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Impact of Insurance Status on Childhood Immunization Uptake

Lindsey M. Webb

ABSTRACT

LINDSEY MARTIN WEBB

Impact of Insurance Status on Childhood Immunization Uptake

Economic barriers remain an obstacle to ensuring that children in the United States are protected against vaccine-preventable diseases. Disparities persist despite programs in place to alleviate them, such as the Vaccines for Children program, which provides free vaccines for eligible children. Using data from the 2010 National Immunization Survey, this study addresses whether insurance status has an impact on immunization uptake by investigating associations between vaccine receipt and insurance type, VFC eligibility, and insurance continuity. Logistic regression was performed using possible important factors suggested in the literature. Among children in the national sample, results showed strong associations between up-to-date immunization status and insurance type, VFC eligibility, and insurance continuity, suggesting that additional steps must be taken to alleviate disparities in vaccine receipt. Regression analysis showed child's age group, insurance continuity, and number of vaccine providers to be the strongest predictors of up-to-date status among children in the national sample.

Keywords: childhood immunization, insurance, NIS, vaccines, VFC

IMPACT OF INSURANCE STATUS ON CHILDHOOD IMMUNIZATION UPTAKE

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IMPACT OF INSURANCE STATUS ON CHILDHOOD IMMUNIZATION UPTAKE

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LIST OF ACRONYMS

ACIP	Advisory Committee on Immunization Practices
CDC	Centers for Disease Control and Prevention
CII	Childhood Immunization Initiative
DHHS	Department of Health and Human Services
DTaP	Diphtheria-Tetanus-acellular-Pertussis Vaccine
Hib	*Haemophilus Influenza* type B
IPV	Inactivated Polio Vaccine
MMR	Measles-Mumps-Rubella Vaccine
MMR-V	Measles-Mumps-Rubella-Varicella Vaccines
NCIRD	National Center for Immunizations and Respiratory Diseases
NCHS	National Center for Health Statistics
NIS	National Immunization Survey
OPV	Oral Live Attenuated Polio Vaccine
PCV	Pneumococcal Conjugate Vaccine
SCHIP	State Children's Health Insurance Program
UTD	Up-To-Date
VFC	Vaccines for Children Program
WIC	Special Supplemental Nutrition Program for Women, Infants, and Children

CHAPTER I

INTRODUCTION

1.1 Background

Since the development of the first vaccine over 200 years ago, immunizations have had a tremendous impact on human populations by greatly reducing the morbidity and mortality associated with infectious diseases. Of the diseases for which vaccines have been recommended for use in all children in the United States (US), smallpox has been eradicated, and polio caused by wild-type viruses has been eliminated from the Western Hemisphere. Others, including measles, rubella, and *Haemophilus influenzae* type b (Hib) have been reduced to just a few cases in children annually. For these reasons, vaccines have been called "one of the greatest achievements of biomedical science and public health (CDC, 1999)."

Immunizations in the United States

Despite the advances, however, vaccine-preventable diseases still occur in the United States, and several challenges remain in ensuring that children are protected against them. Healthy People 2020 lists increasing childhood immunization rates as one of its goals; specifically, to "achieve and maintain effective vaccination coverage levels for universally recommended vaccines among young children (DHHS)." Although national immunization coverage rates are high, it is important to overcome obstacles to ensuring that these rates remain as high as possible. Infectious diseases persist in many countries globally, and can be imported into the US, threatening unprotected persons (CDC, 1999).

For example, the US and other developed areas where measles was once eliminated have experienced a resurgence in cases of the disease due to declining immunization rates. The US has seen multiple outbreaks of measles in unvaccinated school-age children since 2008. In the first six months of 2008, the number of reported measles cases was 131; almost a 100 percent increase over the yearly average for previous years, despite the fact that the measles vaccine is required for most children entering public schools. Some of these cases were imported from other countries, but post-importation transmission accounted for most of the increase in cases over previous years (CDC, 2008a). Public health professionals must also consider ever-changing public views of vaccines, which range from supportive to fearful; and regulations and the expenses of creating and testing vaccines can cause pharmaceutical companies to eschew their development (Stern & Markel, 2005). Also, there are economic barriers to having children immunized, which means that children in poverty or without insurance are less likely than others to receive the full complement of recommended vaccines (Zimmerman, et al., 2006).

According to Healthy People 2020, some childhood immunization objective targets have been met for children 19 to 35 months of age, and the current goal is to maintain the target national immunization rates. Target rates have been reached for children having three doses of hepatitis B vaccine, one dose of the measles-mumps-rubella (MMR) vaccine, three doses of polio vaccine, and one dose of the varicella vaccine by age 19 to 35 months. Objective targets which still must be achieved include having four doses of the diphtheria-tetanus-acellular-pertussis (DTaP) vaccine, three doses of the Hib vaccine, four doses of the pneumococcal conjugate vaccine (PCV), two doses of the hepatitis A vaccine, and two or more doses of rotavirus vaccine by age 19 to 35 months; as well as a birth dose of the

hepatitis B vaccine. Although only 0.6 percent of children 19 to 35 months old in the US had received no doses of recommended vaccines in 2008, only 68 percent of children in that age group had received the full recommended doses of DTaP, polio, MMR, Hib, hepatitis B, PCV, and varicella vaccines (DHHS).

Insurance and Programs that Cover Vaccines

Health insurance in the US is usually either classified as public or private. Private insurance is considered to be that which is purchased through an employer or union, and those insurance plans purchased directly from an insurance company. Public health insurance programs are those sponsored by the government. These include Medicare, for people over 65 years old or disabled; Medicaid, a means-tested program for those with low income; the Indian Health Service, for American Indians and Alaska Natives; the Military Health System, for active duty and retired military members and their families; and the State Children's Health Insurance Program (SCHIP), which was created in 1997 and covers lower-income families whose incomes are too high to qualify for Medicaid.

The percentage of people covered by private insurance has been decreasing since 2001. Those with public health insurance programs rather than private insurance increased by almost 2 million people from 2009 to 2010; in 2010, 31% of Americans were covered by public health insurance. Despite these public insurance programs to assist those who are unable to have privately purchased insurance or health insurance plans through their employer, 16.3 percent of people in the US lack any kind of health insurance. Among children under age 18 in the US, 9.8 percent were uninsured in 2010, with the majority of uninsured children being those living in poverty (U.S. Census Bureau, 2010).

The Vaccines for Children (VFC) program, implemented in 1994 following the 1989-1991 US measles epidemic, provides free vaccines to health care providers for children who may not otherwise have access to vaccines. Children are eligible for the VFC program if they are Medicaid eligible, uninsured, American Indian or Alaska Native, or underinsured. The VFC program defines an underinsured child as "a child who has commercial (private) health insurance but the coverage does not include vaccines, a child whose insurance covers only selected vaccines, or a child whose insurance caps vaccine coverage at a certain amount (CDC, 2011a)".

1.2 Purpose of Study

It is important to maintain appropriate immunization rates. Without routine childhood immunization, morbidity and mortality caused by vaccine-preventable diseases would rise. Also associated with infectious diseases are lost productivity costs for parents and caretakers, and healthcare costs for families as well as health care providers (Chen, et al., 2011). In some areas of the world, a decline in immunization rates has led to the reemergence of infectious diseases, as has occurred with measles in Europe and pertussis in Japan (CDC, 2008a; CDC, 2011b). Maintaining appropriate vaccination rates also protects those children who are not old enough to receive vaccinations and those who cannot for medical reasons (CDC, 2008a).

Economic barriers remain an obstacle to ensuring that children are protected against vaccine-preventable diseases (Zimmerman, et al., 2006). In the United States, children in poverty are more likely to be uninsured (U.S. Census Bureau, 2010). Children living below the poverty line are also less likely to receive routine immunizations than

more affluent children, a trend that has persisted despite programs in place to alleviate the disparity (Zimmerman, et al., 2006; Smith, Stevenson, & Chu, 2006). As Medicaid has been available for quite some time for people with low income who are unable to purchase private insurance, this gap should be gradually closing. Additionally, the implementation of the Vaccines for Children program in 1994 and the State Children's Health Insurance Program in 1997 should be further alleviating the disparities in immunization coverage.

The purpose of this study is to address whether insurance status has an effect on immunization uptake, by investigating associations between vaccine receipt and insurance type, Vaccines for Children eligibility, and insurance continuity.

1.3 Research Questions

1. Is there an association between insurance type and immunization status?

2. Is there an association between Vaccines for Children eligibility and immunization status?

3. Is there an association between immunization status and continuity of health insurance?

4. Which of the selected factors, chosen based on the literature, are most important in determining up-to-date immunization status?

child's age group	child's race/ethnicity
mother's education	mother's marital status
household poverty status	insurance type
insurance continuity	number of vaccine providers

CHAPTER II

REVIEW OF THE LITERATURE
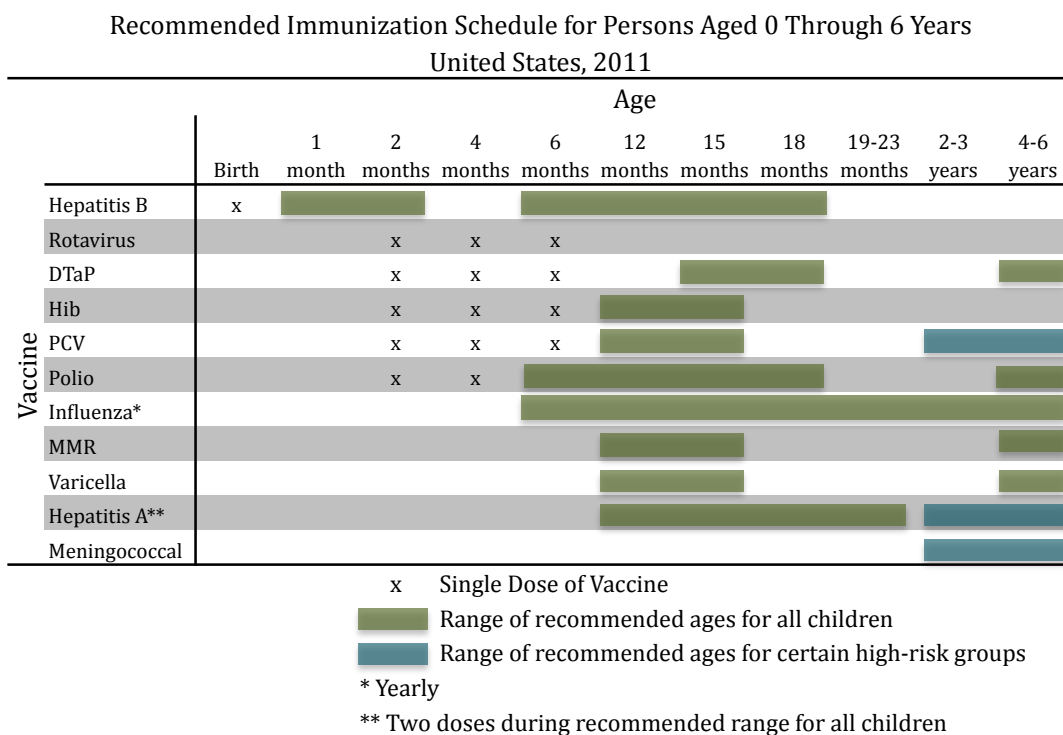
The purpose of this study is to address whether insurance status has an effect on immunization uptake. A review of the literature discusses recommended vaccines and immunization requirements, goals and progress to date on immunization rates, consequences of declining immunization rates, and possible barriers to immunization. Additional literature has investigated the relationship between insurance status and immunization uptake and has sought to determine the impact of the SCHIP and VFC programs.

2.1 Immunizations in the United States

In the United States, the government has been involved in immunizations since the 1800s with the use of the smallpox vaccine. In 1885, Massachusetts passed the first law in the US mandating vaccination of children in schools (CPP, 2011). Little more than one hundred years ago, the mortality rate for children under five years old was a staggering twenty percent; infectious diseases that are now vaccine-preventable were among the most common causes of child mortality. Today, many of these diseases have been contained in the US due to the use of vaccines and immunization requirements (Stern & Markel, 2005). Children are required to have received certain immunizations (or must apply for and receive an exemption) in order to be enrolled in public schools. Though the requirements differ slightly from state to state, most states generally use the childhood immunization schedule recommended by the Centers for Disease Control and Prevention [see table 1

(DHHS, 2011)] when mandating childhood vaccines (NVPO, 2011). Georgia, for example, requires proof of receipt of certain vaccines for children entering any day care facility; those enrolled in Head Start, the state pre-kindergarten program; and those enrolled in public elementary, middle, and high schools. Georgia does not, however, require children to have received the rotavirus, meningococcal, or influenza vaccines for school enrollment (National Network for Immunization Information, 2007).

Table 1. Recommended immunization schedule for persons aged 0 through 6 years, 2011 (DHHS, 2011)

Recommended Immunization Schedule for Persons Aged 0 Through 6 Years
United States, 2011

Vaccine	Birth	1 month	2 months	4 months	6 months	12 months	15 months	18 months	19-23 months	2-3 years	4-6 years
Hepatitis B	x										
Rotavirus			x	x	x						
DTaP			x	x	x						
Hib			x	x	x						
PCV			x	x	x						
Polio			x	x							
Influenza*											
MMR											
Varicella											
Hepatitis A**											
Meningococcal											

x   Single Dose of Vaccine

█ Range of recommended ages for all children

█ Range of recommended ages for certain high-risk groups

* Yearly

** Two doses during recommended range for all children

2.2 Vaccines, Goals and Progress

Healthy People, a set of 10-year national health objectives intended to encourage collaboration, inform health decisions, and measure the impact of prevention activities, has listed targets for immunization coverage rates in the US since its first publication, Healthy People 2000, in 1990 (DHHS). In the US, there are 17 infectious diseases for which vaccines are currently recommended; here the focus is on those pertaining to Healthy People 2020 immunization coverage targets for children aged 19 to 35 months. In 2008, 68 percent of children aged 19 to 35 months had received the recommended doses of the DTaP, polio, MMR, Hib, hepatitis B, varicella, and PCV vaccines; the goal is to increase this to 80 percent by 2020 (DHHS). However, coverage in the US was much higher for the older vaccines, such as the polio vaccine which has been in use for decades, than it was for more recently introduced vaccines such as varicella and for newer vaccine series (CDC, 1999).

Haemophilus Influenzae Type B

Haemophilus influenzae type b (Hib) is a bacterial disease that most often causes serious illness in children less than five years of age. Hib infection can lead to pneumonia, difficulty breathing due to swollen throat, and infections of the blood, joints, bones, and covering of the heart. Before the introduction of the disease, Hib was the leading cause of bacterial meningitis in young children in the US, which can lead to permanent impairments, such as hearing loss or mental retardation, and death. Hib is most commonly transmitted via the bacteria entering the respiratory system. Asymptomatic carriers of Hib can perpetuate transmission. Approximately 1,000 children per year died from complications of Hib infection before the introduction of the vaccine (CDC, 1998; Nelson & Williams,

2007). The Hib vaccine is given as a series of three or four shots, at the recommended ages of two months of age, four months of age, six months of age, and twelve to fifteen months of age. The vaccine is rarely given to individuals over five years of age (CDC, 1998). In Georgia, the Hib vaccine is required for entry into daycare and pre-kindergarten, but is not required for children entering any other grades in the public school system (National Network for Immunization Information, 2007).

Healthy People 2020 lists a goal of 90 percent of children in the US receiving three doses of the Hib vaccine by 19 to 35 months of age. In 2009, however, only 57 percent of children in this age group had received the recommended number of doses, so efforts must be continued and strengthened to achieve the objective (DHHS). Despite the relatively low immunization coverage, however, invasive Hib disease incidence in young children in the US has decrease by 99%, and it may be possible to eliminate endemic transmission of Hib in the country (Nelson & Williams, 2007).

Hepatitis A

Hepatitis A is a liver disease caused by the hepatitis A virus, which can be spread through contact with infected persons and eating food or drinking water contaminated with the virus. Hepatitis A can cause acute flu-like symptoms, jaundice, severe stomach pains and diarrhea; approximately one in five individuals with hepatitis A must be hospitalized (CDC, 2006a). There is no evidence that hepatitis A causes chronic illness. Severity is often inversely associated with age, but the hepatitis vaccine can confer long-term protection when two doses are given (Nelson & Williams, 2007).

The Healthy People 2020 goal for hepatitis A immunization is two doses of the vaccine for 60 percent of children by age 19 to 35 months. In 2008, only 40 percent of children in that age group had received two doses of the hepatitis A vaccine (DHHS).

Hepatitis B

Hepatitis B is a viral disease that affects the liver and can cause both acute and chronic illness. Acute symptoms include loss of appetite, fatigue, jaundice, diarrhea, vomiting, and muscle, joint, and stomach pain. Chronic symptoms include cirrhosis and liver cancer and can lead to death. Hepatitis B is transmitted through contact with infected blood or bodily fluids. In 2005, there were about 51,000 new hepatitis b infections, and approximately 1.25 million Americans have chronic hepatitis b; however, since routine immunization began in 1991, hepatitis b incidence has decreased by more than 95%. The hepatitis b vaccine is given as a series of three or four shots, the first of which should be given at birth and the last of which should be given by six to eighteen months of age. Those not given the vaccine during the recommended time frame should receive it as soon as possible (CDC, 2007).

The target immunization coverage rate is 90 percent for three doses of the hepatitis b vaccine by age 19 to 35 months. In 2008, 94 percent of children in that age range had received the recommended immunization; the Healthy People 2020 goal is to maintain this high rate of coverage. There is a second objective associated with hepatitis b immunization: a birth dose should be given to infants within three days of birth. The target

coverage rate for the birth dose is 85 percent; in 2005, just 51 percent of infants born in 2005 received the vaccine within three days (DHHS).

Measles-Mumps-Rubella

The measles-mumps-rubella (MMR) vaccine protects against the airborne viruses that cause the three diseases. Measles is a highly contagious respiratory disease that causes rash, cough, runny nose, and fever, and can lead to ear infections, pneumonia, seizures, encephalitis, blindness, and death. Mumps is characterized by fever and swollen glands, but can also lead to deafness, meningitis, encephalitis, orchitis, and death. Rubella, sometimes called German measles, causes rash and mild fever, and can cause congenital rubella syndrome (CRS) in infants whose mothers contract rubella while pregnant. CRS can lead to deafness and other birth defects (CDC, 2008d).

The Healthy People 2020 goal for MMR vaccine coverage is one dose for 90 percent of children in the 19 to 35 month age range. In 2008, 92 percent in that age group had received one dose of the MMR vaccine (DHHS). However, it has been noted that a minimum 95 percent measles immunization coverage rate is essential to ensure herd immunity against that disease. Therefore, it may become necessary to further increase coverage rates of the MMR vaccine in order to fully protect the population from measles (Nagaraj, 2006).

Pneumococcal Conjugate Vaccine

The pneumococcal conjugate vaccine (PCV) protects against infection with *Streptococcus pneumoniae* bacteria, which causes blood infections, meningitis, and

pneumonia. Pneumococcal infection is rare, but can cause severe morbidity and is fatal in

approximately ten percent of cases. There are more than 90 types of pneumococcal

bacteria; the current PCV, in use since 2000, offers immunity against 13 strains. The

previous PCV protected against seven types of pneumococcal bacteria; since the newer

vaccine was introduced, incidence of severe pneumococcal disease in children less than five

years of age decreased by almost 80 percent. PCV is intended to be given as a series of four

shots; one each at age two months, four months, six months, and twelve to fifteen months

(CDC, 2010a). The pneumococcal conjugate vaccine is generally given to infants, as very

young children are at the greatest risk of serious illness and death; risk of severe illness

decreases with increased age (DHHS).

The target immunization coverage for PCV is four doses by age 19 to 35 months for

90 percent of children in the US. In 2008, 80 percent of children in that age group had

received all four recommended doses of the vaccine (DHHS). As pneumococcal disease

most commonly affects children under five years of age, the vaccine is not always required

for entry into the public school system, but can be required for younger children enrolling

in daycare or pre-kindergarten programs (National Network for Immunization

Information, 2007).

Polio

The inactivated polio vaccine (IPV) protects against poliomyelitis, or polio, which is

caused by poliovirus. Polio can be asymptomatic or can lead to paralysis and death. After

the polio vaccine was introduced in 1955, incidence declined to the point that endemic

transmission of wild-type poliovirus was declared eliminated in the US in 1979 (CDC, 2000;

Nelson & Williams, 2007). Two polio vaccines exist, IPV and the oral live attenuated

vaccine (OPV), but only IPV is recommended for use in areas in which endemic polio

transmission has been eliminated. The polio vaccine is given as a series of four shots; one

each at age two months, four months, six to eighteen months, and a booster at four to six

years (CDC, 2000).

Healthy People 2020 lists a target immunization rate of 90 percent of children

receiving three doses of the polio vaccine by age 19 to 35 months; in 2008, 94 percent of

children in that age group had received the recommended number of doses (DHHS). High

immunization coverage must be maintained, as polio is still common in many parts of the

world, and can be imported into areas where endemic transmission no longer exists (CDC,

2000).

Rotavirus

Rotavirus is one of the most serious causes of diarrheal disease in young children.

Other symptoms include vomiting, fever, and dehydration. Before the introduction of the

rotavirus vaccine in 2006, almost all US children were infected with rotavirus before the

age of five. The rotavirus vaccine protects children against most cases of rotavirus, and

almost always prevents severe rotavirus illness. The vaccine is oral rather than injected,

and given as a series of either two of three doses, depending on the brand. A dose is

recommended at two months of age, four months of age, and six months of age if a third

dose is necessary (CDC, 2010b).

The Healthy People 2020 rotavirus goal is for at least 80 percent of children to

receive at least two doses of the rotavirus vaccine by age 19 to 35 months. In 2009,

approximately 38 percent of children in that age group had received the recommended

doses (DHHS). The relatively low immunization coverage could be at least partially

attributed to the recent introduction of the vaccine, as well as to the fact that the vaccine is

not mandated by all states (National Network for Immunization Information, 2007).

However, recent research has shown that immunization against rotavirus has greatly

reduced health care and treatment costs for diarrheal disease in young children in the US.

Vaccinated children were shown to have 44 to 58 fewer diarrhea-related hospitalizations

and 37 to 48 fewer related emergency department visits than children not vaccinated

against rotavirus. Researchers estimate that 65,000 diarrhea-related hospitalizations were

averted in the US from 2007 to 2009, saving about $278 million in health care costs (CDC,

2011c).

DTaP

The Diphtheria-Tetanus-acellular Pertussis (DTaP) vaccine protects against

infection with bacteria that cause tetanus, diphtheria, and pertussis. Pertussis, or

whooping cough, is spread from person to person and causes severe coughing spells,

vomiting, and disrupted sleep. The violent coughing can lead to weight loss, incontinence,

and rib fractures. Hospitalization is necessary in two to five percent of cases. Diphtheria

infection is spread from person to person and causes a thick covering to form in the back of

the throat, which can lead to breathing problems and paralysis, heart failure, and death.

Since the introduction of the diphtheria vaccine, cases have fallen by over 99.9 percent in

the US from a yearly average of about 175,000 cases to almost no cases. Tetanus, or

lockjaw, enters the body through open wounds and causes muscle spasms all over the

body, and can lead to extreme tightening of jaw muscles. Tetanus is fatal in about 20 percent of cases; however, incidence in the US has fallen by over 96 percent since the introduction of the vaccine. The DTaP vaccine is given as series of four shots between the ages of two and eighteen months. A booster shot is recommended for children aged four to six years (CDC, 2008c).

The Healthy People 2020 objective for DTaP coverage is 90 percent immunization of four doses of the vaccine by age 19 to 35 months; the current baseline coverage is 85 percent (DHHS). As pertussis, especially, again becomes more and more common in the US, it is important to achieve immunization coverage goals for the DTaP vaccine. Due to declining pertussis immunization rates in the 1970s and 1980s, and the reduced efficacy of the vaccine over time, pertussis incidence has been increasing in the US since about 1980 (Gregory, 2006).

Varicella

Varicella, or chicken pox, is caused by the varicella virus and is characterized by rash, itching, and fever. Before the vaccine was introduced, varicella was a common and often mild childhood illness. However, severe illness can occur, especially in infants and adults, leading to severe skin infection, scarring, pneumonia, brain damage, and death; about 100 people in the US died from varicella infection annually before the vaccine was introduced. Infection with varicella also puts one at risk for shingles much later in life. The varicella vaccine is given as a series of two injections, one each at 12 to 15 months of age and four to six years of age. Additionally, any person who is not fully vaccinated and has never had the chicken pox should be immunized. The varicella vaccine can also be

combined with the MMR vaccine in the measles-mumps-rubella-varicella (MMRV) vaccine (CDC, 2008b).

In 2008, 91 percent of children aged 19 to 35 months had received at least one dose of the varicella vaccine, surpassing the Healthy People 2020 goal of 90 percent immunization coverage (DHHS).

Others

The influenza and meningococcal vaccines are also listed in Table 1 as recommended for children up to the age of the six years. Infection with the influenza virus causes fever, chills, muscle aches, fatigue, cough, and headache. There are two types of influenza vaccine: the inactivated vaccine, given in a shot, and the attenuated vaccine, given in a nasal spray. As different influenza viruses may be active every year, the flu shot changes every year and it is recommended that children over the age of six months receive a dose of either form of the vaccine yearly (CDC, 2011e).
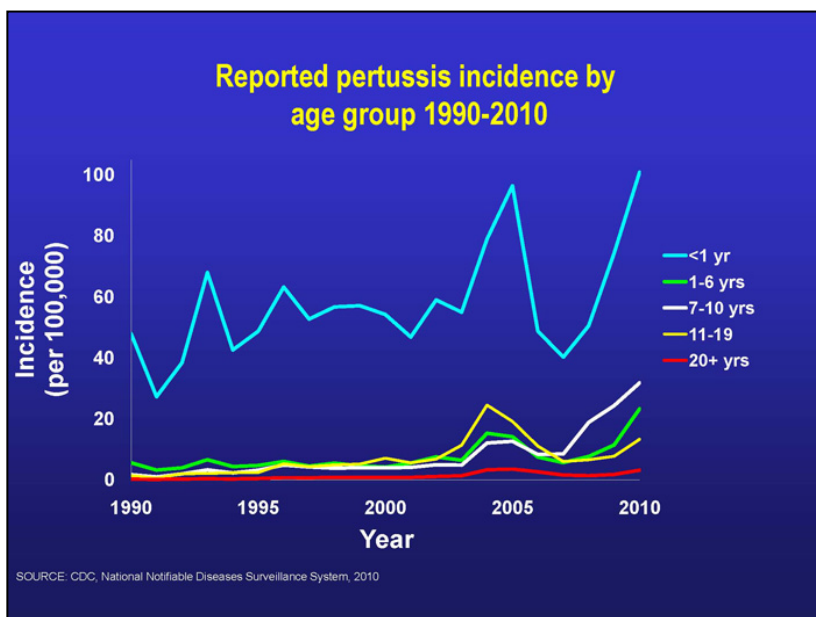
The meningococcal vaccine protects against four types of meningococcal bacteria, which infect the fluid surrounding the brain and spinal cord. Bacterial meningitis is fatal in approximately ten percent of cases. The meningococcal vaccine is recommended for children aged two to six years who fall into a high-risk category, such as those children without a spleen, or those traveling to areas in which bacterial meningitis is endemic (DHHS, 2011; CDC, 2011f).

2.3 Consequences of Unmet Goals

Declining immunization rates lead to increased health care costs as well as increased morbidity and mortality. The United States has experienced recent outbreaks of vaccine-preventable diseases including measles, pertussis, and mumps. In the case of pertussis, recent outbreaks have occurred in California, Michigan, and Ohio. Although immunization coverage seems to be relatively close to the target rate, pertussis can be difficult to diagnose and treat (Gregory, 2006; CDC, 2011d). Douglas notes that "pertussis is the only vaccine-preventable disease associated with increasing deaths in the United States, climbing from 4 deaths in 1996 to 17 in 2001, and occurring almost exclusively in infants younger than one year (Gregory, 2006)." In 2010, there were over 27,500 cases of pertussis in the US, with over 9,000 cases and ten infant deaths occurring in California. This was the worst outbreak of pertussis in California in over half a century. In adults, pertussis may be more difficult to recognize and diagnose, as coughs may not be accompanied by the "whooping" noise associated with the disease. As many as half of the cases seen in children were those in which the children were infected by their caregivers (CDC, 2011d; Falco, 2010). Therefore, as incidence of
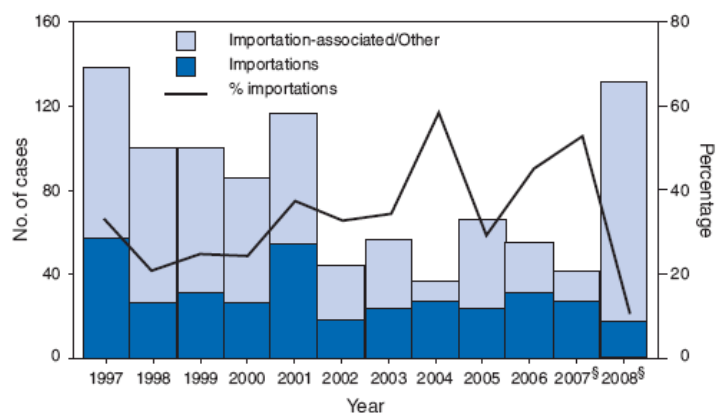
Figure 1. Reported pertussis incidence by age group, 1990-2010 (CDC, 2011g)

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childhood pertussis increases, especially among infants [see figure 1 (CDC, 2011g)], it is necessary to ensure that infants are properly immunized against pertussis by increasing coverage rates of the DTaP vaccine (CDC, 2011g).

The US has also seen a recent increase in measles cases, with 118 cases reported during the first six months of 2011; the highest number since 1996 before endemic transmission was declared eliminated in the country. 35 percent of the cases were in children under five years old. 40 percent of the cases required hospitalization; all but one of the hospitalized cases were completely unvaccinated, and the last had received only one dose of measles vaccine (CDC, 2011c). Approximately 95 percent immunization coverage is necessary to ensure herd immunity (Nagaraj, 2006). However, in 2008, only about 92 percent of children under the age of 35 months were appropriately vaccinated (DHHS); immunization rates have been considerably lower in other countries, leading to imported cases. Measles cases imported into the US can lead to many associated cases [see figure 2 (CDC, 2008a)]. These imported cases can also be extremely costly to the US; due to one imported case of measles in 2008, two Arizona hospitals spent $799,136 responding to the ensuing

Figure 2. Trend in cases of imported measles as a proportion of all measles cases, United States, 1997-July 2008 (CDC, 2008a)

* Measles infection acquired outside of the United States.
† Includes importation, importation-associated (acquired inside the United States but linked epidemiologically to an importation), and other (source unknown) measles cases.
§ Provisional; 2008 data are for January–July only.

outbreak of 14 confirmed cases (Chen, et al., 2011).

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Recent outbreaks of mumps have also occurred in the US. A 2006 outbreak involved more than 2,500 cases in eleven states, making it the largest outbreak in more than fifteen years. Most cases in this outbreak occurred in people aged 18 to 24 years; only about half of the cases had received the recommended two doses of mumps-containing vaccine. A comparison of two college campuses in one Iowa county affected by the outbreak revealed a higher attack rate for students at the college with lower MMR immunization coverage (CDC, 2006). In a more recent outbreak that began in 2009, one case imported from the United Kingdom led to over 1,500 cases in New York and New Jersey. Over 90 percent of cases occurred in children under six years of age. About 75 percent of cases had received the recommended two doses of mumps-containing vaccine; vaccination alone is not enough to prevent mumps from occurring in an individual, but very high immunization coverage can stop mumps transmission in a community and is the most effective way to prevent and control mumps outbreaks (CDC, 2010c). As mumps can often cause relatively mild illness, mumps vaccination is not generally considered a very high priority when compared to other immunizations, but the complications of mumps infection can have long-term consequences. For example, mumps orchitis is a risk factor for testicular cancer; more than one quarter of women in the first trimester of pregnancy who acquire mumps experience spontaneous abortion; mumps-associated pancreatitis may trigger the development of insulin-dependent diabetes mellitus in some affected individuals; and meningitis, the most common cause of mumps-related hospitalizations, occurs in about ten percent of cases. These complications can lead to increased morbidity and higher health care costs for providers, insurers, and patients (Galazka, Robertson, & Kraigher, 1999).

2.4 Immunization Barriers

Immunization barriers prevent some people from being vaccinated or having their children vaccinated against infectious diseases. These barriers may affect either the patients or the providers of vaccines. Deutchman et al. in 2000 found, in a study of providers, that rural parental barriers to immunizations for their children included cost, parental attitudes regarding vaccines, language barriers, and transportation and mobility issues. Many of these barriers are common in urban settings as well; most barriers are common across different geographical regions and areas (Deutchman, Brayden, Siegel, Beaty, & Crane, 2000). Cost of immunization and low socioeconomic status, especially, have long been known as common barriers to childhood immunization, for parents as well as providers, often preventing children living in poverty from receiving recommended immunizations (Zimmerman, et al., 2006; Smith, Stevenson, & Chu, 2006; Thomas, Kohli, & King, 2004). Systemic barriers to immunization, including transportation, are also commonly reported. Other parental barriers associated with incomplete childhood immunization include low maternal education, young maternal age, and large family size (Thomas, Kohli, & King, 2004).

Parental knowledge and attitudes regarding vaccines impact whether children receive recommended childhood immunizations (Stern & Markel, 2005; Thomas, Kohli, & King, 2004). Stern and Markel note that public reactions to vaccines have historically varied from amazement at the wonderful effects of vaccines to distrust and hostility and that "vaccines are powerful medical interventions that induce powerful biological, social, and cultural reactions (Stern & Markel, 2005)." Other studies have concluded that the most important parental barrier to immunization is preconceived attitudes and beliefs about

vaccines, and such beliefs can be a serious threat to the health of communities. Maternal education may contribute to attitudes as well; as better-educated parents may be more aware of the dangers of not immunizing and are more likely to follow immunization guidelines (Thomas, Kohli, & King, 2004). Additionally, vaccines may be victims of their own success; they have worked so well to prevent infectious disease, especially in developed countries, that the public no longer remembers the severity of many once-common diseases (Stern & Markel, 2005). One 1997 study reported that "in general, parents exhibited no understanding of the nature of the diseases immunizations protect against (McCormick, Bartholomew, Lewis, Brown, & Hanson, 1997)."

Parental attitudes regarding immunization are often affected by the media and sensational stories related to potential side-effects of vaccines (McCormick, Bartholomew, Lewis, Brown, & Hanson, 1997). Recent controversies over the safety of the MMR vaccine, for example, have led immunization coverage rates to falter in parts of the developed world (CDC, 2008a). A paper by Wakefield et al., later discovered to be fraudulent and based on unethical research, lead measles vaccination rates to fall from over 90 percent to about 70 percent in the United Kingdom with rates as low as 50 percent in some communities. The percentage of parents choosing not to have their children immunized rises along with the media output of similar sensationalist stories, regardless of their scientific basis (Smith, Ellenberg, Bell, & Rubin, 2008).

Provider barriers to immunization include poor record keeping, low reimbursement rates, vaccine storage issues, and failure to counsel parents and to immunize children at sick visits. Very few physicians report that immunization reimbursement rates are adequate, especially for those children with Medicaid (Zimmerman, et al., 2006).

Nonexistent or inaccessible immunization records can prevent parents from accessing immunization and providers from giving vaccines to children. Multiple relocations during a child's life are associated with incomplete immunization among immigrant children, suggesting that records are not being appropriately transferred from old to new providers. Additionally, providers should be immunizing children whenever possible and appropriate, such as during sick visits. Record keeping is further confused when patients are referred to alternate care locations for immunizations. Generally, immunizations are scheduled for well-child visits, but economic and transportation barriers may lead parents to skip physician appointments when their child is well (Deutchman, Brayden, Siegel, Beaty, & Crane, 2000). Parents have reported that sick-child care is more accessible and available than well-child care (McCormick, Bartholomew, Lewis, Brown, & Hanson, 1997). Therefore, "once these children are 'in the door', proper employment of the immunization practice standards should help improve immunization rates (Deutchman, Brayden, Siegel, Beaty, & Crane, 2000)." Research has also shown that while providers are generally knowledgeable about the safety and importance of immunizations, increased provider education would positively impact immunization uptake among children. Also, even when providers are very well-informed, this knowledge sometimes fails to translate into the clinical setting and does not necessarily result in higher immunization rates (Thomas, Kohli, & King, 2004).

Many providers may refer at least some patients to alternate sources of care – generally, public health departments or clinics – for immunizations, which can lead to these patients forgoing vaccines due to economic, scheduling, and transportation difficulties. Reasons given by providers for immunization referrals include low reimbursement rates,

paperwork, difficulty obtaining vaccines, and ineligibility for or non-participation in the

VFC program. Many providers report feeling that vaccine reimbursement from both public

and private sources is inadequate (Zimmerman, et al., 2006; Deutchman, Brayden, Siegel,

Beaty, & Crane, 2000).   Research has concluded that, in some instances, VFC and SCHIP

have impacted the tendency of physicians to refer uninsured and underinsured children to

alternate providers for immunizations; however, such referrals continue to occur,

especially among providers who do not participate in the VFC program (Zimmerman, et al.,

2006). Also, referring patients to a public health care setting for immunizations may create

an additional barrier, as parents whose children receive vaccines in clinic settings report

having to take much more responsibility for their children's immunizations than parents

whose children receive immunizations from private providers; these parents are more

likely to rely on their provider to initiate vaccinations and to inform them of the

recommended schedule (McCormick, Bartholomew, Lewis, Brown, & Hanson, 1997). The

fragmentation of care creates an additional burden on the parents to have their children

immunized, and coverage rates drop when children do not receive immunizations at their

primary medical home (Zimmerman, et al., 2006).

2.5 Insurance and Immunizations

Researchers have studied the relationship between insurance type and

immunization uptake, most recently to determine the impact of programs such as SCHIP

and VFC on immunization rates. Often, access to vaccines is affected when patients are

referred from one provider to another for vaccines. Referrals seem to have decreased over

time following the introduction of the VFC program, but physicians were still likely to refer

certain children. In a study of primary care physicians in Minnesota and Pennsylvania,

Zimmerman et al. found that likelihood of referrals ranged from three percent for children

with insurance that pays for immunization to 60 percent for children without insurance

whose parents were unable to pay for vaccines (Zimmerman, et al., 2006). However,

Deutchman et al. pointed out that "many patients referred out are those who are uninsured

or whose medical care is publicly funded. In reality, there is no need for these referrals …

because public programs do reimburse providers for immunizations, and the federal

Vaccines for Children (VFC) program provides free vaccines for uninsured and

underinsured children to providers who participate in the program (Deutchman, Brayden,

Siegel, Beaty, & Crane, 2000)." Indeed, physicians not participating in the VFC program

were likely to refer children with Medicaid to alternate care centers for immunizations 55

percent of the time, while participating physicians only referred six percent of Medicaid

children (Zimmerman, et al., 2006).

  Likewise, research studies indicate that insurance type and status are often

associated with immunization rates, despite the programs in place to prevent these

disparities (Zimmerman, et al., 2006; Blewett, Davidson, Bramlett, Rodin, & Messonnier,

2008). This has an important impact on children in the US, as almost ten percent of those

under 18 years of age, or 7.3 million American children, were uninsured in 2008 (U.S.

Census Bureau, 2010). Smith, Johnson, and Chu analyzed National Immunization Survey

data from 2001 and 2002 and found that about 13 percent of children were reportedly

uninsured at some time, and that children without insurance were less likely to be fully

immunized than those with insurance. In fact, children with any break in insurance

coverage were significantly less likely to be fully immunized than those who had been

continuously ensured for their lifetime, regardless of whether they were covered by public or private insurance, a relationship which has been addressed and confirmed by multiple studies (Smith, Stevenson, & Chu, 2006; Blewett, Davidson, Bramlett, Rodin, & Messonnier, 2008). However, those covered by public insurance were more likely to have experienced a break in insurance coverage in their lifetime. Despite the differences between different types of insurance, no significant differences were found between those with public and private insurance as long as coverage was continuous and after researchers controlled for important sociodemographic factors including race, ethnicity, income, mother's age, marital status, and education (Smith, Stevenson, & Chu, 2006).

A previous study of children aged 19 to 35 months reached similar conclusions, with the exception that the differences in immunization coverage between publicly and privately insured children remained significant. In predictive models for insurance type or insurance status combined with other sociodemographic variables, those related to immunization completeness included race/ethnicity, poverty status, and urban residence. However, in each model, insurance type and insurance status remained the most important predictors of complete immunization (Zhao, Mokdad, & Barker, 2004). Although the more recent studies show a less significant impact of insurance type as long as children were insured in some way, there is so far insufficient research to determine whether the impact of the VFC and SCHIP programs have improved immunization coverage rates among children in the US. One study published in 2005 concluded that while immunization rates have increased for all income groups since 1995, the increases were similar across income groups, suggesting that the SCHIP program had little impact on the increase in immunization coverage (Joyce & Racine, 2005). However, research is beginning to indicate

a closing gap between public and private insurance with relation to childhood immunization coverage when other sociodemographic factors are taken into consideration, and that the most vulnerable segment of the population might now be shifting towards those who are intermittently covered with private insurance, as they may not be accessing public insurance or programs that provide vaccines during the times when they are uninsured (Blewett, Davidson, Bramlett, Rodin, & Messonnier, 2008).

Despite the availability of public programs meant to ensure universal access to childhood vaccines, reports continue to show that children in poverty are more likely to be uninsured (U.S. Census Bureau, 2010) and less likely to be appropriately immunized (Zimmerman, et al., 2006; Smith, Stevenson, & Chu, 2006). However, more recent studies indicate that a growing factor in whether children receive the recommended immunizations might be the continuity of insurance coverage, regardless of whether the insurance coverage is public or private (Blewett, Davidson, Bramlett, Rodin, & Messonnier, 2008). This study investigates the relationship between childhood immunizations and insurance status, including whether a child is covered by public or private insurance, whether a child is eligible to receive free vaccines through the Vaccines for Children program, and whether insurance coverage is continuous over time.

CHAPTER III

METHODOLOGY

3.1 Source of Data

The data analyzed was taken from the 2010 National Immunization Survey (NIS), which is a survey conducted by the National Center for Immunizations and Respiratory Diseases (NCIRD) and the National Center for Health Statistics (NCHS) of the CDC. In 1992, the Childhood Immunization Initiative (CII) was established to address vaccine coverage concerns in the US. Healthy People 2000, 2010, and 2020 established related immunization coverage goals. The NIS was created and implemented in order to fulfill the CII mandate of monitoring vaccine coverage and evaluating progress toward the CII and Healthy People goals (NIS, 2011).

The first part of the NIS is a nation-wide, list-assisted random-digit dialing household telephone survey. For households containing children in the target age range, interviewers collect information from the most knowledgeable adult about the child's immunization history. The second part of the survey is a brief written questionnaire designed to collect information from the child's medical records, which is mailed to each child's immunization providers upon the consent of the parent or guardian of the child. NIS data on children in the US between the ages of 19 and 35 months has been collected since 1994, and measures immunization coverage relative to rates recommended by the Advisory Committee on Immunization Practices (ACIP). Immunization coverage estimates are produced for the country as a whole, for each state, and for selected urban areas. Estimates are used to evaluate progress toward national immunization goals and to

determine which states have the highest and lowest immunization coverage rates. The target study population of the NIS includes all children aged 19 to 35 months living in the US at the time of the interview (NIS, 2011).

Children aged 19 to 35 months are considered officially up-to-date (UTD) on immunizations if they have received all of the recommended vaccines [see table 2 (NIS, 2011)]. Coverage of certain series of vaccines is also measured, including the 4:3:1:3:3:1, which lists the number of doses each of DTaP, polio, MMR, Hib, hepatitis B, and varicella vaccines; and the 4:3:1:3:3:1:4, which adds 4 doses of the PCV vaccine to the previous series.

The 2010 NIS household interviews were conducted between January 7, 2010 and February 7, 2011. Provider data was collected between January 2010 and May 2011. In the households surveyed, there were a total of 24,013 children within the appropriate age range. Of these, 17,004 (70.81%) had adequate provider data to determine whether the child was up-to-date with immunizations; more extensive data is available for these children (NIS, 2011).

Table 2. Number of doses per vaccine recommended by the CDC for Children by age 2 years

Vaccine	Number of Doses
DTaP (also TDaP, DTP, or DT)	4
Polio	3
MMR	1
Hib	3 or 4*
Hepatitis B	3
Varicella	1
PCV	4
Hepatitis A	2
Influenza	yearly
Rotavirus	2 or 3*

* Number of doses depends on brand of vaccine used

3.2 Study Measures

The variables analyzed were taken from the 2010 National Immunization Survey Public Use File or created from the data available (DHHS & NCHS, 2011). Selected variables were analyzed with SAS 9.2. The relationships between various insurance factors, as well as sociodemographic and provider-related factors, and immunization status were investigated. Descriptive factors included child's age group, sex, and race/ethnicity; mother's age, education level, and marital status; household poverty status and whether the child was ever a recipient of WIC (the Special Supplemental Nutrition Program for Women, Infants, and Children) benefits. Provider-related measures included whether the child had adequate provider data to determine up-to-date status, and the number of providers responding to the questionnaire for each child.
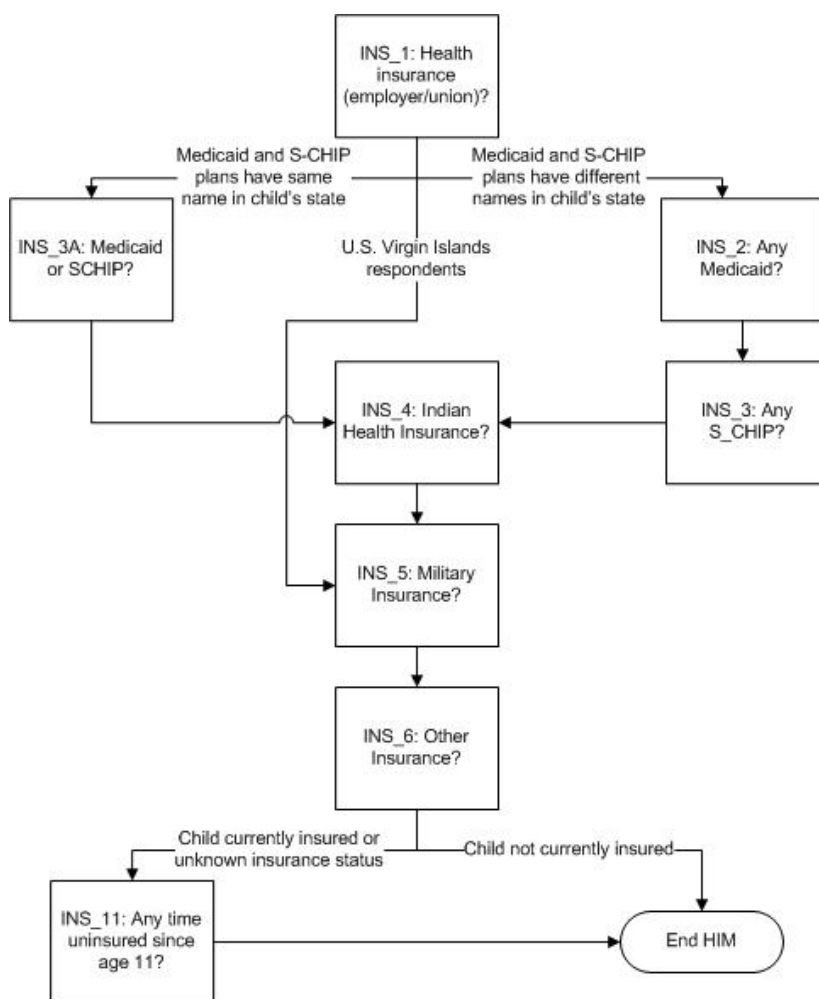
Insurance-related variables analyzed were created from the data

Figure 3. Question flow for the eight insurance variables included in the public use file

available [see figure 3 for the insurance-related question flow (DHHS & NCHS, 2011)].

Insurance measures in the data set included whether or not the child had insurance from an employer or union, whether or not the child was covered by Medicaid or SCHIP, whether or not the child was covered by Indian Health Services, Military Health Care, TRICARE, CHAMPUS, or CHAMP-VA, or whether the child had been covered by health insurance through any other means. Additionally, the data set contained a variable regarding whether the child had ever experienced any gaps in insurance coverage or was covered continuously throughout his or her lifetime. The first insurance-related variable created was whether each child was covered by any health insurance at any point. Next, the variables regarding insurance type were recoded into a single binary variable: public health insurance only (classifying public insurance according to the 2010 National Immunization Survey, the child was covered under Medicaid, SCHIP, Indian Health Services, Military Health Care, TRICARE, CHAMPUS, or CHAMP-VA), or private health insurance (the child was covered at any time by health insurance through an employer, a union, or from another source). Next, reported gaps in insurance coverage were recoded into a binary variable regarding whether health insurance coverage had been continuous throughout the child's lifetime.

The primary dependent variables studied were measures of up-to-date immunization status. Up-to-date immunization status was used to measure immunization uptake, as a means of addressing the overall immunization situation for each child rather than looking at each individual vaccine.   As there is no universally-used definition of up-to-date immunization status, three separate definitions were used (see table 3). The 4:3:1:3:3:1 vaccine series is the most commonly used definition of up-to-date for childhood

immunizations, so provider-reported status for the 4:3:1:3:3:1 series, a composite variable

created by the publishers of the data, was the first variable used to define up-to-date. This

series includes the DTaP, polio, MMR, Hib, hepatitis B, and varicella vaccines. The second

definition of up-to-date insurance status was based on the requirements for entry into the

Georgia public school system, adjusted for age-appropriateness to fit the study population.

This composite variable includes the DTaP, Hepatitis A, polio, MMR, varicella, and hepatitis

B vaccines. This variable is meant to be used as a proxy for general immunization

requirements for entry into public schools, although mandates vary from state to state.

The final definition of up-to-date immunization status is a composite variable, which

includes all vaccines recommended by the CDC for all children in the study population

except the influenza vaccine.

Table 3. Vaccines included in definitions of up-to-date immunization status

		Up-To-Date Status Definitions		
		4:3:1:3:3:1 Series	GA School Requirements*	CDC Recommend-ations
Vaccine (# of doses)	DTaP (4+)	x	x	x
	Hepatitis A (2+)		x	x
	Hepatitis B (3+)	x	x	x
	Hib (3+)			x
	MMR (1+)	x	x	x
	Rotavirus (3+)	x		x
	PCV (4+)			x
	Polio (3+)	x	x	x
	Varicella (1+)	x	x	x

*Age-adjusted to fit study population

3.3 Statistical Analysis

Using SAS 9.2, descriptive statistics including frequencies were performed to describe the study population using each of the variables of interest on observations in the United States as a whole as well as those in Georgia. Survey data from Georgia was used because the Georgia public school requirements were used as a guide for one of the definitions of up-to-date status, and can be used to gather information on differences that may occur when different vaccines are recommended or required. It is important to note that percentages reported relate only to the study population; as the data analyzed here are not weighted, those percentages may not be accurate if applied to national and state populations. Next, crosstabs were run to investigate relationships of interest (see table 4). Variables included in crosstab analysis were AGEGRP (child's age group), INS_CONT (continuous insurance), INS_TYPE (public or private insurance), VFC_I (VFC eligibility), N_PRVR (number of providers), PDAT (adequate provider data), and the three up-to-date status variables (PU431331, GA_REQ, and CDC_REC). These crosstabs were run on observations both from the US and in Georgia, and chi-square statistics and p-values were calculated to determine associations between variables of interest.

Table 4. Crosstab analyses performed

Crosstabs					
	Adequate Provider Data	Number of Vaccine Providers	PU431331	GA_REQ	CDC_REC
Child's Age Group	-	-	x	x	x
Insurance Type	x	x	x	x	x
Insurance Continuity	x	x	x	x	x
VFC Eligibility	-	-	x	x	x
Number of Vaccine Providers	x	-	x	x	x

Logistic regression was also performed to investigate the impact of selected variables on up-to-date status. Variables were selected based on the literature; the goal was not to find the best model for predicting up-to-date status, but simply to further explore relationships among variables generally considered to be important predictors of up-to-date status. Independent variables included those for child's race/ethnicity, mother's education, mother's marital status, household poverty status, insurance type, insurance continuity, and number of providers. The variable for child's age range was included as well, though not specifically listed in the literature, because it might impact whether children are up-to-date at the time of the survey. Logistic regression was performed for the US and for Georgia, using each of the three definitions of up-to-date immunization status as the dependent variable.

CHAPTER IV

RESULTS

4.1 Descriptive Statistics

Frequencies were calculated for sociodemographic variables in order to describe

the study population. The national (n=24013) and state of Georgia (n=420) survey

populations were similar with respect to most variables (see table 5).   Survey participants

Table 5. Descriptive variables for survey populations

	United States		Georgia	
	Frequency	Percent	Frequency	Percent
CHILD'S AGE CATEGORY				
19-23 months	6813	28.37	118	28.1
24-29 months	8493	35.37	166	39.52
30-35 months	8707	36.26	136	32.38
CHILD'S SEX				
Male	12220	50.89	209	49.76
Female	11793	49.11	211	50.27
CHILD'S RACE/ETHNICITY				
Hispanic	4170	17.37	46	10.95
Non-Hispanic White Only	14612	60.85	225	53.57
Non-Hispanic Black Only	2685	11.18	116	27.62
Non-Hispanic Other + Multiple Race	2546	10.6	33	7.86
MOTHER'S EDUCATION				
< 12 Years	2507	10.44	49	11.67
12 Years	4341	18.08	65	15.48
> 12 Years, Non-College Grad	6154	25.63	117	27.86
College Grad	11011	45.85	189	45
MOTHER'S AGE CATEGORY				
<= 19 Years	422	1.76	13	3.1
20-29 Years	7682	31.99	137	32.62
>= 30 Years	15909	66.25	270	64.29
MOTHER'S MARITAL STATUS				
Married	17938	74.7	306	72.86
Unmarried	6075	25.3	114	27.14
HOUSEHOLD POVERTY STATUS				
Above Poverty, > $75K	8658	36.06	145	34.52
Above Poverty, <= $75K	9023	37.58	146	34.76
Below Poverty	5002	20.83	100	23.81
Unknown	1330	5.54	29	6.9
CHILD HAS RECEIVED WIC BENEFITS				
Yes	9869	41.1	189	45
No	14022	58.39	231	55

from Georgia were more likely to be Non-Hispanic Black Only (27%) than national

respondents (11%), and mothers were more likely to be less than 19 years old (3.1% in GA;

1.7% in the US). Georgia households surveyed were more likely to fall below the poverty

line (24%) and to have received WIC benefits (45%) than national participants (21% and

41%, respectively). Frequencies were also determined for variables related to insurance

and provider variables (see table 6) as well as for immunization status (see table 7) for the

US and for Georgia.

Insurance and Provider Information

All children in the survey population had been covered by health insurance at some

point in their lifetimes. Both nationally and in Georgia, most children were covered under

insurance provided through their parents' employer or union (US n=11840, GA n=202).

Approximately 30 percent of those surveyed nationally and in Georgia had only been

covered by public insurance throughout their lifetime; however, a greater percentage of

respondents (US 37%, GA 38%) were eligible for the Vaccines for Children Program. Over

90 percent of children had been covered by insurance continuously throughout their

lifetimes. About 70 percent of respondents had adequate provider data to determine up-

to-date status for vaccines and vaccine series. For children with no providers responding

to the written questionnaire (US 29%, GA 27%), data were inadequate for determining up-

to-date immunization status. For over half of the children in the study population, only one

provider responded with immunization information; few children had two (US 14%, GA

11%) or three or more (US 2%, GA 3%) vaccine providers. Over 90 percent of children in

the national sample received vaccines from providers participating in the VFC program, while just under 85 percent of those in the Georgia sample saw participating providers.

Table 6. Insurance and provider variables

	United States		Georgia	
Source of Health Insurance				
Employer or Union	11840		202	
Medicaid	3586		106	
SCHIP	1488		44	
Medicaid or SCHIP	2501		0	
Other Public	1146		21	
Other Insurance	1369		25	
Derived Insurance Variables				
Any Insurance	18511	100%	316	100%
VFC Eligible	6287	37.43%	117	38.24%
Continuous Coverage	17061	92.01%	288	90.85%
Insurance Type				
Public Only	5748	31.05%	96	30.38%
Private	12763	68.95%	220	69.62%
Provider Variables				
Adequate Provider Data	17004	70.81%	306	72.83%
Number of Vaccine Providers				
0	7063	29.41%	113	26.90%
1	13027	54.25%	251	59.76%
2	3460	14.41%	45	10.71%
3+	463	1.93%	11	2.62%
VFC Participation				
All Providers	11802	69.63%	203	66.12%
Some but Not All Providers	1613	9.52%	27	8.79%
No Providers	1598	9.43%	47	15.31%

Immunization Information

Immunization rates seemed overall to be higher statewide in Georgia than nationally (see table 7). For individual vaccines, the largest disparity was with the hepatitis A vaccine; 65 percent of Georgian respondents had received the appropriate number of vaccine doses, while only 49 percent of national respondents were up-to-date. The only vaccine for which Georgia was below the national percentage was the Hib vaccine; 89 percent of respondents from Georgia and 90 percent of respondents nationally were up-to-date for that vaccine. Coverage rates were about 90 percent or higher for the hepatitis B, Hib, MMR, polio, and varicella vaccines. The lowest up-to-date immunization status rates were for the hepatitis A (48% nationally, 65% in Georgia) and rotavirus (US 61%, GA 67%) vaccines.

Table 7. Immunization variables

	United States			Georgia		
	UTD	Not UTD	% UTD	UTD	Not UTD	% UTD
Individual Immunizations						
DTaP (4+ doses)	14509	2610	84.75	267	40	86.97
Hepatitis A (2+ doses)	8375	8744	48.92	199	108	64.82
Hepatitis B (3+ doses)	15580	1539	91.01	293	14	95.44
Hib (3+ doses)	15420	1699	90.08	274	33	89.25
MMR (1+ doses)	15534	1585	90.74	281	26	91.53
Rotavirus (3+ doses)	10412	6707	60.82	205	102	66.78
PCV (4+ doses)	14309	2810	83.59	274	33	89.25
Polio (3+ doses)	15896	1223	92.86	296	11	96.42
Varicella (1+ doses)	15321	1798	89.5	289	18	94.14
Series: Up-To-Date Definitions						
4:3:1:3:3:1	12731	4388	74.37	231	76	75.24
GA Requirements	7601	9518	44.4	184	123	59.93
CDC Recommendations	5305	11814	30.99	123	184	40.07

Immunization rates nationally and in Georgia varied widely by definition of up-to-date status. For the most commonly used definition of up-to-date status for children in the 19- to 35-month age range included in the study population, the 4:3:1:3:3:1 vaccine series, the immunization coverage rates (US 74% UTD, GA 75% UTD) were higher than when using either of the other two definitions. For the definition of up-to-date status based on requirements for entry into Georgia public schools, in comparison with the 4:3:1:3:3:1 series definition (see table 3), the hepatitis A vaccine is included, but the Hib vaccine is not. Using this definition, a fairly wide gap develops between the percentage considered up-to-date nationally and those considered up-to-date in Georgia. About 44 percent of respondents nationally and 60 percent of those in Georgia were considered up-to-date for age-appropriate immunizations based on this definition. Using the CDC recommendations for the age group in the study population, which includes recommended doses of vaccines for each of the immunizations studied here, coverage rates drop even lower. Only 31 percent of respondents nationally and 41 percent of those in Georgia are considered up-to-date for all recommended vaccines.

4.2 Associations and Background Information

Crosstab analysis was conducted to examine the relationships between some of the variables studied, using survey data from both Georgia and the United States as a whole (see table 8). Chi-square statistics and p-values were calculated for each of the associations explored. Nationally, more of the relationships found appear to be significant for the study respondents than for those using just those survey participants in Georgia. Additional variables including child's age and provider information were explored in order to

determine the impact of background factors that might be influencing insurance type, insurance continuity, and up-to-date immunization status. Nationally, age group was associated with all definitions of up-to-date status; in Georgia, age group appeared to be associated with two of the three definitions.

Whether a child had adequate provider data did not appear to be associated with either whether insurance had so far been continuous throughout the child's lifetime or whether the child had been covered by public health insurance. However, the number of vaccine providers for each child seems to have a strong relationship with whether the child had adequate provider data to determine up-to-date status. For the national sample, the number of vaccine providers per child also is also associated with insurance continuity as well as whether health insurance coverage is public or private. For each crosstab analysis, sample sizes were deemed large enough to appropriately report chi-square statistics.

Table 8. Crosstab associations

Crosstabs					
	Adequate Provider Data	Number of Vaccine Providers	Up-To-Date		
			PU431331	GA_REQ	CDC_REC
Child's Age Group	-	-	+	o	o
Insurance Type	x	+	+	+	o
Insurance Continuity	x	+	+	+	+
VFC Eligibility	-	-	+	+	o
Number of Vaccine Providers	o	-	+	+	+

x = Not Associated
+ = Associated in US only
o = Associated in US and GA

4.3 Research Questions

1. Is there an association between insurance type and immunization status?

For survey participants nationwide, whether a child has public insurance is associated with all three definitions of up-to-date immunization status; the null hypothesis would be rejected for all definitions (see table 9). There is a significant association between insurance type and the 4:3:1:3:3:1 vaccine series (χ^2 = 15.2) and the vaccines required for public school entry in Georgia (χ^2 = 10.3). The association seems to be stronger between insurance type and receipt of all recommended vaccine doses (χ^2 = 53.2). For survey participants in Georgia, insurance type seems to be associated only with whether a child has received all recommended vaccines by age two (χ^2 = 4.5); therefore, the null hypothesis that there is no association is rejected for that definition only. Insurance type does not seem to be associated with either of the other definitions of up-to-date immunization status in the Georgia sample.

2. Is there an association between Vaccines for Children eligibility and immunization status?

Nationwide, whether a child is eligible for the Vaccines for Children program appears to be associated with whether that child is up-to-date for immunizations regardless of definition used; the null hypothesis is rejected for each of the variables used (see table 9). The association between VFC eligibility and the 4:3:1:3:3:1 vaccine series is especially strong (χ^2 = 160.8). As with insurance type, however, VFC eligibility is associated only with being up-to-date for all vaccines recommended by the CDC for the age group surveyed in Georgia (χ^2 = 9.5). The null hypothesis that no association exists is

Table 9. Associations between insurance factors and up-to-date immunization status

United States

		PU431331		GA_REQ		CDC_REC	
		Percentage of UTD		Percentage of UTD		Percentage of UTD	
Insurance Type	Public Only	30.08%		29.60%		26.99%	
	Private	69.96%		70.40%		73.01%	
		χ2 = 15.1557	p < 0.0001	χ2 = 10.2970	p = 0.0013	χ2 = 53.2135	p < 0.0001
VFC Eligibility*	Eligible	36.00%		35.84%		32.56%	
	Not Eligible	63.88%		64.00%		67.29%	
		χ2 = 160.8147	p < 0.0001	χ2 = 40.4728	p < 0.0001	χ2 = 95.9487	p < 0.0001
Insurance Continuity	Not Con.	6.75%		6.47%		5.66%	
	Continuous	93.25%		93.53%		94.34%	
		χ2 = 32.2190	p < 0.0001	χ2 = 17.2732	p < 0.0001	χ2 = 33.7546	p < 0.0001

Georgia

		PU431331		GA_REQ		CDC_REC	
		Percentage of UTD		Percentage of UTD		Percentage of UTD	
Insurance Type	Public Only	30.28%		32.18%		23.73%	
	Private	69.72%		67.82%		76.27%	
		χ2 =0.0638	p = 0.8006	χ2 = 0.4814	p = 0.4878	χ2 = 4.5308	p = 0.0333
VFC Eligibility*	Eligible	36.80%		36.41%		28.46%	
	Not Eligible	62.77%		63.04%		70.73%	
		χ2 = 1.1074	p = 0.5748	χ2 = 1.2575	p = 0.5333	χ2 = 9.5244	p = 0.0085
Insurance Continuity	Not Con.	7.76%		7.95%		5.83%	
	Continuous	92.24%		92.05%		94.17%	
		χ2 = 1.7817	p = 0.1819	χ2 = 0.6347	p = 0.4256	χ2 = 2.5560	p = 0.1099

* Not ascertained for all observations

rejected for this definition only for the Georgia survey population; VFC eligibility does not seem to be significantly associated with either of the other definitions of up-to-date immunization status.

3. Is there an association between immunization status and continuity of health insurance?

In the nationwide survey population, lifetime health insurance continuity is significantly associated with up-to-date immunization status regardless of definition used (see table 9), and the null hypothesis is rejected for each of these. The association with insurance continuity is equally strong for both the 4:3:1:3:3:1 vaccine series ($\chi^2 = 32.2$) and the CDC recommendation series ($\chi^2 = 33.8$). In Georgia, insurance continuity does not seem to be associated with up-to-date status (all $\chi^2 < 3$). None of the null hypotheses for this population are rejected.

4. Which of the selected factors, chosen based on the literature, are most important in determining up-to-date immunization status?

Variables were selected based on stated importance in the literature and on the research questions proposed (see table 10); null hypotheses state that the selected independent variable has no effect on the definition of up-to-date status being examined. Variables for which the null hypothesis was rejected seem to be important in predicting up-to-date status based on the particular definition and population. Overall, child's age appears to be the single most important predictor of up-to-date immunization status and was significant for five of the six groups (for PU431331 in GA, p = 0.4699; all other p <

0.0001). Nationally, child's race/ethnicity was a significant predictor of two definitions of up-to-date status (GA_REQ p = 0.0305, CDC_REC p < 0.0001). Mother's education appears to be significant only when predicting whether a child had received all of the vaccines recommended by the CDC, both nationally and in Georgia. Insurance continuity seemed to be a significant predictor in the national sample (p < 0.0001 for all definitions), but was not significant among respondents in Georgia. Household poverty status was also not significant in the Georgia sample, but was appeared to be somewhat important in predicting 4:3:1:3:3:1 series and CDC recommendations receipt in the national sample. Despite some suggestion in the literature, mother's marital status did not appear to be a predictor of up-to-date immunization status at all. Whether a child had public or private insurance also did not seem to be an important predictor of up-to-date status.

Nationally, using the 4:3:1:3:3:1 series to define up-to-date immunization status, the null hypothesis was rejected for child's age group, household poverty status, insurance continuity, and number of vaccine providers. Defining up-to-date status based on entry requirements to Georgia public schools, the null hypothesis is rejected for child's age group, child's race/ethnicity, insurance continuity, and number of vaccine providers. Using the definition based on all immunizations recommended by the CDC for the age group surveyed, the null hypothesis was rejected for child's age group, child's race/ethnicity, mother's education, household poverty status, insurance continuity, and number of vaccine providers.

For the survey population in Georgia, fewer variables seemed to be important predictors of up-to-date immunization status for each of the definitions used. Using the 4:3:1:3:3:1 vaccine series to define up-to-date status, no null hypotheses are rejected.

Defining up-to-date status based on requirements for entry to Georgia public schools, the

null hypothesis for child's age group is rejected. Basing up-to-date status on the CDC's

recommendations for all vaccines for the age group surveyed, null hypotheses are rejected

for child's age group and mother's level of education.

Table 10. Logistic regression results, US and Georgia; Odds ratio and confidence interval

		United States			Georgia		
		PU431331	GA_REQ	CDC_REC	PU431331	GA_REQ	CDC_REC
Child's Age Group	OR	1.151	1.893	1.422	1.144	2.655	1.96
	95% CI	(1.101, 1.204)*	(1.817, 1.973)*	(1.363, 1.484)*	(0.794, 1.649)	(1.852, 3.808)*	(1.385, 2.772)*
Child's Race / Ethnicity	OR	0.971	0.957	0.914	0.936	1.071	0.865
	95% CI	(0.93, 1.015)	(0.92, 0.996)*	(0.875, 0.953)*	(0.647, 1.356)	(0.754, 1.523)	(0.611, 1.225)
Mother's Education	OR	1.011	0.971	1.058	1.066	1.345	1.524
	95% CI	(0.965, 1.059)	(0.931, 1.012)	(1.012, 1.106)*	(0.76, 1.495)	(0.969, 1.866)	(1.092, 2.127)*
Mother's Marital Status	OR	0.957	0.915	0.915	1.033	0.835	0.59
	95% CI	(0.867, 1.056)	(0.837, 1.001)	(0.83, 1.007)	(0.475, 2.243)	(0.395, 1.766)	(0.28, 1.247)
Household Poverty Status	OR	0.906	0.964	0.932	1.034	1.247	1.081
	95% CI	(0.858, 0.958)*	(0.917, 1.013)	(0.884, 0.982*)	(0.695, 1.537)	(0.848, 1.833)	(0.748, 1.563)
Insurance Type	OR	0.996	1.052	1.078	0.995	0.642	0.902
	95% CI	(0.901, 1.101)	(0.96, 1.152)	(0.978, 1.189)	(0.449, 2.205)	(0.297, 1.387)	(0.418, 1.944)
Insurance Continuity	OR	1.428	1.323	1.387	1.814	1.878	1.976
	95% CI	(1.251, 1.629)*	(1.165, 1.503)*	(1.204, 1.597)*	(0.734, 4.48)	(0.743, 4.742)	(0.734, 5.319)
Number of Vaccine Providers	OR	1.46	1.234	1.129	1.07	1.701	1.599
	95% CI	(1.351, 1.578)*	(1.159, 1.315)*	(1.057, 1.205)*	(0.615, 1.865)	(0.983, 2.945)	(0.961, 2.66)

* Statistically Significant

CHAPTER V

DISCUSSION AND CONCLUSION

Vaccines have greatly reduced the morbidity and mortality associated with infectious diseases. However, vaccine-preventable diseases still occur in the United States, and disparities exist among children who are up-to-date for recommended immunizations. It is important to ensure that immunization rates remain high and that all children are able to readily access appropriate vaccines (CDC, 1999). Imported cases of infectious disease (CDC, 2008a), oft-changing public perception of vaccines (Stern & Markel, 2005), and economic barriers (Zimmerman, et al., 2006) remain challenges to protecting children in the US from infectious diseases. The Healthy People 2020 publication has listed childhood immunization coverage rate targets, some which have been met and must be maintained, and some that have not yet been achieved (DHHS). Health insurance status – including whether a child does or does not have insurance, whether that insurance is public or private, and whether insurance coverage is continuous over time – has previously been seen to be associated with immunization uptake and whether a child is up-to-date for recommended childhood immunizations (Deutchman, Brayden, Siegel, Beaty, & Crane, 2000; Zimmerman, et al., 2006; Blewett, Davidson, Bramlett, Rodin, & Messonnier, 2008; Smith, Stevenson, & Chu, 2006).

The introduction of the State Children's Health Insurance Program (SCHIP) and the Vaccines for Children (VFC) program should be working to close the gap between those children who are fully immunized and those who are not. The VFC program in particular should be having the effect of eliminating the association between insurance status and

immunization uptake. The purpose of this study was to address whether insurance status has an effect on immunization uptake, by investigating associations between vaccine receipt and insurance type, Vaccines for Children eligibility, and insurance continuity.

Crosstab, chi-squared, and logistic regression analyses were performed on data from the 2010 National Immunization Survey using SAS 9.2. Up-to-date immunization status was determined using three definitions: the 4:3:1:3:3:1 vaccine series; requirements for entry into Georgia public schools, age-adjusted to fit the survey population; and all vaccines recommended for all children by the CDC. Insurance type, Vaccines for Children program eligibility, and insurance continuity were examined for associations with each of the three definitions of up-to-date immunization status. Logistic regression was performed using each of those factors as well as others suggested by the literature, such as mother's education level and household poverty status. The goal of the logistic regression was not to determine the best model for predicting up-to-date status, but simply to further investigate the variables being studied.

5.1 Sociodemographic Factors

Demographic factors were not examined at length with respect to their importance in predicting up-to-date immunization status; this analysis generally focused on insurance-related variables. However, some sociodemographic and economic variables were included in order to gain a more in-depth understanding of factors that are generally considered to be important predictors of immunization uptake. A child's age group was found to be a strong and significant predictor of up-to-date status in all models except the one predicting completion of the 4:3:1:3:3:1 vaccine series in respondents in Georgia.

Survey respondents fell into one of three age groups: 19 to 23 months, 24 to 29 months, or 30 to 35 months. About 28 percent of respondents nationally (and 28% in Georgia) were between 19 and 23 months of age; about 35 percent (40%) were between 24 and 29 months of age; and about 36 percent (32%) were between 30 and 35 months of age. If all doses of each vaccine are given at the recommended time, each child should be up-to-date for all vaccines recommended for 2- to 3-year-olds by 18 months of age and before becoming eligible for participation in the National Immunization Survey. In this analysis, however, older children were more likely to be up-to-date. Therefore, it seems clear that even when children are receiving all of the recommended vaccines, they are not necessarily receiving them on the timeline recommended by the CDC. The rationale behind this is not evident from this analysis; indeed, it is unclear whether the association between age group and up-to-date status is having a positive or negative impact on overall immunization coverage rates. For those children receiving vaccines later than recommended who may be missing well-child care visits due to economic or transportation issues, it would seem that providers are taking advantage of sick visits to provide vaccinations for children who might not otherwise receive them. Alternately, such an association could suggest that in general, recommendations are not being closely followed by parents or providers, which could lead to some children missing important vaccines altogether.

A child's race/ethnicity was found to be an important predictor among national respondents for receipt of all recommended vaccines, and a significant but not very strong predictor of up-to-date status for immunization requirements for Georgia public schools. Race/ethnicity was not a significant predictor for any up-to-date status definition among respondents in Georgia, which were more likely to be non-Hispanic black only and less

likely to be Hispanic or non-Hispanic white only. Research has indicated that race/ethnicity is often an important indicator of health outcomes. However, it is possible that it may be more important in the context of other socioeconomic variables than it is directly responsible for the immunization status; confounding variables were not examined in-depth in this analysis.

In the logistic regression analysis, mother's level of education was found to be a significant predictor of up-to-date immunization status only for all CDC-recommended vaccines for survey participants both nationally and in Georgia. Children of better-educated mothers were most likely to be up-to-date for all universally recommended vaccines. The lack of significance of mother's education level for the 4:3:1:3:3:1 series might suggest that providers are generally doing a decent job of explaining the importance of this commonly-cited series of vaccines to mothers. This in turn may be leading to children more often receiving the appropriate doses of these vaccines regardless of mother's education level. Mother's education level is also not a significant predictor of whether a child has received the age-appropriate doses of vaccines required for entry into Georgia public schools; this indicates that information regarding vaccines mandated for school entry may be reaching parents regardless of their education level. However, the analysis indicates that children of better-educated mothers are more likely to have received the full complement of recommended vaccines. This could be due to better-educated mothers making themselves more aware of the importance of immunization overall. This significance, however, might also indicate that while providers seem to be communicating with all mothers regarding well-known series and school mandates, they

are not effectively communicating the importance of all recommended immunizations to less-educated mothers.

Contrary to what has been suggested in previous research, mother's marital status was not found to be a significant predictor of up-to-date status using any of the models. It is possible that mother's marital status is becoming an increasingly less accurate means of predicting health outcomes due to changing family dynamics. Recent census data has revealed that marriage rates have slowed; the percentage of unmarried couples is increasing for economic and other reasons (El Nasser & Overberg, 2011). Additionally, multigenerational families are becoming more common, and "the most common multigenerational family is an older parent who owns the house, living with an adult child and grandchild (CBS News, 2010)." It can be assumed that unmarried mothers living with partners or extended family are receiving some measure of financial or emotional support that is allowing them to ensure their children are immunized. A more appropriate measure to predict health outcomes might be the number of adults in the household. Due to the nature of this data set, it was not possible to compute such a variable for this analysis; however, as mother's marital status did not seem to be a significant factor it should be considered in future research.

Household poverty status was also included in the logistic regression models. In this data set, poverty status has been coded into three categories: below poverty line, above poverty line but below $75,000 per year, and above $75,000 per year. Georgia respondents were slightly more likely to be living below the poverty line than the national sample. In the logistic regression analysis, household poverty status was a significant, but not very strong, predictor of up-to-date status for the 4:3:1:3:3:1 series and all CDC-recommended

vaccines for the national sample. The lack of strong association might indicate that although poverty is known to be an important predictor of many health outcomes, programs put in place to address disparities in immunization uptake have been reducing the impact of poverty on up-to-date status.

The number of vaccine providers responding to the written questionnaire for each child was seen in the logistic regression to be a strong and significant predictor of up-to-date status in the national sample for each of the three definitions used; children with a single vaccine provider were most likely to be up-to-date. This association was also seen to be significant in the crosstab analysis. Additionally, a child's number of vaccine providers was significantly associated with whether adequate provider data was available to determine up-to-date immunization status among respondents nationally and in Georgia. This seems to go along with previous research, which has suggested that increased number of providers leads to poorer record keeping; both may lead lower chances of being up-to-date for immunizations (Deutchman, Brayden, Siegel, Beaty, & Crane, 2000).

5.2 Insurance Type

Historically, children with private insurance have higher immunization rates, better access to care, and improved health outcomes over children with public insurance such as Medicaid. Children with public insurance are more likely to be referred to additional providers for vaccines (Deutchman, Brayden, Siegel, Beaty, & Crane, 2000), and insurance type and immunization status remain associated (Zimmerman, et al., 2006; Blewett, Davidson, Bramlett, Rodin, & Messonnier, 2008), despite programs in place to address both of these problems.

In the 2010 National Immunization Survey sample, approximately 30 percent of children had been covered only by public health insurance throughout their lifetime; the rest of the children had been covered by private health insurance at some point. Of all types of insurance, the majority of respondents were covered under insurance through their parents' employer or union, although this does not necessarily indicate permanent private health insurance coverage. In this analysis, insurance type was found to be associated with all three definitions of up-to-date status in the national sample and with whether a child had received all recommended vaccines among respondents in Georgia. Despite reported trends of declining importance (Zhao, Mokdad, & Barker, 2004; Blewett, Davidson, Bramlett, Rodin, & Messonnier, 2008; Smith, Stevenson, & Chu, 2006), it appears that whether a child has public or private health insurance is still associated with whether that child receives recommended immunizations; those children with only public health insurance were less often up-to-date in the sample. However, in the logistic regression analysis, insurance type was not found to be a significant predictor of whether a child was up-to-date for recommended immunizations when considered along with the other variables included. This suggests that although an association between insurance type and up-to-date status appears to still be present, whether a child has public or private insurance may be no longer one of the most important factors in determining whether a child will receive the recommended vaccines.

Insurance type was also found in this analysis to be associated in the national sample with the number of vaccine providers seen by a child. This suggests that either those with public health insurance are less able to find or maintain a primary health care home, or that providers remain more likely to refer children with public health care to

alternative care sites for vaccines, or that both issues are occurring. It is possible that the tendency to refer children to additional providers is exacerbating the socioeconomic disparities that exist in immunization receipt. This analysis does not take into consideration all possible underlying or confounding causes; however, it is clear opportunities remain to improve immunization rates among children with public health insurance. Also, as long as factors such as number of providers remain associated with both immunization uptake and insurance type, focusing interventions on children with public health care may still provide one of the best opportunities for improving childhood immunization rates overall.

5.3 Vaccines For Children Eligibility

The Vaccines for Children program was implemented in 1994 to eliminate socioeconomic disparities in immunization coverage rates. If a health care provider participates in the VFC program, the provider can order vaccines at no cost through the program to be used for children who are eligible to receive them. To be eligible to receive VFC vaccines, a child must be eligible for Medicaid, uninsured, American Indian or Alaska Native, or underinsured, meaning that the child has private insurance but vaccines are not completely covered (CDC, 2011a). Research has shown that thus far, despite overall improvements in immunization coverage rates, children who are VFC eligible have remained less likely to receive the full complement of immunizations (Zimmerman, et al., 2006; Blewett, Davidson, Bramlett, Rodin, & Messonnier, 2008).

In the 2010 National Immunization Survey population, 37.4 percent of respondents overall and 38.2 percent of those in Georgia were deemed eligible for the VFC program. In

this analysis, children who were eligible for the VFC program were less likely to be fully immunized than ineligible children. VFC eligibility was found to be significantly associated with all three up-to-date status definitions in the national survey population. In Georgia, VFC eligibility was found to be associated with whether a child had received all vaccines recommended by the CDC. The VFC program was created to improve immunization rates by addressing the needs of "children who might not otherwise receive vaccines because of financial barriers or who might receive vaccines late because they would be referred to another setting for free vaccines (GA DPH, 2010)." Almost 40% of children surveyed were eligible for the program, and these children were less likely to be up-to-date than those who were not eligible regardless of definition used. In general, whether a child is eligible for the Vaccines for Children program seems to still be associated with up-to-date immunization status; as yet, a gap still exists. This suggests that there remain opportunities to improve the overall effectiveness of the VFC program.

If the program was having the maximum intended impact, there should be no association between VFC eligibility and immunization uptake; children who are eligible to receive VFC vaccines would be receiving them at least as often as those who are not eligible. This analysis only looks at 2010, the most recent year for which data are available; therefore improvement over time cannot be commented on. This analysis also does not investigate all other causes which may be contributing to the persistent socioeconomic gap; however, some rationales suggested by the literature reviewed include limited access to care, referrals to alternate providers for vaccines, and provider failure to vaccinate children at sick visits who might be unable to return for additional well visits. Despite these

limitations, however, it seems that continued progress is necessary to maximize the impact of the Vaccines for Children program.

5.4 Insurance Continuity

Research has shown that as programs narrow the gap in up-to-date immunization status between children who have private insurance and those who do not, insurance continuity is becoming an increasingly important factor in whether children are up-to-date. Children who experience gaps in health insurance coverage have been shown to be less likely to receive recommended immunizations, sometimes regardless of insurance type (Blewett, Davidson, Bramlett, Rodin, & Messonnier, 2008; Smith, Stevenson, & Chu, 2006). In analysis of 2001 and 2002 NIS data, Smith, Stevenson, and Chu found that 13 percent of children were uninsured at some point in time.

In the 2010 NIS sample, fewer than 10 percent of children were reported to have experienced gaps in health insurance coverage in their lifetimes. Insurance continuity was found to be associated in the national survey population with up-to-date immunization status when using any of the three definitions. Overall, children whose insurance coverage was not continuous were less likely to be up-to-date than children who had experienced uninterrupted coverage. Although that likelihood was seen in respondents in Georgia as well, in this analysis insurance continuity was not found to be associated with immunization status for that group. This association between insurance continuity and up-to-date status in the national sample held true in the logistic regression analysis as well; insurance continuity was found to be a strong and significant predictor of whether children

were up-to-date by any definition used, but was not found to be a significant predictor of up-to-date status in respondents from Georgia.

5.5 Up-To-Date Status Definition

Whether a child was considered up-to-date for recommended immunizations varied widely depending on which definition was used. Overall, children were much more likely to be considered to be up-to-date when using receipt of the full 4:3:1:3:3:1 vaccine series as the defining factor. The 4:3:1:3:3:1 series includes the DTaP, hepatitis B, MMR, rotavirus, polio, and varicella vaccines; approximately three-quarters of children included in the survey were up-to-date for this series. Using the age-adjusted requirements for entry into Georgia public schools, which excludes the rotavirus vaccine but adds the hepatitis A vaccine, fewer children in the sample can be considered up-to-date (US 44.4%, GA 59.9%). When looking at up-to-date receipt of all CDC-recommended vaccines, which includes all vaccines in the previous two definitions as well as the Hib vaccine and the PCV, even fewer children can be considered up-to-date (US 30.9%, GA 40%).

To begin to understand the rationale behind the wide variation in up-to-date status according to definition, it is necessary to look at the individual vaccines included in each definition. The 4:3:1:3:3:1 series, often used to determine up-to-date status, includes mostly vaccines with relatively high coverage rates: in the 2010 NIS survey population, at least about 85 percent of children were up-to-date for each of the individual vaccines with the exception of only the rotavirus vaccine, for which over 60 percent of participants were up-to-date. In comparison, the Georgia public school requirements do not include the rotavirus vaccine, but do include the vaccine for hepatitis A, which has even lower coverage

among respondents at 48 percent up-to-date. When looking at all CDC-recommended vaccines, both of these low-coverage vaccines are included.

While this analysis does not investigate the rationale behind the differences with respect to definition, it is likely that some of the difference can be explained by the age of the vaccines; newer vaccines tend to have lower coverage rates. The hepatitis A vaccine was first recommended for all children in 1999, and the rotavirus vaccine was recommended for all children in 2008. The varicella vaccine, which also was introduced relatively recently, is often combined with the MMR vaccine, possibly leading to higher coverage rates for such a new vaccine.

5.6 Limitations and Recommendations

This study looked only at data from the 2010 National Immunization Survey; therefore trends over time cannot be seen. It would be useful to conduct similar analysis on data from previous years in order to examine to what extent programs have helped to eliminate disparities in immunization status. Additionally, as data used were not weighted, results cannot be extrapolated to the general population. Although data were analyzed for respondents from Georgia and from the United States as a whole, direct comparisons between the two populations may not be possible since weighted data were not used. Further research could also investigate what, if any, other factors are useful in determining up-to-date immunization status; this could facilitate improvements in existing programs and interventions.

Immunization rates have been improving recently across all populations in the United States (Joyce & Racine, 2005). Although the direct effect of programs such as SCHIP

and VFC on immunization rates is as yet unknown, it can be assumed that there has been some positive impact. One sign of this is that alternate provider referrals for vaccines decrease when VFC participation increases (Zimmerman, et al., 2006). Therefore, despite the continued associations between insurance type and continuity and up-to-date immunization status, it does not seem reasonable to assume that programs in place are ineffective. Rather, it seems they could be improved and better-utilized in order to maximize the benefits.

One way to improve immunization coverage among children who have public insurance, are eligible for the Vaccines for Children program, or have experienced gaps in health insurance coverage is to increase provider participation in the VFC program. The inverse association between provider referrals for vaccines and vaccine receipt has been well documented. Participation in the VFC program can reduce provider referrals by making available free vaccines for providers to give to qualifying children, which can in turn lead to improved access to vaccines (GA DPH, 2010; Zimmerman, et al., 2006). Decreased provider referrals will also serve to facilitate better record keeping, which in turn will also help to increase immunization rates. Among the 2010 NIS participants, shot cards were reportedly available for fewer than 27 percent of children. For 30 percent of children, provider data was insufficient to determine up-to-date immunization status (DHHS & NCHS, 2011). Research has shown that having inadequate or inaccessible immunization records can be a barrier to childhood immunization (Deutchman, Brayden, Siegel, Beaty, & Crane, 2000); complete and readily accessible records will facilitate immunization uptake.

Improving interactions with parents will also serve to increase immunization rates. This should be done in two ways: by taking advantage of sick-child visits to give vaccines whenever possible, and by communicating more effectively to parents the importance of ensuring children receive all appropriate vaccines. Immunizing children during sick-child visits has been previously recommended and should be taken into consideration whenever possible. Parents report that sick-child health care is more accessible than well-child care, and parents are more likely to skip well-care appointments for economic or transportation reasons (Deutchman, Brayden, Siegel, Beaty, & Crane, 2000; McCormick, Bartholomew, Lewis, Brown, & Hanson, 1997). Not all vaccines can be given when a child is ill; however, once a child is present in a physician's office or clinic, the opportunity can be taken to plan follow-up visits at which vaccines may be given. This would help to address some of the continued differences in immunization rates caused by economic and systemic barriers.

Improving communication between public health practitioners, health care providers, and parents would further increase immunization rates. Previous studies have reported that parents often have little understanding of the importance of vaccines and that even well-informed providers are not always able to translate that knowledge into improving vaccination coverage among patients (McCormick, Bartholomew, Lewis, Brown, & Hanson, 1997; Thomas, Kohli, & King, 2004). As mother's education was found in this analysis to be an important predictor of up-to-date status in some cases, it seems that providers and practitioners could be doing a better job of assisting parents in making informed decisions regarding immunizations for their children. Creating a rapport between providers and parents can also help in establishing a permanent medical home for a child. All of these factors, when targeted separately and especially when taken together,

can lead to increased opportunities for immunizations, reduced impact of health insurance status, and overall improved health outcomes for children.

5.7 Conclusion

Reaching target childhood immunization coverage rates remains a national public health goal. A child's health insurance type and continuity have been known to affect whether that child is up-to-date for recommended immunizations. Among children between the ages of 19 and 35 months whose families participated in the 2010 National Immunization Survey sample, between 30 percent and 75 percent were up-to-date depending on definition used. In the nationwide sample, health insurance type, Vaccines for Children program eligibility, and insurance continuity were found to be associated with at least some definitions of up-to-date immunization status; for participants in Georgia, only insurance type and VFC eligibility were found to be significant. Further investigation revealed that insurance type might be less important in predicting up-to-date status when other factors, including child's age group, number of vaccine providers, and mother's education, are considered. Further research would serve to better understand the impact of programs intended to decrease disparities in childhood immunization rates. Increased provider participation in the Vaccines for Children program, along with improving communication between public health practitioners, health care providers, and parents, could further improve childhood immunization uptake.

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