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An Examination of the Socio-Demographic Characteristics Associated with Adult Vaccination Prevalence for Preventable Diseases in the United States

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ABSTRACT

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An Examination of the Socio-Demographic Characteristics Associated with Adult Vaccination Prevalence for Preventable Diseases in the United States
(Under the direction of Christine Stauber, Faculty Member)

Background: An estimated 50,000 adults in the United States (U.S.) die each year from one of 10 vaccine preventable diseases. For those who survive vaccine preventable infections, health care costs and loss of income become more significant. While children in the U.S. aged 0-2 exhibit vaccine prevalence rates of almost 90%, some adult vaccine prevalence rates in the U.S. population are reported to be nearly 30-40% less than the goals set forth by Healthy People 2010. The purpose of this study was to examine the associations between socio-demographic characteristics of U.S. adults and adult vaccination prevalence for pneumococcal, hepatitis A, hepatitis B, tetanus, and pertussis.

Methods: Data from the 2008 National Health Interview Survey were assessed examining various health indicators and characteristics of non-institutionalized adults and children. The sample was restricted to adults ≥18 years of age. Odds ratios were calculated and multivariate logistic regression was also conducted. P-values of <0.05 and 95% confidence intervals were used to determine statistical significance.

Results: There were 21781 total observations; 19.3% received the pneumococcal vaccine, 9.4% received the hepatitis A vaccine, 27.2% received the hepatitis B vaccine, 55.1% received the tetanus vaccine, and 15.2% received the pertussis vaccine. Of the socio-demographic characteristics examined, age, health insurance, marital status, and education were significant for either all five or at least four of the vaccines included in this study. As one might expect those who reported health insurance and those who had a higher level of education usually had a higher likelihood of vaccine receipt as compared to those without health insurance and those with less than a high school education. Age associations varied due to age-related recommendations for certain vaccines such as pneumococcal (recommended for adults ≥65). Compared to the married population (referent), marital status results varied, but for reasons unclear. Whites, the referent group, were the most likely to be vaccinated as compared to Blacks, Hispanics/Latinos, and Asians. Hispanics/Latinos typically had the lowest likelihood of vaccination in this examination.

Conclusions: This study further explores the impact of socio-demographic disparities on vaccination status and adds new information to the literature regarding adult vaccination rates for preventable diseases. While research exists related to strengthening interventions such as patient reminder systems, those who do not see the same health care providers on a regular basis remain at risk for lower vaccination prevalence. It is important to better understand the role of social determinants of health, specifically in terms of vaccinations. Future research is needed to further characterize the association of socio-demographic factors with receipt of optional vaccines in adults.

AN EXAMINATION OF THE SOCIO-DEMOGRAPHIC CHARACTERISTICS ASSOCIATED WITH ADULT VACCINATION PREVALENCE FOR PREVENTABLE DISEASES IN THE UNITED STATES

By

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CHAPTER I

INTRODUCTION

1.1 Background

The development and subsequent success of vaccinations has been touted as one of the "greatest public health achievements" to date and the science of vaccines accomplished what no other science could: the eradication of smallpox and the elimination of polio in the United States (U.S.) (André, 2003; Trust for America's Health, 2010; U.S. Department of Health and Human Services, 2000). Vaccines have the ability to prevent infectious diseases and also to reduce the morbidity and mortality associated with some diseases. Currently, there are vaccines available to prevent 26 infectious diseases (André, 2003). However, they often remain under-utilized especially when one considers vaccines for adults which are recommended but not required (U.S. Department of Health and Human Services, 2000). It is estimated that approximately 50,000 adults in the U.S. die annually due to one of 10 vaccine preventable diseases (Marks, 2009; Trust for America's Health, 2010).

Vaccine preventable diseases (VPDs) in the U.S., albeit not the largest public health threat, continue to create additional healthcare expenses for and pose significant risks to the health of the public (Allen, 2010). Low vaccination rates are important to address in general; however, an interesting combination of challenges arise when one considers the adult population. This is a population vulnerable to preventable diseases that are controllable via vaccinations, but such vaccinations are not required by law. In contrast, many vaccine mandates and laws exist with regards to the child and adolescent populations in the U.S. For example, while the specific list of required vaccinations can vary per state, children are not allowed to enroll in U.S. schools unless they provide proof of certain immunizations (Zimet, Maehr, Constantine, & English, 2008). In the state of Georgia, all children attending either school or childcare must receive a full series of the diphtheria, tetanus, pertussis combination vaccine before the age of seven (Georgia Department of Human Resources, 2007). For children younger than seven, parents or guardians must prove that children have started the series of shots and are following a particular vaccination schedule that will result in full vaccination by approximately 5-6 years of age (Georgia Department of Human Resources, 2007). These requirements have been effective in terms of ensuring both proper vaccination rates and subsequent lower morbidity and mortality rates amongst these populations (Zimet et al., 2008). In fact, at the end of the Healthy People 2010 timeframe it was estimated that more than 90% of children aged 0-2 had received the recommended series of vaccinations with the exception of hepatitis B and varicella (U.S. Department of Health and Human Services, 2000).

The success of child immunization practices is positive and it is important to strive to achieve similar vaccine coverage rates in adult populations since adults are exposed to many of the same VPDs that children face. Many factors impact the current vaccine coverage for adult populations. For example, healthcare professionals are not required to remind adults of optional vaccinations and updates/boosters and as a result many adults are either under-vaccinated or not vaccinated at all (Schaffner, 2008). This creates an interesting cycle because these adults, just like children, are at risk for increased morbidity and mortality. In a 2003 study researchers stated that less than 500 child vaccine-preventable deaths were reported annually in the U.S. versus nearly 39,000 adult vaccine-preventable deaths (Adult Immunization Consensus Panel, 2003). The primary reason attributed to this difference was the strong childhood immunization programs versus the lacking immunization rules for adults in the U.S. Furthermore, because unvaccinated adults can be carriers (symptomatic or asymptomatic) of many VPDs, they pose additional infection risks for infants and children who might not yet be fully vaccinated.

Just as children can transmit diseases to adults (and vice versa), vaccines have the ability to protect adults from child disease carriers via herd immunity. Herd immunity means that even though certain groups of people might not be vaccinated, they have immunity from a disease because a large enough proportion of the population is vaccinated either by acquired or inherent immunization and therefore the overall risk of disease spreading throughout the population is low ("Herd Immunity," 2010). Herd immunity is important to consider when reviewing the benefits of vaccinations for both children and adults as a vaccine not only protects the person receiving the vaccine, but it also has the potential to protect surrounding people. It is plausible to state, for example, that if enough of the U.S. child and adult populations were vaccinated against pertussis there would be a much lower risk of non-vaccinated individuals contracting pertussis due to the effects of herd immunity. Even with public service announcements that explain the benefits of vaccines along with vaccine mandates and/or recommendations, there will always be a subset of the population who declines receipt of vaccinations because of religion, personal preferences, and certain freedom of choice issues (Poland & Jacobson, 2001). However, even with this subset of the population, as more people become vaccinated the strength of the overall herd immunity becomes more protective. If vaccines are safe, effective, and accessible then one needs to consider why the U.S. loses 50,000 adults each year to various preventable diseases.

In a report by Schaffner (2008), it was stated that there are three primary reasons why adults underutilize vaccines: 1) missed opportunities, 2) no national programs for adults, 3) public misunderstanding and misconceptions. In his report, Schaffner also suggested that the remedy for the above stated challenges includes more physicians acting more proactively so as to educate and vaccinate their patients. The Healthy People 2010 report supported Schaffner's work, as it stated that not knowing what immunizations are recommended, lacking immunization recommendations from healthcare professionals, and a gap in general knowledge about immunizations are all barriers that impede adult immunization rates (U.S. Department of Health and Human Services, 2000). To further elucidate the reasons for low adult vaccination rates, another 2008 study stated that independent variables of having a "usual" place of care and having a "usual" healthcare provider were positively associated with receipt of preventive care – information that implies continuity of care is associated with adult vaccination rates (Blewett, Johnson, B. Lee, & Scal, 2008).

Reports that discuss a need for healthcare professionals to recommend vaccines along with a patient benefit from continuity of care are not scarce. These results agree with the intuitive concept that as a person visits the same healthcare facility over a period of time, an adequate medical record will be compiled and trends related to the need for annual screenings and vaccination boosters will be more apparent. As a patient's anniversary for a certain screening or treatment approaches, healthcare facilities can implement a patient reminder system so as to encourage the patient to return for his/her regular preventive care. While the solution of encouraging healthcare providers to be more proactive about patient reminders could prove to be successful, it does not account for the portion of the population who either has no access to healthcare or who does not see the same health care provider each time medical attention is needed. If the reasons adults choose to either decline or not seek out optional vaccinations are neither identified nor addressed, the number of annual illnesses and deaths attributed to vaccine preventable diseases will not improve.

1.2 Purpose of Study

Vaccine preventable diseases such as pneumonia, hepatitis A and B, tetanus, and pertussis can account for significant days of hospitalization, healthcare costs, missed work days, and overall morbidity and mortality rates (Trust for America's Health, 2010). It can be hypothesized that if adult vaccination rates for these diseases were to increase, the impact of hospitalizations, healthcare costs, missed work days, and overall morbidity could potentially decrease. Even with the proven success and safety of vaccines these vaccines remain underutilized in the adult, American population (Allen, 2010; U.S. Department of Health and Human Services, 2000). Vaccines not only protect individuals from infectious disease related disability or death, but they also help to protect entire communities by stopping the spread of infections amongst the people (U.S. Department of Health and Human Services, 2000). Existing research has shown that both patient reminder systems and healthcare providers' roles regarding vaccination efforts can increase the percent of adults who receive complete vaccine series and recommended updates. While this is important information, this type of intervention does not assist those who are not part of a primary care network, those who do not seek regular medical care, and those who are under- or un-insured. The purpose of this examination is to assess what socio-demographic characteristics influence adult vaccination receipt and what socio-demographic characteristics act as barriers to adult vaccination receipt. Literature related to adult vaccination rates must be enhanced and expanded so that public health professionals may better understand what interventions to implement in order to increase the prevalence of fully immunized adults in the U.S. This will in turn help the U.S. experience a reduction in vaccine preventable disease related morbidity and mortality rates.

1.3 Research Questions

To further investigate the reasons why adults in the U.S. choose to either receive or decline vaccines for preventable diseases, the following questions will be examined:

1. What are the demographic characteristics of individuals who choose to receive recommended vaccinations?
2. What are the socio-demographic characteristics of individuals who choose to receive recommended vaccinations?
3. Do the typical trends of social determinants of health (those who are more educated, wealthier, those who are White) also apply to vaccination trends?

CHAPTER II

REVIEW OF THE LITERATURE

The purpose of this study is to analyze the potential association between vaccination status (for pneumonia, hepatitis A, hepatitis B, tetanus, and pertussis) and access to healthcare, poverty to income ratio, race/ethnicity, age, gender, region of residence, marital status, and level of education. To support the need for this study a review of existing literature will illustrate the benefits of adult vaccines, the epidemiology of each vaccine in this examination, and the disparities (or determinants of health) that exist in the U.S. While a lot of progress has been made with regards to targeting specific at-risk populations who need optional vaccines, less is understood about the characteristics of the general adult population and overall vaccination prevalence rates and trends.

2.1 History of Vaccines in the U.S.

The oldest vaccine with published accounts of use was a vaccine for smallpox in 1798, and the first vaccine in the U.S. that was licensed for use was the influenza vaccine in 1945 ("Vaccine History: license and/or first manufacture," 2010). Since then numerous additional vaccines have been developed and licensed for use in both adults and children. Vaccines are broadly regarded as one of the most important advances in medicine, and vaccines have been called a "cornerstone" of the success of medicine in general (Baeyens & Michel, 2010). Even the most general literature search will yield reports of the success of vaccines in terms of reducing overall incidence of many infectious diseases. These reductions in incidence appear to be even more impactful when the prevalence of vaccine receipt increases. For example between the years of 1940-1945, approximately 175,000 cases of pertussis were reported per year (Atkinson, Wolfe, Hamborsky, & McIntyre, 2009). After the pertussis vaccine was introduced into clinical practice in the mid-1940s, pertussis incidence rates steadily declined and went from 15,000 cases per year in 1960 to 5,000 cases per year in 1970 to 2,900 cases per year between the years of 1980-1990 (Atkinson et al., 2009). The success of vaccines contributed, in part, to the fact that the U.S. no longer considers infectious diseases the primary source of morbidity and mortality in the country (Turnock, 2009). Additionally, vaccines have been included on the list of reasons why the life expectancy of adults worldwide has increased (Baeyens & Michel, 2010).

2.2 Healthy People 2010

Healthy People, an initiative aimed at establishing health objectives for the U.S., was first developed after the release of the 1979 Surgeon General's Report titled "*Healthy People: The Surgeon General's Report on Health Promotion and Disease Prevention*" (U.S. Department of Health and Human Services, 2000). Subsequent Healthy People editions were released in 1990, 2000, and 2010. The Healthy People initiative creates new goals and objectives related to the improving the health and reducing health disparities for Americans. Updated or new goals and objectives are published every 10 years and during each decade, progress related to the goals is tracked nationwide.

Healthy People 2010 included 467 objectives within 28 focus areas for residents in the U.S. The overall mission of the 2010 initiative, released in 2000, was to improve the health of the American public via prevention efforts focused on the reduction of illness and disability as well as the avoidance of premature death (U.S. Department of Health and Human Services, 2000). With that mission in mind, two primary goals were declared: to increase quality and length of life and to eradicate health disparities (U.S. Department of Health and Human Services, 2000). In the initiative 10 leading health indicators were selected because they affect the general public and because they can be measurably tracked for progress. Additionally, the leading health indicators must also have an ability to influence action.

The Healthy People initiative lists immunizations as one of the top 10 leading health indicators for the nation. The most recent reports of vaccination levels show significantly different accomplishments for children versus adults (Trust for America's Health, 2010; U.S. Department of Health and Human Services, 2000). The results of Healthy People 2010 indicate that while definite progress has been made, the U.S. did not accomplish its immunization goals overall. For example, the goal for pneumococcal vaccine coverage of adults in the U.S. was set at 90% yet as of 1998, only 46% of this population reported receipt of the vaccine (U.S. Department of Health and Human Services, 2000). Additionally, the Healthy People 2010 goals for DTap (diphtheria, tetanus, and pertussis), polio, MMR (measles, mumps, rubella), and Hib (*Haemophilus influenzae* type b) vaccine coverage were set at 80% of the population, yet as of 1998 only 73% of the population received these vaccines (U.S. Department of Health and Human Services, 2000). These incomplete immunization outcomes illustrate the divide between what vaccines are recommended for adults and what vaccines adults are actually receiving.

2.3 Social Determinants of Health

Along with immunization goals the Healthy People 2010 report also focused on disparities, or social determinants of health, that negatively affect health in general such as:

race/ethnicity, gender, income, educational attainment, and access to health care/health insurance (U.S. Department of Health and Human Services, 2000). While these social determinants of health exist in general terms, they also exist specifically in terms of immunization rates. For example, much research has been conducted regarding racial differences and vaccination prevalence. During a focus group study in San Francisco, California researchers addressed attitudes about vaccination and found that African Americans were less trusting of vaccines and healthcare in general as compared to any other race (N. A. Daniels, Juarbe, Rangel-Lugo, Moreno-John, & Pérez-Stable, 2004). Additionally, the Adult Immunization Consensus Panel developed a report specifically addressing immunization rates in African-American adults because there was such a noted difference in both their use of health care as well as their immunization rates (Adult Immunization Consensus Panel, 2003). In a study that addressed issues of immunization and inner-city populations, a racial disparity was noted for pneumococcal vaccination rates in older adults (Nowalk, Zimmerman, Tabbarah, Raymund, & Jewell, 2006).

There is vast research demonstrating the various health disparities experienced in the U.S. The Healthy People 2010 report detailed the following examples of certain health disparities: on average, women in the U.S. live 6 years longer than men even after adjusting for genetic rationale. Race/ethnicity remains a disparity as death attributed to heart disease affects 40% more African Americans than Caucasians. There is a positive relationship between income and health status, meaning those who earn less money tend to be in poorer health. A similar pattern holds true for level of education achieved in that those with higher educational attainment tend to have better health statuses. People with disabilities tend to have less access to medical care or to medical services. Geographic location continues to be a disparity as we note residents in rural areas of the U.S. experience 40% more injury-related deaths as compared to their counterparts in urban environments. Finally, in terms of sexual orientation, males in the United States who identify as homosexuals have a 2-3 times increased risk of attempting suicide as compared to their heterosexual counterparts.

In order to properly address these disparities as well as any trends related to the vaccination rates in this examination, it is important to first understand the diseases: their infectious agents, their transmission routes, the associated symptoms (acute and long term), the applicable treatments available, and prevention – specifically their related vaccines. Additionally, it is important to grasp the burden of each disease in terms of prevalence rates within the U.S. along with how vaccines have affected prevalence rates over time.

2.4 Pneumonia

Pneumococcal disease can result in pneumonia, bacteremia, or meningitis (Atkinson et al., 2009). Pneumococcal pneumonia is the most common syndrome of pneumococcal disease infection and community-acquired pneumonia, regardless of age, is most often attributed to infection from pneumococcal disease bacteria (Atkinson et al., 2009; Heymann, 2008). Pneumococcal pneumonia is also often a secondary complication from influenza or measles infection (Atkinson et al., 2009). For the purposes of this examination, we will focus primarily on pneumococcal pneumonia instead of bacteremia or meningitis.

In 2006 in the United States, the Centers for Disease Control and Prevention stated that 1.2 million people were hospitalized due to pneumonia and 55,477 people died from pneumonia (Centers for Disease Control and Prevention, 2009). Each year it is estimated that 30-100 cases of pneumonia per 100,000 people occur across Europe and North America and 10,000-14,000 people in the U.S. die from pneumococcal disease (Heymann, 2008; U.S. Department of Health and Human Services, 2000). Pneumonia primarily affects the elderly population, infants, and those with certain pre-existing conditions such as cardiovascular disease, diabetes, cirrhosis, HIV infection, and chronic renal failure (Heymann, 2008). While antibiotic treatment for pneumococcal pneumonia exists, studies have shown there is an approximate case-fatality rate of 5-7% for community-acquired pneumonia; this number is likely to significantly increase when only focusing on those most at risk such as the elderly (Atkinson et al., 2009; Marks, 2009). In addition to potential treatment, there is growing concern for infection with antibiotic resistant organisms. Recently researchers estimated that up to 40% of the pneumococcal isolates in the U.S. are resistant to penicillin therefore requiring stronger antibiotics to treat these infections (Atkinson et al., 2009).

The bacteria of pneumococcal disease, *Streptococcus pneumonia,* has at least 90 serotypes and 10 of the most commonly found serotypes account for an estimated 62% of pneumococcal disease globally (Atkinson et al., 2009). *S. pneumonia* can be found in the upper respiratory tract, most commonly in the nasopharynx, and is often found in otherwise healthy humans (Heymann, 2008, p. 473). As a result, many people are able to transmit the disease even though they are asymptomatic. The rate of asymptomatic carriage of *S. pneumonia* can vary depending on multiple socio-demographic and health status characteristics (Atkinson et al., 2009). For example, military establishments note the highest rate of asymptomatic carriers, with students and orphanages following a close second (Atkinson et al., 2009). Adults with no children seem to have the lowest rate of asymptomatic carrying, but more research is needed to better understand these trends (Atkinson et al., 2009).

Once a person is a carrier for *S. pneumonia*, pneumococcal pneumonia can easily be transmitted via droplet spread from sneezing, coughing, and general close human contact (Heymann, 2008). While large outbreaks of pneumonia are not common, they are possible, and they most often occur in overcrowded environments such as nursing homes, hospitals, correctional facilities, and military bases (Atkinson et al., 2009). The combination of asymptomatic carriers along with the ease of disease transmission is concerning in terms of the potential rate of new pneumonia cases each year.

Pneumococcal pneumonia infects the lungs and symptoms include high fever, chest pain, dyspnea, malaise, weakness, and a "rusty" sputum producing cough (Atkinson et al., 2009; Marks, 2009). Onset of symptoms is usually sudden; however, the elderly population sometimes experiences a more gradual onset. Along with the acute symptoms, additional complications from pneumonia infections are possible and include: infections of the pleural space, pericarditis, and even lung abscesses (Atkinson et al., 2009). Pneumonia can affect people of all ages, but as per usual with many illnesses, certain populations are at higher risk such as: children, the elderly, and those with compromised immune systems (Heymann, 2008).

The U.S. licensed the first pneumococcal disease vaccine in 1977. This original vaccine addressed 14 serotypes of pneumococcal disease. It was replaced by a new version in 1983 (Atkinson et al., 2009). The 1983 vaccine, named PPSV23 (Pneumovax 23 by Merck and Company, and Pnu-Immune 23 by Lederle Laboratories) was designed to protect against 23 types of pneumococcal bacteria; however, it is important to note that it is more effective against pneumococcal bacteremia versus pneumonia (Atkinson et al., 2009). According to the CDC, PPSV23 is recommended for all adults over the age of 65 who have not received previous doses.

The vaccine is also safe for people between the ages of 2 - 65 as well as who are at an increased risk for the disease due to compromised immune systems, residence at long-term care facilities, and those with certain pre-existing conditions (Marks, 2009). PPSV23 antibody levels remain constant for approximately 5-10 years and revaccination is not typically recommended, though this can vary depending on the person's age at time of initial vaccination as well as the person's health status (MMWR, Centers for Disease Control and Prevention, 1997). The PPSV23 vaccine has proven to be successful and CDC estimates that the PPSV23 vaccine prevents approximately 60-70% of pneumonia cases in adults who are vaccinated (Marks, 2009).

While the purpose of this examination focuses on adults, it should be noted that an additional pneumococcal vaccine for children was released in 2000. This vaccine, PCV7, protects against seven serotypes of *S. pneumonia* and is recommended for children under 24 months as well as children between 24-59 months who have pre-existing conditions (Atkinson et al., 2009). The PCV7 vaccine for children has had a positive effect on the adult population, because as children are vaccinated, the chance of them passing the disease to surrounding adults decreases and therefore less adults become infected (Schaffner, 2008).

The pneumococcal vaccination is underutilized (Allen, 2010). After tracking vaccination rates from 1991-1998, a Healthy People report estimated that only about 46% of the U.S. population over the age of 65 received the pneumococcal disease vaccine (U.S. Department of Health and Human Services, 2000). When the Healthy People 2010 goals were set in 2000, the hope was that after a ten year effort to increase vaccine coverage, 90% of adults over 65 years of age would be vaccinated against pneumococcal disease (U.S. Department of Health and Human Services, 2000). While the exact numbers vary, current estimates suggest that the Healthy

People 2010 goal was not met. In fact, some studies show that these vaccination rates fell nearly 30% short of the 2010 goal (Marks, 2009). Given the number of public health efforts to vaccinate people against pneumococcal disease, especially the efforts aimed at ensuring the elderly population is vaccinated, reasons for the unmet Healthy People 2010 goals remain unclear.

2.5 Hepatitis A

Before the 1940s there was no distinction between hepatitis A and hepatitis B; however, around 1940 new serologic tests enabled researchers to define a difference between the two disease types (Atkinson et al., 2009). While hepatitis A is not consistently prevalent in the U.S. this country experiences an epidemic approximately once every decade (Heymann, 2008). Hepatitis A became a reportable disease in 1966 and in 1971 the U.S. experienced a record breaking (high) number of 59,606 reported cases in a single year (Atkinson et al., 2009). Between the years 1987-1997 hepatitis A was named one of the U.S.' most frequently reported diseases from the notifiable diseases list, and during this time the U.S. experienced an average 28,000 hepatitis A cases (D. Daniels, Grytdal, & Wasley, 2009).

Hepatitis A is caused by Hepatitis A Virus (HAV), a virus that is transmitted via a fecal-oral route. This can be a result of direct human contact and lack of hygiene as well as a result due to poor water or food quality; the latter being more common in developing nations with inherent water and food quality challenges. From 1990-2000 the most frequent source of infection in the U.S. was reported as "unknown" (45%); however, of those who were able to identify the source of infection the most common transmission route was via sexual and/or household contact with an infected person (14%) (Atkinson et al., 2009).

Symptoms of hepatitis A include fever (with quick onset), malaise, lack of appetite, abdominal pain, darkened urine, and jaundice. When symptoms are present they can last up to six months with an average duration of two months (Atkinson et al., 2009; Heymann, 2008). Given the potentially long duration of these debilitating symptoms, hepatitis A infection has the potential to be significant in terms of lost wages, funds spent on prolonged medication for treatment, hospitalization, and other medically-related expenses. In fact studies have suggested that approximately 11-22% of people who contract hepatitis A become hospitalized, resulting in unexpected healthcare costs as well as time spent unable to work or take care of daily life activities (Atkinson et al., 2009).

A vaccine for hepatitis A was introduced in 1995 at which point, it was recommended for international travelers (Atkinson et al., 2009). The vaccine consists of two injections; one initial shot and one booster dose (Atkinson et al., 2009; D. Daniels et al., 2009; Heymann, 2008). In 1996 Advisory Committee on Immunization Practices (ACIP) expanded the recommendation for hepatitis A vaccine to include men who have sex with men as well as drug users (D. Daniels et al., 2009). In 1999, ACIP once again the broadened the hepatitis A vaccination recommendations to include all children older than two years of age who lived in areas of the U.S. where annual hepatitis A rates were two times higher than the national average (listed as prevalence rates ≥ 20 cases per 100,000 people) (Atkinson et al., 2009). ACIP again updated its recommendations so that as of 2005, all children in the U.S. between the ages of 12-23 months would be vaccinated (D. Daniels et al., 2009; Heymann, 2008). This plan also included catch-up guidelines for children 2 years or older who were not yet vaccinated. The hepatitis A vaccine became part of the routine child vaccination plan as of 2006 (D. Daniels et al., 2009).

In a recent publication from the Morbidity and Mortality Weekly Report, incidence of hepatitis A experienced a significant decline, as rates went from 12/100,000 people to 1/100,000 people between 1995-2007 (D. Daniels et al., 2009). This report also stated that the 2007 hepatitis A incidence rates were the lowest that the U.S. has ever experienced (D. Daniels et al., 2009). There are currently two forms of the hepatitis A vaccine available in the U.S. and their efficacy in terms of preventing hepatitis A infection ranges from 94%-100% (Atkinson et al., 2009). It is estimated that the vaccine remains protective for at least 20 years; however, because the vaccine has only been in existence since 1995 additional research regarding long-term efficacy is currently underway (Atkinson et al., 2009). Per the aforementioned statistics, it is appears that the hepatitis A vaccination efforts in general have been successful; however, the published rates of hepatitis A incidence do not distinguish between adult versus child cases. Therefore it remains unclear as to whether adults are either appropriately or under-vaccinated.

2.6 Hepatitis B

The CDC estimates that 2 billion people throughout the world have been infected with the hepatitis B virus at some point in their lives and that 350+ million people suffer from chronic infection (Atkinson et al., 2009). In the U.S., most adult acute hepatitis B infections are resolved, although the long term potential complications can remain. It has been stated that each year the U.S. sees 5,000-8,000 new cases of chronic hepatitis B and that the adult population accounts for 95% of new cases (Atkinson et al., 2009).

Hepatitis B is caused by the hepatitis B virus (HBV), a virus that can be transmitted either via a perinatal route or via bodily fluids such as blood and serum. HBV is also known to penetrate mucosal surfaces, therefore allowing infections to occur not only from obvious routes such as needle sticks/sharing and sexual contact, but also from hand-to-eye or mucosal lesion contact with an infected source of blood or bodily fluid (Atkinson et al., 2009; Heymann, 2008). In the U.S. the most commonly reported route of transmission is via sexual contact (Atkinson et al., 2009). Even though injection drug use accounts for only 15% of the primary risk factors associated with hepatitis B infection, this risk factor can be quite significant over time. After one year of injection drug use, approximately 40% of drug users will become infected with the virus and after 10 years of drug use, approximately 80% of drug users will become infected with the virus (Atkinson et al., 2009).

Symptoms of acute hepatitis B infection include general malaise (which can last for weeks and months), vomiting, upper abdominal pain towards the right side of the body, and skin rashes. Jaundice often occurs after the aforementioned symptoms appear, followed by light or gray stools and hepatic tenderness (Atkinson et al., 2009). There is no specific treatment for hepatitis B other than management of symptoms and monitoring of a patient's overall health (Heymann, 2008). It should be noted that in approximately 50% of adults, acute infection is asymptomatic. Aside from chronic symptoms in some patients, other long-term effects of hepatitis B include cirrhosis of the liver and hepatocellular carcinoma. In fact, hepatitis B is attributed to approximately 80% of the global burden of hepatocellular carcinoma (Heymann, 2008).

In 1982 the first hepatitis B vaccine was released. There are now two types of hepatitis B vaccines available, including a combination hepatitis B/hepatitis A vaccine option (Heymann, 2008). The hepatitis B vaccine includes a series of three shots and a person is not considered fully immunized until the full series has been completed (Heymann, 2008). The vaccines have been shown to protect against hepatitis B infections for at least 15 years and there is no schedule or recommendation for re-vaccination once a full series of the vaccine has been administered (Atkinson et al., 2009). The hepatitis B vaccines have proven efficacy; however, their impact has not been as drastic as researchers originally hoped since targeting the highest risk populations (injection drug users, heterosexuals with multiple partners, and men who have sex with men) is difficult (Atkinson et al., 2009). Therefore, in order to eliminate hepatitis B transmission the U.S. now recommends the following: screening for HBV in pregnant women and subsequent treatment for newborns; full immunization for at risk populations based on employment hazards (i.e. healthcare or laboratory workers) and sexual habits; immunization for all infants; and catch up immunization plans for any adolescents who did not complete a vaccination series during infancy (Heymann, 2008). It has been shown that countries with a high rate of infant hepatitis B vaccination coverage exhibit the largest decline of hepatitis B incidence and prevalence rates (Heymann, 2008).

2.7 Tetanus

Tetanus is one of the most serious preventable diseases in this examination, as fatality rates are often high depending on the person and the environment. It has been reported that 11% of all reported tetanus cases result in death and that number increases for those over the age of 60 and for those who are not vaccinated (Atkinson et al., 2009). Some of the tetanus-related deaths can be attributed to secondary issues such as nosocomial infections and pulmonary embolisms, but 20% of all tetanus deaths are due to the tetanus toxin (Atkinson et al., 2009). Tetanus is most often noted in environments that are hot and humid, as well as those that have soil which contains high concentrations of organic matter (Atkinson et al., 2009).

Tetanus is caused by the bacteria *Clostridium tetani*, a naturally occurring and spore-forming bacterium found in soil, animal feces, some skin surfaces, and heroin that has been contaminated (Atkinson et al., 2009). *C. tetani* produces two toxins, but the primary fatal toxin is called tetanospasmin. Tetanospasmin is a neurotoxin that causes severe symptoms and complications when introduced to an under-vaccinated or non-vaccinated human. Tetanospasmin is lethal and CDC states that a dose of 2.5ng/kg of tetanospasmin can kill a human weighing approximately 70 kg (or 154lbs) (Atkinson et al., 2009). Transmission of *C. tetani* from the environment into the human body typically occurs via a bodily wound. This can be a result of an accident or other injury as well as via needles used for injection drug "popping" – a process in which a drug, often heroin, is injected just under the skin (Atkinson et al., 2009). A tetanus infection and subsequent potential tetanus-related death is not because of the bacteria alone, but rather, is attributed to the bacteria's production of the tetanospasmin toxin (Atkinson et al., 2009; Heymann, 2008).

Symptoms of an acute tetanus infection include lockjaw, muscle contractions or rigidity, muscle spasms, difficulty with swallowing, and seizures. Muscle spasms can last for 3-4 weeks and longer term effects such as hypertension, sepsis from catheters, and other nosocomial infections are secondary risks. Treatment for a tetanus infection includes wound cleaning, removal of necrotic tissue as applicable, and other therapies to address muscle spasms and airway restriction challenges. Additionally, tetanus immune globulin (TIG) can be administered which helps the body rid itself of any tetanospasmin toxin that has not yet bound to nerve endings. It does not, on the other hand, remove any toxin that has already bound itself to nerve endings or reverse the toxin's negative affects (Atkinson et al., 2009). Once the person's health is stable the tetanus vaccine should also be administered to protect against future infections.

The tetanus vaccine was first added to the routine child immunization schedule in the 1940s, when 0.4 cases per 100,000 people were diagnosed with tetanus in the U.S. annually (Atkinson et al., 2009). In 2003, the U.S. experienced the lowest number of reported cases in history: 0.01 cases per 100,000 people. Almost all of the reported cases of tetanus in the U.S. can be linked to people who are either not vaccinated, or, people who are overdue for a booster shot. The initial vaccination schedule includes 4 doses between 2-18 months of age. The primary vaccine used is a combination vaccine that includes protection against diphtheria, tetanus, and pertussis. The initial vaccination schedule can vary depending on the age at which a child receives his first dose of the vaccine. A vaccine without pertussis may also be used if the child has an adverse reaction to the pertussis vaccine. A booster dose of tetanus and diptheria is needed every 10 years to ensure proper immunization levels exist. While the recommendations for tetanus vaccination and subsequent boosters every 10 years are clear, the process of reminding patients to receive their boosters remains a challenge (Jacobson Vann & Szilagyi, 2008).

2.8 Pertussis

In countries where the vaccine is either unavailable or not used widespread, pertussis causes a significant number of deaths annually (Atkinson et al., 2009). In the U.S. pertussis has had a curious pattern of incidence, as it is one of the only vaccine preventable diseases experiencing a rise in incidence (Judelsohn & Koslap-Petraco, 2007). Pertussis was one of the primary causes of child mortality until the development of a vaccine in the 1940s (Atkinson et al., 2009). In the 1960s the U.S. noted approximately 8 pertussis cases per 100,000; this number decreased to 5 per 100,000 in 1970 and during the 1980-1990 decade, the U.S. saw approximately 1 case per 100,000 people (Atkinson et al., 2009; Heymann, 2008). Overall, it is estimated that the incidence of pertussis has decreased by at least 80% since the development of a vaccine(Atkinson et al., 2009); however, since the 1980s the incidence of pertussis cases has started to increase and in 2004 the nation witnessed the highest number of cases (25,827 cases) since 1959 (Atkinson et al., 2009). While some researchers attribute at least a portion of this increase in reported cases to better diagnostic, surveillance, and reporting tools no definitive reason for this increased incidence has been identified (Atkinson et al., 2009; Judelsohn & Koslap-Petraco, 2007).

Pertussis is caused by the bacteria *Bordetella pertussis* which is a toxin-releasing bacterium. Transmission occurs via contact with respiratory droplets, either directly or indirectly via airborne droplets. The toxins excreted from *B. pertussis* paralyze the cilia in the human respiratory tract and also cause inflammation; both actions therefore making it difficult for a person's respiratory system to tolerate and rid itself of secretions and mucus. This lessened ability to clear secretions and mucus results in an initial round of symptoms similar to a cold: sneezing, runny nose, mild fever, and mild cough. These symptoms increase in severity and the mild cough transitions to one that is episodic, often involving thick mucus that is difficult to expel and that creates shortness of breath for the patient. Additionally, after some of the coughing episodes, a "high-pitched whoop" can be heard (Atkinson et al., 2009, p. 200). Sometimes the coughing attacks are either frequent or violent enough to result in vomiting. Coughing attacks are more common during the night hours, so general malaise and exhaustion often accompany a pertussis infection.

Infected adults often encounter a milder form of pertussis but it is important to keep in mind that anyone infected with pertussis (regardless of the severity of the infection) is able to infect others – especially those who are either under or not vaccinated. The CDC has stated that in a household where more than one pertussis case is identified, the source case is often the older person in that household (Atkinson et al., 2009). In terms of treatment for pertussis, supportive therapy is the most common plan and patients are monitored so that undesirable symptoms can be managed. Antibiotics are sometimes administered in order to reduce communicability and duration of disease, but this is not always effective. Antibiotics are more often administered as a prophylaxis to the close contacts of the pertussis case (Sandora, Gidengil, & G. M. Lee, 2008).

The first pertussis vaccine was introduced in the 1940s, but many newer vaccines have emerged since then. Each version of the vaccine differs only in that it has varying levels of concentrations which are applicable to specific age groups. All pertussis vaccines are of the combination variety and are mixed with tetanus and diphtheria vaccines. The child schedule for pertussis vaccinations includes 4 series of injections between the ages of 2-18 months. Depending on the type of vaccine administered and the schedule followed, booster shots are sometimes needed when the child enters school – typically between the ages of 4-6. After the initial series is completed, a booster shot is usually recommended between the ages of 11-12 years and adults who might not have received pertussis vaccines as children should consider a booster shot between the ages of 19-64 (Atkinson et al., 2009; "CDC Features - Pertussis (Whooping Cough) – What You Need To Know," 2009; Heymann, 2008). Healthcare workers are classified as a priority group when considering pertussis vaccination since they are at a higher risk of infection due to patient contact, and since they could also transmit the disease to their patients (Sandora et al., 2008). This same recommendation holds true for those in close contact with infants younger than one year of age (Brooks & Clover, 2006).

2.9 Summary

Even though the aforementioned diseases are all unique they have one primary commonality: they are preventable via safe and effective vaccines available in the U.S. Organizations such as CDC have prepared multiple vaccination schedules, as seen in the modified recommended immunization schedule for adults (Figure 1) below. While the recommendations are clear to researchers and scientists, the fact that vaccination rates for U.S. adults remain lower than expected begs the question as to whether these recommendations are also clear to the general public. It is imperative that more research is done to investigate the reasons for low vaccination rates so that better interventions can be designed.

Figure 1. U.S. recommended adult immunization schedule, 2010

Vaccine	**Age Group (years)**				
	19-26	**27-49**	**50-59**	**60-64**	**≥65**
Tetanus, diphtheria, pertussis (Td/Tdap)	Td booster every 10 years; substitute one dose Tdap for Td booster.				Td booster every 10 years
Pneumococcal	1 or 2 doses				1 dose
Hepatitis A	2 doses				
Hepatitis B	3 doses				

(Adapted from CDC Vaccines & Immunizations webpage, 2010)

White = recommended
Gray = recommended if additional risk factor is present (medical, occupational, lifestyle)

Chapter III

METHODOLOGY

3.1 Data Source

The data used in this study were obtained from the National Health Interview Survey (NHIS), a publicly available database that contains de-identified information. The NHIS is part of the National Center for Health Statistics (NCHS), a division of the Centers for Disease Control and Prevention (CDC). The NHIS first began in July of 1957 as a result of the 1956 National Healthy Survey Act. This act "provided for a continuing survey and special studies to secure accurate and current statistical information on the amount, distribution, and effects of illness and disability in the U.S. and the services rendered for or because of such conditions" (National Center for Health Statistics, 2010). The NHIS collects information from the U.S. non-institutionalized and civilian population. NHIS' primary goal is to monitor the health of the U.S. The sampling design of the NHIS is based on each decennial census and updated as needed. The sampling design begins with 428 primary sample units (PSU's) which represent a county, a combination of neighboring counties, or a metropolitan statistical area. Overall, the PSU's represent the 50 States in the U.S. as well as the District of Columbia. Additionally, each PSU is divided into two partitions: area segments and permit segments. Area segments are delineated via geographic cut points and permit segments focus on housing units. This is done to ensure that multiple family dwellings such as apartment complexes are not under-represented in the overall sample.

It is important to keep in mind that the NHIS includes an oversampling process for the Black, Asian, and Hispanic/Latino populations. This is managed via an initial oversampling plan for certain area segments within a PSU. Oversampling is also accomplished via a screening process during the time of a household interview. If the household does not have one or more Black, Hispanic/Latino, or Asian person that interview is stopped and the household is considered "screened out". NHIS also oversamples the elderly portion of these groups so that adults aged ≥65 in the Black, Hispanic/Latino, or Asian populations are adequately represented. Along with oversampling, NHIS implemented weighting methodology. The 2008 NHIS sample included 29,421 families in 28,790 households with a total of 74,236 people. Of the total number of people, 29,421 were eligible to complete the Sample Adult questionnaire. A total of 21,781 adults completed these questionnaires. In order to ensure this sample was representative of the nation, data for certain variables were weighted accordingly.

Surveys are conducted continuously throughout each year and data become available to the public annually. Surveys are conducted by trained interviewers who are employees of the U.S. Bureau of the Census. Surveys contain two main sections: a Core questionnaire and a Supplemental questionnaire. The Core questionnaire is subdivided into an overall household section, a family section, a sample adult section, and a sample child section. The two "sample" sections are completed by one adult and one child within the household and the questions are based on more of an individual concept than a family or household concept. The Core questionnaire addresses basic information such as demographics and health status. The Supplemental questionnaire allows for the reporting of new public health data as needed. Examples of Supplemental data include Healthy People 2010 data, complementary and alternative medicine data, and children's mental health data. Survey data is collected onsite via a computer assisted personal interviewing (CAPI) process – in other words, a person completing a survey enters his or her answers directly into a laptop computer provided by the interviewer.

NHIS presents the data online in ASCII format. Users are able to download the files and input them into a variety of statistical software programs. Sample syntax files for SPSS, SAS, and STATA are provided on the NHIS website. For this examination, data files were downloaded from the NHIS website and converted to Statistical Package for Social Sciences (SPSS)® version 17.0 files. SPSS 17.0 was used for all analytics in this examination.

3.2 Study Population

The NHIS includes the civilian and non-institutionalized population residing in the U.S. at the time of the survey. Adults and dependents who reside in a household with an active member of the Armed Forces are able to be included in the survey; however, the active military person is excluded. Along with the incarcerated and active duty military populations, patients in long term care facilities and U.S. citizens who reside in other countries are also excluded from the survey. Age is not an exclusion factor, except in the case of a sample adult or sample child questionnaire. In these cases, age becomes an important inclusion factor though it should be noted that with regards to the sample child questionnaire, an adult in the household is allowed to answer on behalf of a minor, if that preference exists. Survey participation is voluntary and confidential.

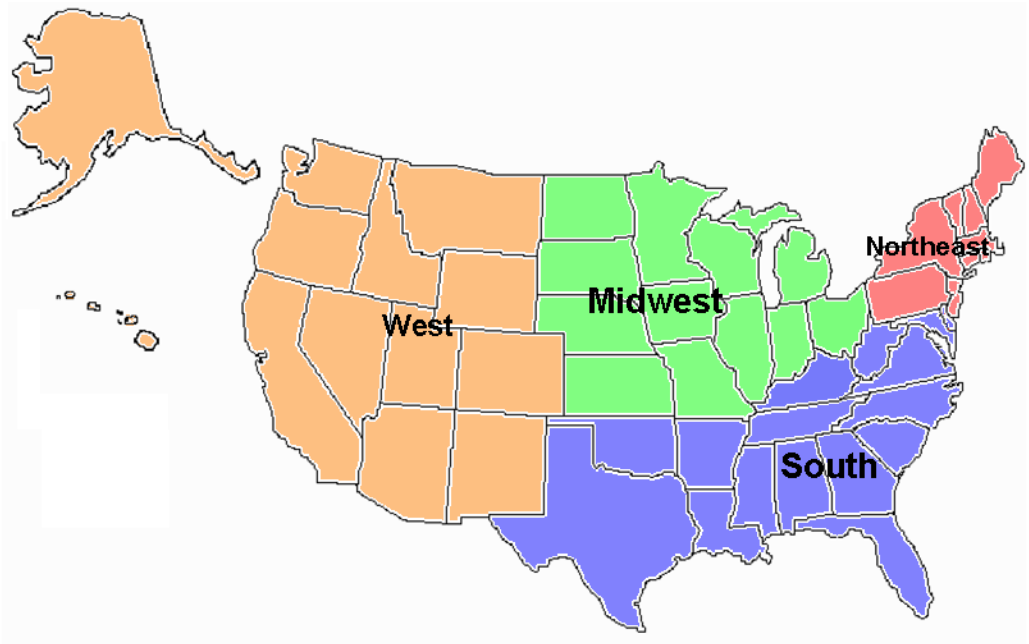
In this examination data from 2008 were used; specifically the household, family, person, and sample adult files. Adults greater than or equal to 18 years of age were the only respondents included in the final dataset. No other exclusions were applied.

3.3 Study Measures

The primary dependent variable for this analysis was receipt of vaccination, which was analyzed by specifically looking at five different vaccines: hepatitis A vaccine, hepatitis B vaccine, pneumococcal disease vaccine, tetanus vaccine, and pertussis vaccine. To address these dependent variables, subjects were typically asked if they had ever received each of these vaccines. In the case of hepatitis A and B, subjects were also asked to quantify how many shots they received if they responded “yes” to whether they had ever received the vaccine. Finally, pertussis vaccination status was asked only to those who had answered affirmatively to the receipt of a tetanus shot within the past 10 years. This is because the pertussis vaccination never stands alone and if offered, is always in combination with tetanus and/or tetanus and diphtheria.

The socio-demographic independent variables used in this study were as follows: race, gender, age, health insurance status, region of the U.S., marital status, education, and poverty to income ratio. Details related for each independent variable including coding are listed in Table 1. Additional information regarding the specific states per region of the U.S. variable can be seen in Figure 2 below.

Figure 2. Map of the U.S. with NHIS grouping of regions.



Northeast: Maine, Vermont, New Hampshire, Massachusetts, Connecticut, Rhode Island, New York, New Jersey, Pennsylvania.

South: Delaware, Maryland, District of Columbia, West Virginia, Virginia, Kentucky, Tennessee, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Oklahoma, Arkansas, Texas

Midwest: Ohio, Illinois, Indiana, Michigan, Wisconsin, Minnesota, Iowa, Missouri, North Dakota, South Dakota, Kansas, Nebraska

West: Washington, Oregon, California, Nevada, New Mexico, Arizona, Idaho, Utah, Colorado, Montana, Wyoming, Alaska, Hawaii

Table 1. Socio-demographic variables and coding

Variable	Coding
Race	1 = White 2 = Black 3 = Hispanic/Latino 4 = Asian 5 = Other (Alaskan Native, American Indian, multiracial, and people who refused to answer)
Gender	1 = Male 2 = Female
Age	1 = 18-24 2 = 25-34 3 = 35-44 4 = 45-54 5 = 55-64 6 = 65-above
Health Insurance Status	1 = Not covered 2 = Covered
Region of U.S.	1 = Northeast 2 = Midwest 3 = South 4 = West
Marital Status	1 = Married 2 = Separated 3 = Divorced 4 = Single/never married 5 = Widowed
Education	1 = Less than high school 2 = High school diploma/GED 3 = Some college (including associate's degree) 4 = Bachelor's degree 5 = Master's degree or higher
Poverty to Income Ratio	1 = Poor (family income is below U.S. poverty threshold) 2 = Near poor (family income is 100% - < 200% of U.S. poverty threshold) 3 = Not poor (family income is ≥ 200% of U.S. poverty threshold)

3.4 Statistical Analysis

Descriptive statistics were created to describe the overall population sample. To better understand the population with regards to each vaccine, descriptive tables were also produced per immunization type. An odds ratio calculation was performed to test the association between receipt of each vaccine and the aforementioned social and demographic characteristics. Using a binary logistic regression analysis, odds ratios were calculated along with 95% confidence intervals and p-values. A p-value of less than 0.05 was considered a statistically significant association between the socio-demographic factor and the receipt of the vaccine.

To further examine potential association between the dependent and independent variables, multivariate logistic regression analyses were performed for each vaccine where all socio-demographic factors were considered at once. Odds ratios were once again calculated, along with 95% confidence intervals and the aforementioned accepted p-value of less than 0.05.

Chapter IV

RESULTS

4.1 Frequencies and Descriptive Statistics

Frequency and descriptive statistics about the study sample are detailed in Table 2. Overall the sample size included 21,781 people; 56.3% were female and 43.7% were male. Caucasian people were the most represented race/ethnicity among the study population (61%) and Asian people were the least represented race/ethnicity (5.7%). The delineation of "other" within the race/ethnicity category consisted of Alaskan Natives, American Indians, multiracial people, and people who refused to state their race/ethnicity. For statistical purposes, the total N for this was group so small (1.2%) that the delineation will not be addressed in the results section of this examination. While the study aimed to have an even representation of people from each region of the U.S., the South had the highest representation (36.9%). For the purpose of this study, which focused on adults, all respondents were adults over the age of 18. The age of participants was approximately evenly distributed except for the age range of 18-24 (9.8% - lowest) and the age range of 65-above (20.4% - highest). Most respondents reported having some type of health insurance (83.2%). Region of residence in the U.S. was lowest for the northeast (16.4%) and highest for the south (36.9%). Almost half of the respondents were married (45.5%) and more than half had either high school or some college education (56.3%). With regards to the poverty to income ratio, the majority of the population fell into the not poor category (55.6%). It should be noted that the poverty to income variable had the highest reported refused/don't know delineation (11.7%). This is because a large number of respondents either refused to provide specific family income data or family income data in general, and the calculated poverty to income ratio processed by the 2008 NHIS depended on family income data.

Table 2. Socio-demographic characteristics of eligible adult subjects who completed the 2008 NHIS

Variable	N	Percent
Overall total	21781	100
Race		
White	13289	61.0
Black	3365	15.4
Hispanic/Latino	3673	16.9
Asian	1238	5.7
Other*	216	1.0
Gender		
Male	9514	43.7
Female	12267	56.3
Age		
18-24	2130	9.8
25-34	3944	18.1
35-44	3947	18.1
45-54	3970	18.2
55-64	3346	15.4
65-above	4444	20.4
Health Insurance status		
Covered	18122	83.2
Not covered	3601	16.5
Refused/Don’t know	58	0.3
Region		
Northeast	3562	16.4
Midwest	4924	22.6
South	8033	36.9
West	5262	24.2
Marital status		
Separated	772	3.5
Divorced	3247	14.9
Married	9903	45.5
Single/never married	5613	25.8
Widowed	2159	9.9
Unknown	87	0.4
Education		
< High School	3749	17.2

High School Diploma or GED	5853	26.9
Some college (incl. AA degree)	6399	29.4
Bachelor’s degree	3757	17.2
Master’s degree or higher	1874	8.6
Refused/Don’t know	149	0.7
Poverty to Income Ratio**		
Poor	2455	16.2
Near poor	2506	16.5
Not poor	8442	55.6
Refused/Don’t know	1769	11.7

*defined as Alaskan Native, American Indian, multiracial, and people who refused to answer
**based on reported income and the U.S. Census Bureau poverty threshold. Poor = family income is below the poverty threshold; near poor=family income 100% - <200% of the poverty threshold; not poor = family income ≥200% of the poverty threshold.

Frequency and descriptive statistics about the study sample’s vaccination status are detailed in Table 3. In terms of immunization status, the tetanus vaccine had the highest prevalence rate (55.1% vaccinated) and the hepatitis A vaccine had the lowest prevalence rate (9.4%). While most people reported they had not received hepatitis A or B vaccinations (82.4% and 66.6% respectively), for those who did receive hepatitis A and/or B vaccines, most of the respondents completed the required number of shots for each. Of those who received the hepatitis A vaccine, 58.5% completed the series and of those who received hepatitis B vaccine, 81.4% completed the series. Just over half of the population received a tetanus shot in the past 10 years (55.1%); however, most of these people were not sure if that shot also contained the pertussis vaccination (70.4%). Finally, the majority of the population reported they had not received a pneumonia vaccination (76.9%).

Table 3. Vaccination status of eligible adults who completed the 2008 NHIS

Variable	N	Percent
Overall total	21781	100
Pneumonia shot		
Yes	4199	19.3
No	16751	76.9
Refused/Don’t know	831	3.8
Hepatitis A status (Ever)		
Yes	2048	9.4
No	17944	82.4
Refused/Don’t know	1789	8.2
If Hepatitis A status = yes, is series complete?	N=2048	
Complete series (≥2 shots)	1198	58.5
Incomplete series (<2 shots)	397	19.4
Refused/Don’t know	453	22.1
Hepatitis B status (Ever)		
Yes	5926	27.2
No	14497	66.6
Refused/Don’t Know	1358	6.3
If Hepatitis B status = yes, is series complete?	N=5926	
Complete series (3 shots)	4824	81.4
Incomplete series (<3 shots)	724	12.2
Refused/Don’t know	378	6.4
Tetanus shot past 10 years		
Yes	12006	55.1
No	8474	38.9
Refused/Don’t know	1301	5.9
If Tetanus shot = yes, did it include Pertussis?	12006	55.1
Yes	690	15.2
No	646	14.3
Don’t know	3189	70.4

4.2 Pneumonia

In the 2008 NHIS questionnaire, a total of 4,199 people reported receipt of the pneumococcal vaccination. Characteristics associated with receipt of pneumococcal vaccine are shown in Table 5. The analysis of the independent variables indicated that all of the independent variables were significantly associated with receipt of pneumococcal vaccine; however, the strength of these associations varied widely. Each subcategory of the race/ethnicity variable was associated with receipt of pneumococcal disease vaccine; however, White people had the highest likelihood of receipt of the vaccine and Hispanic/Latino people had the lowest likelihood (OR = 0.315) which indicated they were 0.315 times less likely to receive the vaccine compared with the referent group (White). With regards to gender, females were 1.23 times more likely to receive the vaccine than males. Age range also played a significant role in odds of receiving the vaccine. People ≥45 were at least 2.16 times more likely to receive the vaccine than the referent group of 18-24 years, and those ≥ 65 were 21.75 times more likely to receive the vaccine compared to the referent age (18-24 years).

Socio-demographic variables analyzed included health insurance, region, marriage status, and reported levels of education. The results are presented in Table 5. As might be expected, those who reported having health insurance were 4.6 times more likely to receive the vaccine compared to those who did not report health insurance. Residence per region of the U.S. was only significant for the west region, where people were 0.861 times less likely to receive the vaccine as compared to the referent group (northeast). In terms of marital status, the only delineation not associated with receipt of the vaccine was those who were divorced. Those who were widowed had the highest association with receipt of the vaccine, as they were 4.93 times more likely to receive the vaccine than any other marital status category (with married being the referent). Those who were single/never married had the lowest association and were 0.439 times less likely to receive the vaccine compared to those who were married. Education was only significantly associated for the some college and bachelors degree categories and overall those with less than a high school degree, the referent group, were the most likely to receive the vaccine. People with some college were 0.81 times less likely to receive the vaccine as compared to the referent group, and people with a bachelor's degree were 0.582 times less likely to receive the vaccination. In terms of poverty level, those who were either near poor or not poor had a higher chance of receiving the vaccine (OR = 1.49 and 1.19, respectively) versus those who were considered poor.

Additional analysis of the factors influencing pneumococcal vaccine was performed by including all of the independent socio-demographic variables in a multivariate logistic regression model. When adjusting for all other factors via the multivariate analysis, the results varied from the individual models and some independent variables were no longer significant. Race/ethnicity outcomes remained similar in that White people were the most likely to receive the vaccine and Hispanic/Latino people were the least likely (OR = 0.555). Gender was no longer a statistically significant factor that was associated with receipt of pneumococcal vaccines. Age remained significant; however, a person's odds of receipt of the vaccine began to increase at an earlier age of 35. Elderly people aged ≥65 remained the most likely to receive the pneumococcal vaccine, as they were 19.24 times more likely to receive the vaccine as compared to the 18-24 year old age range.

In terms of other socio-demographic variables, reported insurance coverage remained positively associated with receipt of the vaccine, as those with insurance were 1.71 times more likely to be vaccinated compared to those who did not report insurance coverage. However, it should be noted that the strength of this association was much lower than what was noted before the data were adjusted for other factors (OR = 4.60). Residence per region of the U.S. showed a different outcome versus the bivariate analysis: when adjusting for all other factors, those who lived in the south were most likely to receive the vaccine (OR = 1.26) and residence in the west region was no longer a significant factor as compared to those who lived in the northeast (referent group). Marital status showed different results once data were adjusted for other factors, as none of the delineations were associated with receipt of the vaccine except for those who were widowed (OR = 1.36). In terms of education level, after adjusting for all other factors the results indicated that only certain groups were more likely to receive the vaccine, whereas the bivariate results showed a decreased likelihood of vaccination for all education levels ≥ high school diploma/GED. Those who completed some college were 1.24 times more likely to be vaccinated compared to those with less than high school education and those with a master's degree or higher were 1.28 times more likely to be vaccinated. When adjusting for all other factors, poverty level was no longer a significant predictor in terms of pneumococcal vaccine receipt.

4.3 Hepatitis A

In the 2008 NHIS questionnaire, a total of 2,048 people reported receipt of the hepatitis A vaccination. Characteristics associated with receipt of hepatitis A vaccine are shown in Table 6. The analysis of the independent variables indicated that all of the independent variables were significantly associated with receipt of the hepatitis A vaccine except for gender and health insurance coverage. With regards to race/ethnicity, Asians had the highest odds ratio and were 1.79 times more likely to receive the vaccine as compared to Whites. As age increased, the likelihood of hepatitis A vaccine receipt decreased. In fact, all age ranges higher than the referent of 18-24 had a lower likelihood of vaccination.

Socio-demographic variables analyzed are also presented in Table 6. Those who lived in the west region of the U.S. were most likely to receive the vaccine (OR = 1.77) as compared to the northeast referent group. For marital status, the strongest association was for the single/never married population; they were 1.72 more likely to receive the vaccine as compared to those who were married. Education level displayed a direct relationship; as education level increased, so did the likelihood of vaccine receipt. Those with a masters degree or higher were the most likely to be vaccinated (OR = 3.47) as compared to those who did not complete high school. Poverty to income ratio showed that those who were near poor were 0.748 times less likely to receive the vaccine versus those who were poor (referent).

Additional analysis of the factors influencing hepatitis A vaccine was performed by including all of the independent socio-demographic variables in a multivariate logistic regression model. When adjusting for all other factors via the multivariate analysis, the results varied from the individual models. Race/ethnicity was no longer a significant factor, and gender remained insignificant. Those who were between the ages of 18-24 (referent) remained the most likely to receive the vaccine, and the inverse relationship of increased age to decreased vaccination odds remained.

In terms of other socio-demographic variables, reported health insurance coverage remained positively associated with receipt of the vaccine, as those with health insurance were 1.31 times more likely to be vaccinated than those who didn’t report coverage. People in the west region of the U.S. (OR = 1.70) remained more likely to be vaccinated than the referent group in the northeast region. In terms of marital status, the only population with a significant result was the separated group; they had a slightly higher chance of being vaccinated (OR = 1.44) as compared to the married referent group. Education remained significant with a direct relationship between increased education and increased vaccination rates. Additionally, the education odds ratios for the multivariate analysis were higher than those for the bivariate analysis meaning once data were adjusted for all other factors, education level became a stronger predictor of hepatitis A vaccination receipt. Those with a masters degree or higher were 4.43 times more likely to be vaccinated as compared to those with a less than high school level education. Poverty level was no longer a significant factor.

4.4 Hepatitis B

In the 2008 NHIS questionnaire, a total of 5,926 people reported receipt of the hepatitis B vaccination. Characteristics associated with receipt of hepatitis B vaccine are shown in Table 7. The analysis of the independent variables indicated a significant association for all independent variables except health insurance status. Using white people as the referent, Asian people were the most likely to receive the vaccine (OR = 1.41) and Hispanic/Latino people were the only group to have a lower likelihood of vaccine receipt (OR = 0.874). Females were 1.30 times more likely to receive the hepatitis B vaccine as compared to males. Age showed a direct, significant relationship in that as the population aged, they were less likely to receive the vaccine.

Socio-demographic variables analyzed are also presented in Table 7. The only region of the U.S. that indicated a significant association with receipt of the hepatitis B vaccine was the Midwest. Residents in the Midwest were 1.25 times more likely to receive the vaccine as compared to those in the Northeast (referent). Marital status results indicated that those who were single/never married had the highest likelihood of receiving the hepatitis B vaccine (OR = 1.83) as compared to those who were married (referent). Education level resulted in a significant, direct relationship and as education level increased, so did the chances of receiving the vaccine (with the exception of the bachelor degree category, however the numeric difference was small). Those with a master's degree were the most likely to receive the vaccine (OR = 3.25) as compared to those who did not complete high school (referent). Those who were classified as near poor were less likely to receive the vaccine (OR = 0.791) as compared to those who were classified as poor (referent).

Additional analysis of the factors influencing hepatitis B vaccine was performed by including all of the independent socio-demographic variables in a multivariate logistic regression model. When adjusting for all other factors via the multivariate analysis, the results varied from the individual models. All factors were significant except for region and poverty to income ratio. Within the race/ethnicity variable, the only association that remained significant after adjusting for all other factors was for the Hispanic/Latino population; this group was 0.840 times less likely to receive the vaccine as compared to Whites. The data showed that females were 1.45 times more likely than males to receive the hepatitis B vaccine; a slightly higher odds ratio versus the individual model outcomes. As the study population became older they also became less likely to receive the vaccine, with those ≥ 65 years showing the lowest odds ratio of 0.063 compared to those 18-24 years of age.

In terms of other socio-demographic variables, reported health insurance became a statistically significant predictor of hepatitis B vaccine receipt as compared to the individual model. People who reported insurance coverage were 1.36 times more likely to receive the vaccine versus those without coverage. Marital status was only a significant factor if the population was widowed, as those people were 0.692 times less likely to receive the vaccine as compared to those who were married (referent). The association of the education variable remained consistent as per the individual model analysis; those with higher education were more likely to receive the vaccine. People with a masters degree or higher were 3.77 times more likely, and overall the most likely, to receive the vaccine versus people who did not have a high school education.

4.5 Tetanus

In the 2008 NHIS questionnaire, a total of 12,006 people reported receipt of the tetanus vaccination. Characteristics associated with receipt of tetanus vaccine are shown in Table 8. The analysis of the independent variables indicated that all of the independent variables were significantly associated with receipt of the hepatitis B vaccine. All race/ethnicities had a lower likelihood of receiving the tetanus vaccination as compared to White people; however, it should be noted that for this vaccine the race/ethnicity with the lowest likelihood of vaccination was the Asian population (OR = 0.402). This is in contrast to most of the other vaccines, where the Hispanic/Latino population typically had the lowest likelihood of vaccine receipt as compared to the referent (White). Females were 0.750 times less likely to receive the vaccine as compared to males. Age was a significant factor overall, and the data showed that those who were above the age of 24 had a slightly lower likelihood of tetanus vaccination. Those in the ≥ 65 category had the lowest likelihood of vaccination as compared to the referent (18-24), with an odds ratio of 0.448.

Socio-demographic variables were analyzed and are presented in Table 8. As might be expected, people with reported health insurance coverage were 1.41 times more likely to be vaccinated against tetanus versus those without health insurance. In the region of the U.S. variable, the only area with a significant association was the Midwest – that population was 1.54 times more likely to receive the vaccine as compared to the referent group in the northeast.

Marital status did not prove to be a strong predictor of vaccine receipt except for those in the widowed population, as they were 0.549 times less likely to be vaccinated compared to the married population (referent). Trends associated with education level were similar to many of the previous analyses in that as education level increased, so did the likelihood of tetanus vaccination. Those with a masters degree or higher had the highest likelihood of tetanus vaccination (OR = 2.24) as compared to those who did not complete high school. In terms of poverty to income ratio, those who were not poor were 1.47 times more likely to receive the tetanus vaccine as compared to those who were poor.

Additional analysis of the factors influencing hepatitis B vaccine was performed by including all of the independent socio-demographic variables in a multivariate logistic regression model. When adjusting for all other factors via the multivariate analysis the results were similar to the individual model, with some minor variations. All race/ethnicity categories had a lower likelihood of being vaccinated as compared to Whites, and those who were Asian were the least likely with an odds ratio of 0.402. Females were less likely to receive the vaccine (OR = 0.770) as compared to males, and those with health insurance coverage were 1.42 times more likely to receive the vaccine as compared to those without health insurance coverage. As the population aged, the odds of receiving a tetanus vaccine decreased and those who were ≥ 65 had the lowest likelihood of receiving the vaccine (OR = 0.320) versus the 18-24 year old referent group.

In terms of other socio-demographic variables, residence in region of the U.S. was more significant for the multivariate model as compared to the individual model results. Compared to the northeast (referent), residence in all other regions was associated with a higher likelihood of receipt of the tetanus vaccine. The Midwest showed the strongest association with an odds ratio of 1.43. Marital status was only significant for the single/never married and the widowed populations; those groups were 0.836 and 0.832 times less likely (respectively) to be vaccinated as compared to the married population. Higher education levels were associated with a higher likelihood of tetanus vaccination with the exception of the master's degree or higher population, which was no longer a statistically significant factor. Poverty to income ratio was significant for the not poor population, which had a slightly increased likelihood of vaccination (OR = 1.11) as compared to those who were poor.

4.6 Pertussis

In the 2008 NHIS questionnaire, a total of 690 people reported receipt of the pertussis vaccination. This limited sample size created limitations with the data. Characteristics associated with receipt of pertussis vaccine are shown in Table 9. The analysis of the independent variables indicated that all of the independent variables were significantly associated with receipt of the pertussis vaccine except for gender, health insurance status, and region. With regards to race/ethnicity, the only significant association was for those who were Asian; a population that was 1.86 times more likely to receive the vaccine as compared to White people. Compared to the referent group of 18-24 year olds, as the population's age increased its likelihood of receiving the pertussis vaccine decreased with an odds ratio range of 0.443-0.584 though it should be noted the association for the 25-34 age range was not statistically significant.

Results of the socio-demographic variables analyzed are presented in Table 9. Compared to the referent group of married people, those who were single/never married were 1.31 times more likely to receive the vaccine. All other marital status categories were not significantly associated. Education level was only significantly associated for those who had a bachelor's degree, as that population was 1.46 times more likely to have the pertussis vaccine compared to people with less than a high school education. Finally, those who were near poor were 0.622 times less likely to receive the pertussis vaccine as compared to those who were poor.

Additional analysis of the factors influencing pertussis vaccine was performed by including all of the independent socio-demographic variables in a multivariate logistic regression model. When adjusting for all other factors via the multivariate analysis, the number of variables with a significant association decreased. Along with the insignificant factors of gender, health insurance status, and region, additional factors of race/ethnicity, marital status, and education level transitioned from significant to insignificant as compared to the individual model. Therefore, after adjusting for all other factors the only independent variables with a significant association were age and poverty to income ratio. For age, those who were ≥ 35 years were between 0.450-0.522 times less likely to receive the pertussis vaccine as compared to the 18-24 cohort (referent). Finally, those who were near poor were 0.595 times less likely to receive the vaccine as compared to those who were poor.

4.7 Consistent Significant Associations

Table 4 shows a summary of the statistically significant demographic characteristics per the multivariate analyses performed in this examination. Pertussis will be treated as an exception because, as mentioned earlier, the sample size was quite small (N=690). Reasons for this challenging sample size will be addressed later in this study.

Table 4. Summary of statistically significant demographic characteristics for each vaccine based on the multivariate analysis results

	Vaccine				
Characteristic	Pneumococcal	Hepatitis A	Hepatitis B	Tetanus	Pertussis
Race	✓		✓	✓	
Gender			✓	✓	
Age	✓	✓	✓	✓	✓
Health insurance	✓	✓	✓	✓	
Region	✓	✓		✓	
Marital status	✓	✓	✓	✓	
Education	✓	✓	✓	✓	
Poverty to income ratio					✓

With the exception of the pertussis vaccine, the characteristics that showed as significant regardless of the vaccine type were age, health insurance, marital status, and education. These results, especially age, health insurance, and education, follow suit with the previous research regarding social determinants of health.

Table 5. Descriptive characteristics and bivariate versus multivariate analysis using logistic regression assessing the association of demographic characteristics with Pneumonia (N=4199) vaccine status in eligible adult subjects who completed the 2008 NHIS

	Descriptive	Bivariate			Multivariate		
Variable	N (%)	OR	CI (95%)	p-value	OR	CI (95%)	p-value
Race							
White	3104 (73.9)	REF	REF	REF	REF	REF	REF
Black	540 (12.9)	0.625	0.565-0.691	<0.001	0.673	0.588-0.772	<0.001
Hispanic/Latino	361 (8.6)	0.354	0.315-0.397	<0.001	0.555	0.471-0.655	<0.001
Asian	147 (3.5)	0.443	0.371-0.529	<0.001	0.609	0.473-0.785	<0.001
Other*	47 (1.1)	0.928	0.668-1.29	0.654	1.31	0.841-2.04	0.233
Gender							
Male	1653 (39.4)	REF	REF	REF	REF	REF	REF
Female	2546 (60.6)	1.23	1.15-1.32	<0.001	1.06	0.961-1.17	0.247
Age							
18-24	118 (2.8)	REF	REF	REF	REF	REF	REF
25-34	190 (4.5)	0.838	0.662-1.06	0.144	0.894	0.644-1.24	0.502
35-44	265 (6.3)	1.19	0.947-1.48	0.138	1.55	1.13-2.12	0.007
45-54	458 (10.9)	2.16	1.75-2.67	<0.001	2.50	1.84-3.40	<0.001
55-64	707 (16.8)	4.49	3.66-5.50	<0.001	4.99	3.68-6.76	<0.001
65-above	2461 (58.6)	21.75	17.88-26.45	<0.001	19.24	14.21-26.05	<0.001
Health Insurance status							
Not covered	3984 (94.9)	REF	REF	REF	REF	REF	REF
Covered	209 (5.0)	4.60	3.98-5.32	<0.001	1.71	1.42-2.07	<0.001
Region							
Northeast	689 (16.4)	REF	REF	REF	REF	REF	REF
Midwest	993 (23.6)	1.05	0.937-1.17	0.431	1.15	0.991-1.33	0.065
South	1606 (38.2)	1.03	0.934-1.14	0.529	1.26	1.10-1.44	0.001
West	911 (21.7)	0.861	0.771-0.961	0.008	1.11	0.954-1.29	0.176
Marital status							
Married	1835 (43.7)	REF	REF	REF	REF	REF	REF
Separated	100 (2.4)	0.653	0.526-0.811	<0.001	1.05	0.817-1.36	0.690
Divorced	642 (15.3)	1.10	0.994-1.22	0.066	0.987	0.865-1.13	0.843

Single/never married	501 (11.9)	0.439	0.395-0.487	<0.001	0.971	0.834-1.13	0.708
Widowed	1108 (26.4)	4.93	4.45-5.45	<0.001	1.36	1.18-1.57	<0.001
Education							
< High School	826 (19.7)	REF	REF	REF	REF	REF	REF
High School Diploma/GED	1238 (29.5)	0.944	0.854-1.04	0.260	1.04	0.896-1.20	0.635
Some college/2 year degree	1197 (28.5)	0.809	0.732-0.894	<0.001	1.24	1.07-1.44	0.005
Bachelor's degree	534 (12.7)	0.582	0.516-0.656	<0.001	0.943	0.789-1.13	0.518
Master's degree or higher	385 (9.2)	0.906	0.790-1.04	0.156	1.28	1.05-1.56	0.015
Poverty to Income Ratio**							
Poor	412 (13.1)	REF	REF	REF	REF	REF	REF
Near poor	588 (18.7)	1.49	1.30-1.72	<0.001	1.08	0.911-1.28	0.373
Not poor	1658 (52.8)	1.19	1.05-1.34	0.005	0.894	0.765-1.04	0.156

*defined as Alaskan Native, American Indian, multiracial, and people who refused to answer

**based on reported income and the U.S. Census Bureau poverty threshold. Poor = family income is below the poverty threshold; near poor=family income 100% - <200% of the poverty threshold; not poor = family income ≥200% of the poverty threshold.

Table 6. Descriptive characteristics and bivariate versus multivariate analysis using logistic regression assessing the association of demographic characteristics with Hepatitis A (N=2048) vaccine status in eligible adult subjects who completed the 2008 NHIS

	Descriptive	Bivariate			Multivariate		
Variable	N (%)	OR	CI (95%)	p-value	OR	CI (95%)	p-value
Race							
White	1221 (59.6)	REF	REF	REF	REF	REF	REF
Black	304 (14.8)	0.997	0.873-1.14	0.960	0.989	0.837-1.17	0.897
Hispanic/Latino	315 (15.4)	0.954	0.837-1.09	0.478	0.840	0.697-1.01	0.068
Asian	178 (8.7)	1.79	1.51-2.13	<0.001	1.12	0.889-1.41	0.340
Other*	30 (1.5)	1.63	1.10-2.42	0.014	1.40	0.852-2.29	0.186
Gender							
Male	934 (45.6)	REF	REF	REF	REF	REF	REF
Female	1114 (54.4)	0.916	0.836-1.00	0.061	0.938	0.834-1.06	0.292
Age							
18-24	446 (21.8)	REF	REF	REF	REF	REF	REF
25-34	546 (26.7)	0.583	0.506-0.670	<0.001	0.525	0.432-0.638	<0.001
35-44	428 (20.9)	0.420	0.363-0.487	<0.001	0.367	0.295-0.456	<0.001
45-54	284 (13.9)	0.260	0.221-0.305	<0.001	0.226	0.178-0.286	<0.001
55-64	218 (10.6)	0.233	0.196-0.277	<0.001	0.196	0.152-0.253	<0.001
65-above	126 (6.2)	0.097	0.079-0.120	<0.001	0.097	0.072-0.132	<0.001
Health Insurance status							
Not covered	1711 (83.5)	REF	REF	REF	REF	REF	REF
Covered	332 (16.2)	1.01	0.893-1.15	0.860	1.31	1.11-1.56	0.002
Region							
Northeast	246 (12.0)	REF	REF	REF	REF	REF	REF
Midwest	451 (22)	1.35	1.15-1.58	<0.001	1.26	1.03-1.55	0.027
South	751 (36.7)	1.38	1.19-1.60	<0.001	1.47	1.21-1.77	<0.001
West	600 (29.3)	1.77	1.51-2.06	<0.001	1.70	1.39-2.08	<0.001
Marital status							
Married	879 (42.9)	REF	REF	REF	REF	REF	REF
Separated	83 (4.1)	1.26	0.993-1.60	0.057	1.44	1.10-1.89	0.009
Divorced	243 (11.9)	0.822	0.709-0.954	0.010	0.964	0.807-1.15	0.690

Single/never married	775 (37.8)	1.72	1.55-1.91	<0.001	0.980	0.840-1.14	0.801
Widowed	62 (3.0)	0.296	0.228-0.385	<0.001	0.862	0.625-1.19	0.365
Education							
< High School	181 (8.8)	REF	REF	REF	REF	REF	REF
High School Diploma/GED	369 (18.0)	1.32	1.10-1.58	0.003	1.62	1.25-2.09	<0.001
Some college/2 year degree	744 (36.3)	2.62	2.21-3.10	<0.001	2.60	2.04-3.32	<0.001
Bachelor's degree	472 (23.0)	2.88	2.41-3.44	<0.001	2.94	2.25-3.82	<0.001
Master's degree or higher	275 (13.4)	3.47	2.85-4.23	<0.001	4.43	3.33-5.89	<0.001
Poverty to Income Ratio**							
Poor	257 (18.4)	REF	REF	REF	REF	REF	REF
Near poor	207 (14.8)	0.748	0.616-0.907	0.003	0.863	0.702-1.06	0.161
Not poor	834 (59.8)	0.910	0.784-1.06	0.211	0.856	0.716-1.02	0.087

*defined as Alaskan Native, American Indian, multiracial, and people who refused to answer

**based on reported income and the U.S. Census Bureau poverty threshold. Poor = family income is below the poverty threshold; near poor=family income 100% - <200% of the poverty threshold; not poor = family income ≥200% of the poverty threshold.

Table 7. Descriptive characteristics and bivariate versus multivariate analysis using logistic regression assessing the association of demographic characteristics with Hepatitis B (N=5926) vaccine status in eligible adult subjects who completed the 2008 NHIS

	Descriptive	Bivariate			Multivariate		
Variable	N (%)	OR	CI (95%)	p-value	OR	CI (95%)	p-value
Race							
White	3588 (60.5)	REF	REF	REF	REF	REF	REF
Black	968 (16.3)	1.09	1.00-1.19	0.048	1.10	0.985-1.23	0.089
Hispanic/Latino	889 (15.0)	0.874	0.802-0.952	0.002	0.840	0.740-0.953	0.007
Asian	412 (7.0)	1.41	1.24-1.60	<0.001	1.08	0.907-1.29	0.378
Other*	69 (1.2)	1.32	0.982-1.77	0.066	1.07	0.724-1.57	0.749
Gender							
Male	2306 (38.9)	REF	REF	REF	REF	REF	REF
Female	3620 (61.1)	1.30	1.22-1.38	<0.001	1.45	1.34-1.58	<0.001
Age							
18-24	1164 (19.6)	REF	REF	REF	REF	REF	REF
25-34	1567 (26.4)	0.525	0.470-0.586	<0.001	0.428	0.366-0.501	<0.001
35-44	1197 (20.2)	0.338	0.302-0.379	<0.001	0.252	0.213-0.298	<0.001
45-54	953 (16.1)	0.241	0.215-0.271	<0.001	0.177	0.149-0.210	<0.001
55-64	654 (11.0)	0.183	0.161-0.207	<0.001	0.141	0.117-0.170	<0.001
65-above	391 (6.6)	0.072	0.063-0.083	<0.001	0.063	0.051-0.078	<0.001
Health Insurance status							
Not covered	4952 (83.6)	REF	REF	REF	REF	REF	REF
Covered	957 (16.1)	1.04	0.954-1.12	0.406	1.36	1.21-1.52	<0.001
Region							
Northeast	888 (15.0)	REF	REF	REF	REF	REF	REF
Midwest	1464 (24.7)	1.25	1.14-1.38	<0.001	1.09	0.962-1.25	0.171
South	2170 (36.6)	1.09	0.992-1.91	0.075	1.01	0.892-1.13	0.931
West	1404 (23.7)	1.09	0.988-1.20	0.085	0.971	0.852-1.11	0.655
Marital status							
Married	2524 (42.6)	REF	REF	REF	REF	REF	REF
Separated	225 (3.8)	1.22	1.04-1.44	0.018	1.20	0.987-1.45	0.067
Divorced	834 (14.1)	1.01	0.917-1.10	0.918	1.07	0.958-1.21	0.219

Single/never married	2131 (36.0)	1.83	1.71-1.97	<0.001	0.900	0.807-1.00	0.057
Widowed	197 (3.3)	0.286	0.245-0.333	<0.001	0.692	0.571-0.839	<0.001
Education							
< High School	571 (9.6)	REF	REF	REF	REF	REF	REF
High School Diploma/GED	1256 (21.2)	1.52	1.36-1.70	<0.001	1.60	1.37-1.86	<0.001
Some college/2 year degree	2162 (36.5)	2.87	2.59-3.19	<0.001	2.56	2.21-2.98	<0.001
Bachelor's degree	1242 (21.0)	2.82	2.52-3.16	<0.001	2.50	2.12-2.95	<0.001
Master's degree or higher	678 (11.4)	3.25	2.85-3.71	<0.001	3.77	3.13-4.54	<0.001
Poverty to Income Ratio**							
Poor	728 (17.9)	REF	REF	REF	REF	REF	REF
Near poor	638 (15.7)	0.791	0.697-0.897	<0.001	0.960	0.832-1.11	0.579
Not poor	2382 (58.7)	0.915	0.828-1.01	0.083	0.930	0.819-1.06	0.258

*defined as Alaskan Native, American Indian, multiracial, and people who refused to answer

**based on reported income and the U.S. Census Bureau poverty threshold. Poor = family income is below the poverty threshold; near poor=family income 100% - <200% of the poverty threshold; not poor = family income ≥200% of the poverty threshold.

Table 8. Descriptive characteristics and bivariate versus multivariate analysis using logistic regression assessing the association of demographic characteristics with Tetanus (N=12006) vaccine status in eligible adult subjects who completed the 2008 NHIS

	Descriptive	Bivariate			Multivariate		
Variable	N (%)	OR	CI (95%)	p-value	OR	CI (95%)	p-value
Race							
White	8002 (66.7)	REF	REF	REF	REF	REF	REF
Black	1611 (13.4)	0.582	0.538-0.630	<0.001	0.643	0.583-0.709	<0.001
Hispanic/Latino	1721 (14.3)	0.555	0.514-0.599	<0.001	0.657	0.590-0.730	<0.001
Asian	532 (4.4)	0.493	0.436-0.557	<0.001	0.402	0.342-0.473	<0.001
Other*	140 (1.2)	1.21	0.901-1.63	0.205	1.11	0.784-1.58	0.546
Gender							
Male	5603 (46.7)	REF	REF	REF	REF	REF	REF
Female	6403 (53.3)	0.750	0.709-0.794	<0.001	0.770	0.716-0.828	<0.001
Age							
18-24	1339 (11.2)	REF	REF	REF	REF	REF	REF
25-34	2241 (18.7)	0.711	0.634-0.797	<0.001	0.591	0.504-0.694	<0.001
35-44	2233 (18.6)	0.698	0.623-0.783	<0.001	0.549	0.464-0.648	<0.001
45-54	2335 (19.4)	0.770	0.687-0.864	<0.001	0.554	0.467-0.656	<0.001
55-64	1861 (15.5)	0.685	0.609-0.771	<0.001	0.482	0.404-0.574	<0.001
65-above	1997 (16.6)	0.448	0.400-0.501	<0.001	0.320	0.267-0.382	<0.001
Health Insurance status							
Not covered	10227 (85.2)	REF	REF	REF	REF	REF	REF
Covered	1753 (14.6)	1.41	1.31-.152	<0.001	1.42	1.29-1.58	<0.001
Region							
Northeast	1833 (15.3)	REF	REF	REF	REF	REF	REF
Midwest	3033 (25.3)	1.54	1.40-1.68	<0.001	1.43	1.28-1.60	<0.001
South	4295 (35.8)	1.05	0.966-1.14	0.254	1.13	1.02-1.25	0.020
West	2845 (23.7)	1.09	0.993-1.19	0.072	1.20	1.08-1.35	0.001
Marital status							
Married	5670 (47.2)	REF	REF	REF	REF	REF	REF
Separated	417 (3.5)	0.866	0.744-1.01	0.063	1.07	0.899-1.28	0.441
Divorced	1843 (15.4)	0.982	0.904-1.07	0.674	0.976	0.882-1.08	0.631

Single/never married	3135 (26.1)	0.970	0.905-1.04	0.384	0.836	0.757-0.924	<0.001
Widowed	901 (7.5)	0.549	0.498-0.605	<0.001	0.832	0.730-0.948	0.006
Education							
< High School	1611 (13.4)	REF	REF	REF	REF	REF	REF
High School	3121 (26.0)	1.53	1.40-1.66	<0.001	1.33	1.19-1.48	<0.001
Some college/2 year	3865 (32.2)	2.08	1.91-2.27	<0.001	1.64	1.47-1.84	<0.001
Bachelor's degree	2202 (18.3)	1.96	1.78-2.15	<0.001	1.79	1.53-2.09	<0.001
Master's degree or higher	1157 (9.6)	2.24	1.99-2.52	<0.001	0.821	0.452-1.49	0.517
Poverty to Income Ratio**							
Poor	1215 (14.7)	REF	REF	REF	REF	REF	REF
Near poor	1289 (15.6)	1.07	0.952-1.20	0.264	1.05	0.931-1.19	0.422
Not poor	4973 (60.1)	1.47	1.34-1.61	<0.001	1.11	0.998-1.24	0.053

*defined as Alaskan Native, American Indian, multiracial, and people who refused to answer

**based on reported income and the U.S. Census Bureau poverty threshold. Poor = family income is below the poverty threshold; near poor=family income 100% - <200% of the poverty threshold; not poor = family income ≥200% of the poverty threshold.

Table 9. Descriptive characteristics and bivariate versus multivariate analysis using logistic regression assessing the association of demographic characteristics with Pertussis (N=690) vaccine status in eligible adult subjects who completed the 2008 NHIS

	Descriptive	Bivariate			Multivariate		
Variable	N (%)	OR	CI (95%)	p-value	OR	CI (95%)	p-value
Race							
White	453 (65.7)	REF	REF	REF	REF	REF	REF
Black	113 (16.4)	1.35	0.992-1.84	0.056	1.21	0.815-1.79	0.346
Hispanic/Latino	86 (12.5)	1.14	0.814-1.59	0.452	1.08	0.689-1.70	0.735
Asian	31 (4.5)	1.86	1.01-3.40	0.045	1.37	0.587-3.21	0.465
Other*	7 (1.0)	1.19	0.396-3.56	0.759	0.501	0.120-2.08	0.341
Gender							
Male	278 (40.3)	REF	REF	REF	REF	REF	REF
Female	412 (59.7)	1.24	0.996-1.54	0.054	1.02	0.770-1.35	0.894
Age							
18-24	109 (15.8)	REF	REF	REF	REF	REF	REF
25-34	171 (24.8)	0.695	0.473-1.02	0.063	0.601	0.352-1.03	0.061
35-44	153 (22.2)	0.584	0.398-0.858	0.006	0.522	0.293-0.929	0.027
45-54	158 (22.9)	0.535	0.366-0.782	0.001	0.519	0.290-0.930	0.028
55-64	99 (14.3)	0.443	0.295-0.667	<0.001	0.450	0.239-0.847	0.013
65-above	--	--	--	--	--	--	--
Health Insurance status							
Not covered	595 (86.2)	REF	REF	REF	REF	REF	REF
Covered	94 (13.6)	1.08	0.793-1.47	0.625	1.12	0.743-0.169	0.586
Region							
Northeast	92 (13.3)	REF	REF	REF	REF	REF	REF
Midwest	166 (24.1)	0.970	0.678-1.39	0.868	1.05	0.665-1.66	0.833
South	265 (38.4)	1.21	0.864-1.70	0.266	1.33	0.862-2.05	0.198
West	167 (24.2)	1.06	0.740-1.52	0.745	1.04	0.660-1.64	0.865
Marital status							
Married	320 (46.4)	REF	REF	REF	REF	REF	REF
Separated	26 (3.8)	0.978	0.559-1.71	0.938	1.27	0.660-2.46	0.470
Divorced	100 (14.5)	0.986	0.719-1.35	0.930	1.09	0.742-1.61	0.653

Single/never married	229 (33.2)	1.31	1.02-1.69	0.032	0.970	0.676-1.39	0.871
Widowed	13 (1.9)	0.943	0.436-2.04	0.943	1.02	0.435-2.38	0.968
Education							
< High School	54 (7.8)	REF	REF	REF	REF	REF	REF
High School Diploma/GED	133 (19.3)	1.02	0.666-0.156	0.932	0.862	0.483-1.54	0.616
Some college/2 year degree	270 (39.1)	1.46	0.977-2.17	0.065	1.22	0.703-2.13	0.477
Bachelor's degree	154 (22.3)	1.59	1.04-2.45	0.034	1.55	0.845-2.86	0.156
Master's degree or higher	75 (10.9)	1.43	0.878-0.233	0.150	1.43	0.731-2.80	0.296
Poverty to Income Ratio**							
Poor	75 (16.4)	REF	REF	REF	REF	REF	REF
Near poor	70 (15.3)	0.622	0.389-0.995	0.048	0.595	0.365-0.972	0.038
Not poor	294 (64.2)	0.776	0.529-1.14	0.193	0.780	0.499-1.22	0.276

*defined as Alaskan Native, American Indian, multiracial, and people who refused to answer

**based on reported income and the U.S. Census Bureau poverty threshold. Poor = family income is below the poverty threshold; near poor=family income 100% - <200% of the poverty threshold; not poor = family income ≥200% of the poverty threshold.

Chapter V

DISCUSSION AND CONCLUSION

5.1 Discussion

Vaccine preventable diseases can cause significant deaths, chronic symptoms, and increased health care costs among the adult population (Trust for America's Health, 2010). Additionally, as adults become infected with certain preventable diseases they pose an increased risk to surrounding children who may not be fully vaccinated (André, 2003). Even though safe and effective vaccines to protect against a variety of diseases exist, many adults remain either un-vaccinated or under-vaccinated. In fact, worldwide more adults die from vaccine-preventable diseases as compared to children (Baeyens, 2010). In order to address low vaccination rates for vaccine preventable diseases a search for literature showed that physician and practitioner driven reminder systems have been a primary focus of research (Trust for America's Health, 2010; E. Uskun, S. B. Uskun, Uysalgenc, & Yagiz, 2008; Zimmerman et al., 2008). Research regarding physician and practitioner reminder systems suggests enhanced patient reminder systems would result in a more vaccinated adult population over time (E. Uskun et al., 2008). While this concept is important, patient reminder systems cannot be the sole solution. They do not account for the portion of the adult population who is either uninsured or not seeing the same healthcare provider for each visit, and reminder systems do not address the disparities amongst different socio-demographic characteristics.

The purpose of this work was to examine the potential association of specific socio-demographic characteristics with the receipt of adult optional vaccines. Previous public health research has revealed a variety of social determinants of health which have been shown to directly affect a person's health (U.S. Department of Health and Human Services, 2000). These determinants, which include but are not limited to race/ethnicity, age, and education level, are malleable and can be overcome (Kovner & Knickman, 2008; Turnock, 2009; U.S. Department of Health and Human Services, 2000). A better understanding of the characteristics that describe the vaccinated portion of the population is needed in order to address these aforementioned socio-demographic disparities and in order to eliminate them. As a better understanding of the characteristics of the vaccinated adult population is gained, public health and healthcare professionals will be able to implement more informed and targeted interventions aimed at increasing adult vaccination rates. As the U.S. achieves its immunization goals the population will become more protected and healthier.

Race/Ethnicity

Race/ethnicity, while not a factor consistently associated with the receipt of adult vaccines in this study, is an important factor to consider. Results regarding the relationship between race/ethnicity varied depending on the vaccine. The pneumococcal and tetanus vaccines followed patterns established in preexisting literature where the highest likelihood of medical care in general was for White people and all other groups had a decreased likelihood of medical care (Adult Immunization Consensus Panel, 2003; N. A. Daniels, Juarbe, Moreno-John, & Pérez-Stable, 2007; N. A. Daniels et al., 2004; Nowalk et al., 2006). In this study, the odds of receiving both of these vaccines were lower for all other races/ethnicities as compared to the White population. On the other hand, the results for the analysis of the race/ethnicity variable with respect to the prevalence of hepatitis B vaccine receipt indicated that no race/ethnicity groups were significantly associated with vaccine receipt except for the Hispanic/Latino population; a group that was 0.840 times less likely to receive the vaccine. Results for hepatitis A and pertussis did not display significant relationships for the race/ethnicity variable. Reasons why some vaccines exhibited racial disparities and others did not are unclear; additional research is needed.

In general, the results from this analysis suggested that none of the race/ethnicity groups were as likely to receive vaccines as the White population. This finding complimented the trends already noted in many social determinants studies: those who are White tend to have either better health or at the very least, fewer disparities to overcome with regards to health (Adult Immunization Consensus Panel, 2003; U.S. Department of Health and Human Services, 2000). While receipt of optional vaccines may not serve as a causal pathway to what one would consider improved health, it is reasonable to relate the concepts of vaccines and better health since a person who is more vaccinated is therefore at less risk for disease. Along with studies that have shown Whites have better health overall, existing literature has also stated that differences in health outcomes across race/ethnicity groups is in part due to the types of healthcare providers each race utilizes as well as the training of each provider and the resources he or she offers (Fiscella & Holt, 2007; Zimmerman et al., 2008). These provider variations were not part of the NHIS data, but could be an underlying factor related to race-related vaccine differences.

The results from this analysis also showed that after adjusting for other variables and assessing statistical significance the Hispanic/Latino population was less likely to receive vaccines with the exception of the hepatitis A and pertussis vaccines (both were not significant). The lack of significance may be due to smaller sample sizes and lower prevalence of vaccination compared to the other vaccines' prevalence rates. It is also potentially explained by results from previous public health studies where minorities, specifically Blacks and Hispanics/Latinos, often have lower health statuses than Whites (Adult Immunization Consensus Panel, 2003; Callahan & Cooper, 2004; U.S. Department of Health and Human Services, 2000). For the data used in this study, it is unclear whether the lower likelihood of vaccination for the Hispanic/Latino population was due to language barriers versus other factors such as cultural differences or types of providers commonly utilized. Future research should be conducted to consider the Hispanic/Latino population's vaccination rates along with possible language barriers, differences in access to health care, potential differences regarding patterns of use of health care, accessibility issues such as lack of transportation and additional accessibility access challenges such as a person's normal working hours versus hours of operation at clinics and vaccine-providing facilities.

Gender

Gender was only significant for the hepatitis B and tetanus vaccines. Females were more likely to receive the hepatitis B vaccine as compared to males and one possible reason for this association is because of gender trends in health care professions. The hepatitis B is either occupationally mandated or strongly recommended for certain jobs such as those in the health care industry due to the increased risk from bodily fluid/blood contact (Immunization Action Coalition, 2009). In general, one could safely make the observation that health care provision (for example, nursing) is often a female dominated profession so it would make sense that the data indicated a higher likelihood of hepatitis B vaccination for females. Since occupation was not included in the analysis, it is not possible to analyze the role of occupation in this study, but it deserves further research in the future.

On the other hand, females were less likely to receive the tetanus vaccine as compared to males. This result is interesting since tetanus vaccination and decennial tetanus boosters are recommended for everyone, regardless of gender and regardless of a profession within health care (Heymann, 2008; Rhee, Nunley, Demetriades, Velmahos, & Doucet, 2005). Tetanus is not a common disease in the U.S. due to better sanitary conditions as well as a strong immunization program (Rhee et al., 2005). People often receive additional tetanus boosters when they endure an unexpected injury, but it should be noted that this vaccination does not remove the potential for tetanus infection from the current injury; it simply protects against future infections (Rhee et al., 2005). It would seem that the association between adult injuries and adult tetanus vaccines would result in a higher likelihood of vaccination for men since men are more often found doing occupations and hobbies that are higher in risk (Leigh, Waehrer, Miller, & McCurdy, 2006). However, the exact reasons for a lower likelihood of female tetanus vaccinations are unclear and more research is needed in order to explore this association.

Age

Age influenced vaccination prevalence differently for different vaccinations. For the tetanus, hepatitis A, hepatitis B, and pertussis vaccines the data indicated that those between the ages of 18-24 had the highest likelihood of vaccine receipt. Since certain vaccines (such as tetanus and hepatitis B) are required for school aged people the higher prevalence of vaccine receipt among this age group is linked to these requirements. For example, most schools and universities in the U.S. do not allow students to matriculate unless they have received a tetanus booster within the past ten years (MMWR, Centers for Disease Control and Prevention, 2006). Furthermore, because tetanus, pertussis, and hepatitis B are now routine childhood vaccinations there is a higher likelihood of these vaccines in the young adult population (Atkinson et al., 2009; Heymann, 2008; MMWR, Centers for Disease Control and Prevention, 2006). An adapted chart detailing recommended child and adolescent immunizations per age is shown in Figure 3, below.

Figure 3. Recommended child and adolescent immunization schedule, 2010

<table>
<tr><th>Age</th><th>Hepatitis A</th><th>Hepatitis B</th><th>Diptheria/Tetanus/Pertussis</th></tr>
<tr><td>Birth</td><td></td><td>1st dose</td><td></td></tr>
<tr><td>2 Months</td><td></td><td>2nd dose (1-2 months)</td><td>DTaP</td></tr>
<tr><td>4 Months</td><td></td><td></td><td>DTaP</td></tr>
<tr><td>6 Months</td><td></td><td rowspan="5">3rd dose (6-18 months)</td><td>DTaP</td></tr>
<tr><td>12 Months</td><td rowspan="4">2 doses administered 6 months apart age 12-23 months</td><td></td></tr>
<tr><td>15 Months</td><td rowspan="2">DTaP</td></tr>
<tr><td>18 Months</td></tr>
<tr><td>19-23 Months</td><td rowspan="5">(catch up as needed)</td><td></td></tr>
<tr><td>4-6 Years</td><td rowspan="4">(catch up as needed)</td><td>DTaP</td></tr>
<tr><td>7-10 Years</td><td></td></tr>
<tr><td>11-12 Years</td><td>Tdap</td></tr>
<tr><td>13-18 Years</td><td></td></tr>
</table>

(Adapted from the Immunization Action Coalition website, 2010)

For the pneumococcal vaccine, there was an opposite age trend in that as people aged, they were more likely to receive the vaccine. In fact, people ≥ 65 had the highest likelihood of receipt of the vaccine and were almost 20 times more likely to be vaccinated than the youngest age group. This strong association is likely explained by the strong recommendation for pneumococcal vaccine in those ≥ 65 as a mechanism to reduce the disease (Heymann, 2008; Peetermans & Lacante, 1999).

Access to Health Insurance

Access to insurance was positively associated with receipt of each vaccine addressed in this study. Those who reported some form of access to health insurance were between 1.12 (pertussis) and 1.71 (pneumococcal) times more likely to be vaccinated. These results align with previous research which has discussed the association between health insurance and either health status or vaccine status (Callahan & Cooper, 2004; Dombkowski, Lantz, & Freed, 2004; Hannan, Buchanan, & Monroe, 2009). In fact, it has even been stated that lack of insurance can lead not only to lower health status, but also to longer periods of no healthcare as well as less screening and preventive care (Chou, Johnson, Ward, & Blewett, 2009).

The literature indicates that for most children who reside in the U.S., cost is not a significant factor when addressing vaccine rates since most children are either covered via private insurance plans or federal programs such as Vaccines for Children (Hannan et al., 2009). This is an important finding to consider because there is no similar vaccine program for adults, especially for the optional vaccines discussed in this examination. Many adults in the U.S. are uninsured, as displayed in this study where 16.5% of the population included in the analysis here reported no form of health insurance. Previous studies cite similar levels for the U.S. populations citing approximately 15.9% of the population or one in six people were uninsured

(Center on Budget and Policy Priorities, 2006; Newport & Mendes, 2009). Given that there is no adult version of the Vaccines for Children program, the adult U.S. population is at risk for lower vaccine rates; especially those who do not have insurance and/or the financial means to pay for such vaccines. While this study cannot explain the precise reasons why health insurance is a strong predictor of vaccine receipt it can be hypothesized that rationales such as cost, access, and patient reminders are probable.

Region of the U.S.

This independent variable did not yield any trends that could show an overall association between region and likelihood of adult vaccination receipt. People who lived in the South were the most likely to receive the pneumococcal, hepatitis A, and pertussis vaccines while people who lived in the Midwest were most likely to receive the hepatitis B and tetanus vaccines. Interestingly, when using the Northeast as the referent group, all other regions had a higher likelihood of receipt of vaccine except for hepatitis B where the West had the lowest likelihood. There is no clear explanation for these outcomes, as the literature did not state any of the vaccines noted in this examination were either more or less encouraged per region of the U.S. Region of the U.S. might be a proxy for other factors which predict adult vaccination, so this variable is difficult to interpret without further analysis.

It is possible that a more appropriate variable for this examination could have been residence in an urban versus rural area instead of the region of the U.S. There is ample literature that discusses both the challenges and benefits of living in these different types of environments. For example, urban areas tend to have problems with overcrowding and air pollution, but on the other hand they sometimes have better access to resources (Frumkin, 2005). Rural areas do not always encompass overcrowding and pollution challenges, but because of their sprawling landscape there is often an issue with access to medical care which is nearby (Frumkin, 2005). With that said, it should be noted that using an urban versus rural independent variable for this particular dataset would require more complete income information than what was obtained for the 2008 NHIS. This would ensure income was neither a confounder nor an effect modifier in terms of association strength.

Marital Status

Marital status, while not initially a factor one would intuitively assume could significantly affect vaccination status, was a significant factor for all vaccines aside from pertussis. In a 2008 study, marital status (more specifically, marital trajectories and timing) was compared with mortality rates in U.S. adults and it was suggested that those who are separated/divorced suffer the most negative health outcomes due to stress, loss of income, emotional distress, and significant and sometimes unexpected changes in daily life (Dupre, Beck, & Meadows, 2009). In the same study it was also suggested that those who are widowed, endure multiple marriage dissolutions (divorce or widowhood), and those who are married at a young age (<18) have a higher likelihood of negative health outcomes, including mortality, overall (Dupre et al., 2009).

The trends noted in this examination do not completely agree with the Dupre et al. study from 2009, because some vaccines showed lower likelihood of vaccination with the unmarried marital statuses (hepatitis A, tetanus) and other vaccines showed higher likelihood of vaccination with the unmarried marital statuses (hepatitis B, pneumonia – except for widowed category). It is possible that for diseases easily transmitted via sexual contact (such as hepatitis B) marital status might a stronger, clearer association with vaccine receipt as compared to diseases which are not transmitted sexually; in other words, people who are not married might have more sexual partners, be at higher risk for sexually transmitted diseases, and choose to receive vaccines for preventive reasons. Rationales for this possible idea as well as reasons for the marital status trends in this examination are unclear. It is also possible that either age or occupational trends could be explanations for these results, but more research is needed in order to better address the association.

In terms of pneumococcal vaccines, those who were widowed were more likely to receive the vaccine. It is plausible that this is because we can assume more elderly people are widowed as compared to younger people. Therefore, because this vaccine is intended primarily for elderly persons, the data showed a strong association between vaccine status and widowed status. Similarly, the tetanus vaccination data showed that those who were single/never married had the highest likelihood of vaccine receipt as compared to those who were married. Once again this can be related to age trends. Much of the single/never married population likely falls within the younger age ranges which are the same populations who are more likely to be in school and therefore required to receive the vaccine.

Education

In this examination the overall results indicated that as education level increased, so did the likelihood of additional adult vaccinations. In fact, for most vaccines addressed the results showed that those with a master's or professional degree had the highest likelihood of vaccine receipt as compared to both the referent group (less than a high school education) as well as all other levels of education lower than a master's or professional degree. This result supports social determinant of health theories which state that education level is a good predictor of health and that as people become more educated they tend to be in better health (Kawachi, Adler, & Dow, 2010).

Research has also proven that as people become more educated they tend to have better access to healthcare (Callahan & Cooper, 2004). Therefore, education level affects one's health in multiple ways, as it acts in synergy with access to insurance and thus, access to care. The analyses performed did not address why people with a higher level of education tended to have higher prevalence of the vaccines examined in this study. It is possible that this is due to increased knowledge of health indicators, more knowledge and support of the concept related to the need for and benefit of preventive healthcare, and possibly better access to care via employer sponsored insurance, but data from the 2008 NHIS were not collected regarding these ideas. Finally, one should not ignore the possibility that in this study, higher education levels might have been proxies for socio-economic status since higher education levels could plausibly indicate better paying jobs.

Poverty to Income Ratio

Results from this study showed that once data were adjusted for all other factors, differences between those who were poor, near poor, and not poor were largely insignificant. The only association found to be statistically significant for receipt of vaccines was the relationship between the near poor population and the pertussis vaccine. The results suggested that those who were near poor were 0.60 times less likely to receive the vaccine as compared to those who were classified into the poor category. While this is a somewhat counterintuitive result, it is possible this near poor population was neither financially stable enough to afford vaccines (lack of insurance, lack of income) nor poor enough to qualify for government funded healthcare and benefits. However, the sample was small and possibly difficult to generalize to the overall population of interest.

As mentioned earlier, the lack of associations for poverty to income ratio and prevalence of vaccination was most likely due to the fact that this variable was weak in terms of data. The number of questionnaire respondents who refused to provide family income data was quite large, which caused an answer of "refused/don't know" for 11.7% the poverty to income ratio statistic, and many of the people who were willing to provide the information would only do so via increments of $50,000. Therefore the income data was either largely missing or vague. It is unclear whether the data would have shown more associations had the income data been stronger. In general the literature suggests that overall, those who are either poor or near poor typically have lower levels of access to healthcare and poorer levels of overall health (Flory, Joffe, Fishman, Edelstein, & Metlay, 2009; U.S. Department of Health and Human Services, 2000; Zimmerman et al., 2009). Therefore, it would be expected that this variable would be an important indicator in prevalence of vaccines. However, without either a better understanding of this measure or perhaps more accurate income data, this association within the 2008 NHIS data remains unclear. Additional research related to poverty level and adult vaccine receipt is needed.

5.2 Study Limitations

This examination encountered multiple limitations that are important to acknowledge. First, the design of the study created some challenges. Because the study was cross-sectional, the associations between socio-demographic characteristics and vaccine receipt could be assessed; however, the study design was not strong enough to enable an analysis of direct causation for these factors and vaccine prevalence. Second, the NHIS data for this study were self-reported and therefore errors due to recall bias were both possible and unavoidable.

Another limitation was sample size. While overall sample size was not a challenge for this study, it became challenging for the pertussis portion, as the total number of people who stated they had ever received the pertussis vaccine was 690. The 2008 NHIS questionnaire linked tetanus and pertussis together, so if a respondent reported receipt of a tetanus shot within the past 10 years, s/he was asked if that shot also contained the pertussis vaccine. If respondents did not receive a tetanus vaccine in the past 10 years, they were not asked about pertussis. This questionnaire pattern is a potential reason why the pertussis sample was so low. Additionally, the majority of people who were asked of their pertussis vaccine status answered "don't know" which resulted in a large portion of unusable pertussis data.

As mentioned earlier, data related to family income were largely incomplete. Per statements from the NHIS, income information was hard to collect from survey participants resulting in a lot of missing information. Because income data was used to calculate the poverty to income ratio (PIR), both the income and the PIR data were therefore not as strong as they could have been. This lack of family income data could also be why some inconsistencies within the PIR numbers existed. Along with the need for more complete family income data, there was also a need for vaccine cost data. No data related to either the cost of vaccines or to people's attitudes about the cost of vaccines were collected. It would have been helpful to know if cost, either actual or perceived, acted as a barrier to vaccine receipt.

Another limitation was the lack of information about respondents' religious beliefs, sexual orientation, and current student status. Religion would have been helpful to include in the

NHIS questionnaire because religious beliefs can be very important when one considers use of health care. It is possible that religious beliefs could have had a significant impact on overall vaccine prevalence in the 2008 NHIS data. Sexual orientation would have been helpful to include, as it is one of the primary social determinants noted in the Healthy People 2010 report. Additionally, some vaccines such as hepatitis B are strongly recommended for specific sexual orientations (D. Daniels et al., 2009; Heymann, 2008; Immunization Action Coalition, 2009). Furthermore, in a 2009 study it was shown that significant differences in access to healthcare exist between homosexual and heterosexual people in the U.S. (Buchmueller & Carpenter, 2010). It would have been helpful to know if those who are at higher risk were either appropriately or under-vaccinated. Finally, knowing whether each respondent was either a current student or in a certain line of work would have been beneficial, as this information could have helped to either prove or disprove that some of the population was vaccinated because they were required due to current student and/or occupation status.

One final limitation to be addressed was related to the education variable. In this examination, the education groupings from the original dataset were altered for ease of data comparison. Those with associate's degrees were placed into the "some college" population so that those who had completed a four year degree (bachelor's degree) could be analyzed. As such, in some of the multivariate results the trajectory of increased vaccination likelihood with increased education level was slightly skewed for the some college category. Even though overall the data showed that as education level increased, so did the chances of being vaccinated, the some college category often displayed a slightly higher odds ratio as compared to the bachelor's degree category. It is possible that those who completed associates degrees should have been combined with the bachelor's degrees population.

5.3 Recommendations

Additional research is needed to address the limitations noted above, as well as to expand the available literature related to the socio-demographic characteristics associated with receipt of optional adult vaccines. Specifically, an additional study that addresses behavioral aspects of vaccination receipt choices would be helpful to expand the literature beyond socio-demographic factors. For example, it would be helpful to know if healthier habits overall (i.e. non smokers, people with lower body mass indexes, people who utilize preventive health care regularly, people who engage in regular physical activity, etc.) lead to more vaccinations.

Also, additional studies to address whether a specific type of health insurance leads to a change in vaccination status would be helpful. This would allow researchers, policy makers, and health professionals the opportunity to develop and implement interventions aimed at resolving these differences. More research related to insurance type differences could also better illuminate the disparities among different socio-economic statuses. For example, it is possible that people covered by Medicaid have higher vaccination rates as compared to people with private insurance. Or, it is even more possible that some vaccinations are covered by certain types of insurance whereas other types of insurance treat those same vaccines as out of pocket expenses. These are questions that are not easily answered via a review of current literature.

Another focus for additional research is related to patient reminder systems. It would be helpful to know if reminder systems vary depending on each type of health care provider or type of insurance. Also related to patient reminder systems and patient knowledge is the issue of the pertussis vaccine and the fact that the majority of the people who received a tetanus vaccine in the past 10 years did not know if that shot also contained the pertussis vaccine. There must be a way to ensure that more people are aware of the health care they receive. Some research related to take-home patient records exists, but more is needed in order to create a stronger need for interventions moving forward.

The results for the tetanus vaccine showed that as age increased likelihood of vaccination decreased overall, especially after the age of 54. More research is needed to try and identify why this trend exists. Clearly the efforts implemented to encourage receipt of the pneumonia vaccine for people $\geq$ 65 have worked, as evidenced by the results in the current and previous studies. It is possible that these types of targeted efforts could be used for the $\geq$55 population with regards to tetanus.

Finally, the U.S. must find a way to better educate the public (both patients and providers) about the benefits of and the need for immunizations against vaccine preventable diseases. These efforts must include multi-lingual outreach methods, especially for those who are Hispanic/Latino. The Hispanic/Latino population was the least vaccinated overall in this study, yet the majority of the literature states that Blacks tend to have the least access to healthcare. While no minority should ever be ignored, it is abundantly clear from the data reviewed in this examination that the Hispanic/Latino population is at a much higher risk of preventable diseases. Reasons for this higher risk need to be identified and addressed

5.4 CONCLUSION

In the current era of waning primary care physicians and exponential numbers of specialists (Kovner & Knickman, 2008), it is imperative that preventive care not be overlooked. One could hypothesize that as more adults see specialists, less adults receive the routine care that tends to include vaccination discussions. For example, if a large percent of the U.S. population sees only specialists (only a gynecologist, only a physical therapist), education about the importance of immunizations might not be passed along to those patients since information about optional vaccines is not a typical office visit discussion. Therefore, following the recommendations from current research regarding increasing healthcare providers' awareness of vaccine preventable diseases could indeed be an effective solution. For those specialists who might normally never address a pneumococcal or tetanus vaccine, the introduction of vaccine importance at their practice and subsequently to their patients could be the only time those patients become educated and aware. However, this approach must not be the sole solution to increasing adult vaccine rates for preventable diseases since it will not account for those who are affected by the aforementioned disparities in age, gender, race, and so forth.

Public health professionals, healthcare providers, policy makers, and the general population must all understand what factors cause adults to either receive or decline optional vaccines. There is no genetic reason why Hispanic/Latino people, less educated people, lower income people, or different marital statuses should be less vaccinated and at higher risk for VPDs. The U.S. must find a way to either remove or counteract these disparities. And, while variables such as age or increased risk due to preexisting conditions cannot be reversed, they are factors that can be accounted for via public service announcements and better outreach. Better knowledge of socio-demographic factors associated with receipt of adult, optional vaccines is imperative for stronger interventions and subsequent improved vaccination rates.

REFERENCES

Adult Immunization Consensus Panel. (2003). Increasing immunization rates among African-American adults. *Journal of the National Medical Association*, *95*(4 Suppl), 37S-48S.

Allen, J. (2010). *U.S adults forgo routine immunization: report*. Reuters. Retrieved from http://www.reuters.com/article/idUSTRE6133HO20100204

André, F. E. (2003). Vaccinology: past achievements, present roadblocks and future promises. *Vaccine*, *21*(7-8), 593-595.

Atkinson, W., Wolfe, S., Hamborsky, J., & McIntyre, L. (Eds.). (2009). *Epidemiology and Prevention of Vaccine-Preventable Diseases.* (11th ed.). Washington, DC: Public Health Foundation.

Baeyens, J. (2010). Ensuring the willingness to vaccinate and be vaccinated. *Expert Review of Vaccines*, *9*(3s), 11-14.

Baeyens, J., & Michel, J. (2010). Immunization as a preventive healthcare strategy in older adults. *Expert Review of Vaccines*, *9*(3s), 1-1.

Blewett, L. A., Johnson, P. J., Lee, B., & Scal, P. B. (2008). When a usual source of care and usual provider matter: adult prevention and screening services. *Journal of General Internal Medicine*, *23*(9), 1354-1360.

Brooks, D. A., & Clover, R. (2006). Pertussis Infection in the United States: Role for Vaccination of Adolescents and Adults. *J Am Board Fam Med*, *19*(6), 603-611.

Buchmueller, T., & Carpenter, C. S. (2010). Disparities in Health Insurance Coverage, Access, and Outcomes for Individuals in Same-Sex Versus Different-Sex Relationships, 2000-2007. *Am J Public Health*, *100*(3), 489-495.

Callahan, S. T., & Cooper, W. O. (2004). Gender and Uninsurance Among Young Adults in the United States. *Pediatrics*, *113*(2), 291-297.

CDC Features - Pertussis (Whooping Cough) – What You Need To Know. (2009). Retrieved February 26, 2010, from http://www.cdc.gov/Features/Pertussis/

Center on Budget and Policy Priorities. (2006). The Number of Uninsured Americans Is At An All-Time High. Retrieved from http://www.cbpp.org/cms/?fa=view&id=628

Centers for Disease Control and Prevention. (2009). CDC Features: Pneumonia Can Be Prevented - Vaccines Can Help. Retrieved February 16, 2010, from http://www.cdc.gov/Features/Pneumonia/

Chou, C., Johnson, P. J., Ward, A., & Blewett, L. A. (2009). Health Care Coverage and the Health Care Industry. *Am J Public Health*, *99*(12), 2282-2288.

Daniels, D., Grytdal, S., & Wasley, A. (2009). Surveillance for acute viral hepatitis - United States, 2007. *MMWR. Surveillance Summaries: Morbidity and Mortality Weekly Report. Surveillance Summaries / CDC*, *58*(3), 1-27.

Daniels, N. A., Juarbe, T., Moreno-John, G., & Pérez-Stable, E. J. (2007). Effectiveness of adult vaccination programs in faith-based organizations. *Ethnicity & Disease*, *17*(1 Suppl 1), S15-22.

Daniels, N. A., Juarbe, T., Rangel-Lugo, M., Moreno-John, G., & Pérez-Stable, E. J. (2004). Focus group interviews on racial and ethnic attitudes regarding adult vaccinations. *Journal of the National Medical Association*, *96*(11), 1455-1461.

Dombkowski, K. J., Lantz, P. M., & Freed, G. L. (2004). Risk factors for delay in age-appropriate vaccination. *Public Health Reports (Washington, D.C.)*, *119*(2), 144-155.

Dupre, M. E., Beck, A. N., & Meadows, S. O. (2009). Marital Trajectories and Mortality Among US Adults. *Am. J. Epidemiol.*, *170*(5), 546-555.

Fiscella, K., & Holt, K. (2007). Impact of primary care patient visits on racial and ethnic disparities in preventive care in the United States. *Journal of the American Board of Family Medicine: JABFM*, *20*(6), 587-597.

Flory, J. H., Joffe, M., Fishman, N. O., Edelstein, P. H., & Metlay, J. P. (2009). Socioeconomic risk factors for bacteraemic pneumococcal pneumonia in adults. *Epidemiology and Infection*, *137*(5), 717-726.

Frumkin, H. (Ed.). (2005). *Environmental Health: From Global to Local*. San Francisco, CA: Jossey-Bass.

Georgia Department of Human Resources. (2007). Summary of Georgia Immunization Requirements for Child Care and School Attendance.

Hannan, C., Buchanan, A. D., & Monroe, J. (2009). Maintaining the Vaccine Safety Net. *Pediatrics*, *124*(Supplement_5), S571-572.

Herd Immunity. (2010). *Dictionary*.com. Retrieved March 15, 2010 from: http://dictionary.reference.com/browse/herd+immunity

Heymann, D. L. (Ed.). (2008). *Control of Communicable Diseases Manual* (19th ed.). Washington, DC: American Public Health Association.

Immunization Action Coalition. (2009, October). Healthcare Personnel Vaccination Recommendations. Retrieved from http://www.immunize.org/catg.d/p2017.pdf

Jacobson Vann, J., & Szilagyi, P. (2008). Patient reminder and recall systems to improve immunization rates. *Cochrane Database of Systematic Reviews 2005*, (3). Retrieved from http://www2.cochrane.org/reviews/en/ab003941.html

Johnson, D. R., Nichol, K. L., & Lipczynski, K. (2008). Barriers to adult immunization. *The American Journal of Medicine, 121*(7 Suppl 2), S28-35.

Judelsohn, R. G., & Koslap-Petraco, M. B. (2007). Public health perspectives on the rising incidence of pertussis. *Public Health Nursing (Boston, Mass.), 24*(5), 421-428.

Kawachi, I., Adler, N. E., & Dow, W. H. (2010). Money, schooling, and health: Mechanisms and causal evidence. *Annals of the New York Academy of Sciences, 1186* (The Biology of Disadvantage: Socioeconomic Status and Health), 56-68.

Kovner, A. R., & Knickman, J. R. (Eds.). (2008). *Health Care Delivery in the United States* (9th ed.). New York: Springer Publishing Company.

Leigh, J. P., Waehrer, G., Miller, T. R., & McCurdy, S. A. (2006). Costs differences across demographic groups and types of occupational injuries and illnesses. *American Journal of Industrial Medicine*, *49*(10), 845-853.

Marks, S. (2009). Adult Immunization: The Need for Enhanced Utilization. American Council on Science and Health. American Council on Science and Health. Accessed from: http://www.acsh.org/publications/pubID.1844/pub_detail.asp

MMWR, Centers for Disease Control and Prevention. (1997). Prevention of Pneumococcal Disease: Recommendations of the Advisory Committee on Immunization Practices (ACIP). *April 4, 1997, 46,* 1-24.

MMWR, Centers for Disease Control and Prevention. (2006). Preventing Tetanus, Diptheria, and Pertussis Among Adolescents: Use of Tetanus Toxoid, Reduced Diptheria Toxoid and Acellular Pertussis Vaccines. *55*(RR-3), 1-34.

MMWR, Centers for Disease Control and Prevention (2003). Racial/ethnic disparities in influenza and pneumococcal vaccination levels among persons aged > or =65 years--United States, 1989-2001. *52*(40), 958-962.

National Center for Health Statistics. (2010). NHIS - National Health Interview Survey Homepage. *National Health Interview Survey*. Retrieved January 3, 2010, from http://www.cdc.gov/nchs/nhis.htm

Newport, F. & Mendes, E. (2009, July 22). About One in Six U.S. Adults Are Without Health Insurance. Gallup. Retrieved from http://www.gallup.com/poll/121820/one-six-adults-without-health-insurance.aspx

Nowalk, M. P., Zimmerman, R. K., Tabbarah, M., Raymund, M., & Jewell, I. K. (2006). Determinants of adult vaccination at inner-city health centers: a descriptive study. *BMC Family Practice*, *7*, 2.

Peetermans, W. E., & Lacante, P. (1999). Pneumococcal vaccination by general practitioners: an evaluation of current practice. *Vaccine*, *18*(7-8), 612-617.

Poland, G. A., & Jacobson, R. M. (2001). Understanding those who do not understand: a brief review of the anti-vaccine movement. *Vaccine*, *19*(17-19), 2440-2445.

Rehm, S. J., Farley, M. M., File, T. M., Hall, W. J., Hopkins, R., Levine, O. S., Nichol, K. L., et al. (2009). Higher pneumococcal disease vaccination rates needed to protect more at-risk US adults. *Postgraduate Medicine*, *121*(6), 101-105.

Rhee, P., Nunley, M. K., Demetriades, D., Velmahos, G., & Doucet, J. J. (2005). Tetanus and trauma: a review and recommendations. *The Journal of Trauma*, *58*(5), 1082-1088.

Sandora, T. J., Gidengil, C. A., & Lee, G. M. (2008). Pertussis Vaccination for Health Care Workers. *Clin. Microbiol. Rev.*, *21*(3), 426-434.

Schaffner, W. (2008). Update on vaccine-preventable diseases: are adults in your community adequately protected? *The Journal of Family Practice*, *57*(4 Suppl), S1-11; quiz S12.

Trust for America's Health. (2010). *Adult Immunization: Shots to Save Lives*. Trust for America's Health. Retrieved from http://healthyamericans.org/assets/files/TFAH2010AdultImmnzBrief13.pdf

Turnock, B. J. (2009). *Public Health: What It Is and How It Works* (4th ed.). Sudbury, MA: Jones and Bartlett Publishers.

U.S. Department of Health and Human Services. (2000). *Healthy People 2010: Understanding and Improving Health.* (2nd ed.). Washington, DC: U.S. Government Printing Office.

Uskun, E., Uskun, S. B., Uysalgenc, M., & Yagiz, M. (2008). Effectiveness of a training intervention on immunization to increase knowledge of primary healthcare workers and vaccination coverage rates. *Public Health*, *122*(9), 949-958.

Vaccine History: license and/or first manufacture. (2010). Retrieved from http://www.vaclib.org/news/vaccinelicense.htm

Zimet, G., Maehr, J., Constantine, N., & English, A. (2008). School-Entry Vaccination Requirements: A Position Statement of the Society for Adolescent Medicine. *Journal of Adolescent Health*, *42*(3), 310-311.

Zimmerman, R. K., Nowalk, M. P., Tabbarah, M., Hart, J. A., Fox, D. E., & Raymund, M. (2009). Understanding adult vaccination in urban, lower-socioeconomic settings: influence of physician and prevention systems. *Annals of Family Medicine*, *7*(6), 534-541.

Zimmerman, R. K., Nowalk, M. P., Terry, M. A., Raymund, M., Tabbarah, M., Fox, D. E., & Wilson, S. A. (2008). Assessing Disparities in Adult Vaccination Using Multimodal Approaches in Primary Care Offices: Methodology. *Journal of Urban Health*, *85*(2), 217-227.