29.4-39.8)	65.6% (60.2-70.6)		
Family member, friend, nanny, or neighbor inside home on a regular schedule	32.6% (26.8-39.0)	67.4% (61.0-73.2)		
Stay-at-home parent/guardian	34.3% (31.7-37.0)	65.7% (63.0-68.3)		

***listwise deleted=22; the number in the columns are the total listwise deleted for that variable, including the 22

Table 3.1 Multivariate Analysis of KABs predictors of pediatric vaccine decision making (Model 1)

	Delay vs. Accept		**Refuse vs. Accept**		**Refuse vs. Delay**	
	Adj. OR (95%CI)		Adj. OR (95%CI)	p-value	Adj. OR (95%CI)	p-value
When choosing a doctor was one of your considerations whether they would allow you to delay or refuse vaccines for your youngest child? *Listwise deleted=20*						
Yes	2.11 (1.43, 3.13)	**p = 0.000**	2.40 (1.42, 4.05)	**p = 0.001**	1.13 (0.65, 1.97)	p = 0.652
No	*ref*		*ref*		*ref*	
Did a doctor or nurse influence your decision to vaccinate? *Listwise deleted=38*						
Yes	0.55 (0.40, 0.78)	**p = 0.001**	0.30 (0.16, 0.54)	**p = 0.000**	0.53 (0.29, 0.98)	**p = 0.041**
No	*ref*		*ref*		*ref*	
Statement that best describes how your approach childhood vaccines *Listwise deleted=29*						
I tend not to ask any questions about a vaccine before it is given to my child	*ref*		*ref*		*ref*	
I tend to ask basic questions about a vaccine (i.e. side effects) before it is given to my child	1.33 (0.67, 2.65)	p = 0.420	4.74 (1.19, 18.85)	**p = 0.027**	3.57 (0.85, 14.98)	p = 0.082
I tend to ask serious questions about a vaccine and/or whether my child really needs it	2.56 (1.28, 5.15)	**p = 0.008**	21.43 (5.79, 79.32)	**p = 0.000**	8.36 (2.16, 32.33)	**p = 0.002**
Statement that best describes how you think other parent's approach childhood vaccines *Listwise deleted=65*						
They tend not to ask any questions about a vaccine before it is given to my child	*ref*		*ref*		*ref*	
They tend to ask basic questions about a vaccine (i.e. side effects) before it is given to my child	0.49 (0.34, 0.69)	**p = 0.000**	0.67 (0.39, 1.18)	p = 0.169	1.39 (0.76, 2.55)	p = 0.286
They tend to ask serious questions about a vaccine and/or whether my child really needs it	0.25 (0.12, 0.49)	**p = 0.000**	0.35 (0.17, 0.70)	**p = 0.003**	1.39 (0.58, 3.37)	p = 0.461

Table 3.1 Model 1 Continued

	Delay vs. Accept		**Refuse vs. Accept**		**Refuse vs. Delay**	
	Adj. OR (95%CI)		Adj. OR (95%CI)	p-value	Adj. OR (95%CI)	p-value
Do you personally know anyone, including yourself, whose child has experienced a severe reaction to a vaccine? By severe reaction, we mean having a reaction to a vaccine that required medical attention and could not be treated at home. *Listwise deleted=35*						
Yes	2.44 (1.69, 3.53)	**p = 0.000**	2.58 (1.50, 4.43)	**p = 0.001**	1.05 (0.61, 1.82)	p = 0.848
No	*ref*		*ref*		*ref*	
Do you personally know anyone who has chosen to delay their child's vaccinations? *Listwise deleted=27*						
Yes	6.35 (4.00, 10.09)	**p = 0.000**	2.69 (1.16, 6.24)	**p = 0.021**	0.42 (0.18, 1.02)	p = 0.056
No	*ref*		*ref*		*ref*	
Do you personally know anyone who has chosen to refuse any of the recommended vaccines for their child? *Listwise deleted=22*						
Yes	0.95 (0.63, 1.43)	p = 0.803	3.78 (1.58, 9.05)	**p = 0.003**	3.98 (1.68, 9.45)	**p = 0.002**
No	*ref*		*ref*		*ref*	
Vaccine Attitude Score						
--	0.48 (0.38, 0.61)	**p = 0.000**	0.21 (0.16, 0.27)	**p = 0.000**	0.44 (0.34, 0.55)	**p = 0.000**

Table 3.2 Multivariate Analysis of Sociodemographic predictors of pediatric vaccine decision making (Model 2)

	Delay vs. Accept		Refuse vs. Accept		Refuse vs. Delay	
	Adj. OR (95%CI)	p-value	Adj. OR (95%CI)	p-value	Adj. OR (95%CI)	p-value
Gender						
Male	*ref*		*ref*		*ref*	
Female	1.45 (1.02, 2.08)	**p = 0.041**	1.35 (0.86, 2.12)	p = 0.188	0.93 (0.54, 1.62)	p = 0.798
Age						
18-29	*ref*		*ref*		*ref*	
30-44	2.38 (1.57, 3.61)	**p = 0.000**	1.19 (0.72, 1.96)	p = 0.495	**0.50 (0.27, 0.93)**	**p = 0.030**
45+	1.41 (0.72, 2.74)	p = 0.317	1.14 (0.51, 2.53)	p = 0.749	0.81 (0.30, 2.21)	p = 0.680
Race/Ethnicity *(choose all that apply)*						
White	*ref*		*ref*		*ref*	
Hispanic	0.34 (0.14, 0.83)	**p = 0.017**	0.11 (0.04, 0.30)	**p = 0.000**	0.32 (0.09, 1.19)	p = 0.089
Black	0.40 (0.16, 1.00)	**p = 0.049**	0.38 (0.14, 1.03)	p = 0.057	0.94 (0.25, 3.56)	p = 0.924
American Indian/Alaskan Native	0.25 (0.04, 1.57)	p = 0.140	0.06 (0.00, 1.08)	p = 0.056	0.25 (0.01, 7.13)	p = 0.421
Asian/Native Hawaiian/Pacific Islander	0.42 (0.19, 0.89)	**p = 0.023**	0.09 (0.02, 0.33)	**p = 0.000**	0.21 (0.05, 0.96)	**p = 0.044**
Education						
High School Graduate or less	*ref*		*ref*		*ref*	
Some College/Associate's degree	1.64 (0.95, 2.86)	p = 0.078	1.18 (0.68, 2.06)	p = 0.551	0.72 (0.34, 1.53)	p = 0.395
Bachelor's degree or higher	2.21 (1.22, 4.01)	**p = 0.009**	0.99 (0.58, 1.69)	p = 0.959	0.45 (0.21, 0.96)	**p = 0.040**
Household Income						
< $20,000	*ref*		*ref*		*ref*	
$20,000-$99,999	1.32 (0.69, 2.53)	p = 0.401	1.74 (0.85, 3.58)	p = 0.133	1.32 (0.52, 3.36)	p = 0.565
$100,000 or more	1.14 (0.54, 2.39)	p = 0.736	0.70 (0.30, 1.65)	p = 0.416	0.62 (0.21, 1.85)	p = 0.389
Region						
Northeast	1.26 (0.75, 2.10)	p = 0.385	0.98 (0.49, 1.95)	p = 0.960	0.78 (0.34, 1.79)	p = 0.562
Midwest	1.10 (0.72, 1.68)	p = 0.674	1.70 (1.03, 2.82)	**p = 0.038**	1.55 (0.83, 2.93)	p = 0.172
West	1.64 (1.11, 2.43)	**p = 0.014**	1.36 (0.75, 2.45)	p = 0.308	0.83 (0.42, 1.63)	p = 0.582
South	*ref*		*ref*		*ref*	
Childcare Type *listwise deleted=49*						
Daycare outside home	0.62 (0.39, 0.98)	**p = 0.042**	0.40 (0.24, 0.68)	**p = 0.001**	0.66 (0.33, 1.29)	p = 0.220
Family member, friend, nanny, or neighbor outside home on a regular schedule	0.73 (0.46, 1.18)	p = 0.204	0.60 (0.28, 1.28)	p = 0.185	0.81 (0.34, 1.95)	p = 0.643
Family member, friend, nanny, or neighbor inside home on a regular schedule	0.55 (0.33, 0.92)	**p = 0.023**	0.70 (0.39, 0.00)	p = 0.222	1.27 (0.61, 2.66)	p = 0.525
Stay-at-home parent/guardian	*ref*		*ref*		*ref*	

Table 3.3 Models 3 & 4: sociodemographic factors by knowledge, attitude, and behavior outcomes

	Model 3: Was your doctor choice affected by whether they would allow you to delay or refuse vaccines for your child? (Logistic Regression)		Model 4: Did a doctor or nurse influence your decision to vaccinate your child? (Logistic Regression)	
	Adj. OR (95%CI)		Adj. OR (95%CI)	
Gender				
Male	*ref*		*ref*	
Female	1.14 (0.85, 1.52)	p = 0.378	0.90 (0.74, 1.08)	p = 0.261
Age				
18-29	*ref*		*ref*	
30-44	1.03 (0.74, 1.42)	p = 0.871	0.91 (0.73, 1.13)	p = 0.387
45+	0.81 (0.44, 1.49)	p = 0.499	0.91 (0.64, 1.30)	p = 0.608
Race/Ethnicity *(choose all that apply)*				
White	*ref*		*ref*	
Hispanic	1.27 (0.72, 2.22)	p = 0.408	1.73 (1.16, 2.59)	**p = 0.007**
Black	0.98 (0.62, 1.57)	p = 0.947	1.51 (1.11, 2.06)	**p = 0.010**
American Indian/Alaskan Native	1.00 (0.26, 3.84)	p = 0.999	1.96 (0.67, 5.67)	p = 0.217
Asian/Native Hawaiian/Pacific Islander	0.72 (0.42, 1.24)	p = 0.239	2.16 (1.45, 3.22)	**p = 0.000**
Education				
High School Graduate or less	*ref*		*ref*	
Some College/Associate's degree	0.81 (0.59, 1.11)	p = 0.189	0.76 (0.60, 0.96)	**p = 0.022**
Bachelor's degree or higher	0.98 (0.69, 1.38)	p = 0.901	0.83 (0.64, 1.06)	p = 0.138
Household Income				
< $20,000	*ref*		*ref*	
$20,000-$99,999	0.55 (0.36, 0.82)	**p = 0.003**	0.91 (0.67, 1.23)	p = 0.529
$100,000 or more	0.41 (0.25, 0.68)	**p = 0.001**	1.14 (0.79, 1.65)	p = 0.478
Region				
Northeast	1.56 (1.03, 2.36)	**p = 0.035**	1.18 (0.89, 1.55)	p = 0.246
Midwest	1.27 (0.92, 1.74)	p = 0.141	1.09 (0.87, 1.36)	p = 0.477
West	1.37 (0.97, 1.92)	p = 0.072	0.81 (0.64, 1.02)	p = 0.076
South	*ref*		*ref*	
Childcare Type *listwise deleted=49*				
Daycare outside home	0.78 (0.56, 1.08)	p = 0.136	0.90 (0.72, 1.12)	p = 0.348
Family member, friend, nanny, or neighbor outside home on a regular schedule	1.19 (0.80, 1.76)	p = 0.387	1.18 (0.91, 1.54)	p = 0.212
Family member, friend, nanny, or neighbor inside home on a regular schedule	0.94 (0.63, 1.40)	p = 0.772	1.28 (0.95, 1.72)	p = 0.104
Stay-at-home parent/guardian	*ref*		*ref*	

Table 3.4 Multivariate analysis of sociodemographic factors against how parents view their own approach to vaccines and how they think other parents approach vaccines

	Model 5: How do you approach childhood vaccines? (Ordinal Regression)	
	Adj. OR (95%CI)	
Statement that best describes how your approach childhood vaccines		
I tend not to ask any questions about a vaccine before it is given to my child	*ref*	
I tend to ask basic questions about a vaccine (i.e. side effects) before it is given to my child	4.59 (2.64, 7.97)	**p = 0.000**
I tend to ask serious questions about a vaccine and/or whether my child really needs it	0.23 (0.13, 0.40)	**p = 0.000**
Gender		
Male	*ref*	
Female	0.89 (0.74, 1.08)	p = 0.248
Age		
18-29	*ref*	
30-44	0.87 (0.69, 1.09)	p = 0.216
45+	0.71 (0.51, 1.00)	p = 0.053
Race/Ethnicity *(choose all that apply)*		
White	*ref*	
Hispanic	1.03 (0.67, 1.58)	p = 0.899
Black	0.92 (0.68, 1.25)	p = 0.599
American Indian/Alaskan Native	1.97 (0.75, 5.15)	p = 0.167
Asian/Native Hawaiian/Pacific Islander	**1.90 (1.37, 2.65)**	**p = 0.000**
Education		
High School Graduate or less	*ref*	
Some College/Associate's degree	**0.73 (0.57, 0.93)**	**p = 0.010**
Bachelor's degree or higher	1.00 (0.78, 1.27)	p = 0.992
Household Income		
< $20,000	*ref*	
$20,000-$99,999	1.15 (0.84, 1.58)	p = 0.368
$100,000 or more	**1.55 (1.07, 2.23)**	**p = 0.020**
Region		
Northeast	0.89 (0.66, 1.19)	p = 0.416
Midwest	0.85 (0.68, 1.05)	p = 0.135
West	0.85 (0.68, 1.06)	p = 0.155
South	*ref*	
Childcare Type *listwise deleted=49*		
Daycare outside home	**1.38 (1.11, 1.71)**	**p = 0.004**
Family member, friend, nanny, or neighbor outside home on a regular schedule	1.05 (0.81, 1.35)	p = 0.710
Family member, friend, nanny, or neighbor inside home on a regular schedule	0.97 (0.73, 1.29)	p = 0.836
Stay-at-home parent/guardian	*ref*	

Table 3.5: Model 6 How do you think other parents approach childhood vaccines? (Logistic Regression)

	Asks Basic Questions vs. Asks No Questions		**Asks Serious Questions vs. Asks No Questions**		**Asks Serious Questions vs. Asks Basic Questions**	
	Adj. OR (95%CI)		Adj. OR (95%CI)	p-value	Adj. OR (95%CI)	p-value
Gender						
Male	*ref*		*ref*		*ref*	
Female	0.90 (0.75, 1.09)	p = 0.286	1.37 (0.96, 1.95)	p = 0.081	**1.52 (1.08, 2.14)**	**p = 0.016**
Age						
18-29	*ref*		*ref*		*ref*	
30-44	1.16 (0.92, 1.46)	p = 0.208	1.01 (0.69, 1.47)	p = 0.961	0.87 (0.61, 1.25)	p = 0.453
45+	0.87 (0.60, 1.26)	p = 0.460	0.98 (0.55, 1.75)	p = 0.951	1.13 (0.65, 1.97)	p = 0.672
Race/Ethnicity *(choose all that apply)*						
White	*ref*		*ref*		*ref*	
Hispanic	**0.49 (0.33, 0.75)**	**p = 0.001**	0.59 (0.29, 1.18)	p = 0.133	1.19 (0.60, 2.37)	p = 0.621
Black	1.01 (0.72, 1.41)	p = 0.967	1.39 (0.84, 2.32)	p = 0.198	1.39 (0.86, 2.23)	p = 0.181
American Indian/Alaskan Native	0.88 (0.34, 2.31)	p = 0.799	0.65 (0.13, 3.36)	p = 0.606	0.74 (0.13, 4.05)	p = 0.724
Asian/Native Hawaiian/Pacific Islander	1.27 (0.81, 2.00)	p = 0.300	1.84 (0.96, 3.53)	p = 0.067	1.45 (0.80, 2.61)	p = 0.219
Education						
High School Graduate or less	*ref*		*ref*		*ref*	
Some College/Associate's degree	0.81 (0.63, 1.05)	p = 0.110	0.84 (0.57, 1.24)	p = 0.383	1.03 (0.71, 1.49)	p = 0.874
Bachelor's degree or higher	0.85 (0.66, 1.11)	p = 0.229	**0.59 (0.38, 0.92)**	**p = 0.020**	0.69 (0.45, 1.06)	p = 0.087
Household Income						
< $20,000	*ref*		*ref*		*ref*	
$20,000-$99,999	0.98 (0.72, 1.33)	p = 0.905	0.78 (0.47, 1.28)	p = 0.328	0.79 (0.49, 1.28)	p = 0.346
$100,000 or more	1.11 (0.77, 1.60)	p = 0.568	0.57 (0.29, 1.10)	p = 0.091	**0.51 (0.27, 0.97)**	**p = 0.039**
Region						
Northeast	0.79 (0.59, 1.05)	p = 0.103	1.00 (0.61, 1.65)	p = 0.999	1.27 (0.79, 2.04)	p = 0.320
Midwest	0.82 (0.66, 1.03)	p = 0.087	0.80 (0.53, 1.23)	p = 0.316	0.98 (0.65, 1.47)	p = 0.921
West	1.06 (0.83, 1.34)	p = 0.648	1.14 (0.75, 1.74)	p = 0.530	1.08 (0.72, 1.62)	p = 0.702
South	*ref*		*ref*		*ref*	
Childcare Type *listwise deleted=49*						
Daycare outside home	1.09 (0.87, 1.37)	p = 0.449	1.02 (0.70, 1.48)	p = 0.907	0.94 (0.66, 1.33)	p = 0.718
Family member, friend, nanny, or neighbor outside home on a regular schedule	1.13 (0.86, 1.48)	p = 0.399	1.10 (0.68, 1.79)	p = 0.698	0.98 (0.61, 1.57)	p = 0.929
Family member, friend, nanny, or neighbor inside home on a regular schedule	1.19 (0.85, 1.66)	p = 0.303	1.07 (0.61, 0.00)	p = 0.819	0.90 (0.53, 1.52)	p = 0.686
Stay-at-home parent/guardian	*ref*		*ref*		*ref*	

Table 3.6 Model 7: Do you know anyone whose child experienced a severe reaction to a vaccine? (Logistic Regression)

	Adj. OR (95%CI)	
Gender		
Male	*ref*	
Female	1.40 (1.06, 1.86)	**p = 0.019**
Age		
18-29	*ref*	
30-44	0.89 (0.66, 1.20)	p = 0.437
45+	1.25 (0.75, 2.07)	p = 0.397
Race/Ethnicity *(choose all that apply)*		
White	*ref*	
Hispanic	0.75 (0.43, 1.31)	p = 0.314
Black	0.79 (0.49, 1.26)	p = 0.313
American Indian/Alaskan Native	0.93 (0.27, 3.21)	p = 0.913
Asian/Native Hawaiian/Pacific Islander	0.39 (0.15, 0.99)	**p = 0.047**
Education		
High School Graduate or less	*ref*	
Some College/Associate's degree	1.38 (0.99, 1.93)	p = 0.059
Bachelor's degree or higher	1.18 (0.84, 1.67)	p = 0.339
Household Income		
< $20,000	*ref*	
$20,000-$99,999	0.70 (0.46, 1.06)	p = 0.094
$100,000 or more	0.51 (0.31, 0.85)	**p = 0.009**
Region		
Northeast	0.97 (0.65, 1.47)	p = 0.899
Midwest	0.94 (0.68, 1.28)	p = 0.682
West	1.20 (0.86, 1.67)	p = 0.281
South	*ref*	
Childcare Type *listwise deleted=49*		
Daycare outside home	0.73 (0.53, 1.00)	p = 0.050
Family member, friend, nanny, or neighbor outside home on a regular schedule	1.18 (0.83, 1.66)	p = 0.357
Family member, friend, nanny, or neighbor inside home on a regular schedule	0.49 (0.32, 0.76)	**p = 0.001**
Stay-at-home parent/guardian	*ref*	

Table 3.6 Models 8 & 9: Do you know someone who delayed or refused a vaccine for their child? (Logistic Regression)

	Model 8: Do you know someone who delayed a vaccine for their child?		Model 9: Do you know someone who refused a vaccine for their child?	
	Adj. OR (95%CI)		Adj. OR (95%CI)	
Gender				
Male	*ref*		*ref*	
Female	1.50 (1.25, 1.81)	**p = 0.000**	1.47 (1.20, 1.79)	**p = 0.000**
Age				
18-29	*ref*		*ref*	
30-44	0.95 (0.76, 1.18)	p = 0.642	1.03 (0.82, 1.29)	p = 0.831
45+	0.98 (0.67, 1.43)	p = 0.905	1.11 (0.76, 1.62)	p = 0.599
Race/Ethnicity *(choose all that apply)*				
White	*ref*		*ref*	
Hispanic	0.33 (0.22, 0.48)	**p = 0.000**	0.35 (0.23, 0.53)	**p = 0.000**
Black	0.44 (0.31, 0.61)	**p = 0.000**	0.52 (0.35, 0.76)	**p = 0.001**
American Indian/Alaskan Native	0.44 (0.19, 1.03)	p = 0.060	0.51 (0.20, 1.30)	p = 0.161
Asian/Native Hawaiian/Pacific Islander	0.40 (0.27, 0.59)	**p = 0.000**	0.41 (0.27, 0.64)	**p = 0.000**
Education				
High School Graduate or less	*ref*		*ref*	
Some College/Associate's degree	1.80 (1.41, 2.30)	**p = 0.000**	1.70 (1.32, 2.20)	**p = 0.000**
Bachelor's degree or higher	2.08 (1.61, 2.68)	**p = 0.000**	1.81 (1.38, 2.37)	**p = 0.000**
Household Income				
< $20,000	*ref*		*ref*	
$20,000-$99,999	1.40 (1.04, 1.88)	**p = 0.027**	1.30 (0.96, 1.78)	p = 0.092
$100,000 or more	1.18 (0.83, 1.67)	p = 0.370	1.00 (0.69, 1.45)	p = 0.999
Region				
Northeast	1.14 (0.86, 1.50)	p = 0.357	1.27 (0.95, 1.70)	p = 0.106
Midwest	1.12 (0.90, 1.39)	p = 0.304	1.35 (1.08, 1.69)	**p = 0.008**
West	1.49 (1.20, 1.86)	**p = 0.000**	1.62 (1.29, 2.04)	**p = 0.000**
South	*ref*		*ref*	
Childcare Type *listwise deleted=49*				
Daycare outside home	0.76 (0.61, 0.93)	**p = 0.009**	0.68 (0.55, 0.85)	**p = 0.001**
Family member, friend, nanny, or neighbor outside home on a regular schedule	0.86 (0.66, 1.12)	p = 0.254	1.03 (0.79, 1.35)	p = 0.828
Family member, friend, nanny, or neighbor inside home on a regular schedule	0.94 (0.70, 1.26)	p = 0.673	0.96 (0.70, 1.32)	p = 0.805
Stay-at-home parent/guardian	*ref*		*ref*	

Table 3.7 Model 10: Vaccine Attitude Score (Linear Regression)

	Adj. Coef. (95%CI)	
Gender		
Male	*ref*	
Female	0.03 (-0.03, 0.09)	p = 0.289
Age		
18-29	*ref*	
30-44	-0.01 (0.00, 0.05)	p = 0.685
45+	0.03 (-0.08, 0.14)	p = 0.578
Race/Ethnicity *(choose all that apply)*		
White	*ref*	
Hispanic	0.14 (0.04, 0.25)	**p = 0.009**
Black	0.09 (0.00, 0.18)	**p = 0.041**
American Indian/Alaskan Native	0.13 (-0.19, 0.45)	p = 0.424
Asian/Native Hawaiian/Pacific Islander	0.04 (-0.06, 0.15)	p = 0.412
Education		
High School Graduate or less	*ref*	
Some College/Associate's degree	0.02 (-0.05, 0.10)	p = 0.549
Bachelor's degree or higher	0.13 (0.06, 0.21)	**p = 0.001**
Household Income		
< $20,000	*ref*	
$20,000-$99,999	0.01 (-0.09, 0.10)	p = 0.883
$100,000 or more	0.12 (0.00, 0.23)	**p = 0.028**
Region		
Northeast	0.01 (-0.07, 0.09)	p = 0.856
Midwest	-0.08 (-0.15, 0.00)	**p = 0.043**
West	-0.05 (-0.13, 0.02)	p = 0.173
South	*ref*	
Childcare Type *listwise deleted=49*		
Daycare outside home	0.08 (0.01, 0.14)	**p = 0.016**
Family member, friend, nanny, or neighbor outside home on a regular schedule	-0.03 (-0.11, 0.05)	p = 0.469
Family member, friend, nanny, or neighbor inside home on a regular schedule	0.11 (0.02, 0.19)	**p = 0.012**
Stay-at-home parent/guardian	*ref*	

Table 3.8 Multivariate Analysis of predictors of pediatric vaccine decision making (Full/Saturated Model)

	Delay vs. Accept		Refuse vs. Accept		Refuse vs. Delay	
	Adj. OR (95%CI)	p-value	Adj. OR (95%CI)	p-value	Adj. OR (95%CI)	p-value
Gender						
Male	*ref*		*ref*		*ref*	
Female	1.24 (0.79, 1.93)	p = 0.346	1.13 (0.64, 1.99)	p = 0.674	0.91 (0.50, 1.66)	p = 0.764
Age						
18-29	*ref*		*ref*		*ref*	
30-44	2.65 (1.66, 4.23)	**p = 0.000**	1.61 (0.84, 3.08)	p = 0.148	0.61 (0.30, 1.25)	p = 0.175
45+	1.28 (0.64, 2.53)	p = 0.485	1.09 (0.43, 2.82)	p = 0.851	0.86 (0.29, 2.52)	p = 0.780
Race/Ethnicity *(choose all that apply)*						
White	*ref*		*ref*		*ref*	
Hispanic	0.42 (0.16, 1.14)	p = 0.088	0.18 (0.05, 0.75)	**p = 0.018**	0.44 (0.09, 2.08)	p = 0.299
Black	0.55 (0.19, 1.64)	p = 0.285	0.83 (0.35, 1.97)	p = 0.677	1.51 (0.46, 4.91)	p = 0.494
American Indian/Alaskan Native	0.27 (0.03, 2.39)	p = 0.241	0.32 (0.01, 8.17)	p = 0.488	1.16 (0.03, 48.72)	p = 0.937
Asian/Native Hawaiian/Pacific Islander	0.78 (0.31, 1.98)	p = 0.602	0.18 (0.01, 2.05)	p = 0.166	0.23 (0.02, 2.76)	p = 0.244
Education						
High School Graduate or less	*ref*		*ref*		*ref*	
Some College/Associate's degree	1.18 (0.60, 2.29)	p = 0.634	0.69 (0.32, 1.49)	p = 0.342	0.58 (0.25, 2.76)	p = 0.218
Bachelor's degree or higher	2.10 (1.04, 4.27)	**p = 0.039**	1.14 (0.54, 2.40)	p = 0.728	0.54 (0.23, 1.27)	p = 0.158
Household Income						
< $20,000	*ref*		*ref*		*ref*	
$20,000-$99,999	1.27 (0.62, 2.61)	p = 0.516	2.06 (0.99, 4.30)	p = 0.054	1.62 (0.67, 3.96)	p = 0.287
$100,000 or more	1.23 (0.55, 2.75)	p = 0.618	1.24 (0.46, 3.36)	p = 0.668	1.01 (0.33, 3.09)	p = 0.983
Region						
Northeast	1.38 (0.79, 2.41)	p = 0.260	1.36 (0.50, 3.75)	p = 0.547	0.99 (0.35, 2.80)	p = 0.984
Midwest	1.07 (0.66, 1.73)	p = 0.797	1.26 (0.71, 2.22)	p = 0.427	1.18 (0.64, 2.19)	p = 0.595
West	1.70 (1.10, 2.63)	**p = 0.017**	1.30 (0.69, 2.44)	p = 0.411	0.77 (0.40, 1.46)	p = 0.419
South	*ref*		*ref*		*ref*	
Childcare Type *listwise deleted=49*						
Daycare outside home	0.77 (0.46, 1.29)	p = 0.324	0.59 (0.31, 1.12)	p = 0.411	0.76 (0.38, 1.54)	p = 0.444
Family member, friend, nanny, or neighbor outside home on a regular schedule	0.76 (0.44, 1.29)	p = 0.308	0.68 (0.27, 1.75)	p = 0.428	0.90 (0.35, 2.36)	p = 0.838
Family member, friend, nanny, or neighbor inside home on a regular schedule	0.63 (0.36, 1.10)	p = 0.106	0.86 (0.36, 2.05)	p = 0.734	1.37 (0.59, 3.20)	p = 0.463
Stay-at-home parent/guardian	*ref*		*ref*		*ref*	

Table 3.8 Continued (Full/Saturated Model)

	Delay vs. Accept		Refuse vs. Accept		Refuse vs. Delay	
	Adj. OR (95%CI)	p-value	Adj. OR (95%CI)	p-value	Adj. OR (95%CI)	p-value
When choosing a doctor was one of your considerations whether they would allow you to delay or refuse vaccines for your youngest child? *Listwise deleted=20*						
Yes	2.14 (1.41, 3.23)	**p = 0.000**	2.62 (1.57, 4.37)	**p = 0.000**	1.23 (0.72, 2.09)	p = 0.454
No	*ref*		*ref*		*ref*	
Did a doctor or nurse influence your decision to vaccinate? *Listwise deleted=38*						
Yes	0.60 (0.43, 0.85)	**p = 0.004**	0.34 (0.18, 0.61)	**p = 0.000**	0.56 (0.30, 1.02)	p = 0.059
No	*ref*		*ref*		*ref*	
Statement that best describes how your approach childhood vaccines *Listwise deleted=29*						
I tend not to ask any questions about a vaccine before it is given to my child	*ref*		*ref*		*ref*	
I tend to ask basic questions about a vaccine (i.e. side effects) before it is given to my child	1.20 (0.62, 2.31)	p = 0.593	3.40 (0.96, 12.11)	p = 0.059	2.84 (0.73, 11.08)	p = 0.132
I tend to ask serious questions about a vaccine and/or whether my child really needs it	2.57 (1.34, 4.93)	**p = 0.005**	17.59 (5.20, 59.55)	**p = 0.000**	6.84 (1.86, 25.21)	**p = 0.004**
Statement that best describes how you think other parent's approach childhood vaccines *Listwise deleted=65*						
They tend not to ask any questions about a vaccine before it is given to my child	*ref*		*ref*		*ref*	
They tend to ask basic questions about a vaccine (i.e. side effects) before it is given to my child	0.48 (0.33, 0.69)	**p = 0.000**	0.63 (0.35, 1.13)	p = 0.121	1.33 (0.72, 2.45)	p = 0.368
They tend to ask serious questions about a vaccine and/or whether my child really needs it	0.26 (0.12, 0.52)	**p = 0.000**	0.29 (0.12, 0.67)	**p = 0.004**	1.13 (0.42, 3.03)	p = 0.813

Table 3.8 Continued (Full/Saturated Model)

	Delay vs. Accept		Refuse vs. Accept		Refuse vs. Delay	
	Adj. OR (95%CI)	p-value	Adj. OR (95%CI)	p-value	Adj. OR (95%CI)	p-value
Do you personally know anyone, including yourself, whose child has experienced a severe reaction to a vaccine? By severe reaction, we mean having a reaction to a vaccine that required medical attention and could not be treated at home. *Listwise deleted=35*						
Yes	2.34 (1.60, 3.42)	**p = 0.000**	2.45 (1.42, 4.23)	**p = 0.001**	1.04 (0.61, 1.80)	p = 0.875
No	*ref*		*ref*		*ref*	
Do you personally know anyone who has chosen to delay their child's vaccinations? *Listwise deleted=27*						
Yes	4.76 (2.77, 8.19)	**p = 0.000**	2.10 (0.84, 5.23)	p = 0.111	0.44 (0.17, 1.16)	p = 0.096
No	*ref*		*ref*		*ref*	
Do you personally know anyone who has chosen to refuse any of the recommended vaccines for their child? *Listwise deleted=22*						
Yes	0.96 (0.63, 1.46)	p = 0.832	3.41 (1.32, 8.81)	**p = 0.011**	3.57 (1.40, 9.10)	**p = 0.008**
No	*ref*		*ref*		*ref*	
Vaccine Attitude Score						
--	0.42 (0.33, 0.54)	**p = 0.000**	0.19 (0.14, 0.26)	**p = 0.011**	0.46 (0.36, 0.59)	**p = 0.000**

Figure 1. Hypothesized model

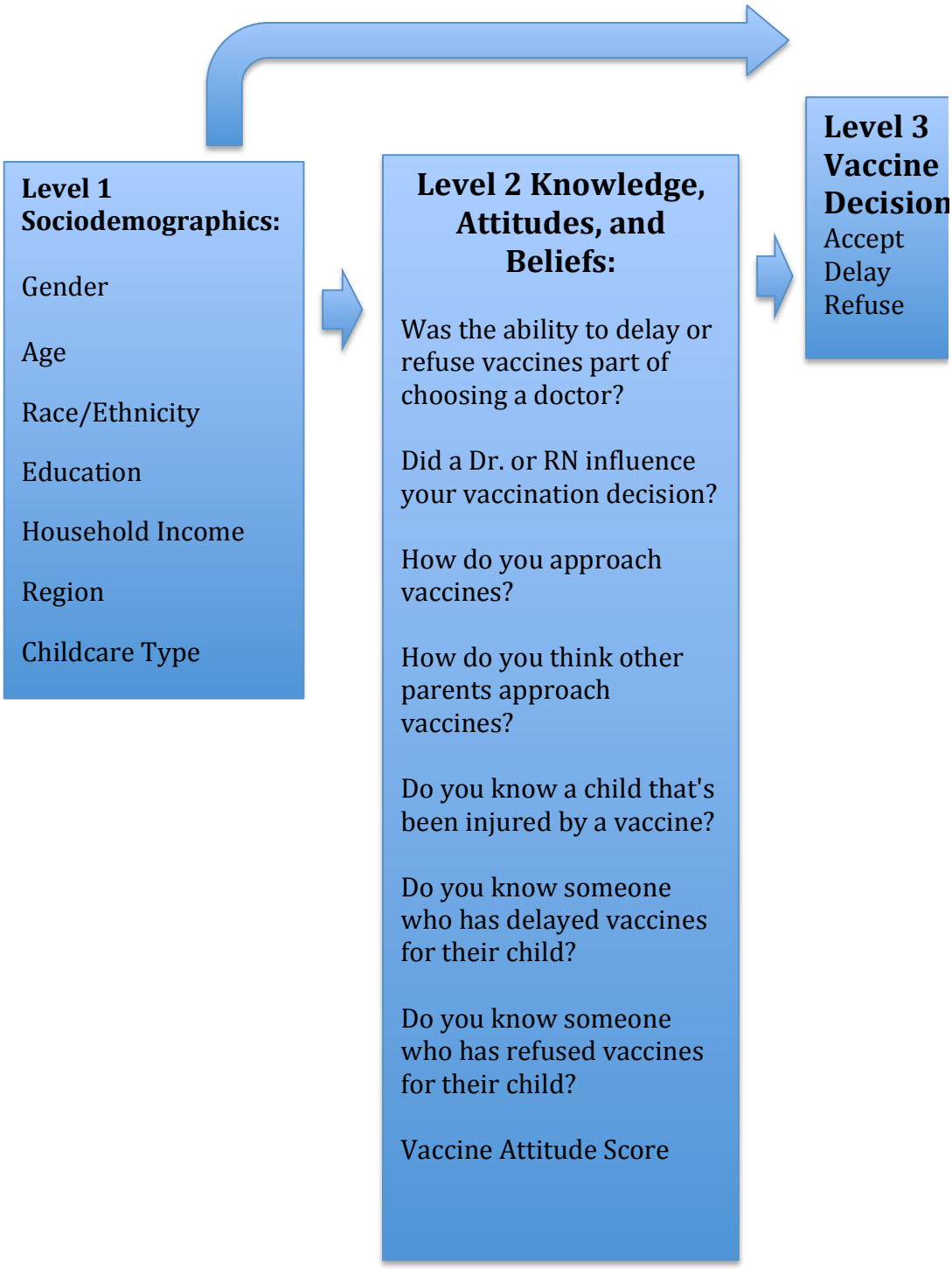
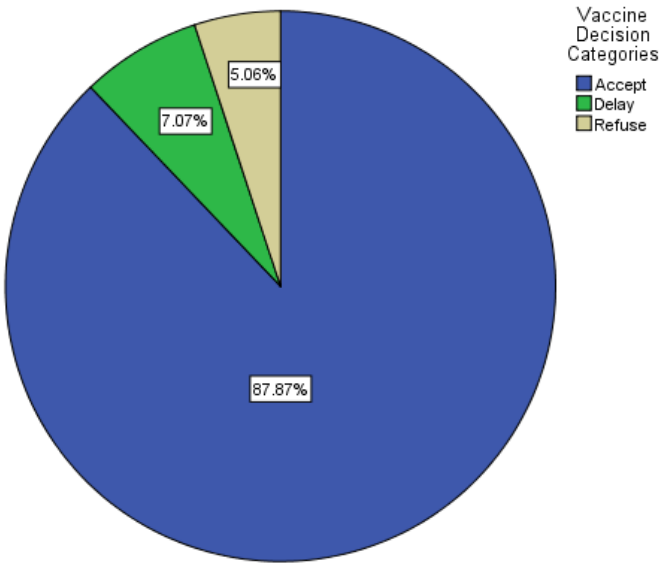


Figure 2. Sample Population Vaccine Decision



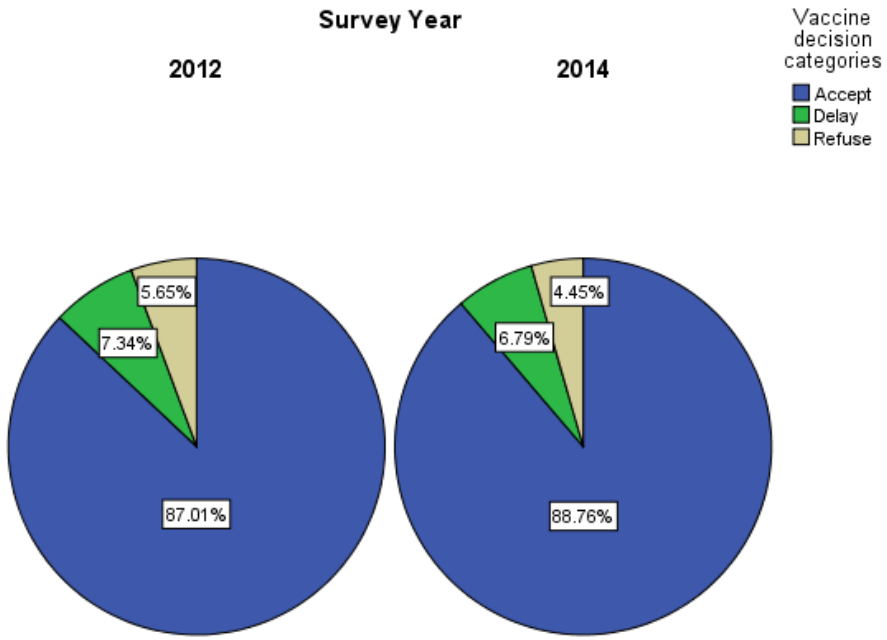


Figure 3. Comparing Vaccine Attitude Score with Vaccine Decision