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Bachelor of Science
University of Oklahoma
2015

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A thesis submitted to the Faculty of the
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# Abstract

Attitudes, beliefs, and characteristics mediating acceptance of childhood non-influenza live attenuated and conjugate vaccines in a 2016 national survey of parents

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***Background:*** Understanding the factors related to vaccine acceptance and refusal has been of specific interest in efforts to maintain sufficient vaccine coverage in the United States, but most studies to this point have focused on a wide overview of vaccine acceptance or on a single vaccine or population.
***Methods:*** In November 2016, a cross-sectional survey of parents with a child <7 years of age was conducted to study vaccine-related and non-vaccine-related factors associated with vaccine acceptance (n=886). The survey obtained information on receipt and perceived importance of all vaccines in the childhood schedule, as well as attitudes, beliefs, and information sources. These variables were included in multivariate logistic regression for five routine non-influenza live attenuated and conjugate vaccines to determine mediating factors of receipt.
***Results:*** Reporting social media as a top vaccine information source was associated with highly decreased likelihood of parental reported receipt for MMR (OR: 0.12, 95% CI: 0.021, 0.632), varicella (OR: 0.2, 95% CI: 0.06, 0.86), and RV (OR: 0.1, 95% CI: 0.02, 0.40). Children with no insurance were much less likely to receive Hib vaccine than children with public (OR: 13.5, 95% CI: 2.43, 75.27) or private insurance coverage (OR: 19.0, 95% CI: 3.26, 110.65) and less likely to receive RV than children with public insurance coverage (OR: 4.0, 0.98, 15.95).
***Conclusions:*** The role of information sources, such as social media, family, friends, and religious leaders, as positive or negative mediators of vaccine behavior reinforces the likely influence of social networks in parents' vaccine decision-making. Sociodemographic differences in insurance coverage, household income, education, and marital status highlight both potential barriers to access and populations choosing not to vaccinate. These varying factors suggest that diverse approaches should be taken when targeting specific vaccines for studies or interventions.

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# BACKGROUND/LITERATURE REVIEW

## *Childhood vaccine development and utilization in the United States*

### *Variolation, vaccination, and smallpox*

Edward Jenner is often credited with creating the first vaccine for smallpox in 1796 after successfully protecting an 8-year-old boy from smallpox through inoculation with fresh cowpox matter.[1] This was not, however, the first form of preventive inoculation against smallpox, nor was Jenner the first to use this particular method.[2] Variolation, or inoculation with smallpox virus, was previously practiced in other parts of the world as early as 1000 B.C.E.[3] Gaining popularity in England in the early 18th century due to the advocacy of Lady Mary Wortley Montague, variolation was the standard for preventing smallpox until Jenner's method was popularized in the latter part of the century.[1] Benjamin Jesty inoculated his family with the closely related cowpox prior to Jenner's first vaccination, but he did not publish his results, thus giving Jenner the opportunity to popularize the procedure.[1,4] Both procedures introduce matter from fresh lesions from infected persons into the skin of a healthy person, though other methods of variolation have also been noted.[3]

Variolation came with some associated risks; estimates suggest that 1-2% of those variolated died—a very small proportion compared to the estimated 30% who died from smallpox contracted naturally.[1] Additionally, variolation and vaccination both posed the risk of accidentally transmitting other diseases through the blood. Still, vaccination provided a safer, non-inferior alternative to variolation. Jenner's vaccine would make global smallpox eradication possible, and this incredible achievement is a testament to Jenner's work and that of countless others who worked to eradicate such a deadly and debilitating disease. Following the global eradication of smallpox, vaccination in the US for smallpox has been limited to those considered at risk of occupational exposure—mainly those working in smallpox-related research and members of the military.[5 6]

*Live attenuated vaccines*

Live attenuated vaccines were first pioneered by Louis Pasteur, who accidentally discovered that inoculating chickens with a month-old bacterial culture resulted only in mild symptoms and protected them from severe disease when inoculated with a fresh culture.[7] Pasteur continued his research on bacterial attenuation throughout the late 19th century and subsequently developed attenuated anthrax and rabies vaccines. Other bacterial and viral attenuated vaccines have since followed.[8] For example, a vaccine protecting against tuberculosis, now known as BCG, was developed in 1908 by Albert Calmette and Camile Guerin utilizing *in vitro* attenuated *Mycobacterium bovis,* but use of this vaccine today in the US is quite limited.[9] Current recommendations for vaccination only include those at very high risk of continual exposure to tuberculosis due to the vaccine's limited effectiveness in preventing certain types of tuberculosis disease and the low prevalence of tuberculosis in the general population.[9 10]

A vaccine for yellow fever (YF) was also developed using *in vitro* attenuation in 1936.[11] This vaccine used passage through mosquitos and rhesus monkeys to attenuate the virus, containing a strain known as the Asibi strain, which is the parent strain to the modern 17D vaccine.[12] Currently endemic in tropical parts of Africa and South America, YF is a flavivirus transmitted by mosquitos that results in illness characterized by fever, headache, and in severe cases jaundice and hemorrhagic symptoms.[13] It is fatal in 20-50% of severe cases and has no treatment, thus prevention is key to reducing morbidity and mortality. The ACIP recommends YF vaccination for laboratory personnel who may be exposed, for persons at least nine months of age who are traveling to or staying prolonged periods in areas at risk for YF transmission and for those traveling to certain countries that require proof of vaccination for entry. A number of serious adverse events have been associated with YF vaccine, including anaphylaxis, vaccine-associated neurologic disease, and vaccine-associated viscerotropic disease, which makes consideration of the risks and benefits of YF vaccination important for providers advising patients who may be at risk of YF.

Oral polio vaccine (OPV) was first developed by Albert Sabin in 1961 as an alternative to Jonas Salk's inactivated polio vaccine (IPV).[3] Poliomyelitis is a disease classically characterized by flaccid paralysis, but paralytic polio only accounts for a very small proportion of those infected, most of whom are asymptomatic. Sabin's OPV uses three live, *in vitro* attenuated polioviruses to induce both intestinal and mucosal immunity by asymptomatically infecting the gastrointestinal tract.[14] After what came to be known as the "Cutter Incident" highlighted safety concerns in the production of IPV in 1955, the climate was right for Sabin's OPV to enter the market.[3] Because it induced intestinal as well as mucosal immunity and was easy to administer, trivalent OPV remained the polio vaccine of choice in the US until the development of new IPV formulations in the late 1980s.[15] Shedding of the attenuated viruses in OPV also allowed for passive vaccination of contacts after immunization, giving OPV a key role in the strategy to eliminate polio globally.[3] However, these attenuated viruses also had the capacity to become pathogenic again and cause poliomyelitis in vaccinated individuals or their contacts, a rare phenomenon known as "vaccine-associated paralytic polio"(VAPP).[15] Because of the risk of VAPP and the elimination of polio in the US, a transition to an all IPV schedule began with a switch to an IPV-OPV sequential schedule in 1996 and ended with an IPV only schedule beginning in 2000.[14 15] OPV is no longer recommended for use in the US, but bivalent OPV continues to be used globally in the effort to eliminate poliomyelitis.[16]

In 1963, the first live attenuated measles vaccine, Rubeovax, was licensed in the US.[17] Other attenuated measles vaccines were licensed in 1965, and the first national measles vaccine campaign occurred in 1966. These efforts targeted one of the most contagious diseases worldwide, which was the leading cause of vaccine-preventable deaths in children until 2000.[9] Measles is characterized by symptoms including fever of increasing severity, respiratory symptoms such as cough and runny nose, and a characteristic maculopapular rash.[14] Many measles cases have at least one complication; possible complications include diarrhea, otitis media, pneumonia, acute encephalitis, seizures, and adverse birth outcomes such as spontaneous abortion. Additionally, some measles complications such as pneumonia and acute encephalitis may lead to death. Measles vaccine is now only available in the US in combination vaccines, most commonly the measles, mumps, rubella (MMR) vaccine. Two doses are currently recommended beginning at 12 months of age, demonstrating high rates of seroconversion. Adverse reactions following vaccination include fever, rash, thrombocytopenia, lymphadenopathy, and allergic reaction. Since the introduction of measles vaccines in the US, endemic measles has been eliminated from the Western Hemisphere, but importation of measles from endemic countries still occurs and has resulted in outbreaks predominantly in under- and un-vaccinated populations.[18-20]

Another component of the MMR vaccine, mumps vaccine was first licensed in the US in 1967.[3] Another live attenuated vaccine, mumps vaccine was recommended for routine use in 1977 to protect against a viral illness that was a common cause of aseptic meningitis and deafness in children.[14] Mumps is most commonly characterized by parotitis, or swelling of the salivary glands, as well as nonspecific symptoms such as myalgia, malaise, and low-grade fever. Asymptomatic infections were observed in the prevaccine period, but it remains unclear how this may have changed in the postvaccine period. Though incidence of mumps has been drastically reduced compared to the prevaccine period, outbreaks continue to occur, even in highly vaccinated populations.[21-24] This is likely due to vaccine failure, even after two doses of the vaccine, though estimates of vaccine effectiveness range from 66 to 95%.[14] Due to its inclusion in the MMR combination vaccine, mumps vaccination occurs on the same schedule as measles vaccine at or after 12 months of age. Adverse events following vaccination are usually attributed to the measles or rubella components of the vaccine, although rare cases of central nervous system dysfunction within two months of vaccination have been reported but not confirmed to be caused by mumps vaccine.

Rubella vaccine, another component of the MMR vaccine, was first developed in 1969 that causes childhood disease and congenital rubella, which can result in deafness, cataracts, or fetal and neonatal deaths.[3 14] This live attenuated vaccine has a high level of efficacy, though rare cases of rubella infection have occurred in vaccinated individuals. Rubella was declared eliminated from the US in 2004, though importation continues to occur, especially in groups with lower rates of rubella immunization. Rubella vaccine has been commonly associated with fever, lymphadenopathy, and arthralgia, especially in adult women. The associated joint symptoms occur in approximately 25% of women, occurring generally 1 to 3 weeks following vaccination for anywhere from 1 day to 3 weeks. As part of the MMR vaccine, rubella vaccine is recommended for those 12 months of age and older without contraindications or documented immunity.

Varicella vaccine is a live attenuated vaccine containing varicella zoster virus (VZV), a member of the herpesvirus group, and protects children from varicella disease, commonly known as the chickenpox.[9] Though development began in Japan in the 1970s, varicella vaccine was not licensed in the US until 1995.[14] It has long been a common childhood disease characterized by a generalized, pruritic rash that spreads from the head and torso to the extremities, fever, and malaise. Symptoms in adults and immunocompromised children are often more severe, and these groups are more likely to develop complications. Generally, lifetime immunity is acquired after primary varicella infection, though immunocompromised persons and occasionally healthy people may develop a second occurrence of chickenpox after primary infection. Reactivation of latent VZV leads to herpes zoster, or shingles, though the mechanism by which this occurs is not well understood. Complications of primary infection include secondary bacterial infections of the skin, pneumonia, central nervous system manifestations, and Reye syndrome. Those at increased risk of complications include those who are under one year of age, older than 15 years, immunocompromised, and neonates. Between the vaccine’s introduction in 1995 and 2010, varicella cases declined by 97%, most strikingly among children five to nine years of age. Varicella vaccine is associated with local adverse reactions, generalized rash, and occasionally fever. Varicella vaccine is recommended for routine immunization older than 12 months and younger than 13 years of age regardless of prior history of varicella and for adolescents and adults 13 years of age and older without prior history of varicella.

Rotavirus vaccine aims to protect children from the leading cause of severe acute gastroenteritis worldwide.[3] The first oral rotavirus vaccine was licensed in 1998 and was recommended for infants at two, four, and six months of age. However, this first rotavirus vaccine was pulled from the market after only 14 months due to reports of what appeared to be vaccine-associated intussusception, a rare blockage of the intestines. Subsequently, two new oral rotavirus vaccines were licensed in 2006 and 2008. Following reintroduction of rotavirus vaccine in 2006, rotavirus seasons have been shorter, generally saw fewer cases of severe disease, and demonstrated possible indirect protection of unvaccinated and unprotected children. Adverse events following vaccination included diarrhea, vomiting, otitis media, irritability, cough or runny nose, and flatulence for currently licensed vaccines. The vaccine is recommended in either 2 or 3 doses, depending upon the specific brand used, at 2 months of age with doses spaced by four to eight weeks, and the vaccine should not be given to infants older than 8 months.

*Killed whole-cell and inactivated virus vaccines*

Killed whole-cell and inactivated virus vaccines utilize a variety of methods including heat, radiation, and chemical treatments to prevent microbes from causing illness while still allowing them to trigger an immune response.[3] This method of vaccine development comes with some advantages and disadvantages; an advantage of this is that the pathogen cannot revert back to virulence like with attenuation, while a disadvantage is that these vaccines may not be as effective long-term as attenuated vaccines. Early killed vaccines included cholera, typhoid, and the plague, all developed in the 1890s.

Whole-cell pertussis vaccine was first licensed in the US in 1914.[14] Whole-cell pertussis vaccine uses formalin to inactivate the pathogen *Bordetella pertussis*, which was later combined with the diphtheria and tetanus toxoids to create the combination vaccine DTP (or DTwP) in the 1940s. The four dose series of pertussis vaccine was highly effective in preventing serious disease, but there were issues with waning immunity in the years following the last dose. This vaccine commonly caused local adverse reactions such as redness and swelling, in addition to systemic reactions such as fever. Concerns about safety led to the development of the acellular vaccine, thus whole-cell pertussis vaccine is no longer recommended or administered in the US.[25 26]

As mentioned previously, Jonas Salk's inactivated polio vaccine (IPV) was licensed in the US in 1955 following nationwide seasonal epidemics that peaked in 1952.[14] More than 21,000 cases of paralytic polio were seen at the peak of the epidemic, and when considered in the broader context of the small proportion of infections that progressed to paralysis, the likely number actually infected is in the millions. Though Salk's vaccine lost popularity following both the Cutter Incident in 1955 and the introduction of OPV in the early 1960s, IPV once again came into favor when an enhanced-potency formulation was licensed in 1987.[3 27] This formulation of Salk's IPV is the only available polio vaccine in the US today, and a push for incorporating IPV into national immunization schedules worldwide is ongoing.[15 28-33] IPV is currently recommended for infants beginning at 2 months of age as the first dose of a four dose series.[14] Unlike the VAPP associated with OPV, IPV generally only causes local reactions following injection, though individuals allergic to antibiotics in the vaccine may experience allergic reactions following vaccination.

Hepatitis A vaccine is another example of an inactivated virus vaccine first licensed in 1995.[3 14] Hepatitis A is caused by a picornavirus first isolated in 1979 and was the most frequently reported type of hepatitis in the US until 2004. Hepatitis A causes abrupt onset of symptoms including fever, malaise, nausea, dark urine, and jaundice after an incubation period of approximately 28 days. In young children, most infection are asymptomatic, but older children and adults usually develop the characteristic jaundice. Complications due to hepatitis A can include many organ systems, and fulminant hepatitis can lead to death. Though the case-fatality rate for hepatitis A is low, an estimated 0.3-0.6%, the impact of its morbidity has substantial direct and indirect costs. Adult and pediatric formulations of the vaccine exist, and the vaccine is routinely recommended for all children between 12 and 23 months of age and for all children if previously unimmunized. Adults at increased risk should also be routinely vaccinated. Adverse reactions to vaccination are usually local reactions, such as injection site pain, erythema, and swelling, while some systemic reactions such as fever, malaise, and fatigue have also been reported. No serious adverse reactions to hepatitis A vaccine have been reported.

*Toxoid vaccines*

Toxoid vaccines rely on the inactivation of bacterial toxins for protection from the effects of these toxins in case of infection.[8] One such toxoid vaccine is diphtheria vaccine, which was developed in the early 1920s by Gaston Ramon but did not gain widespread use until the following decade.[14] Protecting against the effects of the toxin produced by toxigenic *Corynebacterium diphtheriae*, diphtheria toxoid is produced by incubating toxin with formaldehyde. Diphtheria disease can involve almost any mucous membrane, thus leading to clinical classifications of diphtheria based on anatomic site: anterior nasal, pharyngeal and tonsillar, laryngeal, and cutaneous. These manifestations present very differently, but the most common and dangerous form is pharyngeal and tonsillar diphtheria followed by laryngeal diphtheria, where the development of a pseudomembrane can lead to respiratory obstruction and death. High levels of absorbed toxin can often cause myocarditis and neuritis, and the case-fatality rate is approximately 5-10%. This is higher in those younger than five years of age and older than 40. Occurring worldwide but largely in tropical areas, diphtheria is rare in industrialized countries like the US. Once a significant cause of death and disease in children, only 4,880 cases were reported globally in 2011. Diphtheria toxoid is administered as part of combination vaccines that also include tetanus toxoid, using a three to four dose schedule with ten-year booster doses. Known adverse events include urticaria, anaphylaxis, and neurological complications as well as local reactions, some of which may be severe.

Tetanus toxoid is another common toxoid vaccine also first produced in the early 1920s by Gaston Ramon.[34] Created through the same process with formaldehyde treatment, tetanus toxoid is also only available in the US in combination vaccines and always includes diphtheria toxoid, at minimum.[14] Since it is always administered with diphtheria toxoid, it follows the same three to four dose schedule with booster shots every ten years. Since widespread implementation of tetanus toxoid, rates of disease have declined from a peak of approximately 600 cases per year just before 1950 to an average of 29 cases per year in 2012. In cases of tetanus between 2001 and 2008, none of the 233 total cases were under age five, demonstrating the protection afforded by tetanus toxoid to vaccinated children.

*Subunit and recombinant vaccines*

Subunit and recombinant vaccines are vaccines that provide protection against pathogens by containing only specific parts of the microbe that will activate an immune response.[3] One such vaccine is inactivated influenza vaccine, which is either a split-virus or a subunit inactivated vaccine in the US.[14] These vaccines can be derived from viruses propagated in cell-culture or through recombinant technology that is cell-culture free. These vaccines have variable efficacy and effectiveness by year as their formulations change to keep up with antigenic drift and shift of circulating viruses. Usually the effectiveness of these vaccines is estimated at around 60% in those under 65 years of age, but this only holds true when the vaccine is well matched to circulating strains. For those over 65 years of age, the benefits of influenza immunization are not completely clear, and the evidence is mixed.[35-40] The annual influenza vaccine is recommended for all persons aged 6 months and older with special emphasis on vaccination for high risk groups such as persons with asthma, who are pregnant, or who are immunosuppressed.[14]

Another vaccine in this group is the acellular pertussis vaccine. As previously discussed, the acellular pertussis vaccine was developed due to concerns about the safety of the whole-cell pertussis vaccine.[25 26] This vaccine was less reactogenic than the whole-cell vaccine, which suggests that it is safer, though much less protective.[41] Administered in combination most commonly with diphtheria and tetanus toxoids as DTaP, the series consists of five doses in the first 15 to 18 months of life.[14]

The first two recombinant hepatitis B vaccines were licensed in the US in the mid to late 1980s.[8 14] Hepatitis B surface antigen was first described in 1965, which is the primary antigen in hepatitis B vaccines today.[3 14] Hepatitis B infection is characterized by a long incubation period of 120 days on average, as well as nonspecific symptoms before the onset of jaundice including malaise, nausea, vomiting, fever, headache, and others.[14] Jaundice can last from one to three weeks, while malaise and fatigue can persist even after the disappearance of jaundice. Complications of hepatitis B infection include fulminant hepatitis, which can be fatal. Chronic hepatitis B infection occurs in many children infected in infancy or early childhood and is responsible for most morbidity and mortality associated with hepatitis B. Hepatitis B vaccine is recommended for all infants soon after birth followed by an additional two doses.

*Conjugate vaccines*

Conjugate vaccines use parts of the bacteria's outer capsule conjugated to another immune response provoking carrier protein in order to generate a better immune response than the capsule would have by itself.[3] One such vaccine is pneumococcal conjugate vaccine (PCV), which protects against *Streptococcus pneumonia*e infection, also known as pneumococcal disease.[14] This infection can cause pneumonia, bacteremia, and meningitis. Pneumococcal pneumonia presents with fever, rigors, chest pain, cough, and other symptoms, and causes an estimated 400,000 hospitalizations per year in the US. Approximately 36% of adult community-aquired pneumonia is attributable to pneumococcal infection. Bacteremia is a common complication of pneumonia and has an average case-fatality rate of about 20%, though much higher in the elderly. Pneumococcal infections also cause a majority of cases of bacterial meningitis in the US, an estimated 3,000 to 6,000 cases per year. About 8% of children and 22% of adults die from pneumococcal meningitis, and survivors commonly have neurologic sequelae. PCV is more than 90% effective against invasive disease in children and is recommended for a four dose schedule beginning at 2 months of age. It’s also recommended for adults age 65 and older. Adverse reactions commonly include local reactions such as swelling or redness, while rare, serious reactions such as febrile seizures have also been reported.

Another conjugate vaccine widely used to prevent pneumonia and meningitis in children is *Haemophilus influenzae* type b vaccine (Hib).[14] This vaccine protects against invasive disease due to *H. influenzae*, most commonly meningitis, epiglottitis, pneumonia, arthritis, and cellulitis. Hib is recommended for children beginning at 2 months of age, with the number of doses dependent on the type of vaccine used. The vaccine efficacy is estimated between 95% and 100%. Adverse reactions to vaccination include local reactions such as swelling, redness and pain, while systemic reactions such as fever are uncommon, and serious reactions are rare.

*Combination vaccine formulations*

Many combination vaccines exist that allow children and adults to receive more vaccines in a single injection.[14] These combination vaccines are sometimes default options for certain vaccines, such as MMR, DTaP, and Tdap, while others allow for fewer injections for vaccines commonly given in the same visit, such as formulations containing hepatitis A and B vaccines, MMR and varicella (MMRV), DTaP and IPV, and others. Generally, these vaccines are just as safe as their separate counterparts, though MMRV has been associated with increased rates of fever after vaccination compared to MMR and varicella vaccines separately.

***Vaccines and childhood vaccine mandates***

*Smallpox vaccine and the evolution of US vaccine mandates*

The introduction of smallpox vaccination to the United States also brought about the first vaccine mandate in the early 19th century.[42] The intention of Massachusetts' mandate in 1809 was clear: to prevent smallpox outbreaks that posed a health and economic burden on society. Massachusetts subsequently implemented a school smallpox vaccination requirement in 1855.[43] Other states followed this example, a recurring theme in the legislation of immunization requirements in the United States, where federal vaccine mandates have never existed.[44 45] Instead, states have led the way in introducing and evolving vaccine mandates that generally create a substitute, patchwork national immunization policy.[45]

With Massachusetts's smallpox vaccination requirements came pushback. In the 1905 *Jacobson v. Massachusetts* decision, the US Supreme Court ruled in favor of compulsory smallpox vaccination, citing that the need to protect public health outweighed an individual right to privacy.[46] The US Supreme Court also upheld school mandates for smallpox vaccination in the 1922 case *Zucht v. King*, which paved the way for contemporary immunization policy that took shape in the last third of the 20th century.[42]

The widespread burden of measles and recurring outbreaks in schools led to the introduction of measles school vaccination requirements, and by 1969, 17 states had laws requiring measles vaccination prior to school entry.[45] The enforcement of these laws was a critical part of ensuring vaccination and preventing outbreaks, as states with school immunization laws had only 40-50% lower incidence of measles by 1977 than states without school immunization laws.[45 47]

*Vaccine uptake in the United States*

The National Immunization Survey (NIS) 2015 estimates of national vaccination coverage in among children between 19 and 35 months demonstrate high levels of coverage for the recommended vaccines.[48] Coverage for DTaP has been consistently high between 2011 and 2015 with an estimated 95% of children receiving 3 or more doses and 84.6% of children receiving 4 or more doses. There were limited differences between racial and ethnic groups, but Asian children did have a higher proportion vaccinated with 97% with having received three or more doses and 90% with four or more doses compared to White, non-Hispanic children who had estimates of 95% and 85%, respectively. Four dose DTaP coverage varied regionally, ranging from 89% in the northeastern US (HHS Region 1) to 82% in the south, central US (HHS Region 6).

Estimates of IPV coverage have generally stayed at about 93% between 2011 and 2015, and an estimated 93.7% of children received three or more doses of IPV in 2015.[48] As with DTaP, Asian children had higher coverage with IPV than White, non-Hispanic children with three dose coverage  of 97% versus 93%. The proportion of children who received one or more doses of MMR was estimated at 92% in 2015, consistent with the estimates from the previous four years.[48] No racial or ethnic differences in coverage were observed in 2015. Regional coverage estimates varied from 90% in the mid-Atlantic US (HHS Region 3) to 94% in the northeastern US (HHS Region 1) and the Pacific Northwest (HHS Region 10). Hib coverage was also high with primary series completion estimated at 94% in 2015, consistent with previous years.[48] Full series completion was estimated at 83%, up from 80% in 2011. Primary series completion was consistently high among racial and ethnic groups, but full series completion was lower for Black, non-Hispanic children compared to White, non-Hispanic children (83% versus 79%).

HBV coverage was high for three or more doses received at 93% vaccinated, but the proportion of children receiving a birth dose was decidedly lower with only 72% of children vaccinated at birth.[48] As with other vaccines, Asian children had higher receipt of three or more doses of HBV than White, non-Hispanic children—96% versus 92%. Birth dose coverage also varied significantly by racial and ethnic group; Black, non-Hispanic children had 74% coverage at birth, Hispanic children had 78% coverage, American Indian and Alaska Native children had 81% coverage, and Asian children had 77% coverage compared to White, non-Hispanic children who had an estimated HBV coverage of 68%. Regional estimates of HBV birth dose coverage ranged from 61% in New York and New Jersey (HHS Region 2) to 77% in the central Plains states (HHS region 7).

Nationally, an estimated 92% of children received one or more doses of varicella vaccine in 2015, consistent with coverage levels observed in the previous four years.[48] Coverage level did not vary significantly by racial and ethnic group. Coverage for PCV was also high nationally in 2015 with an estimated 93% of children having received 3 or more doses, which was consistent with the previous four-year period. An estimated 84% of children received four or more doses of PCV, also consistent with the previous four years. No significant differences were observed between racial and ethnic groups for children receiving three or more doses, but Black, non-Hispanic children did have lower levels of coverage with four or more doses compared to White, non-Hispanic children—81% and 85%, respectively.

Hepatitis A coverage was estimated at 86% nationally in 2015 for one or more doses, up from 81% in 2011.[48] Coverage with two or more doses was relatively low at an estimated 60%, though this was a significant increase from the 2011 estimate of 52%. The only significant difference between racial and ethnic groups was between Asian children and White, non-Hispanic children, with Asian children having 68% two dose coverage compared to 60% two dose coverage in White children. Regional estimates of two dose coverage of HAV ranged from 56% in the southeastern US (HHS Region 4) to 65% in the northeastern US (HHS Region 1). Rotavirus coverage nationally was estimated at 73% in 2015, up from 67% in 2011.[48] Notably, Black, non-Hispanic children had lower RV coverage, estimated at 70%, than White, non-Hispanic children, estimated at 75%. Regionally, estimates ranged from 70% in the southeastern US (HHS Region 4) to 81% in the northeastern US (HHS Region 1).

Overall coverage was estimated for the combined series consisting of four or more doses of DTaP, three or more doses of IPV, one or more doses of MMR, full series completion of Hib, three or more doses of HBV, one or more doses of Var, and four or more doses of PCV.[48] Rotavirus and HAV were not included. For 2015, overall combined series coverage was estimated at 72% nationally, an increase from 69% in 2011. There were not significant differences between racial and ethnic groups when compared to White, non-Hispanic children. Regionally, estimates ranged from 70% in the Midwestern US (HHS Region 5) to 78% in the northeastern US (HHS Region 1).

*Medical and nonmedical exemptions to vaccination requirements*

Exemptions to state immunization requirements fall into two categories: medical and nonmedical exemptions. Medical exemptions are granted for children who are unable to be immunized for one or more vaccines due to a medical contraindication.[49] Policies for nonmedical exemptions vary by state, but are generally given if parents are against immunization for religious or philosophical reasons. All states allow for medical exemptions, but policies regarding nonmedical exemptions vary by state and by administrative requirements.[50-53] Nonmedical exemption rates increased between 1994 and 2011, with states allowing personal belief exemptions having higher rates of overall nonmedical exemptions than states that only allowed for religious exemptions.[50 51] States with low difficulty in getting a nonmedical exemption and allowing personal belief exemptions have also been shown to have increased rates of nonmedical exemption and increased pertussis incidence.[50 53 54]

Studies of nonmedical exemptions have shown that these children are often clustered geographically and socially, providing opportunity for outbreaks of vaccine-preventable diseases in these communities.[50 54-58] Higher nonmedical exemption rates have been demonstrated in private schools, and in schools predominantly white, college-educated communities.[49 56]

### ***Origins and evolution of vaccine hesitancy, delay and refusal***

#### *Populations choosing to delay or refuse vaccines and the vaccine-hesitant*

With the introduction of vaccine mandates came pushback from both individuals and groups. As school immunization requirements expanded and evolved over the latter half of the 20$^{th}$ century and into the 21$^{st}$ century, this phenomenon did the same. Those voicing opposition to required immunization for school entry have generally been a small minority, as most parents in the US continued to vaccinate their children as recommended. A 2014 survey estimated that 91% of US parents were accepting of vaccines, while 6% were classified as “delayers” because they intentionally delayed one or more vaccines and 4% were classified as refusers because they intentionally refused one or more vaccines.[59] This study estimated that only 2% of parents had refused all vaccines for their child. The NIS also estimates the number of children who had received no vaccines was low in 2015, approximately 1%.[48]

Many studies have looked at differences between parents who delay and refuse vaccines and those who accept vaccines, both in the US and elsewhere. There are some difficulties in determining if delay or non-receipt may be due to barriers to access.[60] Studies in the US show that those who are vaccine-hesitant or who delay or refuse vaccines are more likely to be women, White, highly educated, higher income, and married, but heterogeneity between studies makes finding patterns in socioeconomic groups difficult.[61-66] There is some evidence to suggest that there are differences in underlying reasons for vaccine hesitancy between socioeconomic strata, which may explain this heterogeneity.[62] Additionally, there are problems with separating those who have concerns about vaccines but still vaccinate and those who act on those concerns. For example, Freed et al. found that Hispanic parents had more concerns about serious adverse events associated with vaccines, but they were also more likely to follow their doctor's recommendations and less likely to refuse vaccines.[61] Gust et al. described mothers over 30 years of age and those living in the Western US as more likely to be vaccine hesitant, while mothers who had more than one child or were not married were more likely to be delayers.[67] Additionally, non-Hispanic, White mothers were more likely to be delayers. Ideologies and concerns appear to have more consistent influence on vaccine receipt than sociodemographic factors.

*Reasons for vaccine delay and refusal*

The reasons cited by parents who delay or refuse vaccines or are vaccine hesitant are varied. One reason has been cited by antivaccination groups since the first mandates were put in place: infringement on individual rights.[46 68-70] Government distrust is also often listed as a reason for vaccine refusal for a number of reasons, the predominant one being the financial influence of the pharmaceutical companies who produce the vaccines.[68 69 71] These parents believe that vaccines are at best a scheme to profit from products that do not work or have minor risks and at worse a sinister collusion to push harmful products for profit.[70]

Another driver of concern around vaccines is the continued fallout behind the retraction of a study claiming to demonstrate a link between MMR and autism.[69 72] The implications of this study published by Andrew Wakefield in 1998 have been far-reaching and persistent. Though the study was exposed as a fake, the damage it has done is lasting, with many antivaccine groups continuing to espouse the idea that vaccines and autism are linked. Additionally, many studies have been conducted to disprove this lasting misperception, but despite the mounting evidence, the notion persists.

Another objection sometimes given by antivaccine groups and parents is to vaccine's ingredients or processes by which they are made. The use of cell cultures obtained from fetuses has raised objections from both religious and non-religious groups.[69 70] Additionally, use of cell lines from other species may lead to concern about cross-species contamination and unknown risks. Some religious groups simply object to vaccination because they find it to be contrary to their religious beliefs about medical intervention and disease. Concerns about ingredients such as thimerosal and aluminum are perpetuated due to misconceptions about the risks these ingredients have and the role they play in vaccines.[68 69 73] As of 2008, seven states had banned the use of thimerosal in vaccines, and 20 states had considered doing so, going against scientific consensus on the safety of thimerosal. Combined with the federal government's decision to discontinue use of thimerosal in most vaccines, this likely drove the controversy and may have been seen as evidence that thimerosal was not safe.

In a similar vein, many parents who delay or refuse vaccines, and even those who do not, have concerns about associated side effects, adverse events, and the safety of vaccines.[66 69 70 72-74] These concerns encompass mild, common side effects like fever, more uncommon and more distressing side effects like anaphylaxis and neurological complications, and even unproven links to coma and death.[69 75 76] Parents who are concerned about vaccine safety are not always delayers or refusers, but increased level of concern does increase the likelihood of vaccine delay or refusal.[61 67]

Another factor in this is perceived importance of vaccines and risk of disease. Parents who see the risk of contracting a vaccine-preventable disease as low and the vaccine unimportant are likely to delay or refuse the vaccine.[66 69 70 77 78] Additionally, some parents may perceive some diseases as less severe than they actually are and are therefore more willing to take the risks associated with disease over the perceived risks associated with vaccination.[66 72 73 78 79] Likely because they view the disease as less severe, parents may voice preference for natural immunity over the "unnatural" immunity conferred by vaccines, perceiving natural immunity to be better and life-long.[69 70 76]

Other concerns about vaccines include the administration of multiple vaccines in one visit, as parents perceive this to be too much for a child's immune system to handle.[66 70 72 73] Though today's vaccines contain a small fraction of those used in the past, the number of diseases vaccinated for in a single visit gives parents the perception that the burden on the immune system is higher than it was previously.[72] Conversely, some parents simply think there are too many injections and are not as concerned about overloading the immune system.[72 73] Some parents cite the use of combination vaccines as a default and the unavailability of single disease vaccines as a reason for not vaccinating. These parents may perceive combination vaccines to have higher associated risks or that they will overload the immune system, preferring single disease vaccines in order to space them out over multiple visits.

The parent's interactions with health care providers have been demonstrated to play a key role in their vaccination decision-making.[72 73] Parents having negative experiences related to vaccines with physicians and may be more likely to seek out alternative health care providers who may not support vaccination.[80] These negative experiences can be related to the length and depth of conversations about vaccines, perception of the physician's attitude about their concerns or questions, and somewhat unrelated factors such as waiting at the doctor's office or communications with the office staff.[80] Some providers may misconstrue a parent's questions about vaccines as intention to not vaccinate, which may push parents to not vaccinate.

*Drivers and perpetuators of vaccine hesitancy, delay, and refusal*

The advent of the Internet boosted the visibility and connectivity of these vaccine refusing parents and groups.[68] Likewise, the introduction and rising popularity of social media platforms and blogging allowed these parents to share information, stories, and advice with a larger audience.[68] Because the internet is open and available, there is ample opportunity for antivaccine groups and individuals to reach a wider audience and to spread misconceptions about vaccines and vaccine safety. Sharing stories of unproven adverse events and negative experiences with vaccines can appeal to parents' emotions. The engagement of celebrities in the antivaccine movement, both online and offline, has also caused it to rise in visibility. Media portrayals of vaccines and their safety and efficacy also have an effect on parents' views of vaccines.[68 81-84] News stories can cause parents to see vaccines in a negative light, as antivaccine groups may be given a voice in an attempt to keep coverage well-rounded and balanced.[68]

Additionally, parents who report thinking about vaccination in advance are more likely to delay or refuse vaccines.[76 85] Similarly, parents who feel they had inadequate information about vaccines or that there was insufficient research on vaccines were also less likely to vaccinate.[80] Studies have also shown that a history of not vaccinating increases the likelihood that a parent will not vaccinate in the future.[85-87]

***Barriers to immunization and sociodemographic disparities***

Separately from parents who choose not to vaccinate or to delay vaccination, some parents may face barriers to vaccination.[88-90] One key barrier to vaccination is household income.[48 87 89-93] The NIS estimated that in 2015, children under the federal poverty level were significantly less likely to receive DTaP, IPV, MMR, Hib, PCV, HAV, RV, and a combined overall series of 7 vaccines.[48] These children are part of the target of programs such as Vaccines for Children (VFC), a federal program that funds vaccines for children whose families cannot afford them.

Children living in rural areas were also less likely than those living in cities to receive DTaP, IPV, PCV, HAV, and RV, suggesting that the parents of these children may have limited access to providers that administer the vaccines, especially providers participating in the VFC progam.[48] Racial disparities have been noted specifically for Black, non-Hispanic children with regards to Hib, PCV, and RV.[48] Children in the southeastern US demonstrated lower coverage for some vaccines than those in many other regions, which may be attributable to a mix of factors including barriers to access and the presence of vaccine hesitant or refusing parents.[48]

**Title:** Attitudes, beliefs, and characteristics mediating acceptance of childhood non-influenza live attenuated and conjugate vaccines in a 2016 national survey of parents

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**Abstract**

***Background:*** Understanding the factors related to vaccine acceptance and refusal has been of specific interest in efforts to maintain sufficient vaccine coverage in the United States, but most studies to this point have focused on a wide overview of vaccine acceptance or on a single vaccine or population.

***Methods:*** In November 2016, a cross-sectional survey of parents with a child <7 years of age was conducted to study vaccine-related and non-vaccine-related factors associated with vaccine acceptance (n=886). The survey obtained information on receipt and perceived importance of all vaccines in the childhood schedule, as well as attitudes, beliefs, and information sources. These variables were included in multivariate logistic regression for five routine non-influenza live attenuated and conjugate vaccines to determine mediating factors of receipt.

***Results:*** Reporting social media as a top vaccine information source was associated with highly decreased likelihood of parental reported receipt for MMR (OR: 0.12, 95% CI: 0.021, 0.632), varicella (OR: 0.2, 95% CI: 0.06, 0.86), and RV (OR: 0.1, 95% CI: 0.02, 0.40). Children with no insurance were much less likely to receive Hib vaccine than children with public (OR: 13.5, 95% CI: 2.43, 75.27) or private insurance coverage (OR: 19.0, 95% CI: 3.26, 110.65) and less likely to receive RV than children with public insurance coverage (OR: 4.0, 0.98, 15.95).

***Conclusions:*** The role of information sources, such as social media, family, friends, and religious leaders, as positive or negative mediators of vaccine behavior reinforces the likely influence of social networks in parents' vaccine decision-making. Sociodemographic differences in insurance coverage, household income, education, and marital status highlight both potential barriers to access and populations choosing not to vaccinate. These varying factors suggest that diverse approaches should be taken when targeting specific vaccines for studies or interventions.

## Introduction

The reduction in the global burden of vaccine-preventable diseases has been heralded as one of the top public health achievements of the late 20$^{th}$ and early 21$^{st}$ centuries.[68] Since the development of the smallpox vaccine in 1796, vaccines have been developed for over 20 different diseases, many of these diseases occurring most predominantly in children.[3 8] In the United States (US) today, 10 vaccines are routinely recommended for children during the first seven years of life.[94] These vaccines safely and effectively protect children from a variety of pathogens, including measles, Hepatitis A and B, rotavirus, and tetanus. Uptake of these recommended vaccines is generally very high, often leading to a net benefit for the entire population and not just those who are vaccinated.[48] High vaccine uptake allows for disruption of disease transmission, and the phenomenon of herd immunity protects those who are not vaccinated.[71] While there are those who have medical contraindications against vaccination for one or more diseases, there is also a population of parents deliberately delaying or refusing vaccines for children who could otherwise be vaccinated.[59 66 72-74 95]

Understanding the motivations and attitudes of those who are vaccine-hesitant, vaccine delayers, or vaccine refusers has been of increasing importance in recent years.[86 96-100] The practical elimination of many previously prevalent childhood diseases such as measles, polio, and diphtheria has led to a change in perception of the risks associated with both vaccine-preventable diseases and the vaccines themselves.[68] These parents often perceive the risks of diseases as being lower than they actually are, while the risks of real or speculative adverse effects of vaccines are perceived as much higher than they actually are.[101] This negative shift in perceived risk-benefit profile may be associated with a variety of factors including use of alternative medicine, sources of vaccine information, and mistrust of the government and pharmaceutical companies.[71 102 103] Additionally, misinformation has been demonstrated to effectively spread through the internet, social media platforms, and personal social networks, which may change geographic distribution of under- or unimmunized children across the US.[54 55 59 69 104-108] Clusters of such children present opportunities for localized outbreaks, and more widespread groups of these children may lead to the resurgence of these diseases on a national scale.[19 21 24 54 55 58 108 109]

By characterizing who in the population is vaccine-hesitant or deliberately delaying or refusing vaccines—as opposed to parents who may face barriers to vaccination and are not deliberately undervaccinating, health care providers and public health organizations can better understand and target these groups for interventions designed to address their vaccine-related concerns with the ultimate goal of increased uptake.[68 77 81 101 110-116] Previous studies have demonstrated sociodemographic and ideological differences between parents who are hesitant or choose to delay or refuse vaccines compared to non-hesitant parents.[64 66 67 73 81 117 118] These studies have generally either focused on if the child was up to date on all vaccines or on a single vaccine, population, or geographic area.[61 63 74 79 86 88 95 96 100 103 108 119-133] The purpose of this study is to determine if factors influencing vaccine receipt differ by vaccine and to assess any overarching patterns in factors mediating acceptance among the vaccines.

## Methods

### *Study Design and Sample*

During November of 2016, a cross-sectional survey of U.S. parents drawn from aggregated market research panels was conducted using Qualtrics. Panel members meeting initial inclusion criteria were randomly selected to receive an email invitation to participate, a method that enables Qualtrics to select a population that approximates the U.S. adult population.

Our sampling frame included English-speaking, non-institutionalized parents or guardians aged ≥ 18 years living in the U.S. with at least one child aged < 7 years. Selected participants were invited via email to take the online survey and received a cash-equivalent incentive for survey completion. Overall response rate was 59.0% (886 valid responses/1502 attempts). Participation is described in **Figure 1**. The Emory University Institutional Review Board reviewed the study prior to survey implementation.

### *Measurement*

The survey examined reported behaviors of parents of children less than 7 years of age towards childhood immunization, as this age group is primarily affected by school entry immunization policies and are included in the CDC recommended immunization schedule for infants and children. Sociodemographic data included parent's sex, race and ethnicity, income, highest level of education, region of residence, and age, as well as the insurance coverage of parent and child and the child's age. To assess vaccination decisions, we asked respondents if their youngest child had received the recommended vaccines, specifically: Hepatitis B (HBV); Rotavirus (RV); Diphtheria, Tetanus, acellular Pertussis (DTaP); *Haemophilus influenzae* type b (Hib); Pneumococcal (PCV); Inactivated Poliovirus (IPV); 2015/16 and 2016/17 Influenza (Flu); Measles, Mumps, Rubella (MMR); Varicella (Var); and Hepatitis A (HAV). Vaccines were addressed separately as described, and the survey did not include combination vaccine formulations (e.g., DTaP-Hib-IPV). This analysis focuses on receipt of non-influenza live, attenuated and conjugate vaccines in the childhood schedule, specifically MMR, Hib, PCV, Var, and RV.

Vaccination status was indicated with "Yes, my child has received this vaccine," "No, my child did not receive this vaccine," or "I don't know." Responses of "I don't know" were excluded in further analysis, as were responses for a vaccine that was not recommended given the age of the child regardless of self-reported vaccination status. Overall perceived vaccine importance score was calculated from 11 questions asking about each of the vaccines in the childhood schedule, including two seasons of influenza vaccination. This score was then categorized into 3 importance groups: "high importance," "moderate importance," and "low importance." Those in the "very high importance" category ranked all immunizations as important (score=11), while those in the "high importance" category ranked one to three vaccines as not important and/or were unsure of importance (score 8-10). Those in the "low to moderate importance" category ranked four or more vaccines as not important and/or were unsure of their importance (score <8).

Several types of attitude and belief factors were also considered for inclusion in each logistic regression model, in addition to sociodemographic variables. These included Likert-type items assessing personal values and vaccine opinion formation as well as other questions assessing comfort level with vaccines between children and top information sources. Personal values questions utilized a 5-point scale to measure importance of things such as “a sense of belonging,” “excitement,” and “warm relationships with others” in the parent’s daily life. Vaccine opinion formation questions utilized a 5-point scale to measure agreement with statements including “I like thinking a lot about vaccination decisions,” “I prefer to do my own research about vaccines rather than be told what to do or accept,” and “I prefer detailed/in-depth answers to my questions about vaccines over simple ones.”

Parent’s comfort level with vaccines between children was measured by the question “Has your comfort level regarding all recommended vaccines for children changed between your older child(ren) and your youngest child?” Possible responses included “I feel more comfortable about vaccinating my youngest child than I did with my older child(ren),” “I feel less comfortable about vaccinating my youngest child than I did with my older child(ren),” “My approach has not changed. I have never felt comfortable about vaccinating my child(ren),” “My approach has not changed. I have always felt comfortable about vaccinating my child(ren),” or “Not Applicable – I only have one child.” Parent’s top information sources for vaccine information were measured by the question “Where do you get your most trusted information regarding childhood vaccines and their safety and effectiveness?" and parents were asked to choose their top three sources from a list of 11 options and a textbox for other responses. Interaction between community type and number of children was also considered. A summary of all survey questions considered for multivariate model inclusion can be found in **Appendix 1.**

***Statistical Analysis***

Analysis of the study population was performed using SAS 9.2 (Cary, NC). Multivariate logistic regression model selection was conducted after bivariate analysis to determine the factors mediating receipt of each of the selected non-influenza vaccines in the childhood immunization schedule for children under 7 years of age, and an alpha of 0.05 was used for all analyses, including variable selection for regression models. Multivariate models were selected using backwards elimination.

## Results

***Subjects***

Eight hundred eighty-six responses were initially eligible for inclusion in each analysis. The overall study sample characteristics can be found in **Table 1**. A majority of the parents surveyed were white (78%), non-Hispanic (88%), aged 25 to 34 (59%), and female (82%). Sixty percent of parents had an income of $60,000 or less, and 47% were covered by private insurance only. Only 12% of parents reported working in a healthcare field. Most parents' youngest child was between 2 and 7 years old (64%), and most families had 2 or fewer children in the household (78%). Fifty-three percent of children were covered only by government insurance, and 44% lived in suburban communities.

The final sample included in each model varied based on the recommended age at the start of series initiation and a breakdown of responses age-eligible for each model are described in **Table 2**. Because MMR and Var are not given until 12 months of age, only 83% of responses were eligible for inclusion in these models, while 98% of responses were eligible for all other models because these vaccines are administered during the first year of life. The proportion of “I don’t know” responses varied by vaccine, ranging from 4.3% for MMR to 18% for PCV, and these responses were excluded from multiple logistic regression for purposes of reliability and ease of interpretation.

***Vaccine uptake and importance***

After all ineligible responses were excluded for each vaccine, vaccine series initiation was estimated for each of the recommended non-influenza vaccines and described in **Table 3**. Vaccine importance scores ranged from 0 to 11. The median score was 10, and the mean score was 9. Twenty-one percent of parents (n=187) had a vaccine importance score <8 and were in the “low to moderate importance” category used as the reference group. The “very high importance” group consisted of 33% of parents (n=295), and the “very high importance” group consisted of 46% of parents (n=404).

***Measles, Mumps, and Rubella vaccine***

Of the 886 responses eligible for study inclusion, 705 responses (79.6%) were eligible for inclusion in bivariate and multivariate analysis. Of those eligible for analysis, 93.9% reported that their child had received the MMR vaccine by survey administration. Those who reported MMR receipt were more likely to cite doctors ($\chi^2$=5.6, p=0.02) and less likely to cite social media ($\chi^2$=14.1, p=0.0002) as top vaccine information sources than those reporting non-receipt. All other information sources were non-significant in bivariate analysis. There was significant association between MMR receipt and reported vaccine comfort level change between older child(ren) and youngest child, with parents reporting “less comfort with younger child” being more likely to report non-receipt than parents with only one child (17.8% vs, 6.1%,  p=0.004), and parents reporting that they were “always comfortable” were more likely to report receipt of vaccine than parents with only one child (97.6% vs. 93.9%, p=0.0005) . Male parents were more likely to report non-receipt than female parents (12.0% vs. 4.6%, $\chi^2$=10.7, p=0.001). The child’s type of insurance coverage was also associated with MMR receipt; 96.4% of children with private insurance were reported to have received MMR compared to 87.5% of children with no insurance coverage (p=0.02). There was not significant regional variation, nor significant association of MMR receipt with parent age, marital status, community type, number of children in the household, working in a healthcare field, Hispanic ethnicity, or race.

The results bivariate and multivariate analyses for MMR vaccine receipt are described in **Table 4** and **Table 5**. MMR receipt was associated with vaccine importance category with parents in the “high importance” category and “very high importance” category being more likely to report MMR receipt compared to parents in the “low to moderate importance” category in multivariate analysis. Listing social media as a top three-trusted source for vaccine information was associated with MMR non-receipt compared to those who did not list social media, while listing family as a top information source increased odds of receipt by over 5 times compared to those who did not list family. The increasing importance of two values factors were also associated with MMR receipt; parents placing more value on “excitement” in daily life were two times less likely to report receipt, while those valuing “warm relationships with others” were more 2.5 times likely to report receipt.

MMR receipt was also associated with the parent’s comfort level with vaccines between children. Parents reporting they were “less comfortable” with their younger child were significantly less likely to report receipt than parents with only one child. The parent’s type of insurance coverage was also associated with vaccine receipt, but due to low numbers in some insurance categories, there are no reliable estimates of effect for this variable. This model also included significant interaction between the number of children in the household and the type of community the respondents lived in. Families with multiple children in both suburban and rural communities were less likely to report vaccination, an effect that increased when the number of children in the household increased, when compared with families in urban communities.

**Haemophilus influenzae *type b vaccine***

Of the 736 responses (83.1%) eligible for inclusion in multivariate analysis, 87.8% reported that their child had received the Hib vaccine. Parents reporting Hib receipt were more likely to cite doctors ($\chi^2$=7.6, p=0.006) and less likely to cite the internet ($\chi^2$=11.9, p=0.0006) as a major source of vaccine information than those reporting non-receipt. All other information sources were non-significant with regard to vaccine receipt in bivariate analysis. Parents working in a healthcare field were less likely to report Hib receipt than those not in a healthcare field (81.6% vs. 88.7%, $\chi^2$=4.0, p=0.05), and male parents were more likely to report non-receipt than female parents (18.7% vs. 10.8%, $\chi^2$=6.3, p=0.01). The child’s type of insurance coverage was also associated with Hib receipt; 89.1% of children with private insurance were reported to have received Hib compared to 54.5% of children with no insurance coverage (p=0.03). Parental income was associated also associated with vaccine receipt, with parents making $60,000 or less being more likely than parents making $100,000 or more to report Hib receipt (90.5% vs. 87.3%, p=0.02), while parents making between $60,000 and $100,000 were less likely to report Hib receipt than those reporting income over $100,000 (81.2% vs. 87.3%, p=0.01). There was not significant regional variation in bivariate analysis, nor significant association of Hib receipt with parent age, marital status, number of children in the household, community type, vaccine comfort level change between children, Hispanic ethnicity, or race.

**Table 4** and **Table 5** describes the estimates of effect for bivariate and multivariate models for Hib receipt. Vaccine importance was associated with Hib receipt with the "high importance" group having 6 times higher odds of Hib receipt compared to those in the "low to moderate importance" category, and those in the "very high importance" category were 13 times more likely to report receipt compared to the reference group. The most trusted vaccine information sources associated with receipt of Hib vaccine in multivariate analysis were the internet and academic journals; parents citing the internet were twice as likely to report non-receipt of Hib, while parents citing academic journals were over four times more likely to report receipt.

Placing importance on "self-fulfillment" in daily life was associated with increased Hib receipt compared to parents who placed little importance on "self-fulfillment," but placing importance on "self-respect" decreased odds of receipt by over 2.5 times compared to parents who did placed little or no importance on "self-respect." The type of insurance coverage the child had was also associated with Hib receipt.

Compared to children with no insurance coverage, the odds of vaccine receipt were 19 times higher for those with private insurance coverage only, while the odds of vaccine receipt were 13.5 times higher for children covered by one or more public insurance plans. Children with both private and public insurance plans were 18 times more likely to report vaccine receipt, though the confidence intervals for these estimates are wide. Racial differences were also noted in multivariate analysis, with Black parents being significantly more likely to report non-receipt than White parents. Other race and mixed race parents were also less likely to report vaccination than White parents, but these differences were not statistically significant. Finally, there were differences in vaccine receipt by household income. Those with income $60,000 or less were over twice as likely to report vaccination than parents with income over $100,000, while household income between $60,000 and $100,000 was associated with a two-fold decrease in likelihood of Hib receipt compared to parents in the $100,000 and over category.

***Pneumococcal conjugate vaccine***

Of the 713 responses eligible for multivariate analysis, 78.1% reported their youngest child receiving PCV. Parents citing “friends and/or other parents” as a top vaccine information source were less likely to report PCV receipt than those who did not list this information source ($\chi^2$=7.6, p=0.006). All other information sources were non-significant in bivariate analysis. There was significant association between PCV receipt and vaccine comfort level change between children, with parents reporting they felt “less comfortable with vaccines” being more likely to report non-receipt than parents with only one child (p=0.004). Single or unmarried parents were also less likely to report PCV receipt than married parents, as were divorced or separated parents, but these differences were not statistically significant. Parent age was also associated with reporting PCV receipt with parents between 25 and 34 years of age being more likely to report PCV receipt than parents 18 to 24 years of age, and parents 45 and over being less likely to report PCV receipt than parents between 18 and 24 years of age. Parents reporting an income between $60,000 and $100,000 were less likely to report PCV vaccination than parents making over $100,000 (p=0.02). There was not significant regional variation in bivariate analysis, nor significant association of PCV receipt with parent sex, working in a healthcare field, community type, Hispanic ethnicity, or race.

Results of bivariate and multivariate models for PCV receipt are described in **Table 4** and **Table 5**. Vaccine importance was associated with PCV receipt with the odds of receipt being 4.6 times higher for parents in the “high importance” group compared to those in the “low to moderate importance” group. The odds of receipt were 14.1 times higher for those in the “very high importance” group compared to the reference group. Family being among the top three trusted information sources was associated with PCV receipt, while those listing friends and/or other parents were two times less likely to report PCV receipt. No other factors were associated with PCV receipt at alpha=0.05.

***Rotavirus vaccine***

Seven hundred forty-four responses were eligible for inclusion in bivariate and multivariate analysis, and of those, 90.1% reported their youngest child receiving RV. Results of bivariate and multivariate analyses are described in **Table 4** and **Table 5**. Parents reporting RV receipt were less likely to cite social media as a top vaccine information source than those reporting non-receipt ($\chi^2$=10.6, p=0.001), as well as less frequently citing the internet as a top information source than those reporting non-receipt

($\chi^2$=6.7, p=0.009). They also were more likely to cite doctors as a top information source ($\chi^2$=13.0, p=0.0003). All other information sources were non-significant in bivariate analysis. Male parents were less likely to report RV receipt than female parents (83.5% vs. 91.5%, $\chi^2$=7.9, p=0.005). Community type was also associated with vaccine receipt, as parents in rural communities were more likely to report RV receipt than parents in urban and suburban communities ($\chi^2$=6.4, p=0.04), as was marital status ($\chi^2$=6.2, p=0.04). No significant association of RV receipt was seen by region or with vaccine comfort level between children, parent age, working in a healthcare field, Hispanic ethnicity, or race.

In the multivariate model, vaccine importance was associated with reporting receipt of RV, as parents in the "high importance" category had odds of reporting receipt 4 times higher than those in the "low to moderate importance" reference group, and parents in the "very high importance" category had odds of reporting receipt of RV over 46 times higher than those in the reference group. Reporting religious leaders as a top vaccine information source decreased odds of vaccine receipt by approximately 10 times compared to those who did not list religious leaders, and listing social media also decreased odds of RV receipt by 10 times compared to those who did not list social media. Valuing "warm relationships with others" was associated with reporting vaccine receipt compared to parents who placed less importance on this, while parents who agreed with "I like thinking a lot about vaccine decisions" were 30% less likely to report RV receipt than those who disagreed with this statement.

The parent's type of insurance coverage was also associated with vaccine receipt, but due to small numbers in some subgroups, there are no estimates of effect for this variable. The child's insurance coverage group was also associated with vaccine receipt, but none of the groups had significant aORs. Children in households with an income less than $60,000 were over twice as likely to receive RV compared to children in households making over $100,000, and children in households making between $60,000 and $100,000 were 20% less likely to receive RV, but these were not statistically significant. The parent's marital status was also a significant factor in multivariate analysis with single or not married parents being less likely to report vaccination than parents who were married, in a domestic partnership, or widowed. Divorced or separated parents were twice as likely to report receipt, but this was not statistically significant. Additionally, the parent's education level was also associated with vaccine receipt, but none of the aORs were statistically significant. This model also included significant interaction between the number of children in the household and the type of community the respondents lived in. Families with multiple children in both suburban and rural communities were less likely to report vaccination, an effect that increased when the number of children in the household increased, when compared with families in urban communities.

***Varicella vaccine***

Of the 671 responses eligible for analysis, 88.4% reported that their youngest child had received the varicella vaccine. Parents reporting Var receipt were less likely to cite social media as a top information source than those reporting non-receipt ($\chi^2$=4.7, p=0.03), as well as less frequently citing the internet as a top information source than parents reporting non-receipt ($\chi^2$=5.3, p=0.02). Parents reporting Var receipt also were more likely to cite doctors as a top information source compared to parents not reporting Var receipt ($\chi^2$=4.3, p=0.04). All other information sources were non-significant in bivariate analysis. Var receipt differed significantly by marital status ($\chi^2$=8.3, p=0.02).

No significant association of Var receipt was seen by region or with parent sex, vaccine comfort level between children, parent age, community type, working in a healthcare field, Hispanic ethnicity, or race.

The results of bivariate and multivariate regression models can be found in **Table 4** and **Table 5**. Vaccine importance was associated with increased odds of reporting Var receipt, with those in the "high importance" category having odds of reporting receipt 5.5 times higher than those in the "low to moderate importance" group, and the "very high importance" category having odds of reporting receipt 7.4 times higher than those in the reference group. Reporting social media as a top trusted vaccine source was associated with highly decreased odds of reporting vaccine receipt compared to parents who did not report social media. The parent's marital status was also associated with reporting vaccine receipt with the odds of receipt being was two times lower for parents who were single or not married when compared to parents who were married, had a domestic partner, or were separated.

## Discussion

The findings of this study indicate that the factors influencing receipt of non-influenza live attenuated and conjugate vaccines in the childhood vaccine schedule are diverse but have common themes. In multivariate models for MMR, RV, and Var receipt, citing social media as a top vaccine information source was consistently associated with approximately 8 to 10 times lower odds of vaccine receipt compared to those who did not list social media as a top information source. Additionally, listing the internet was associated with a two-fold decrease in likelihood of Hib receipt compared to parents who did not list the internet as a top vaccine information source. This concurs with the growing body of evidence that suggests that social media and the internet are often key sources of misinformation on vaccine safety and effectiveness as well as a focal point for vaccine-hesitant and anti-vaccine individuals and groups to exchange information and ideas.[69 70 104 105 134-139]

Listing friends and/or other parents as a top source of vaccine information was associated with two-fold lower odds of PCV receipt than those who did not list this group, while listing religious leaders was associated with a ten-fold decrease in likelihood of RV receipt compared to those who did not list religious leaders, reinforcing the idea that social networks and perceived norms or social pressures may influence parents' decisions whether or not to vaccinate their child for certain diseases.[103 140 141] Listing family as a top information source had the opposite effect, increasing likelihood of vaccine receipt for PCV by about two times and MMR by about five times, an important effect to consider due to the previously demonstrated influence of family members in vaccine discussions and decisions.[72 103 140 141] Brown et al. observed that perceiving peers/family to be in favor of MMR vaccination was a significant predictor of MMR uptake in a catch-up campaign in the United Kingdom in 2008-2009, and the positive influence of family in our study could be due to a similar influence.[120] Academic journals were also a top information source associated with vaccine uptake; these parents were four times more likely to report Hib receipt than parents who did not list academic journals.

A number of sociodemographic factors highlight both possible disparities in vaccine access and potential populations choosing to delay vaccination or not to vaccinate. Since the Affordable Care Act became law, preventive services, including recommended vaccines, are required to be covered completely by health insurers with no cost sharing to eliminate financial barriers to access.[142] In this study, children with no insurance were much less likely to receive Hib vaccine than children with public or private insurance coverage and less likely to receive RV than children with public insurance coverage, highlighting a possible barrier to vaccination for children that remain uninsured.[60 89] Children with private insurance were 10 times less likely to receive RV than children without insurance, however, suggesting that parents in this group may be choosing not to vaccinate rather than facing a barrier to vaccination. A 2011 study of the 2009 NIS saw a similar effect, as parents who chose to delay and refuse vaccines were significantly more likely to have private health insurance than parents who neither delayed nor refused vaccines.[129]

Another group that should be considered for both potential barriers to vaccination and choosing not to vaccinate are single or unmarried parents. Compared to parents who were married, in a domestic partnership, or widowed, single parents were about one-and-a-half times less likely to have a child who received RV and two times less likely to have a child who received Var. Parents who were divorced or separated were twice as likely as married/domestic partner/separated parents to have a vaccinated child for both RV and Var, but this difference was not statistically significant. Gust et al. observed that mothers who were not married were twice as likely to delay vaccines compared to married mothers, which could indicate that these single parents may be facing barriers to vaccination because of decreased support to be able to attend medical appointments.[67] Conversely, some single parents may be choosing not to vaccinate, but that cannot be determined from this study due to its design. Racial differences in vaccine uptake were only significant for Hib, for which Black parents were much more likely to report non-receipt than White parents, which was also observed in the NIS for full series completion of Hib.[48] This difference may be attributable to barriers to vaccination for this specific group or a mistrust causing parents to choose not to vaccinate.[133]

In considering populations that may be choosing not to vaccinate or to delay vaccination, a few key sociodemographic factors stand out. Children were less likely to be vaccinated for Hib if their household income was between $60,000 and $100,000, while households under $60,000 were more than twice as likely as households over $100,000 to have their child receive Hib and RV. Households between $60,000 and $100,000 were less likely to report RV vaccination than those over $100,000, but this difference was not statistically significant. Together, this suggests that households in the middle and upper ranges of income may choose not to vaccinate their child for one or more vaccines rather than face barriers to access, since those with lower household incomes demonstrated much higher rates of vaccination. Parents with a Bachelor's degree were less likely than parents with a high school diploma or less to vaccinate for RV, again suggesting that this population of well-educated parents is choosing not to vaccinate rather than facing barriers to vaccination, as all other groups showed similar or higher likelihood of vaccination than those with a high school diploma or less. Smith et al. observed that a larger proportion of mothers who delay and refuse vaccines were college graduates compared to those who neither delayed nor refused vaccines (44.9% vs. 32.1%), supporting this conclusion.[129]

Overall, reported vaccination coverage was high for MMR and RV, though PCV, Hib, and Var had relatively low reported series initiation. According to results from the

2014 National Immunization Survey (NIS), 91.9% of children aged 19-35 months received at least one dose of MMR vaccine, and this value is similar to our estimated uptake given the differing study designs and samples.[48] The NIS also reported 73.2% of children in this age range received a full series of RV, which was much lower than our estimated coverage of 90.1%. We estimated coverage for PCV at 78.1%, which was much lower than the NIS national estimate of 93.3% for at least three doses of PCV. Similarly, we estimated Hib series initiation at 87.8%, considerably lower than the primary series coverage estimate in the NIS (94.3%). Var coverage was just slightly lower than the NIS estimate of 91.8% at 88.4%. The impact of study design and reliance on parental report is likely a key reason for such wide discrepancies between studies. NIS moved from parental report to provider-verified immunization history because of the demonstrated discrepancies between parental report and actual immunization history. The large proportion of “I don’t know” responses for vaccines such as PCV likely influenced the estimated vaccine uptake, as a study by Frew et al. previously demonstrated that PCV was one of the least refused vaccines in two consecutive national surveys of parents.[59]

Parents placing increased value on excitement in daily life were less likely to report MMR vaccination in multivariate analysis. Similarly, parents who placed increasing value on self-respect in daily life were less likely to report Hib vaccination. Understanding how personal values describe parents who are vaccine hesitant or refusing may also shed some light on why they make certain vaccine decisions. In a national consumer survey examining impact of various factors on maintaining a healthy lifestyle, increased importance placed on excitement was significantly associated with decreased likelihood of maintaining a healthy lifestyle.[143] The authors concluded that those placing high value on a “hedonistic” value like excitement do not place as much importance on more utilitarian values and behaviors. It’s possible these parents are more likely to ascribe to the idea that natural risks—sins of omission—are more allowable than perceived “unnatural” risks—sins of commission—associated with vaccination because of a perception of immunization to be a utilitarian and cookie-cutter approach to maintaining health rather than one personalized to their lifestyle. This may also be reflected in the importance of self-respect to these groups. Thompson et al. concluded that those ascribing to natural health values often referenced the pursuit of thoughtful choice and mindfulness in their health decisions and not going with the status quo simply because it was what was expected.[144] Parents refusing Hib may consider their ability to execute their own ideas on health and protect their children from disease to be a reflection of themselves, thus tying it to their feelings of self-respect. Conversely, increased importance of warm relationships with others in daily life was associated with increased uptake of both MMR and RV, suggesting that relationships to those around them have an influence on their lives, and the types of relationships they have and foster may also influence their vaccine decision-making. Placing increased importance on self-fulfillment in daily life was also associated with increased Hib uptake. Thompson et al. also noted that self-fulfillment can take many forms depending upon the group being discussed, making the meaning of this finding difficult to ascertain with any degree of certainty.[144]

Differences in vaccine behavior between older and younger children may be due to negative experiences with older children or a change in attitude since the birth of their younger child or children. Understanding how parents’ attitudes towards vaccines change between children could provide opportunities for interventions to curb delay or refusal. For MMR, parents who reported being “less comfortable with vaccines” with their youngest child than they were with previous children were expectedly less likely to report MMR vaccination for their youngest child. Reasons for this change are likely varied, but Stockwell et al. previously observed that parents who reported a negative vaccination experience were twice as likely to have an underimmunized child.[80] This negative experience was attributable to the child’s reaction, time spent waiting, and interactions with practice staff, reinforcing that parents’ reasons for changing level of comfort with vaccines are variable. Additionally, Gust et al. observed that MMR was the second highest ranked vaccine of those causing the most doubt among all parents, so it is likely that this vaccine may be more susceptible to changing comfort levels than other vaccines.[67]

Parents reporting increased agreement with the statement that they “like thinking about vaccine decisions” were less likely to report RV receipt than parents who agreed less with this statement. It is likely that this captures a discrepancy in the amount of consideration non-hesitant parents give to vaccination compared to parents who may be hesitant about RV specifically. This also suggests that parents who think about vaccine decisions prior to health care visits are less likely to vaccinate, concurring with previous studies that show that advanced planning decreased likelihood of vaccination.[76 85] This item was also associated with MMR and Hib receipt in bivariate analysis, suggesting that this plays a role to some degree in the thought process of all vaccine hesitant parents but other factors may modulate this effect.

There were several key limitations to this study to note. First, the study sample was not known to be nationally representative, though the invited participants were selected by Qualtrics in a manner that approximates the US population. Additionally, from the invited study participants, a response rate of only 59% was observed. This response rate may have led to bias in our study sample due to differences between participating and non-participating parents. Each vaccine analysis also excluded a number of responses due to age-ineligibility and “I don’t know” answers regarding vaccine receipt. Age-ineligibility most noticeably affected MMR and Var models due to their administration in the second year of life. “I don’t know answers” excluded a varying proportion of otherwise eligible responses, which may have led to bias in the multivariate models. Relying on self-report for vaccination status also invites potential bias in the study. Recall bias, as noted in the variable number of “I don’t know” responses and otherwise directly unobservable in the responses, could contribute to discrepancies in vaccine uptake between our studies and national estimates of vaccine uptake. Studies of self-reported status compared to medical records have demonstrated that self-report is not always reliable.[145 146] The study also cannot differentiate between vaccine delay and refusal, which could contribute differences between these groups that were unobservable. Additionally, social desirability bias may have influenced answers to many questions in the survey, but the anonymity of the survey may have mediated this effect.

To accommodate for some variability in dates of receipt that may occur due to appointment scheduling or other reasons, some flexibility was incorporated in to the recommended age window, allowing for slightly early vaccinations. This could have included some incorrectly reported vaccination when the child had not been vaccinated yet. Other questions included in the survey but not considered for this analysis may have also mediated vaccine uptake. Finally, due to sparse data for certain parental insurance coverage groups, quasi-complete separation of data points was observed in the MMR and RV multivariate models. This prevented the estimation of effect for these particular groups, but the variable was left in the model due to the likely important influence of the other categories it contains. Leaving the variable in the model has been supported by previous considerations of the effects of quasi-complete separation on logistic regression models.[147] Still, leaving this variable in these models may have introduced some bias in the estimates.

This study demonstrates that factors influencing receipt are individually varied, but when comparing vaccines, overall patterns emerge. Vaccine information sources are highly influential for all vaccines studied, particularly social media, which was consistently associated with very low likelihood of parent reported vaccine receipt. Additionally, information sources that are part of close social networks such as friends, family, and religious leaders all influenced vaccine receipt of at least one of the vaccines studied. The role of these close social ties in mediating vaccine receipt should not be discounted, and future interventions for these vaccines should consider the role of these groups in message targeting. Known barriers to immunization were observed, reinforcing that current efforts have not been sufficient to eliminate them. Key demographics characteristics associated with vaccine delay and refusal were also present as mediators of vaccine receipt, which highlights the continued presence of vaccine delaying and refusing parents nationwide. Future studies should observe trends across the wider childhood schedule to see if these patterns hold true for other categories of vaccines.

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**Table 1.** Selected study participant characteristics

| | n (%) (N=886) |
|---|---|
| Youngest child's age | |
| < 1 year | 160 (18.1%) |
| 1 - <2 years | 157 (17.7%) |
| 2 - <7 years | 569 (64.2%) |
| Parent's age | |
| 18 -24 | 121 (13.7%) |
| 25 - 34 | 518 (58.5%) |
| 35 - 44 | 200 (22.6%) |
| 45 - 54 | 44 (5.0%) |
| 55+ | 3 (0.3%) |
| Parent gender | |
| Female | 725 (81.8%) |
| Hispanic | |
| Yes | 109 (12.3%) |
| Race | |
| White | 693 (78.2%) |
| Black | 94 (10.6%) |
| Asian | 36 (4.1%) |
| Other | 33 (3.7%) |
| Mixed race | 30 (3.4%) |
| Income | |
| $60,000 or less | 530 (59.8%) |
| $60,001 to $80,000 | 216 (24.4%) |
| $100,001 or more | 140 (15.8%) |
| Parent's insurance coverage | |
| Private only | 415 (46.8%) |
| Public only | 376 (42.4%) |
| Private and public | 25 (2.8%) |
| Don't know | 9 (1.0%) |
| None | 61 (6.9%) |
| Child's insurance coverage | |
| Private only | 367 (41.4%) |
| Public only | 469 (52.9%) |
| Private and public | 26 (2.9%) |
| Don't know | 10 (1.1%) |
| None | 14 (1.6%) |
| US Census Region | |
| Northeast | 168 (19.0%) |
| South | 380 (42.9%) |
| Midwest | 194 (21.9%) |
| West | 143 (16.1%) |
| US Territories or Virgin Islands | 1 (0.1%) |
| Community Type | |

| | |
|---|---|
| Urban | 292 (33.0%) |
| Suburban | 392 (44.2%) |
| Rural | 202 (22.8%) |
| Number of Children in household | |
| 1 | 378 (42.7%) |
| 2 | 313 (35.3%) |
| 3 | 131 (14.8%) |
| 4 | 47 (5.3%) |
| 5+ | 17 (1.9%) |
| Parent's marital status | |
| Single/not married | 192 (21.7%) |
| Married/domestic partner/widowed | 641 (72.4%) |
| Divorced/separated | 53 (6.0%) |
| Parent's education | |
| High school or less | 195 (22.0%) |
| Some college | 185 (20.9%) |
| Technical school/Associate's degree | 163 (18.4%) |
| Bachelor's degree | 237 (26.8%) |
| Master's degree or higher | 106 (12.0%) |

**Table 2.** Self-reported recommended childhood vaccine series initiation in age-eligible children

| Vaccine | Model-eligible n (%) | Received n (%) | Did not receive n (%) | Don't know n (%) |
|---|---|---|---|---|
| Measles, Mumps, Rubella (MMR) | 737 (83.2%) | 662 (89.8%) | 43 (5.8%) | 32 (4.3%) |
| H. influenzae type B (Hib) | 870 (98.2%) | 646 (74.3%) | 90 (10.3%) | 134 (15.4%) |
| Pneumococcal disease (PCV) | 870 (98.2%) | 557 (64.0%) | 156 (17.9%) | 157 (18.0%) |
| Rotavirus (RV) | 870 (98.2%) | 670 (77.0%) | 74 (8.5%) | 126 (14.5%) |
| Varicella (Var) | 737 (83.2%) | 593 (80.5%) | 78 (10.6%) | 66 (9.0%) |

**Table 3.** Proportion of recommended childhood vaccine series initiated for model-eligible responses

| Vaccine | Received<br>n (%) | Did not receive<br>n (%) |
|---|---|---|
| Measles, Mumps, Rubella (MMR) | 662 (93.9%) | 43 (6.1%) |
| H. influenzae type B (Hib) | 646 (87.8%) | 90 (12.2%) |
| Pneumococcal disease (PCV) | 557 (78.1%) | 156 (21.9%) |
| Rotavirus vaccine (RV) | 670 (90.1%) | 74 (9.9%) |
| Varicella (Var) | 593 (88.4%) | 78 (11.6%) |

**Table 4.** Vaccine uptake by statistically significant bivariate and multivariate predictors

| | Received vaccine n (%) |
|---|---|
| **Measles, Mumps, Rubella vaccine** | |
| Vaccine importance group‡ | |
| Low to moderate | 106 (80.9%) |
| High | 231 (97.1%) |
| Very high | 325 (96.7%) |
| Vaccine info source: doctor* | |
| Yes | 618 (94.5%) |
| No | 44 (86.3%) |
| Vaccine info source: family† | |
| Yes | 89 (97.8%) |
| No | 573 (93.3%) |
| Vaccine info source: social media‡ | |
| Yes | 9 (69.2%) |
| No | 653 (94.4%) |
| Values in daily life: excitement† | |
| Very important/important | 478 (93.5%) |
| Not at all important/slightly important/moderately important | 184 (94.8%) |
| Values in daily life: warm relationships with others‡ | |
| Very important/important | 596 (94.5%) |
| Not at all important/slightly important/moderately important | 66 (89.2%) |
| Values in daily life: self-fulfillment* | |
| Very important/important | 573 (94.7%) |
| Not at all important/slightly important/moderately important | 89 (89.0%) |
| Like thinking about vaccine decisions* | |
| Strongly agree/agree | 254 (90.1%) |
| Strongly disagree/disagree/neutral | 408 (96.5%) |
| Parent's insurance coverage‡ | |
| None | 38 (88.4%) |
| Private only | 330 (96.2%) |
| Public only | 267 (91.8%) |
| Private and public | 20 (100.0%) |
| Don't know | 7 (87.5%) |
| Change in vaccine comfort level between children‡ | |
| Only have one child | 138 (93.9%) |
| More comfortable with younger child | 143 (91.1%) |
| Less comfortable with younger child | 37 (82.2%) |
| Never comfortable with vaccines | 55 (91.7%) |
| Always comfortable with vaccines | 289 (97.6%) |

| | |
|---|---|
| Child's insurance coverage* | |
| None | 7 (87.5%) |
| Private only | 296 (96.4%) |
| Public only | 335 (92.3%) |
| Private and public | 19 (95.0%) |
| Don't know | 5 (71.4%) |
| Parent sex* | |
| Male | 125 (88.0%) |
| Female | 537 (95.4%) |
| **Haemophilus influenzae type B vaccine** | |
| Vaccine importance group‡ | |
| Low to moderate | 81 (61.8%) |
| High | 219 (90.5%) |
| Very high | 346 (95.3%) |
| Vaccine info source: doctor* | |
| Yes | 605 (88.7%) |
| No | 41 (75.9%) |
| Vaccine nfo source: academic journal† | |
| Yes | 63 (91.3%) |
| No | 583 (87.4%) |
| Vaccine info source: internet‡ | |
| Yes | 94 (78.3%) |
| No | 552 (89.6%) |
| Values in daily life: self-fulfillment‡ | |
| Very important/important | 558 (88.3%) |
| Not at all important/slightly important/moderately important | 88 (84.6%) |
| Values in daily life: self-respect† | |
| Very important/important | 594 (87.6%) |
| Not at all important/slightly important/moderately important | 52 (89.7%) |
| Like thinking about vaccine decisions* | |
| Strongly agree/agree | 250 (84.2%) |
| Strongly disagree/disagree/neutral | 396 (90.2%) |
| Prefer to do own research about vaccines* | |
| Strongly agree/agree | 283 (85.2%) |
| Strongly disagree/disagree/neutral | 363 (89.9%) |
| Child's insurance coverage‡ | |
| None | 6 (54.6%) |
| Private only | 279 (89.1%) |
| Public only | 337 (87.8%) |
| Private and public | 20 (90.9%) |
| Don't know | 4 (66.7%) |

| | |
|---|---|
| Race† | |
| White | 514 (88.6%) |
| Black | 59 (79.7%) |
| Asian | 31 (93.9%) |
| Other | 21 (87.5%) |
| Mixed race | 21 (84.0%) |
| Income‡ | |
| $60,000 or less | 398 (90.5%) |
| $60,001 to $100,000 | 138 (81.2%) |
| $100,001 or more | 110 (87.3%) |
| Parent works in healthcare field* | |
| Yes | 80 (81.6%) |
| No | 566 (88.7%) |
| Parent sex* | |
| Male | 109 (81.3%) |
| Female | 537 (89.2%) |
| **Pneumococcal Conjugate Vaccine** | |
| Vaccine importance group‡ | |
| Low to moderate | 56 (43.1%) |
| High | 180 (77.9%) |
| Very high | 321 (91.2%) |
| Vaccine info source: family† | |
| Yes | 78 (82.1%) |
| No | 479 (77.5%) |
| Vaccine info source: friends and/or other parents‡ | |
| Yes | 58 (66.7%) |
| No | 499 (79.7%) |
| Change in vaccine comfort level between children* | |
| Only have one child | 111 (75.0%) |
| More comfortable with younger child | 130 (80.8%) |
| Less comfortable with younger child | 32 (61.5%) |
| Never comfortable with vaccines | 51 (79.7%) |
| Always comfortable with vaccines | 233 (80.9%) |
| Parent marital status* | |
| Single/not married | 112 (71.8%) |
| Married/domestic partner/widowed | 416 (80.6%) |
| Divorced/separated | 29 (70.7%) |
| Parent's age* | |
| 18 -24 | 73 (76.8%) |
| 25 - 34 | 336 (80.4%) |
| 35 - 44 | 126 (77.8%) |

| | |
|---|---|
| 45+ | 22 (57.9%) |
| Income* | |
| $60,000 or less | 331 (78.6%) |
| $60,001 to $100,000 | 122 (72.2%) |
| $100,001 or more | 104 (84.6%) |
| **Rotavirus vaccine** | |
| Vaccine importance group‡ | |
| Low to moderate | 88 (66.7%) |
| High | 223 (90.7%) |
| Very high | 359 (98.1%) |
| Vaccine info source: doctor* | |
| Yes | 629 (91.2%) |
| No | 41 (75.9%) |
| Vaccine info source: religious leaders† | |
| Yes | 8 (80.0%) |
| No | 662 (90.2%) |
| Vaccine info source: social media‡ | |
| Yes | 9 (64.3%) |
| No | 661 (90.6%) |
| Vaccine info source: internet* | |
| Yes | 103 (84.4%) |
| No | 567 (91.2%) |
| Values in daily life: warm relationships with others‡ | |
| Very important/important | 607 (91.0%) |
| Not at all important/slightly important/moderately important | 63 (81.8%) |
| Values in daily life: security* | |
| Very important/important | 627 (90.5%) |
| Not at all important/slightly important/moderately important | 43 (84.3%) |
| Values in daily life: self-fulfillment* | |
| Very important/important | 580 (90.3%) |
| Not at all important/slightly important/moderately important | 90 (88.2%) |
| Like thinking about vaccine decisions‡ | |
| Strongly agree/agree | 252 (84.6%) |
| Strongly disagree/disagree/neutral | 418 (93.7%) |
| Prefer to do own research about vaccines* | |
| Strongly agree/agree | 292 (87.2%) |
| Strongly disagree/disagree/neutral | 378 (92.4%) |
| Parent's insurance coverage† | |
| None | 42 (89.4%) |
| Private only | 325 (91.3%) |
| Public only | 272 (87.7%) |

| | |
|---|---|
| Private and public | 24 (100.0%) |
| Don't know | 7 (100.0%) |
| Child's insurance coverage‡ | |
| None | 7 (63.6%) |
| Private only | 289 (90.6%) |
| Public only | 344 (90.1%) |
| Private and public | 23 (95.8%) |
| Don't know | 7 (87.5%) |
| Income‡ | |
| $60,000 or less | 411 (92.6%) |
| $60,001 to $100,000 | 152 (85.4%) |
| $100,001 or more | 107 (87.7%) |
| Parent marital status‡ | |
| Single/not married | 127 (84.7%) |
| Married/domestic partner/widowed | 503 (91.3%) |
| Divorced/separated | 40 (93.0%) |
| Parent's education† | |
| High school or less | 144 (91.7%) |
| Some college | 142 (90.5%) |
| Technical school/Associate's degree | 128 (94.8%) |
| Bachelor's degree | 173 (85.2%) |
| Master's degree or higher | 83 (90.2%) |
| Parent sex* | |
| Male | 111 (83.5%) |
| Female | 559 (91.5%) |
| Community Type‡ | |
| Urban | 216 (87.1%) |
| Suburban | 295 (89.9%) |
| Rural | 159 (94.6%) |
| Number of children in household‡ | |
| 1 | 266 (85.8%) |
| 2 | 244 (92.1%) |
| 3 | 109 (98.2%) |
| 4 | 39 (88.6%) |
| 5+ | 12 (85.7%) |
| **Varicella Vaccine** | |
| Vaccine importance group‡ | |
| Low to moderate | 83 (67.5%) |
| High | 203 (91.9%) |
| Very high | 307 (93.9%) |
| Vaccine info source: doctor* | |

| | |
|---|---|
| Yes | 555 (89.1%) |
| No | 38 (79.2%) |
| Vaccine info source: social media‡ | |
| Yes | 9 (69.2%) |
| No | 584 (88.8%) |
| Vaccine info source: internet* | |
| Yes | 79 (81.4%) |
| No | 514 (89.6%) |
| Prefer to do own research about vaccines* | |
| Strongly agree/agree | 268 (86.5%) |
| Strongly disagree/disagree/neutral | 325 (90.0%) |
| Parent marital status‡ | |
| Single/not married | 125 (82.2%) |
| Married/domestic partner/widowed | 428 (89.7%) |
| Divorced/separated | 40 (95.2%) |

*significant in bivariate analysis ($p<0.05$)

†significant in multivariate analysis ($p<0.05$)

‡significant in both bivariate and multivariate analysis ($p<0.05$)

**Table 5.** Odds of vaccine receipt in bivariate and multivariate logistic regression models by vaccine

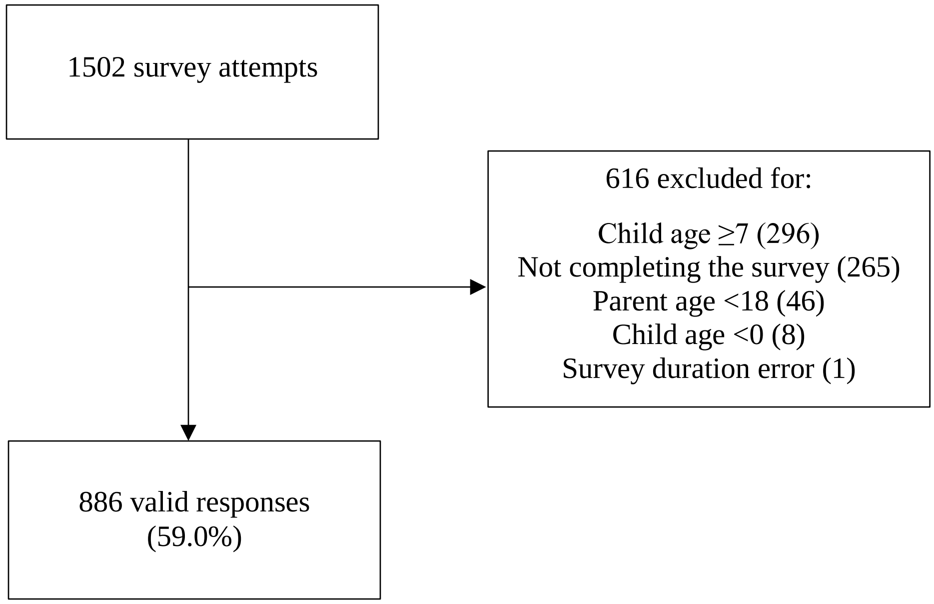
| | OR (95% CI) | aOR (95% CI) |
|---|---|---|
| **Measles, Mumps, Rubella vaccine** | | |
| Vaccine importance group | | |
| Low to moderate | ref | ref |
| High | **7.8 (3.26, 18.56)** | **6.0 (2.32, 15.72)** |
| Very high | **7.0 (3.32, 14.64)** | **7.6 (3.16, 18.42)** |
| Vaccine info source: family | 3.2 (0.76, 13.40) | **5.1 (1.05, 24.31)** |
| Vaccine info source: social media | **0.13 (0.040, 0.456)** | **0.12 (0.021, 0.632)** |
| Values: excitement | 0.81 (0.563, 1.16) | **0.50 (0.307, 0.812)** |
| Values: warm relationships with others | **1.6 (1.14, 2.30)** | **2.5 (1.51, 4.00)** |
| Parent's insurance coverage | | |
| None | ref | ref |
| Private only | **3.3 (1.13, 9.88)** | **6.5 (1.66, 25.08)** |
| Public only | 1.5 (0.53, 4.07) | 2.3 (0.64, 8.37) |
| Private and public* | - | - |
| Don't know | 0.92 (0.09, 9.13) | 1.3 (0.10, 16.48) |
| Comfort level with vaccines between children | | |
| Only have one child | ref | ref |
| More comfortable with younger child | 0.7 (0.28, 1.59) | 0.7 (0.23, 2.16) |
| Less comfortable with younger child | **0.3 (0.11, 0.84)** | **0.2 (0.07, 0.87)** |
| Never comfortable | 0.7 (0.23, 2.24) | 1.2 (0.30, 4.57) |
| Always comfortable | 2.7 (0.98, 7.38) | 1.8 (0.55, 5.86) |
| **Haemophilus influenzae type B vaccine** | | |
| Vaccine importance group | | |
| Low to moderate | ref | ref |
| High | **5.9 (3.37, 10.25)** | **6.0 (3.26, 11.14)** |
| Very high | **12.6 (6.89, 22.92)** | **13.1 (6.75, 25.54)** |
| Vaccine info source: academic journal | 1.5 (0.64, 3.60) | **4.2 (1.46, 12.13)** |
| Vaccine info source: internet | **0.4 (0.25, 0.70)** | **0.5 (0.27, 0.93)** |
| Values: self-fulfillment | **1.5 (1.15, 1.89)** | **1.8 (1.30, 2.54)** |
| Values: self-respect | 0.9 (0.60, 1.21) | **0.4 (0.27, 0.73)** |
| Child's insurance coverage | | |
| None | ref | ref |
| Private only | **6.8 (1.98, 23.61)** | **19.0 (3.26, 110.65)** |
| Public only | **6.0 (1.76, 20.35)** | **13.5 (2.43, 75.27)** |
| Private and public | **8.3 (1.28, 54.42)** | **18.0 (1.80, 179.94)** |
| Don't know | 1.7 (0.21, 13.22) | 2.0 (0.13, 31.38) |
| Race | | |
| White | ref | ref |

| | | |
|---|---|---|
| Black | **0.5 (0.27, 0.94)** | **0.3 (0.16, 0.71)** |
| Asian | 2.0 (0.47, 8.51) | 3.3 (0.60, 17.71) |
| Other | 0.9 (0.26, 3.10) | 0.8 (0.19, 2.97) |
| Mixed race | 0.7 (0.23, 2.02) | 0.8 (0.22, 2.88) |
| Income | | |
| $60,000 or less | 1.4 (0.75, 2.55) | **2.4 (1.17, 5.06)** |
| $60,001 to $100,000 | 0.6 (0.33, 1.20) | 0.6 (0.27, 1.24) |
| $100,001 or more | ref | ref |
| **Pneumococcal Conjugate Vaccine** | | |
| Vaccine importance group | | |
| Low to moderate | ref | ref |
| High | **4.7 (2.93, 7.43)** | **4.6 (2.86, 7.32)** |
| Very high | **13.7 (8.25, 22.70)** | **14.1 (8.39, 23.54)** |
| Vaccine info source: family | 1.3 (0.76, 2.33) | **2.2 (1.10, 4.21)** |
| Vaccine info source: friends and/or other parents | **0.5 (0.31, 0.83)** | **0.5 (0.26, 0.86)** |
| **Rotavirus vaccine** | | |
| Vaccine importance group | | |
| Low to moderate | ref | ref |
| High | **4.8 (2.77, 8.50)** | **4.1 (2.10, 7.92)** |
| Very high | **25.6 (11.14, 58.67)** | **46.3 (16.52, 129.65)** |
| Info source: religious leaders | 0.4 (0.09, 2.09) | **0.1 (0.01, 0.91)** |
| Info source: social media | **0.2 (0.06, 0.58)** | **0.1 (0.02, 0.40)** |
| Values: warm relationships with others | **1.6 (1.19, 2.10)** | **1.6 (1.07, 2.30)** |
| Like thinking about vaccine decisions | **0.7 (0.55, 0.84)** | **0.7 (0.49, 0.89)** |
| Parent's insurance coverage | | |
| None | ref | ref |
| Private only | 0.8 (0.30, 2.18) | 0.9 (0.10, 8.07) |
| Public only | 0.7 (0.42, 1.13) | **0.2 (0.04, 0.59)** |
| Private and public* | - | - |
| Don't know* | - | - |
| Child's insurance coverage | | |
| None | ref | ref |
| Private only | **0.2 (0.05, 0.66)** | 0.1 (0.01, 2.09) |
| Public only | 0.9 (0.57, 1.56) | 4.0 (0.98, 15.95) |
| Private and public | 2.4 (0.31, 18.37) | 1.2 (0.11, 13.06) |
| Don't know | 0.7 (0.09, 6.13) | 1.4 (0.11, 17.30) |
| Income | | |
| $60,000 or less | 1.7 (0.92, 3.33) | 2.3 (0.93, 5.92) |
| $60,001 to $100,000 | 0.8 (0.41, 1.61) | 0.8 (0.33, 2.00) |
| $100,001 or more | ref | ref |

| | | |
|---|---|---|
| Parent marital status | | |
| Single/not married | **0.5 (0.31, 0.90)** | **0.4 (0.19, 0.82)** |
| Married/domestic partner/widowed | ref | ref |
| Divorced/separated | 1.3 (0.38, 4.28) | 2.0 (0.42, 9.79) |
| Parent's education | | |
| High school or less | ref | ref |
| Some college | 0.9 (0.39, 1.86) | 1.1 (0.40, 2.89) |
| Technical school/Associate's degree | 1.7 (0.64, 4.27) | 3.1 (0.91, 10.31) |
| Bachelor's degree | 0.5 (0.26, 1.03) | 0.6 (0.24, 1.66) |
| Master's degree or higher | 0.8 (0.34, 2.03) | 2.1 (0.61, 6.91) |
| **Varicella Vaccine** | | |
| Vaccine importance group | | |
| Low to moderate | ref | ref |
| High | **5.4 (2.95, 10.03)** | **5.5 (2.97, 10.26)** |
| Very high | **7.4 (4.09, 13.29)** | **7.3 (4.03, 13.34)** |
| Info source: social media | **0.3 (0.09, 0.95)** | **0.2 (0.06, 0.86)** |
| Parent marital status | | |
| Single/not married | **0.5 (0.32, 0.89)** | **0.5 (0.30, 0.91)** |
| Married/domestic partner/widowed | ref | ref |
| Divorced/separated | 2.3 (0.54, 9.78) | 2.4 (0.54, 10.58) |

*ORs unavailable due to quasi-complete separation of data points

**Figure 1.** Study participation and exclusion criteria



## PUBLIC HEALTH IMPLICATIONS AND POSSIBLE FUTURE DIRECTIONS

Maintaining appropriately high levels of immunization not only benefits those vaccinated by protecting them from disease, but also protects those who cannot be vaccinated and reduces the financial and societal costs of diseases and outbreaks. An increase in parents choosing to delay or refuse vaccines could sufficiently lower vaccine coverage, at least locally, to provide opportunities for outbreaks that may lead to severe morbidity and mortality. By gaining a better understanding of parents who are vaccine-hesitant and those who delay and refuse vaccines, interventions designed to maintain or raise vaccination rates can be well-informed and evidence-based.

The results of this study indicate that the factors influencing vaccine receipt for the selected vaccines, and likely the other vaccines in the childhood schedule, are varied but have common themes. This underscores that a "one size fits all" approach will likely not be sufficient to successfully maintain or raise vaccine uptake and also suggests trends for further study and intervention. The sources that parents trust most to receive their vaccine information from are varied, but their consistent association with vaccine uptake highlights the importance of information-seeking behavior in parents' vaccine decision-making. The influence of information sources tied to social networks—face-to-face interactions or online—reinforces that interpersonal relationships hold large sway over how parents view vaccines, and finding ways to leverage these social connections to improve vaccine uptake will likely go a long way to reduce vaccine hesitancy. Information sources should continue to be a target of studies of vaccine hesitancy as well as interventions aimed to improve vaccine knowledge and understanding.

The ideological differences influencing vaccine acceptance are also key to understanding how to effectively communicate with those who may be vaccine hesitant. If these ideological differences vary significantly by vaccine, then it is key that messaging be tailored to these specific populations when talking about specific vaccines. Overall perceived vaccine importance will always be a key predictor of vaccine uptake, as parents who believe some or all vaccines are not important will be less likely to receive any vaccine, but understanding other values that may mediate this helps differentiate what may be influencing vaccine receipt. Valuing things such as self-fulfillment and warm relationships in daily life was associated with increased vaccine uptake, perhaps suggesting that these parents feel empowered and optimistic, leading them to be less distrustful and more confident in their relationships with others, including their physician. Parents who placed more value on excitement and self-respect in their daily lives were less likely to report vaccination, which may indicate that these parents are more concerned with personalized approaches to health care and feeling secure in their decisions.

Additionally, understanding sociodemographic differences in populations not receiving specific vaccines highlights both populations facing disparities in access and those choosing to delay or refuse vaccines. Understanding the vaccine behavior patterns of these two different groups is key to differentiating between those who face disparities and those who are hesitant or refusing vaccination. Groups facing barriers to vaccination for specific vaccines may not have been as apparent in studies of overall up-to-date status and vaccine acceptance. By differentiating which vaccines still show evidence of large disparities in access, these groups can be better targeted for interventions. Parents less accepting of one vaccine may be different than those not accepting other vaccines, and understanding what these groups look like and any similarities they might hold provides the opportunity to more specifically target messaging to these groups.

Future studies should observe trends across the wider childhood schedule to see if these patterns hold true for other categories of vaccines. Additionally, the study should be conducted on a larger sample with a nationally representative study sample to validate the trends seen in this study.

**Appendix 1.** Factors considered in vaccine acceptance model selection by topic

| Topic | | | | | |
|---|---|---|---|---|---|
| Top information sources[a] | Values[b] | Vaccine opinion formation[b] | Comfort level | Vaccine importance[c] | Demographics |
| Doctor | Sense of belonging | Like thinking a lot about vaccine decisions | Has your comfort level with vaccines changed between children? | MMR | Parent age |
| Community or school clinic | Excitement | Prefer to do own research | | Hib | # of children in household |
| Pharmacy | Warm relationships with others | Prefer detailed/in-depth answers to vaccine questions | | PCV | Census region |
| Friends and/or other parents | Self-fulfillment | | | IPV | Marital status |
| Family | Being well-respected | | | DTaP | Community type |
| Religious leader | Fun and enjoyment of life | | | HBV | Parent sex |
| News | Security | | | RV | Working in healthcare field |
| Media | Self-respect | | | Var | Hispanic ethnicity |
| Social media | A sense of accomplishment | | | HAV | Parent's insurance coverage |
| Internet | | | | 2015/16 Flu | Child's insurance coverage |
| Scientific journal | | | | 2016/17 Flu | Parent's race |

[a]Selected up to 3
[b]Likert-type items
[c]Condensed into a summary scale and categorized for ease of interpretation

Instructions: Please complete the following questions to reflect your opinions as accurately as possible and to answer questions to the best of your knowledge. Your information will be kept strictly confidential.

Q1 What is your youngest child's date of birth? (yyyy/mm/dd)

If What is your youngest child... Is Less Than 2010/10/20, Then Skip To End of Block

Q2 How old are you (years)?

If How old are you (years)? Is Less Than 18, Then Skip To End of Block

Q3 What is your gender?
- ❍ Female (1)
- ❍ Male (2)

Q4 Do you consider yourself to be of Hispanic origin or descent, such as Mexican, Mexican-American, Central American, South American or Puerto Rican, Cuban, or other Spanish-Caribbean background?
- ❍ Yes (1)
- ❍ No (2)

Q5 Please choose one or more of the following to describe your race (select all that apply):
- ❑ White (1)
- ❑ Black or African-American (2)
- ❑ American Indian (3)
- ❑ Asian (4)
- ❑ Native Hawaiian or other Pacific Islander (5)
- ❑ Other (6)

Q6 In what country/territory were you born?
- ❍ United States (1)
- ❍ Puerto Rico, Guam, U.S. Virgin Islands, or another U.S. territory (2)
- ❍ Country outside the U.S. (3)

Q7 In what country/territory was your youngest child born?
- ❍ United States (1)
- ❍ Puerto Rico, Guam, U.S. Virgin Islands, or another U.S. territory (2)
- ❍ Country outside the U.S. (3)

Q8 Please indicate the geographic region in which you live:

- Alabama (1)
- Alaska (2)
- Arizona (3)
- Arkansas (4)
- California (5)
- Colorado (6)
- Connecticut (7)
- Delaware (8)
- Florida (9)
- Georgia (10)
- Hawaii (11)
- Idaho (12)
- Illinois (13)
- Indiana (14)
- Iowa (15)
- Kansas (16)
- Kentucky (17)
- Louisiana (18)
- Maine (19)
- Maryland (20)
- Massachusetts (21)
- Michigan (22)
- Minnesota (23)
- Mississippi (24)
- Missouri (25)
- Montana (26)
- Nebraska (27)
- Nevada (28)
- New Hampshire (29)
- New Jersey (30)
- New Mexico (31)
- New York (32)
- North Carolina (33)
- North Dakota (34)
- Ohio (35)
- Oklahoma (36)
- Oregon (37)
- Pennsylvania (38)
- Rhode Island (39)
- South Carolina (40)
- South Dakota (41)
- Tennessee (42)
- Texas (43)
- Utah (44)
- Vermont (45)
- Virginia (46)
- Washington (47)
- Washington, D.C. (48)

- ❍ West Virginia (49)
- ❍ Wisconsin (50)
- ❍ Wyoming (51)
- ❍ U.S. territories and Virgin Islands (52)

Q9 Which of the following best describes the type of community you live in?
- ❍ Urban (1)
- ❍ Suburban (2)
- ❍ Rural (3)

Q10 In your household, how many children under the age of 18 years old do you make medical decisions for?
- ❍ 1 (1)
- ❍ 2 (2)
- ❍ 3 (3)
- ❍ 4 (4)
- ❍ 5 (5)
- ❍ 6 (6)
- ❍ 7 or more (7)

Q11 What type of health or medical insurance do you have (select all that apply):
- ❑ Private Insurance Plan (1) ____________________
- ❑ Medicare (2)
- ❑ Medicaid (3)
- ❑ Veteran (4)
- ❑ Another government benefit health care program (5)
- ❑ No health insurance (6)
- ❑ Do not know (7)

Q12 What type of health or medical insurance does your child(ren) have (select all that apply):
- ❑ Private Insurance Plan (1) ____________________
- ❑ Medicaid (2)
- ❑ State government benefit health care program (3)
- ❑ No health insurance (4)
- ❑ Do not know (5)

Q13 Where would you go to get a complete record of your child's immunization/vaccine history? (select all that apply)
- ❑ Primary care provider/Pediatrician/Family physician (1)
- ❑ I keep these records at home (2)
- ❑ State or Local Public Health Department (3)
- ❑ My child's school (4)
- ❑ Immunization Registry (information system providing full immunization records) (5)
- ❑ I don't know (6)
- ❑ Other (7) ____________________

Q14 Has your comfort level regarding all recommended vaccines for children changed between your older child(ren) and your youngest child?

- ❍ I feel more comfortable about vaccinating my youngest child than I did with my older child(ren). (1)
- ❍ I feel less comfortable about vaccinating my youngest child than I did with my older child(ren). (2)
- ❍ My approach has not changed. I have never felt comfortable about vaccinating my child(ren). (3)
- ❍ My approach has not changed. I have always felt comfortable about vaccinating my child(ren). (4)
- ❍ Not Applicable – I only have one child (5)

Instructions Please select the answer choice that best describes your knowledge of the vaccines your youngest child has received.

Q16

| | Yes, s/he has received this vaccine (1) | No, s/he has not received this vaccine (2) | Not sure if s/he has received this vaccine (3) |
|---|---|---|---|
| Whooping Cough (Diphtheria, Tetanus, and acellular Pertussis (DTaP)) (1) | ❍ | ❍ | ❍ |

Q17

| | Yes, s/he has received this vaccine (1) | No, s/he has not received this vaccine (2) | Not sure if s/he has received this vaccine (3) |
|---|---|---|---|
| Polio (1) | ❍ | ❍ | ❍ |

Q18

| | Yes, s/he has received this vaccine (1) | No, s/he has not received this vaccine (2) | Not sure if s/he has received this vaccine (3) |
|---|---|---|---|
| Hepatitis A (HAV) (1) | ❍ | ❍ | ❍ |

Q19

| | Yes, s/he has received this vaccine (1) | No, s/he has not received this vaccine (2) | Not sure if s/he has received this vaccine (3) |
|---|---|---|---|
| Hepatitis B (HBV) (1) | ❍ | ❍ | ❍ |

Q20

| | Yes, s/he has received this vaccine (1) | No, s/he has not received this vaccine (2) | Not sure if s/he has received this vaccine (3) |
|---|---|---|---|
| Hib (Haemophilus Influenzae type b) (1) | ❍ | ❍ | ❍ |

Q21

| | Yes, s/he has received this vaccine (1) | No, s/he has not received this vaccine (2) | Not sure if s/he has received this vaccine (3) |
|---|---|---|---|
| Rotavirus (RV) (1) | ❍ | ❍ | ❍ |

Q22

| | Yes, s/he has received this vaccine (1) | No, s/he has not received this vaccine (2) | Not sure if s/he has received this vaccine (3) |
|---|---|---|---|
| Flu (Influenza) – Last Season (2015/2016) (1) | ❍ | ❍ | ❍ |

Q23

| | Yes, s/he has received this vaccine (1) | No, s/he has not received this vaccine (2) | Not sure if s/he has received this vaccine (3) |
|---|---|---|---|
| Flu (Influenza) – Current Season (2016/2017) (1) | ❍ | ❍ | ❍ |

Q24

| | Yes, s/he has received this vaccine (1) | No, s/he has not received this vaccine (2) | Not sure if s/he has received this vaccine (3) |
|---|---|---|---|
| Measles, mumps, and rubella (MMR) (1) | ❍ | ❍ | ❍ |

Q25

| | Yes, s/he has received this vaccine (1) | No, s/he has not received this vaccine (2) | Not sure if s/he has received this vaccine (3) |
|---|---|---|---|
| Pneumonia (Pneumococcal (PCV)) (1) | ❍ | ❍ | ❍ |

Q26

| | Yes, s/he has received this vaccine (1) | No, s/he has not received this vaccine (2) | Not sure if s/he has received this vaccine (3) |
|---|---|---|---|
| Chickenpox (Varicella) (1) | ❍ | ❍ | ❍ |

Q27 In general, where do you get your child(ren) vaccinated?
- ❍ Primary care provider/Pediatrician/Family physician office (1)
- ❍ Community/Public Health clinic (2)
- ❍ Hospital (3)
- ❍ Pharmacy/retail clinics (e.g., CVS, Walgreens, Walmart, grocery store pharmacy) (4)
- ❍ School health clinic (5)
- ❍ Place of worship (6)
- ❍ Other (7) ____________________

Instructions Please rate your level of trust in each of the following items.

Q28

| | No Trust - 1 (1) | 2 (2) | 3 (3) | 4 (4) | Complete Trust - 5 (5) | Don't Know (6) | Don't Use (7) |
|---|---|---|---|---|---|---|---|
| Vaccine information and recommendations from my child(ren)'s doctor or health care provider (1) | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |

Q29

| | No Trust - 1 (1) | 2 (2) | 3 (3) | 4 (4) | Complete Trust - 5 (5) | Don't Know (6) | Don't Use (7) |
|---|---|---|---|---|---|---|---|
| Vaccine information from complementary/ alternative medicine sources (1) | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |

Q30

| | No Trust - 1 (1) | 2 (2) | 3 (3) | 4 (4) | Complete Trust - 5 (5) | Don't Know (6) | Don't Use (7) |
|---|---|---|---|---|---|---|---|
| Vaccine information from friends/other parents (1) | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |

Q31

| | No Trust - 1 (1) | 2 (2) | 3 (3) | 4 (4) | Complete Trust - 5 (5) | Don't Know (6) | Don't Use (7) |
|---|---|---|---|---|---|---|---|
| Vaccine information from family members (1) | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |

Q32

| | No Trust - 1 (1) | 2 (2) | 3 (3) | 4 (4) | Complete Trust - 5 (5) | Don't Know (6) | Don't Use (7) |
|---|---|---|---|---|---|---|---|
| Vaccine information suggested or identified by Internet search engines (1) | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |

Q33

| | No Trust - 1 (1) | 2 (2) | 3 (3) | 4 (4) | Complete Trust - 5 (5) | Don't Know (6) | Don't Use (7) |
|---|---|---|---|---|---|---|---|
| Vaccine information from health information sites (e.g., webpages, apps) (1) | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |

Q34

| | No Trust - 1 (1) | 2 (2) | 3 (3) | 4 (4) | Complete Trust - 5 (5) | Don't Know (6) | Don't Use (7) |
|---|---|---|---|---|---|---|---|
| Vaccine information from news sites (1) | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |

Q35

| | No Trust - 1 (1) | 2 (2) | 3 (3) | 4 (4) | Complete Trust - 5 (5) | Don't Know (6) | Don't Use (7) |
|---|---|---|---|---|---|---|---|
| Vaccine information from social media (e.g., Facebook, Twitter) (1) | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |

Q36

| | No Trust - 1 (1) | 2 (2) | 3 (3) | 4 (4) | Complete Trust - 5 (5) | Don't Know (6) | Don't Use (7) |
|---|---|---|---|---|---|---|---|
| Food & Drug Administration (FDA), the federal government agency that licenses vaccines (1) | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |

Q37

| | No Trust - 1 (1) | 2 (2) | 3 (3) | 4 (4) | Complete Trust - 5 (5) | Don't Know (6) | Don't Use (7) |
|---|---|---|---|---|---|---|---|
| Centers for Disease Control and Prevention (CDC), the federal government agency that makes recommendations about who should get licensed vaccines (1) | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |

Q38

| | No Trust - 1 (1) | 2 (2) | 3 (3) | 4 (4) | Complete Trust - 5 (5) | Don't Know (6) | Don't Use (7) |
|---|---|---|---|---|---|---|---|
| Federal government agencies responsible for monitoring the safety of recommended childhood vaccines (1) | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |

Q39

| | No Trust - 1 (1) | 2 (2) | 3 (3) | 4 (4) | Complete Trust - 5 (5) | Don't Know (6) | Don't Use (7) |
|---|---|---|---|---|---|---|---|
| Experts who make vaccines recommendations (1) | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |

Q40

| | No Trust - 1 (1) | 2 (2) | 3 (3) | 4 (4) | Complete Trust - 5 (5) | Don't Know (6) | Don't Use (7) |
|---|---|---|---|---|---|---|---|
| Scientists involved in developing and testing new vaccines (1) | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |

Q41

| | No Trust - 1 (1) | 2 (2) | 3 (3) | 4 (4) | Complete Trust - 5 (5) | Don't Know (6) | Don't Use (7) |
|---|---|---|---|---|---|---|---|
| Companies that make or produce the vaccines recommended for children (1) | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |

Q42

| | No Trust - 1 (1) | 2 (2) | 3 (3) | 4 (4) | Complete Trust - 5 (5) | Don't Know (6) | Don't Use (7) |
|---|---|---|---|---|---|---|---|
| Vaccine information from religious/faith organization(s) or leader(s) (1) | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |

Q43

| | No Trust - 1 (1) | 2 (2) | 3 (3) | 4 (4) | Complete Trust - 5 (5) | Don't Know (6) | Don't Use (7) |
|---|---|---|---|---|---|---|---|
| Vaccine information from magazines/ newspapers/radio/television (1) | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |

Q44

| | No Trust - 1 (1) | 2 (2) | 3 (3) | 4 (4) | Complete Trust - 5 (5) | Don't Know (6) | Don't Use (7) |
|---|---|---|---|---|---|---|---|
| Vaccine information from a celebrity or other public figure (1) | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |

Q45 Where do you get your most trusted information regarding childhood vaccines and their safety and effectiveness? (select your top three choices)

- ❑ Child(ren)'s Primary care provider/Pediatrician/Family physician (1)
- ❑ Community or school clinic (2)
- ❑ Pharmacy (3)
- ❑ Friends and/or other parents (4)
- ❑ Internet research (5)
- ❑ Academic journals (6)
- ❑ News Media (TV/radio/print news) (7)
- ❑ Media (TV/radio shows, etc.) (8)
- ❑ Family Members (9)
- ❑ Religious/Faith Leader(s) (10)
- ❑ Social Media (11)
- ❑ Other (12) ____________________

Instructions On a scale of 1 (strongly disagree) to 5 (strongly agree), please indicate how strongly you agree with the following statements about vaccines.

Q46

| | 1 - Strongly disagree (1) | 2 - Disagree (2) | 3 - Neutral (3) | 4 - Agree (4) | 5 - Strongly agree (5) |
|---|---|---|---|---|---|
| I generally don't have time to get my child vaccinated. (1) | ❍ | ❍ | ❍ | ❍ | ❍ |

Q47

| | 1 - Strongly disagree (1) | 2 - Disagree (2) | 3 - Neutral (3) | 4 - Agree (4) | 5 - Strongly agree (5) |
|---|---|---|---|---|---|
| I often find it difficult to find transportation to go get my child vaccinated. (1) | ❍ | ❍ | ❍ | ❍ | ❍ |

Q48

| | 1 - Strongly disagree (1) | 2 - Disagree (2) | 3 - Neutral (3) | 4 - Agree (4) | 5 - Strongly agree (5) |
|---|---|---|---|---|---|
| I am generally satisfied with the information available about vaccine safety. (1) | ❍ | ❍ | ❍ | ❍ | ❍ |

Q49

| | 1 - Strongly disagree (1) | 2 - Disagree (2) | 3 - Neutral (3) | 4 - Agree (4) | 5 - Strongly agree (5) |
|---|---|---|---|---|---|
| I am generally satisfied with the information available about vaccine effectiveness. (1) | ❍ | ❍ | ❍ | ❍ | ❍ |

Q50

| | 1 - Strongly disagree (1) | 2 - Disagree (2) | 3 - Neutral (3) | 4 - Agree (4) | 5 - Strongly agree (5) |
|---|---|---|---|---|---|
| Getting my child immunized generally costs too much money. (1) | ❍ | ❍ | ❍ | ❍ | ❍ |

Q51

| | 1 - Strongly disagree (1) | 2 - Disagree (2) | 3 - Neutral (3) | 4 - Agree (4) | 5 - Strongly agree (5) |
|---|---|---|---|---|---|
| I often worry that my child cannot deal with the pain from the needles used for vaccines. (1) | ❍ | ❍ | ❍ | ❍ | ❍ |

Instructions On a scale of 1 (strongly disagree) to 5 (strongly agree), please indicate how strongly you agree with the following statements.

Q52

| | 1 - Strongly disagree (1) | 2 - Disagree (2) | 3 - Neutral (3) | 4 - Agree (4) | 5 - Strongly agree (5) |
|---|---|---|---|---|---|
| I have someone I think of as my child's pediatrician or healthcare provider. (1) | ❍ | ❍ | ❍ | ❍ | ❍ |

Q53

| | 1 - Strongly disagree (1) | 2 - Disagree (2) | 3 - Neutral (3) | 4 - Agree (4) | 5 - Strongly agree (5) |
|---|---|---|---|---|---|
| When I was selecting a primary care provider/ pediatrician/family physician for my youngest child, I considered whether the provider would allow me to decide what vaccine schedule was best for my child. (1) | ❍ | ❍ | ❍ | ❍ | ❍ |

Q54

| | 1 - Strongly disagree (1) | 2 - Disagree (2) | 3 - Neutral (3) | 4 - Agree (4) | 5 - Strongly agree (5) |
|---|---|---|---|---|---|
| I generally trust my healthcare provider to tell me about both the risks and benefits of vaccines. (1) | ❍ | ❍ | ❍ | ❍ | ❍ |

Q55

| | 1 - Strongly disagree (1) | 2 - Disagree (2) | 3 - Neutral (3) | 4 - Agree (4) | 5 - Strongly agree (5) |
|---|---|---|---|---|---|
| My child’s primary care provider/pediatrician/family physician spends enough time with me to answer my questions about vaccines. (1) | ❍ | ❍ | ❍ | ❍ | ❍ |

Instructions On a scale of 1 (strongly disagree) to 5 (strongly agree) please indicate how strongly you agree with the following statements about vaccines.

Q56

| | 1 - Strongly disagree (1) | 2 - Disagree (2) | 3 - Neutral (3) | 4 - Agree (4) | 5 - Strongly agree (5) |
|---|---|---|---|---|---|
| Vaccines strengthen a child's immune system. (1) | ❍ | ❍ | ❍ | ❍ | ❍ |

Q57

| | 1 - Strongly disagree (1) | 2 - Disagree (2) | 3 - Neutral (3) | 4 - Agree (4) | 5 - Strongly agree (5) |
|---|---|---|---|---|---|
| Vaccines protect the community from harmful diseases. (1) | ❍ | ❍ | ❍ | ❍ | ❍ |

Q58

| | 1 - Strongly disagree (1) | 2 - Disagree (2) | 3 - Neutral (3) | 4 - Agree (4) | 5 - Strongly agree (5) |
|---|---|---|---|---|---|
| Vaccines protect my child against serious diseases. (1) | ❍ | ❍ | ❍ | ❍ | ❍ |

Instructions Which vaccine(s), if any, do you think are important for your child?

Q59

| | Yes, this vaccine is important for my child (1) | No, this vaccine is not important for my child (2) | Not sure (3) |
|---|---|---|---|
| Whooping Cough (Diphtheria, Tetanus, and acellular Pertussis (DTaP)) (1) | ❍ | ❍ | ❍ |

Q60

| | Yes, this vaccine is important for my child (1) | No, this vaccine is not important for my child (2) | Not sure (3) |
|---|---|---|---|
| Polio (1) | ❍ | ❍ | ❍ |

Q61

| | Yes, this vaccine is important for my child (1) | No, this vaccine is not important for my child (2) | Not sure (3) |
|---|---|---|---|
| Hepatitis A (HAV) (1) | ❍ | ❍ | ❍ |

Q62

| | Yes, this vaccine is important for my child (1) | No, this vaccine is not important for my child (2) | Not sure (3) |
|---|---|---|---|
| Hepatitis B (HBV) (1) | ❍ | ❍ | ❍ |

Q63

| | Yes, this vaccine is important for my child (1) | No, this vaccine is not important for my child (2) | Not sure (3) |
|---|---|---|---|
| Hib (Haemophilus Influenzae type b) (1) | ❍ | ❍ | ❍ |

Q64

| | Yes, this vaccine is important for my child (1) | No, this vaccine is not important for my child (2) | Not sure (3) |
|---|---|---|---|
| Rotavirus (RV) (1) | ❍ | ❍ | ❍ |

Q65

| | Yes, this vaccine is important for my child (1) | No, this vaccine is not important for my child (2) | Not sure (3) |
|---|---|---|---|
| Flu (Influenza) – Current Season (2016-2017) (1) | ❍ | ❍ | ❍ |

Q66

| | Yes, this vaccine is important for my child (1) | No, this vaccine is not important for my child (2) | Not sure (3) |
|---|---|---|---|
| Flu (Influenza) – Last Season (2015-2016) (1) | ❍ | ❍ | ❍ |

Q67

| | Yes, this vaccine is important for my child (1) | No, this vaccine is not important for my child (2) | Not sure (3) |
|---|---|---|---|
| Measles, mumps, and rubella (MMR) (1) | ❍ | ❍ | ❍ |

Q68

| | Yes, this vaccine is important for my child (1) | No, this vaccine is not important for my child (2) | Not sure (3) |
|---|---|---|---|
| Pneumonia (Pneumococcal (PCV)) (1) | ❍ | ❍ | ❍ |

Q69

| | Yes, this vaccine is important for my child (1) | No, this vaccine is not important for my child (2) | Not sure (3) |
|---|---|---|---|
| Chickenpox (Varicella) (1) | ❍ | ❍ | ❍ |

Instructions On a scale of 1 (strongly disagree) to 5 (strongly agree) please indicate how strongly you agree with the following statements about vaccines.

Q70

| | 1 - Strongly disagree (1) | 2 - Disagree (2) | 3 - Neutral (3) | 4 - Agree (4) | 5 - Strongly agree (5) |
|---|---|---|---|---|---|
| It is possible to get too many vaccines at once. (1) | ❍ | ❍ | ❍ | ❍ | ❍ |

Q71

| | 1 - Strongly disagree (1) | 2 - Disagree (2) | 3 - Neutral (3) | 4 - Agree (4) | 5 - Strongly agree (5) |
|---|---|---|---|---|---|
| I generally understand how vaccines work. (1) | ❍ | ❍ | ❍ | ❍ | ❍ |

Q72

| | 1 - Strongly disagree (1) | 2 - Disagree (2) | 3 - Neutral (3) | 4 - Agree (4) | 5 - Strongly agree (5) |
|---|---|---|---|---|---|
| I often worry that vaccines might cause short-term problems like fever or discomfort. (1) | ❍ | ❍ | ❍ | ❍ | ❍ |

Q73

| | 1 - Strongly disagree (1) | 2 - Disagree (2) | 3 - Neutral (3) | 4 - Agree (4) | 5 - Strongly agree (5) |
|---|---|---|---|---|---|
| I often worry that vaccines might cause long-term problems like seizure disorders. (1) | ❍ | ❍ | ❍ | ❍ | ❍ |

Q74

| | 1 - Strongly disagree (1) | 2 - Disagree (2) | 3 - Neutral (3) | 4 - Agree (4) | 5 - Strongly agree (5) |
|---|---|---|---|---|---|
| I often worry that vaccines are recommended more for money or business reasons than because of need. (1) | ❍ | ❍ | ❍ | ❍ | ❍ |

Q75

| | 1 - Strongly disagree (1) | 2 - Disagree (2) | 3 - Neutral (3) | 4 - Agree (4) | 5 - Strongly agree (5) |
|---|---|---|---|---|---|
| I generally think that vaccines for children are unsafe. (1) | ❍ | ❍ | ❍ | ❍ | ❍ |

Instructions On a scale of 1 (strongly disagree) to 5 (strongly agree), please indicate how strongly you agree with the following statements.

Q76

| | 1 - Strongly disagree (1) | 2 - Disagree (2) | 3 - Neutral (3) | 4 - Agree (4) | 5 - Strongly agree (5) |
|---|---|---|---|---|---|
| My friends would think I am a good person for getting my child(ren) vaccinated. (1) | ❍ | ❍ | ❍ | ❍ | ❍ |

Q77

| | 1 - Strongly disagree (1) | 2 - Disagree (2) | 3 - Neutral (3) | 4 - Agree (4) | 5 - Strongly agree (5) |
|---|---|---|---|---|---|
| It is important for everyone to get the recommended vaccines for their child(ren). (1) | ❍ | ❍ | ❍ | ❍ | ❍ |

Q78

| | 1 - Strongly disagree (1) | 2 - Disagree (2) | 3 - Neutral (3) | 4 - Agree (4) | 5 - Strongly agree (5) |
|---|---|---|---|---|---|
| Members of my family think it is important to get children vaccinated. (1) | ❍ | ❍ | ❍ | ❍ | ❍ |

Q79

| | 1 - Strongly disagree (1) | 2 - Disagree (2) | 3 - Neutral (3) | 4 - Agree (4) | 5 - Strongly agree (5) |
|---|---|---|---|---|---|
| I feel social pressure to get the recommended vaccines for my child(ren). (1) | ❍ | ❍ | ❍ | ❍ | ❍ |

Q80

| | 1 - Strongly disagree (1) | 2 - Disagree (2) | 3 - Neutral (3) | 4 - Agree (4) | 5 - Strongly agree (5) |
|---|---|---|---|---|---|
| Most people I know are getting their child(ren) vaccinated. (1) | ❍ | ❍ | ❍ | ❍ | ❍ |

Instructions On a scale of 1 (strongly disagree) to 5 (strongly agree), please indicate how strongly you agree with the following statements.

Q81

| | 1 - Strongly disagree (1) | 2 - Disagree (2) | 3 - Neutral (3) | 4 - Agree (4) | 5 - Strongly agree (5) |
|---|---|---|---|---|---|
| I like thinking a lot about vaccine decisions. (1) | ❍ | ❍ | ❍ | ❍ | ❍ |

Q82

| | 1 - Strongly disagree (1) | 2 - Disagree (2) | 3 - Neutral (3) | 4 - Agree (4) | 5 - Strongly agree (5) |
|---|---|---|---|---|---|
| I prefer to do my own research about vaccines rather than be told what to do or accept. (1) | ❍ | ❍ | ❍ | ❍ | ❍ |

Q83

| | 1 - Strongly disagree (1) | 2 - Disagree (2) | 3 - Neutral (3) | 4 - Agree (4) | 5 - Strongly agree (5) |
|---|---|---|---|---|---|
| I prefer detailed/in-depth answers to my questions about vaccines over simple ones. (1) | ❍ | ❍ | ❍ | ❍ | ❍ |

Instructions On a scale of 1 (strongly disagree) to 5 (strongly agree), please indicate how strongly you agree with the following statements.

Q84

| | 1 - Strongly disagree (1) | 2 - Disagree (2) | 3 - Neutral (3) | 4 - Agree (4) | 5 - Strongly agree (5) |
|---|---|---|---|---|---|
| I often give my opinions about childhood vaccines to other parents. (1) | ❍ | ❍ | ❍ | ❍ | ❍ |

Q85

| | 1 - Strongly disagree (1) | 2 - Disagree (2) | 3 - Neutral (3) | 4 - Agree (4) | 5 - Strongly agree (5) |
|---|---|---|---|---|---|
| I believe I influence other parents' opinions about childhood vaccines. (1) | ❍ | ❍ | ❍ | ❍ | ❍ |

Q86

| | 1 - Strongly disagree (1) | 2 - Disagree (2) | 3 - Neutral (3) | 4 - Agree (4) | 5 - Strongly agree (5) |
|---|---|---|---|---|---|
| Other parents turn to me for advice about child(ren)'s vaccines. (1) | ❍ | ❍ | ❍ | ❍ | ❍ |

Q87

| | 1 - Strongly disagree (1) | 2 - Disagree (2) | 3 - Neutral (3) | 4 - Agree (4) | 5 - Strongly agree (5) |
|---|---|---|---|---|---|
| I try to persuade other parents to get their child(ren) vaccinated. (1) | ❍ | ❍ | ❍ | ❍ | ❍ |

Instructions The following is a list of things that some people look for or want out of life. For each item please rate how important it is in your daily life, where 1=very unimportant and 5=very important.

Q88

| | 1 - Not at all Important (1) | 2 (2) | 3 (3) | 4 (4) | 5 - Very Important (5) |
|---|---|---|---|---|---|
| Sense of Belonging (1) | ❍ | ❍ | ❍ | ❍ | ❍ |

Q89

| | 1 - Not at all Important (1) | 2 (2) | 3 (3) | 4 (4) | 5 - Very Important (5) |
|---|---|---|---|---|---|
| Excitement (1) | ❍ | ❍ | ❍ | ❍ | ❍ |

Q90

| | 1 - Not at all Important (1) | 2 (2) | 3 (3) | 4 (4) | 5 - Very Important (5) |
|---|---|---|---|---|---|
| Warm relationships with others (1) | ❍ | ❍ | ❍ | ❍ | ❍ |

Q91

| | 1 - Not at all Important (1) | 2 (2) | 3 (3) | 4 (4) | 5 - Very Important (5) |
|---|---|---|---|---|---|
| Self-fulfillment (1) | ❍ | ❍ | ❍ | ❍ | ❍ |

Q92

| | 1 - Not at all Important (1) | 2 (2) | 3 (3) | 4 (4) | 5 - Very Important (5) |
|---|---|---|---|---|---|
| Being well respected (1) | ❍ | ❍ | ❍ | ❍ | ❍ |

Q93

| | 1 - Not at all Important (1) | 2 (2) | 3 (3) | 4 (4) | 5 - Very Important (5) |
|---|---|---|---|---|---|
| Fun and enjoyment of life (1) | ❍ | ❍ | ❍ | ❍ | ❍ |

Q94

| | 1 - Not at all Important (1) | 2 (2) | 3 (3) | 4 (4) | 5 - Very Important (5) |
|---|---|---|---|---|---|
| Security (1) | ❍ | ❍ | ❍ | ❍ | ❍ |

Q95

| | 1 - Not at all Important (1) | 2 (2) | 3 (3) | 4 (4) | 5 - Very Important (5) |
|---|---|---|---|---|---|
| Self-respect (1) | ❍ | ❍ | ❍ | ❍ | ❍ |

Q96

| | 1 - Not at all Important (1) | 2 (2) | 3 (3) | 4 (4) | 5 - Very Important (5) |
|---|---|---|---|---|---|
| A sense of accomplishment (1) | ❍ | ❍ | ❍ | ❍ | ❍ |

Instructions Please indicate your level of confidence in each item below about childhood vaccines for children ages 0 to 6 years.

Q97

| | I don't know (1) | 1 - Not confident at all (2) | 2 (3) | 3 (4) | 4 (5) | 5 - Very confident (6) |
|---|---|---|---|---|---|---|
| Vaccines recommended for young children are safe. (1) | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |

Q98

| | I don't know (1) | 1 - Not confident at all (2) | 2 (3) | 3 (4) | 4 (5) | 5 - Very confident (6) |
|---|---|---|---|---|---|---|
| Getting my child immunized is one of the best things to do to protect his/her health. (1) | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |

Q99

| | I don't know (1) | 1 - Not confident at all (2) | 2 (3) | 3 (4) | 4 (5) | 5 - Very confident (6) |
|---|---|---|---|---|---|---|
| Vaccines recommended for children are effective. (1) | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |

Q100

| | I don't know (1) | 1 - Not confident at all (2) | 2 (3) | 3 (4) | 4 (5) | 5 - Very confident (6) |
|---|---|---|---|---|---|---|
| The research done in humans to test new vaccines (clinical trials) result in safe and effective childhood vaccines. (1) | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |

Q101

| | I don't know (1) | 1 - Not confident at all (2) | 2 (3) | 3 (4) | 4 (5) | 5 - Very confident (6) |
|---|---|---|---|---|---|---|
| Vaccine advisory committees that advise the federal government make trustworthy recommendations. (1) | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |

Q102

| | I don't know (1) | 1 - Not confident at all (2) | 2 (3) | 3 (4) | 4 (5) | 5 - Very confident (6) |
|---|---|---|---|---|---|---|
| Vaccines prevent serious diseases. (1) | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |

Q103

| | I don't know (1) | 1 - Not confident at all (2) | 2 (3) | 3 (4) | 4 (5) | 5 - Very confident (6) |
|---|---|---|---|---|---|---|
| Not getting my child immunized increases his/her chances of getting a serious disease. (1) | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |

Q104

| | I don't know (1) | 1 - Not confident at all (2) | 2 (3) | 3 (4) | 4 (5) | 5 - Very confident (6) |
|---|---|---|---|---|---|---|
| My doctor or nurse is a trustworthy source for vaccine information. (1) | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |

Q105

| | I don't know (1) | 1 - Not confident at all (2) | 2 (3) | 3 (4) | 4 (5) | 5 - Very confident (6) |
|---|---|---|---|---|---|---|
| Vaccines protect children from diseases in the community. (1) | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |

Q106

| | I don't know (1) | 1 - Not confident at all (2) | 2 (3) | 3 (4) | 4 (5) | 5 - Very confident (6) |
|---|---|---|---|---|---|---|
| The companies that make vaccines produce safe and effective childhood vaccines. (1) | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |

Q107

| | I don't know (1) | 1 - Not confident at all (2) | 2 (3) | 3 (4) | 4 (5) | 5 - Very confident (6) |
|---|---|---|---|---|---|---|
| Vaccines are made with safe ingredients. (1) | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |

Q108

| | I don't know (1) | 1 - Not confident at all (2) | 2 (3) | 3 (4) | 4 (5) | 5 - Very confident (6) |
|---|---|---|---|---|---|---|
| My doctor or nurse has my child(ren)’s best interest in mind when making vaccine recommendations. (1) | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |

Q109 Please select your current relationship status:
- Single/Not Married (1)
- Divorced (2)
- Widowed (3)
- Married (4)
- Domestic Partner (5)
- Separated (6)

Q110 Describe your religious beliefs:
- Atheist/Agnostic (1)
- Buddhist (2)
- Protestant (3)
- Catholic (4)
- Orthodox (5)
- Mormon (6)
- Hindu (7)
- Jewish (8)
- Muslim (9)
- Spiritual, not religious (10)
- Other (11) ____________________

Q111 What is the highest level of education you have completed?
- K - 8th grade (1)
- 9th -11th grade (2)
- High school graduate/GED (3)
- Some college credit but no degree (4)
- Technical/Vocational or Associates degree (5)
- Bachelor's degree (6)
- Master's degree (7)
- Doctorate (e.g. MD, JD, PhD) (8)

Q112 Which of the following best describes your current employment status?
- Employed—full time (1)
- Employed—part-time (2)
- Self-employed (3)
- Homemaker (4)
- Student (5)
- Military (6)
- Unemployed and looking for work (7)
- Unemployed and not looking for work (8)
- Unable to work (9)
- Retired (10)
- Other (11) ____________________

Q113 Do you work in the healthcare field?
- Yes (1)
- No (2)

Q114 What is your annual household income (i.e., combined income of all members of your family)?

- Less than $20,000 (1)
- $20,001-$40,000 (2)
- $40,001-$60,000 (3)
- $60,001-$80,000 (4)
- $80,001-$100,000 (5)
- $100,001-$120,000 (6)
- $120,001-$140,000 (7)
- $140,001-$160,000 (8)
- $160,001-$180,000 (9)
- $180,001-$200,000 (10)
- $200,001 or more (11)