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An Analysis of Household-reported Health Status and Socio-demographic Characteristics Associated with Adolescent Influenza Vaccination Rates in the United States: 2008 National Immunization Survey-Teen

Lindy Liu

ABSTRACT

LINDY LIU
An Analysis of Household-reported Health Status and Socio-demographic Characteristics Associated with Adolescent Influenza Vaccination Rates in the United States: 2008 National Immunization Survey- Teen
(Under the direction of Christine Stauber, Faculty Member)

Background: Influenza is a highly contagious but preventable acute respiratory illness associated with high morbidity. Seasonal influenza affects approximately 20% to 40% of children and adolescents. Annual influenza vaccination is an effective approach to prevent illness but recent studies suggests that adolescents are underutilizing important preventive health services and that influenza vaccination coverage in high risk adolescents is also suboptimal. The purpose of this study was to examine the association between household reported health status and socio-demographic characteristics of U.S. adolescents who reported receiving an influenza vaccination.

Methods: Data from the 2008 National Immunization Survey were assessed examining various demographic and socioeconomic characteristics, as well as reported health status of non-institutionalized adolescents in the U.S. The sample was limited adolescents aged 13-17. Odds ratios were calculated and multivariate logistic regression was conducted. P-values of < 0.05 and 95% confidence intervals were used to determine statistical significance.

Results: There were 29063 total observations with 18.9% reporting receiving the influenza vaccine. The results of this study indicate that sex, race and ethnicity, poverty status, health insurance status, asthma status, having an underlying health condition, missed school days due to illness or injury, and maternal age are associated with getting immunized against influenza. As one might expect those who reported having health insurance, having asthma, and having an underlying health condition had higher likelihood of vaccine. Interestingly, non-Hispanic other race and multi-race teens in the study were the most likely to receive the influenza vaccine compared with non-Hispanic white teens.

Conclusions: This study further examines the impact of socio-demographic disparities and health status on influenza vaccination coverage. Although the current influenza vaccine recommendations now include all individuals ages 6 months and older, it should still be important to recognize disparities and inequalities which contribute to non-vaccination or under-vaccination. Improved understanding of demographic and socioeconomic characteristics, as well as existing underlying health conditions, will facilitate the path to improving interventions, vaccination rates, and subsequent reduction in the burden of this preventable disease.

AN ANALYSIS OF HOUSEHOLD-REPORTED HEALTH STATUS AND SOCIODEMOGRAPHIC CHARACTERISTICS ASSOCIATED WITH ADOLESCENT INFLUENZA VACCINATION RATES IN THE UNITED STATES: 2008 NATIONAL IMMUNIZATION SURVEY-TEEN

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Atlanta, GA

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CHAPTER I

INTRODUCTION

1.1 Background

Influenza is a preventable and highly contagious viral acute respiratory disease of global importance that has caused pandemics of human disease for centuries [1-2]. The World Health Organization (WHO) estimates that 3 to 5 million case of severe illness and 250,000 to 500,000 deaths worldwide are attributed to influenza, and that the direct and indirect costs of influenza in industrialized countries are approximately 10-60 million United States Dollars per million persons per season [3-4]. Although the severity of an influenza season can vary substantially each year, approximately 200,000 hospitalizations and 23,000 deaths are caused by influenza in a typical endemic season in the United States [5-7].

People of all ages are afflicted, but the pediatric burden is considerable and the prevalence is greatest in school-age children [7-8]. Approximately 20% to 40% of children and adolescents are affected by influenza each year [9]. In children with high-risk health conditions, the disease accounts for 2 to 4 times higher rates of hospitalizations, 120 to 200 outpatient visits, and 65-140 antibiotic courses per 1000 children per year [10]. Although influenza-associated pediatric mortality is rare and children with risk factors for influenza complications are at highest risk for death, many influenza infections are not diagnosed clinically and the majority of pediatric deaths have occurred among previously healthy children without any known high-risk conditions

[11-12]. In addition, recent studies have shown an increase in bacterial co-infections in influenza-associated pediatric cases where children were significantly older and more likely to have pneumonia [11].

Annual influenza vaccination is the most effective strategy for preventing infection and decreasing transmission within communities [13]. Routine vaccination of children, health-care professionals, and other individuals who could serve as a source of influenza virus transmission provides additional protection to persons at risk for influenza complications and reduces the overall influenza burden [13]. High vaccination coverage in school-aged children not only provides indirect protection to families, unimmunized classmates, and school staff, but it may also benefit schools by reducing student and teacher absenteeism [14].

Although seasonal influenza is the most common cause of vaccine-preventable death in the Unites States, vaccination rates remain low for all categories of people at highest risk [15-16]. Despite the burden of disease, the development of safe and effective vaccines, and long-standing vaccination recommendations by the Advisory Committee on Immunization Practices (ACIP), studies have revealed that influenza vaccination coverage among children and adolescents with high-risk conditions ranges only from 9% to 31% [15, 17]. Although there are many vaccine mandates for the pediatric population in the United States, there are no known influenza vaccination mandates for students enrolled in school or day care. Currently, requirements only exist in long-term care facilities in select states [18]. Even with vaccine recommendations and public service announcements that explain the benefits of vaccines, there remains a subset of the population who declines vaccinations because of religious beliefs, personal preferences, and freedom of choice [19].

1.2 Purpose of Study

Influenza illness severity, mortality, healthcare costs, and productivity losses are greatest in high-risk groups, but cost and lost productivity among non-high-risk groups are also considerable [20]. Adolescent youth are an active and collective group, and play an important role in the spread of disease, but studies suggest that adolescents do not access health care regularly despite recommendations for annual health care-visits [21-22]. Strategies and programs to reduce missed opportunities in physicians' offices to improve vaccine coverage have had limited success [14].

Substantial disparities attributed to demographic and socio-economic status exists in the receipt of annual influenza vaccination, and interventions do not cover those who do not seek regular medical care or those who are not insured [23]. Secondly, mothers are often strongly influential in the vaccination of their children and assume primary responsibility for their children's preventive health services [24]. If adolescents are underutilizing important preventive health services, and if influenza vaccination coverage in high-risk adolescents is suboptimal, it is important to examine and characterize this population to increase coverage. Therefore an understanding of the socio-demographic characteristics, including maternal socio-demographic characteristics, as well as household-reported health status in adolescents may provide opportunity for targeted approaches to reduce the health disparities for influenza vaccination and ultimately the burden of disease.

1.3 Research Question

To further investigate predictors of why adolescents aged 13 to 17 in the 2008 National Immunization Survey- Teen receive the influenza vaccine, the following questions will be examined:

1. What are the demographic characteristics of adolescents who receive influenza vaccinations?
2. What are the socioeconomic characteristics of adolescents who receive influenza vaccinations?
3. What are the household-reported health status of adolescents who receive influenza vaccinations?
4. What are the maternal socio-demographic characteristics of adolescents who receive influenza vaccinations?
5. Do the typical trends of social determinants of health also apply to influenza vaccination trends?

Chapter II

REVIEW OF THE LITERATURE

Healthy People 2010 established goals of having at least 90% of children aged 13-15 years fully vaccinated with recommended and catch-up vaccines, and one of the new objectives of Healthy People 2020 seeks to increase routine vaccination coverage levels recommended by the ACIP for adolescents aged 13-17, including the influenza vaccine [25]. Recent additions of human papillomavirus (HPV), tetantus toxoid-reduced diphtheria toxoid-acellular pertussis, and meningococcal conjugate vaccines to the adolescent vaccination schedule has renewed interest in understanding how to improve vaccination rates among adolescents [17]. Although some studies have described aggregate influenza vaccination rates that include adolescents, very few studies specifically focus predictors for vaccination on this specific age group.

Influenza-associated pediatric mortality, which includes the adolescent population, became a nationally notifiable condition in 2004 after a severe 2003-2004 influenza season [11]. Improved understanding of the factors which influence influenza vaccination in the adolescent age group is also an imperative public health goal as the recent 2009 A/H1N1 pandemic has highlighted the weaknesses and strengths of modern global pandemic preparedness and changed the manner in which the world responds to future pandemics [26]. The pandemic surprised the world in April 2009 by initiating in Mexico and the U.S., and has also presented challenges because plans to control pandemics had not been calibrated for a pandemic of milder disease [26].

Epidemiological tools and prediction models had suggested that an influenza pandemic would likely start from Asia and spread westward towards Europe, Africa, and the America [26].

The purpose of this study is to analyze the association between influenza vaccination status in adolescents aged 13 to 17 and socio-demographic characteristics and household-reported health status based on data from 2008 National Immunization Survey- Teen. Socio-demographic characteristics include age, sex, race and ethnicity, region of the U.S., number of children under the age of 18 in household, health insurance status, and poverty status. Household-reported health status included whether the teen had asthma, whether the teen had any other underlying health conditions (including diabetes, heart conditions, and weakened immune system, etc.), and the number of missed school days due to illness or injury. Maternal socio-demographic characteristics include mother's age, education level, and marital status.

2.1 Virology

Influenza viruses are negative-stranded RNA viruses in the *Orthomyxoviridae* family and divided into three majors types: A, B, and C [16]. The three virus types vary in pathogenicity and host range [8]. Influenza A viruses affect warm-blooded animals, including birds, swine, horses, humans, and other mammals, and are further characterized into sixteen hemagglutinin and nine neuraminidase subtypes [8]. Influenza A viral replication peaks approximately 48 hours after inoculation into the nasopharynx, and the viruses replicate in both the upper and lower respiratory tract [8]. Novel influenza virus variants result from frequent antigenic change caused by point mutations (antigenic drift) and recombination events (antigenic shift) that occur during viral replication. As a result, new influenza A subtypes have the potential to cause a pandemic when they are able to cause human illness and demonstrated efficient human-to-human transmission and when little or no previously existing immunity has been identified [1].

Influenza B viruses infect a smaller number of species, namely humans and seals, and recent circulating influenza B viruses are separated in the Yamagata or Victoria genetic lineages [8, 13]. Influenza B viruses undergo antigen drift less rapidly than influenza A viruses and do not cause pandemics [8, 13]. Influenza C viruses are endemic and sporadically cause mild respiratory disease [8].

2.2. Clinical Course and Epidemiology

Symptoms of influenza infection include onset of high fever, coryza, cough, headache, prostration, and inflammation of the respiratory tree and trachea [8]. Acute symptoms and fever often persist for 7 to 10 days, and severe complications from influenza infection could include hemorrhagic bronchitis, pneumonia, and death [8]. Prevalence of infection is greatest in school-age children while disease severity is greatest in the elderly, infants, and those with underlying health conditions including chronic pulmonary or cardiac disease, and diabetes [8]. Diagnosis of influenza infection can be made by virus isolation, detection of viral proteins, and detection of viral nucleic acid using nasopharyngeal or throat swabs as well serological assays which detect antibodies to the influenza virus [1].

Influenza outbreaks have occurred since the Middle Ages and there have been approximately a dozen influenza A virus pandemics since 1700 [8]. The pandemic of 1918 caused approximately 546,000 excess deaths and killed up to 50 million people worldwide [27-28]. Annual influenza epidemics in the United States usually occur in the fall or winter months but the peak of influenza activity can occur as late as April or May [13]. Influenza activity during the 2009 H1N1 pandemic peaked in June during the first wave and mid-October during the second wave [29]. The second wave was also associated with higher pediatric mortality and higher rates of hospitalization in children and young adults than in previous five seasons [29].

2.3 Vaccine History

Annual influenza vaccination remains the primary and most effective method of preventing influenza infection and decreasing viral transmission within a community [13]. It is also highly cost effective and even cost saving among the elderly, and may be cost effective for young children and adults [30]. The Armed Forces Commission on influenza was responsible for the development and evaluation of influenza vaccines in order to prevent outbreaks of influenza illness in the US military during the Second World War [31]. Regular evaluations of aqueous whole-virus inactivated vaccines containing prevalent strains as well as evaluation of various innovative vaccines continued from 1943 to 1969, but the use of whole viruses in vaccines ended with the introduction of split or subunit preparation [31].

The vaccine had been efficacious in preventing infections by viruses similar to those included in the vaccine, but in 1947, antigenic drift caused the vaccine's efficacy to drop [32].. After 1977, trivalent vaccines containing 2 representative influenza A subtypes and a representative B type have been used [33]. Although purity, potency and standardization of the vaccine has improved, major challenges with the trivalent vaccine included limited breadth of immunity, short duration of protection, needle inoculation, lower protection induced in older individuals, and dependence on egg supply [31].

2.4 Vaccination Types and Recommendations

After the introduction of influenza vaccines for limited use in the military in the 1940s, indications for vaccine use gradually increased [34]. The Advisory Committee on Immunization Practice (ACIP) has now recommended a universal influenza immunization policy for seasonal influenza vaccine for all persons aged 6 months and older for the 2010-2011 influenza season [13]. Children aged 6 months to 8 years are recommended to receive 2 doses of the 2010-2011 influenza vaccine 4 or more weeks apart unless 1) they have received either 1 dose of the 2009 H1N1 vaccine last flu season and 2) at least 1 dose of seasonal vaccine prior to the 2009-2010 influenza season or 2 doses of 2009-10 seasonal flu vaccine last flu season [35]. If a child has fulfilled both requirements, only 1 dose of the vaccine is needed [35]. All other individuals aged 9 and older receive only 1 dose.

Prior to the universal recommendation, there have been over 20 indications where influenza immunization was recommended [34]. Health care professionals, pregnant women, immunocompromised individuals, and those with chronic heart or pulmonary disease are special populations which the ACIP targets influenza immunization [13]. In addition, because children younger than 6 months cannot get a vaccine or antiviral drugs, but are at high risk for serious flu-related complications, the ACIP recommends the vaccine for caregivers and household contacts of children less than 6 months old, children younger than 5 years old, and adults aged ≥50 years old [13, 29]. The ACIP first recommended annual influenza vaccination of health care workers to reduce nosocomial transmission of influenza to patients at high risk for infection in 1986 [36]. Healthy children less than 2 years of age had not been included in recommendation for routine influenza vaccination until the 2002-2003 season [37]. Finally, in 2008 ACIP expanded their recommendation to include not only persons aged 50 and over, 18-49 years at higher risk for influenza complications, and 6 months to 4 years of age, but also all children aged 5-18 for the 2008-2009 influenza season [38].

Currently, the two types of vaccine available are the trivalent inactivated vaccine (TIV) administered by intramuscular infection and the live attenuated (LAIV) administered by intranasal spray. Whereas TIV contains inactivated viruses and cannot cause influenza, LAIV contains live attenuated influenza viruses that have the potential to cause mild signs or symptoms related to vaccine virus infection [13]. Currently, both contain two types of influenza A (H1N1 and H3N2) and one B-strain, and have been proven to be safe and effective [39]. TIV is licensed for use among person aged 6 months and older for those with chronic medical conditions and those who are healthy, but LAIV is only licensed for use among non-pregnant persons aged 2-49 years [13]. Safety or effectiveness of LAIV has not been established in persons with underlying medical conditions that confer a higher risk for influenza complications [13].

TIV is contraindicated to persons who have anaphylactic hypersensitivity to eggs or to other components of the influenza vaccine, and prophylactic use of antiviral agents is an option for preventing influenza among such persons [13]. Persons with moderate or severe acute illness with or without fever is a precaution for TIV and Guillain-Barré Syndrome within 6 weeks following a previous dose of influenza vaccine is considered to be a precaution for use of influenza vaccine [13].

2.5 Vaccination Supply and Coverage

The annual supply of influenza vaccine and the timing of its distribution cannot be guaranteed in any year, and distribution delays or vaccine shortages remain possible [13]. The U.S. has experienced disruptions in the manufacture or distribution of inactivated influenza vaccine in 4 seasons during the last decade [40-41]. If supplies of season influenza vaccine are not adequate, vaccination is carried out in accordance with local circumstances of supply and demand based on the judgment of state and local health officials and health-care providers [13]. Multiple manufacturing and regulatory issues, and inherent critical time constraints in manufacturing the vaccine given the annual updating of influenza vaccine strains may affect production [13]. During shortages of TIV, LAIV is recommended when feasible for all healthy non-pregnant persons aged 2-49 who desire or are recommended for vaccination in order to increase the availability of inactivated vaccine for persons at high risk [13].

The Centers for Disease Control and Prevention (CDC) routinely monitors influenza vaccination coverage levels using Behavioral Risk Factor Surveillance System (BRFSS), the National Immunization Survey (NIS), the National Health Interview Survey (NHIS), and eight sentinel immunization information system (IIS) sites located in the United States [38]. Specifically, the NIS was established to fulfill the 1992 Childhood Immunization Initiative (CII) mandate of monitoring vaccination coverage and progress towards achieving the Healthy People 2010 objective of having at least 90 percent of children aged 13-15 years fully vaccination with recommended and catch-up vaccines [42]

Influenza vaccine coverage in all recommended groups remains suboptimal and below Healthy People 2010 objectives [13]. Recent NHIS estimates of vaccine coverage levels among adults with high-risk conditions aged 18-49 years were 30.4% in the 2007-08 season and 33% in the 2008-09 season [13]. Among adults with asthmas aged 18-49 years and 50-64 years, approximately 24% and 55%, respectively received the vaccination [13]. Vaccination levels are reportedly not only low among children at increased risk for influenza complications but also decline with increasing age [13]. Coverage among children with asthma aged 2-17 years was approximately 29% for the 2004-05 influenza season [43]. Data from the eight IIS sentinel sites also revealed that coverage was 29% among children aged 6-23 months, 22% among children 2-4 years, and 9% among children aged 13-18 years [44].

2.6 Vaccination Predictors

Although many studies have investigated predictors associated with influenza vaccine coverage among high-risk or ACIP recommended groups, few studies have examined predictors among healthy adults [45]. Among the ACIP recommended or high-risk groups, perceived doctor’s recommendations, belief that getting the influenza vaccine is a “smart idea”, concern about vaccine side-effects, and perception that the vaccine was not needed have been found to be predictors of influenza vaccination [46-47]. The available studies among healthy adults reveal that predictors of vaccine acceptance are similar to those of high-risk patient population and health care workers [48].

Few studies have also examined the influence of socioeconomic and demographic factors and influenza vaccination. Results of a few studies have suggested that parental education status, gender, household income, and size of household may significantly contribute to chances of getting immunized [2, 45].

Reducing racial and ethnic disparities in influenza coverage also presents a national public health challenge [13]. Although adult influenza vaccination levels have increased in the past decade, recent studies continue to document racial and ethnic differences in vaccination coverage [49]. Vaccination coverage levels in 2008 among person aged 65 and over were 70% for non-Hispanic whites, 52% for non-Hispanic blacks, and 52% for Hispanics [13]. In a study among nursing home patients, fewer blacks and Hispanics were offered vaccine or received it compared with whites, and blacks refused vaccination more frequently [50].

2.7 Influenza, Vaccinations, and Adolescents

Influenza vaccine may be comparatively more effective among children and

adolescents and

studies have demonstrated a definite advantage over influenza vaccination in this age group [22]. Unfortunately, studies have found that missed opportunities, lack of population-based immunization registries that include adolescents, low public and peer awareness about immunization covered in this age group, misperceptions about vaccine safety, and lack of knowledge about the importance of vaccinations all contribute to low immunization rates [51]. Although healthy adolescents are not a high-risk group for severe influenza infection, they still may act as vectors for transmitting disease to contacts and family members considered high risk [22]. In addition, with the emergence of new influenza strains, patterns of disease severity diverging from previous experiences have been observed [22]. For example, cases of adolescents and young adults suffering severe H1N1 influenza have been reported much more frequently [22]. With the increase in bacteria co-infections seen in the older pediatric population, reducing the risk of influenza infection could also presumably reduce the invasive bacterial infections that are facilitated by disruptions in host defenses during influenza virus infection [11].

Summary

Influenza vaccines are among the oldest of successful vaccines that are still in use and deficiencies are being addressed by a number of innovative approaches in vaccine development [31]. Despite the burden of influenza infection and universal vaccination recommendation, studies have suggested that coverage in all groups remain low [13]. Additional research should be done to investigate opportunities how to improve coverage as well as education to both health care providers and general public.

Chapter III

METHODOLOGY

3.1 Data Source

The data used in this study were obtained from the 2008 National Immunization Survey (NIS) Teen, a publicly available database that contains de-identified information. The NIS is sponsored by the National Center for Immunizations and Respiratory Diseases (NCIRD) and is conducted jointly with the National Center for Health Statistics (NCHS) of the Centers for Disease Control and Prevention. Established as part of the Childhood Immunization Initiative by President Clinton, the NIS is a list-assisted, random-digit-dialing telephone survey followed by a mailed survey to participants' immunization providers. Telephones numbers are drawn independently, for each quarter, within selected geographical areas. The survey began data collection in April 1994 to monitor childhood immunization coverage and is repeated annually.

NIS is targeted to children ages 19-35 months living in the United States at the time of the interview and the data collected are used to produce estimates of vaccination coverage rates for all childhood vaccinations recommended by the ACIP. However, to assist in measuring progress towards the Healthy People 2010 objectives for teens, the NIS-Teen was developed and conducted for the first time in 2006 as an expansion of NIS. If a household with a 19-35 month old child is identified and the NIS interview is completed, the household is then screened for the presence of any13-17 year old children. Households that do not have a 19-35 month old child are immediately screened for the presence of 13-17 year-old children. If a household contains one or more children aged

13-17, a teen is randomly chosen and the adult who is most knowledgeable about the teen's vaccinations is interviewed. With the consent of the teen's parents or guardian, NIS-Teen also follow-up via mail with the teen's health care provider(s) to request information on the teen's vaccination status from medical records. Survey participation is voluntary and confidential.

NIS provides data online in ASCII format and interested users are allowed to download the files into a variety of statistical software. Syntax files for SAS and R are provided on the NIS website. The 2008 NIS-Teen data files were downloaded from the NIS website and converted from a SAS7bdat file for Statistical Package for Social Sciences (SPSS) version 18.0. SPSS 18 was used for all analysis in this study.

3.2 Study Population

The target population for NIS-Teen was children aged 13-17 living in non-institutionalized households in the United States at the time of the interview. Household interviews began January 3, 2008 and ended on February 4, 2009. All fifty states, including the District of Columbia, were surveyed. Findings from the surveys were released only in summary form. In this study, only data from the 2008 survey were available and utilized.

3.3. Study Measures and Variables

The primary dependent variable for this study was the teen's receipt of influenza vaccination in the last 12 months based on the respondent's recall. The January 2008 to February 2009 timeframe of the household interviews allows for the possibility that influenza vaccination status could be in response for the 2006-2007, 2007-2008, and 2008-2009 influenza seasons.

The demographic independent variables for each household included: sex, age, race and ethnicity, region of U.S., and number of children under the age of 18 living in the household. The socioeconomic independent variables used in this study were poverty status and health insurance status. Poverty status was based on the 2007 Census poverty threshold of $14, 291 in a two person household with 1 child under the age of 18 [52] . Types of health insurance surveyed included: employer health insurance, Medicaid, S-CHIP, Indian Health Services, Military/Tricare/CHAMPUS/CHAMP-VA, or other form of health insurance not named.

The household-reported health status included whether or not the teen had been told by a health professional that he or she has asthma or an underlying health condition. Underlying conditions was defined by the NIS as having a lung condition other than asthma, a heart condition, a kidney condition, sickle cell anemia or other anemia, a weakened immune system caused by a chronic illness or by medicines taken for a chronic illness. These underlying health conditions are typically risk factors which may put individuals at higher risk for complications from influenza infection. The number of school days missed due to illness or injury was also collected. Maternal socio-demographic characteristics included mother's age, education level, and the marital status.

Variables that were taken directly as coded from the original data set were: age, race and ethnicity, region of U.S., asthma status, and underlying health condition. Race and ethnicity was coded as non-Hispanic white, non-Hispanic black, non-Hispanic other race and multirace. Hispanic or Latino included those who identified the teens as Mexican, Mexican-American, Central American, South American or Puerto Rican, Cuban, or other Spanish- Caribbean. Non-Hispanic other race or multirace included Native American, Alaskan native, Asian, Native Hawaiian, Pacific Islanders, and those who identified the teens as “Other.” Other variables that were used as coded in the original data set included the number of children under 18 in the household, poverty status, and the maternal socio-demographic characteristics. Poverty status was re-categorized by NIS into the follow three groups: above poverty and > $75k, above poverty <= $75k, and below poverty. Mother’s age was grouped into 34 years of age and younger, 35-44 years, and 45 years of age and older. Mother’s education level was grouped into the following: less than 12 years, 12 years, more than 12 years but non-college graduate, and college graduate. Mother’s marital status was grouped into widowed/divorced/separated, never married, and married.

The following variables were re-categorized in the current analysis: health insurance and days of school missed. Health insurance status was re-categorized to a dichotomous variable that was zero if the teen reported no insurance and one if the teen was covered by one or more form of the following health insurance plans listed above. The number of missed school days by teen due to illness or injury was re-categorized into the following: 0, 1 to 9 days, 10-19 days, 20-29 days, and 30 or more.

3.4 Statistical Analysis

Descriptive statistics were created to describe the population sample. An odds ratio calculation was performed to analyze any association between receipt of influenza vaccination and socio-demographic characteristics and household-reported health status. Using a binary logistic regression analysis, odds ratios were calculated along with 95% confidence intervals and p-value. A p-value of < 0.05 was considered a statistically significant association between the socio-demographic factors, household-reported health status, with receipt of the vaccine.

To further examine potential associations between the dependent and independent variables, multivariate logistic regression analysis was performed for influenza vaccine receipt where all socio-demographic characteristics and household-reported health status variables were considered at once. Odds ratios were calculated, along with 95% confidence intervals and variables were considered significantly associated with receipt of the influenza vaccine at the aforementioned accepted p-value of < 0.05.

Chapter IV

RESULTS

4.1 Frequencies and Descriptive Statistics

Frequencies and descriptive statistics about the study sample are detailed in Tables 1 through 6. The sample size for this study included 29063 adolescents where 19.8% of the respondents reported receiving the influenza vaccine (Table 1). A total of 1,618 respondents who reported not knowing the influenza vaccination status, refused to respond, or had a missing response and were excluded from this analysis.

In this study population, 51.9% were male and 48% were female. Limited data were available for influenza vaccine type, month of vaccination, and place of vaccination. These results are presented in Tables 1 and 2.

Of the five age categories, the 16 year old age group was the most represented category with 21.4% of the respondents. Non-Hispanic whites were the most represented race/ethnicity among the study population (68.6%) and non-Hispanic other race and multirace were the least represented race/ethnicity (7.1%). More than one third (36.4%) of the study population resided in the South, and approximately one half of the teens (50.9%) lived in households with 2 or 3 children under the age of 18.

Of those surveyed where information on income and health insurance status was obtained, almost half (46.6%) of the study population reported annual family income above the 2007 U.S. Census Bureau poverty threshold and less than or equal to $75,000, and 93.3% reported having one or more form of health insurance. Nonresponse as a result of refusal to answer, lack of knowledge, or dropped interview resulted in 6 percent of the poverty status and 20 percent of the health insurance unavailable for analysis. The results are presented in Table 4.

Of those surveyed where the teen's household-reported health status was available, 18.1% reported having been told by a health professional that the teen had asthma, and 5.8% reported having been told he or she has an underlying health condition. The results are presented in Table 5.

Table 1. Influenza Vaccine Receipt Data

Vaccine Receipt	N (%)
Yes	5752 (19.8)
No	23311 (80.2)
	29063

Table 2. Influenza Vaccine Descriptive Data by Type, Place, and Month of Vaccination

Vaccine Type	**N (%)**
Shot	5184 (94.1)
Spray/Mist	324 (5.9)
	5508
Place of Vaccination	N (%)
Doctor's Office	3330 (58.1)
Health Department	331 (5.8)
Clinic	1087 (19.0)
Hospital	235 (4.1)
Other Medical Facility	102 (1.8)
Pharmacy	169 (2.9)
Work	65 (1.1)
Other Non-Medical Place	417 (7.3)
	5736

Table 2. Influenza Vaccine Descriptive Data by Type, Place, and Month of Vaccination Cont'd

Month	**N (%)**
January	194 (3.7)
February	118 (2.2)
March	52 (1)
April	30 (0.5)
May	30 (0.5)
June	20 (0.4)
July	23(0.4)
August	123 (2.3)
September	412 (7.9)
October	2088 (40.0)
November	1709 (32.8)
December	411 (7.9)
	5210

Table 3. Demographic Characteristics and Vaccination Status of NIS Teen 2008 Influenza Vaccination Study Population

Demographic Characteristic	N (%)	No. Vaccinated (%)
Sex		
Male	15111 (51.9)	2867 (19.0)
Female	13952 (48.0)	2885 (20.7)
Total	29063	
Age		
13	5395 (18.6)	1147 (21.2)
14	5850 (20.1)	1250 (21.3)
15	5953 (20.4)	1173 (19.7)
16	6212 (21.4)	1170 (18.8)
17	5633 (19.4)	1012 (18.0)
Total	29063	
Race and Ethnicity		
Non-Hispanic White	19946 (68.6)	3579 (17.9)
Hispanic	3516 (12.1)	777 (22.1)
Non-Hispanic Black	3535 (12.2)	831 (23.5)
Non-Hispanic Other & Multirace	2066 (7.1)	565 (27.3)
Total	29063	
Region of U.S.		
Northeast	5469 (18.8)	1099 (20.1)
Midwest	6823 (23.5)	1240 (18.2)
South	10571 (36.4)	2214 (20.9)
West	6200 (21.3)	1199 (19.3)
Total	29063	
No. of Children < 18 in Household		
1	11594 (39.9)	2204 (19.0)
2 or 3	14796 (50.9)	2978 (20.0)
4 or more	2673 (9.2)	570 (21.3)
Total	29063	

Table 4. Socioeconomic Characteristics and Vaccination Status of NIS Teen 2008 Influenza Vaccination Study Population

Socio-demographic Characteristics	N (%)	No. Vaccinated (%)
Poverty Status		
Above Poverty >75k	11044 (38.0)	2292 (20.8)
Above Poverty <=75k	12679 (43.6)	2296 (18.1)
Below Poverty	3471 (11.9)	807 (23.0)
Missing/Don't know/Refused	1869 (6.4)	
Total	29063	5395
Health Insurance Status		
Insured	21773 (74.9)	4361 (20.0)
Not Insured	1553 (5.3)	217 (14.0)
Missing/Don't Know/Refused	5954 (20.5)	
Total	29063	4587

Table 5. Household-reported Health Status and Vaccination Status of NIS Teen 2008 Influenza Vaccination Study Population

Household-reported Health Status	N (%)	No. Vaccinated
Has been told he/she has asthma		
Yes	5286 (18.2)	1572(29.7)
No	23736 (81.7)	4167 (17.6)
Missing/Don't Know/Refused	41 (0.14)	
Total	29063	
Has ever been told he/she had underlying health condition?*		
Yes	1688 (5.8)	528 (31.2)
No	27347 (94.1)	5216 (19.1)
Missing/Don't Know/Refused	28 (0.1)	
Total	29063	
No. of Missed School Days because of Illness or Injury		
0	8212 (28.3)	1544 (18.8)
1 to 9	18033 (62.0)	3491 (19.4)
10-19	1862 (6.4)	446 (24.0)
20-29	337 (1.2)	92 (27.3)
30 or more	342 (1.2)	95 (27.8)
Missing/Unknown/Refused/Did not go to school	277 (0.95)	
Total	29063	

Table 6. Maternal Socio-demographic Characteristics and Vaccination Status of NIS Teen 2008 Influenza Vaccination Study Population

Maternal Socio-demographic Characteristics	N	No. Vaccinated (%)
Mother's Age		
<=34 yrs	2342 (8.1)	546 (23.3)
35-44 yrs	13157 (45.3)	2538 (19.3)
>=45 yrs	13564 (46.7)	2688 (19.8)
Total	29063	
Mother's Education Level		
< 12 yrs	2879 (10.0)	614 (21.3)
12 years	6336 (21.8)	1174 (18.5)
>12 years, Non-college graduate	8907 (30.6)	1684 (18.9)
College graduate	10941 (37.6)	2280 (20.8)
Total	29063	
Mother's Marital Status		
Widowed/Divorced/Separated	5099 (17.5)	1013 (19.9)
Never Married	2027 (7.0)	497 (24.5)
Married	21937 (75.5)	4242 (19.3)
Total	29063	

With regards to maternal socio-demographic characteristics, teens with mothers in the 45 and older age group were the most represented (46%) whereas only 8.1% of teens with mothers were in the 34 and younger age group. More than one third (36.7%) of the respondents reported that the teen's mother was a college graduate, and approximately three quarters (75.5%) reported that the teen's mother was married.

Frequency and prevalence of influenza vaccination are also detailed in Tables 3 through 6. Females, 14 year olds, non-Hispanic other race and multirace, the southern region of the U.S., and households with four or more children under 18 years of age had the highest prevalence of vaccination in the study population. Descriptive results revealed that 20% of the female adolescents were vaccinated compared with 19% of males. Approximately 21% of 14 year old teens in this study reported receiving the vaccination. Approximately 27 % of teens in the non-Hispanic other race and multirace category reported receiving the influenza vaccine, where as only 17.9% of the non-Hispanic white teens reported receiving the influenza vaccine. Teens who resided in the Southern region of the U.S. reported the highest prevalence of vaccination at 20.9% whereas teens who resided in the Midwest reported a prevalence of only 18%. Finally, 21% of teens in the survey who resided in households with 4 or more children under the age of 18 were vaccinated.

With regards to socioeconomic factors, teens with one or more form of health insurance, and teens who reported living below poverty had highest prevalence of influenza vaccination. With regards to household-reported health status, teens who reported having asthma and underlying health conditions, and those who reported missing 30 or more days of school due to illness or injury all reported having the highest prevalence of vaccination. Teens whose mothers were in the 45 years of age and older age group, mothers who had less than 12 years of education, and mothers who never married were found to have the highest prevalence of influenza vaccination in the study population.

4.2. Demographic characteristics

Bivariate analysis using logistic regression assessed the association of demographic characteristics with the receipt of influenza vaccine. The results are shown in Table 7. With regards to sex, females were 1.11 times more likely to receive the vaccine compared with males. Age also played a significant role in the odds of receiving the vaccine where a one year increase in age resulted in a slight decrease (OR=0.94) in the odds of vaccination ($p < 0.001$). Those who were identified themselves as non-Hispanic other race and multi-race teens were the most likely to have received the influenza vaccine compared to non-Hispanic whites (OR=1.72). When region of the U.S. was analyzed, the only subcategory found to be statistically significant was the Midwest (OR=0.88, $p=0.007$). Teens who lived in households which had four or more children under 18 were 1.16 times more likely to receive the vaccine as compared to those who had only one child under the age of 18 ($p=0.006$).

Additional analysis of the demographic factors influencing influenza vaccine receipt was performed by including all of the independent variables in a multivariate logistic regression model. Results are presented in Table 11. Both sex and race/ethnicity remained statistically significant. Females 1.15 times more likely to receive the vaccine than males and non-Hispanic other race & multirace teens were 1.71 times more likely to receive the vaccine compared with the non-Hispanic white referent group. Age also remained statistically significant where a one year increase in age resulted in a slight decrease in odds of vaccination (OR=0.95,p< 0.001). Region of U.S., and number of children under 18 in the household were no longer statistically significant in the multivariate model.

Table 7. Bivariate Analysis Using Logistic Regression Assessing the Association of Demographic Characteristics in NIS Teen 2008 Influenza Vaccination Study Population

Variable	OR	CI	p-value
Sex			
Male	REF	REF	REF
Female	1.11	1.05-1.18	<0.001
Age	0.94	0.92-0.96	<0.001
Race and Ethnicity			
Non-Hispanic White	REF	REF	REF
Hispanic	1.30	1.19-1.42	<0.001
Non-Hispanic Black	1.41	1.29-1.53	<0.001
Non-Hispanic Other & Multirace	1.72	1.55-1/91	<0.001
Region of U.S.			
Northeast	REF	REF	REF
Midwest	0.88	0.81-0.97	0.007
South	1.05	0.97-1.14	0.21
West	0.95	0.87-1.05	0.31
No. of Children < 18 in Household			
1	REF	REF	REF
2 or 3	1.07	1.01-1.13	0.023
4 or more	1.16	1.04-1.28	0.006

4.3 Socioeconomic Characteristics

Bivariate analysis using logistic regression assessed the association of socioeconomic characteristics with the receipt of influenza vaccine. The results are shown in Table 8. The analysis of both poverty status and health insurance status indicated that both were correlated with receipt of the influenza vaccine. Teens who lived below poverty were 1.16 times more likely while teens who lived above poverty but less than or equal to $75,000 were less likely (OR=0.86, p<0.001) to receive the influenza vaccine when compared with the referent group (teens who lived above poverty and more than $75,000). Teens who had at least one form of health insurance were 1.54 times more likely to have received the vaccine compared to those who reported no health insurance.

Additional analysis of the socioeconomic factors influencing influenza vaccine was performed by including all of the independent variables in a multivariate logistic regression model. Poverty status remained statistically significant, but only in the category of those who reported annual income above the poverty threshold but less than or equal to $75,000. Health insurance also remained a statistically significant predictor of influenza vaccination. (OR=1.54, p<0.001).

Table 8. Bivariate Analysis Using Logistic Regression Assessing the Association of Socioeconomic Characteristics in NIS Teen 2008 Influenza Vaccination Study Population

Variable	OR	CI	p-value
Poverty Status			
Above Poverty >75k	REF	REF	REF
Above Poverty <=75k	0.84	0.79-0.90	<0.001
Below Poverty	1.16	1.06-1.27	0.002
Health Insurance	1.54	1.33-1.79	<0.001

4.4 Household-reported Health Status

Analysis of the teens' household-reported health status indicated that teens who had asthma and other underlying health conditions, and missed more days of school were all more likely to receive the vaccine. All three independent variables measuring teen health status were significantly associated with receipt of influenza vaccine, and the results are presented in Table 9. All three also remained statistically significant when included in the multivariate model but the strength of the associations were lower after adjustment for other factors.

4.5 Maternal Socio-demographic Characteristics

Independent analysis of maternal socio-demographic characteristics indicated that all three independent variables were statistically associated with receipt of influenza vaccine. Teens whose mothers were in the 35-44 age group were the least likely (OR=0.79, p<0.001) to receive the influenza vaccine compared with the referent group (mothers aged 34 or younger). Teen whose mothers were in the 45 years and older age group were also less likely to receive the vaccine compared with the referent group (OR=0.81, p<<0.001). Teens whose mothers who completed high school only were the least likely (OR=0.84, p=0.002) to receive the vaccine compared with the referent group (less than 12 years of school). Teens whose mothers who were never married were 1.31 times more likely to receive the vaccine compared with the widowed/divorced/separated referent group (p<0.001).

After adjusting for other variables, the only significant maternal socio-demographic characteristics variable was maternal age. Similar to the results from the bivariate analysis, teens whose mothers were in 35-44 age group were the least likely to receive the influenza vaccine compared with the referent group (mothers aged 34 or younger).

Table 9. Bivariate Analysis Using Logistic Regression Assessing the Association of Household-reported Health Status in NIS Teen 2008 Influenza Vaccination Study Population

Variable	OR	CI	p-value
Has been told teen has asthma	1.99	1.86-2.13	<0.001
Has ever been told teen had underlying health condition?*	1.93	1.74-2.15	<0.001
Still has the underlying health condition	1.76	1.42-2.19	<0.001
No. of Missed School Days by teen because of illness or injury			
0	REF	REF	REF
1 to 9	1.04	0.98-1.11	0.288
10-19	1.36	1.21-1.53	<0.001
20-29	1.62	1.27-2.07	<0.001
30 or more	1.66	1.30- 2.12	<0.001

Table 10. Bivariate Analysis Using Logistic Regression Assessing the Association of Maternal Socio-demographic Characteristics in NIS Teen 2008 Influenza Vaccination Study Population

Variable	OR	CI	p-value
Mother's Age			
<=34 yrs	REF	REF	REF
35-44 yrs	0.79	0.71-0.87	<0.001
>=45 yrs	0.81	0.73-0.89	<0.001
Mother's Education Level			
< 12 yrs	REF	REF	REF
12 years	0.84	0.75-0.94	0.002
>12 years, Non-college graduate	086	0.78-0.95	0.004
College graduate	0.97	0.88-1.07	0.57
Mother's Marital Status			
Widowed/Divorced/Separated	REF	REF	REF
Never Married	1.31	1.16-1.48	<0.001
Married	0.97	0.90-1.04	0.39

Table 11. Multivariate Analysis Using Logistic Regression Assessing the Association of Socio-demographic Characteristics in NIS Teen 2008 Influenza Vaccination Study Population

Variable	OR	CI	p-value
Sex			
Male	REF	REF	REF
Female	1.15	1.07-1.23	<0.001
Age	0.95	0.92-0.97	<0.001
Race and Ethnicity			
Nonhispanic White	REF	REF	REF
Hispanic	1.33	1.19-1.49	<0.001
Nonhispanic Black	1.29	1.14-1.44	<0.001
Nonhispanic Other & Multirace	1.71	1.51-1.93	<0.001
Region of U.S.			
Northeast	REF	REF	REF
Midwest	0.93	0.84-1.04	0.19
South	1.04	0.94-1.14	0.45
West	0.93	0.83-1.04	0.19
No. of Children < 18 in Household			
1	REF	REF	REF
2 or 3	1.07	0.99-1.16	0.08
4 or more	1.12	0.98-1.30	0.10
Poverty Status			
Above Poverty >75k	REF	REF	REF
Above Poverty <=75k	0.80	0.74-0.87	<0.001
Below Poverty	0.96	0.84-1.09	0.55
Health Insurance	1.50	1.27-1.75	<0.001
Has been told teen has asthma	1.90	1.75-2.06	<0.001
Has ever been told teen had underlying health condition?*	1.70	1.50-1.93	<0.001

Table 11. Multivariate Analysis Using Logistic Regression Assessing the Association of Socio-demographic Characteristics in NIS Teen 2008 Influenza Vaccination Study Population Cont'd

Variable	OR	CI	p-value
No. of Missed School Days by teen because of illness or injury			
0	REF	REF	REF
1 to 9	1.03	0.95-1.12	0.44
10-19	1.31	1.14-1.51	<0.001
20-29	1.54	1.17-2.04	0.002
30 or more	1.47	1.11-1.95	0.007
Mother's Age			
<=34 yrs	REF	REF	REF
35-44 yrs	0.81	0.71-0.91	0.01
>=45 yrs	0.86	0.75-0.98	0.03
Mother's Education Level			
< 12 yrs	REF	REF	REF
12 years	0.92	0.81-1.05	0.23
>12 years, Non-college graduate	0.96	0.84-1.10	0.54
College graduate	1.06	0.92-1.21	0.43
Mother's Marital Status			
Widowed/Divorced/Separated	REF	REF	REF
Never Married	1.16	1.00-1.35	0.05
Married	0.99	0.90-1.09	0.83

***Underlying health condition was defined as having a lung condition other than asthma, a heart condition, a kidney condition, sickle cell anemia or other anemia, a weakened immune system caused by a chronic illness or by medicines taken for a chronic illness.**

4.6 Significant Association

Table 12 shows a summary of the statistically significant socio-demographic characteristics and household-reported health status based on the bivariate and multivariate analyses performed for this study.

Sex, age, race and ethnicity, residing in the Midwest region, poverty status, health insurance, having asthma, having an underlying health condition, higher number of missed school days, and mother's age, mother's education level, and mother's marital status were found to be statistically significant with the receipt of vaccination using the bivariate logistic regression model. Sex, age, race and ethnicity, living above poverty but less than $75,000, health insurance, having asthma, having an underlying health condition, higher number of missed school days, and mother's age were found to be statistically significantly with the receipt of vaccination using the multivariate logistic regression model.

Table 12. Summary of Bivariate and Multivariate Analyses Statistically Significant Socio-demographic Characteristics and Household-reported Health Status for NIS Teen 2008 Influenza Vaccination Study Population

Variable	Bivariate analysis p-value	Multivariate analysis p-value
Female	**<0.001**	**<0.001**
Age	**<0.001**	**<0.001**
Hispanic	**<0.001**	**<0.001**
Nonhispanic Black	**<0.001**	**<0.001**
Nonhispanic Other Race and Multirace	**<0.001**	**<0.001**
Midwest	**0.007**	0.19
South	0.21	0.45
West	0.31	0.19
No. of children < 18: 2 or 3	**0.023**	0.08
No. of children <18: 4+	**0.006**	0.10
Above Poverty<=$75k	**<0.001**	**<0.001**
Below Poverty	**<0.001**	0.55
Health Insurance	**<0.001**	**<0.001**
Asthma	**<0.001**	**<0.001**
Underlying Health Condition	**<0.001**	**<0.001**
No. of Missed School Days: 1-9	0.29	0.44
No. of Missed School Days: 10-19	**<0.001**	**<0.001**
No. of Missed School Days 20-29	**<0.001**	**0.002**
No. of Missed School Days: 30+	**<0.001**	**0.007**
Mother's Age: 35-44 yrs	**<0.001**	**0.01**
Mother's Age: >=45 yrs	**<0.001**	**0.03**
Mother's Education Level: 12 yrs	**0.002**	0.23
Mother's Education Level: >12 yrs, Non-college graduate	**0.004**	0.54
Mother's Education Level: College graduate	0.57	0.43
Mother's Marital Status: Never Married	**<0.001**	**0.05**
Mother's Marital Status: Married	0.39	**0.83**

Chapter V

Discussion and Conclusion

5.1 Discussion

. High influenza vaccination coverage of school-aged children not only provides both direct and indirect protection to students, school staff, and the broader community, but it also reduces student and teacher absenteeism [14]. Studies have demonstrated that encouragement from health care professionals can lead to beneficial health practices and higher vaccination rates[45]. However, primary care visits would have to increase by more than two thirds to achieve high vaccine coverage of 5 to 18 year olds [14]. Physician case loads have been near capacity with previous influenza vaccination recommendations and relying solely on the primary care provider could exacerbate existing health care disparities [14]. In addition, reminder and recall systems and reducing missed opportunities have only had limited success in increasing vaccination rates and do not account for the population of teens who are uninsured or do not see the same health care professional each time [14]. Reminder systems also do not address the disparities among different socio-demographic characteristics or the time and cost parents must spend to vaccinate their children.

The purpose of this work was to examine the association between specific socio-demographic characteristics and household-reported health status with receipt of influenza vaccinations in teens. Studies on the characteristics that describe the vaccinated portion of the adolescent population will allow public health and health care professionals implement appropriate interventions aimed at improving adolescent vaccination rates.

Demographic Characteristics

Sex

Results from the multivariate analysis in this study revealed that female teens were more likely than male teens to receive the influenza vaccination. Some studies of health services use among school-aged patients revealed no differences according to sex [17]. However, another study determined older adolescent female subjects had more overall visits, largely because of visits to obstetricians/gynecologists [17]. Obstetrician-gynecologists are the first and most frequent point of contact for women who seek medical consultation for reproductive health and are primary caregivers for many non-pregnant women who have little or no contact with the healthcare system [53]. It is also possible this study population had female teens who were pregnant during influenza season and thus were recommended to receive the vaccine. The statistical significance found in the analysis could also be due to a large sample size, and exact reasons for a higher likelihood of female teen influenza vaccination in this study population are unclear. Further research is needed to explore this association.

Age

Results from this multivariate analysis revealed that age was a statistically significant predictor with influenza vaccination in this study population. The lower vaccination coverage found in older adolescents may have resulted from greater parental or health care provider influence on younger adolescents regarding immunization [17]. For example, providers have reported that they are more likely to assess immunization status and to administer immunizations in younger adolescents [51]. It is also important to note that adolescents in the 13-17 age group, except those who had underlying health conditions, had not been included in any of the ACIP influenza recommended groups until the 2008-2009 influenza season [38]. Given these findings as well as the change to a universal recommendation by ACIP following the influenza A H1N1 pandemic of 2009, further research is needed to explore the association of the age and influenza vaccination.

Race

Results from the multivariate analysis revealed race and ethnicity was a significant predictor of influenza vaccination. However, findings from this study differed from what has been reported previously in the literature and in general trends noted in many social determinant studies, where Whites typically have fewer health problems and tend to have better health and fewer disparities to overcome with regards to health [54]. Although they constituted less than 10 percent of the study population, teens in the non-Hispanic other race and multirace group were the most likely to receive the vaccine compared with non-Hispanic white teens. It is unclear whether the lower immunization rates in the non-Hispanic white teens might be a reflection of the poor overall coverage or whether having better health might have led to the false perceptions that influenza is a mild disease and therefore the vaccine is not needed. It is also possible the higher likelihood of influenza vaccination seen in teens in the non-Hispanic other race and multirace category was a result of targeted immunization campaigns as a result of socioeconomic status or underlying health conditions. Further research is needed to assess the association between influenza vaccination and race and ethnicity, as well as any immunization interventions received among the different race and ethnic groups.

Region of the U.S.

Region of the U.S. did not reveal trends that could show an overall association between region and likelihood of influenza vaccination. Although review of the literature did not indicate whether any region perceived higher risk of infection, or were more or less likely to receive the influenza vaccination, an important point to consider is that an universal vaccination strategy may not work across all cities with the same level of effectiveness [55]. There is no clear explanation for the results found in this study and regions might have been a proxy for other factors which predict adolescent vaccination. It is also important to note the local and state public health departments differ in their capacity to administer vaccinations. Many public health clinics do not have adequate capacity to bill and recover the costs of immunizations, 24 states are unable to provide vaccines for underinsured children in the private sectors, and only 56% of public health department immunization clinics use tracking and recall system [14, 53, 56]. More appropriate variables for this examination may have been population size, urban versus rural area, or distance and travel time required to receive vaccinations.

Number of children under 18 in household

Although trends from the descriptive data and odds ratio from the bivariate analysis indicated that teens were more likely to receive the influenza vaccination as the number of children under 18 in the household increased, results from the multivariate model revealed that after adjusting for other variables, the number of children was not a statistically significant predictor for receipt of influenza vaccination. Previous research has revealed mixed findings with household size and immunization coverage. One study of Latino and African-American preschool aged children suggested that an increase in the number of preschool aged children in the household resulted in lower likelihood of receiving childhood immunizations with [57]. A European study on socioeconomic determinants and influenza vaccination found that person living in two persons households were more likely to be vaccinated but living in a household with three or more persons had a negative effect on the vaccination rate [2]. The number of children could be a proxy for other factors and further studies should analyze the impact of both age group and number of children and persons in the household. It is possible that a more appropriate variable could have been one which stratified the age groups of children in the household as literature has shown that office visits for preventive and episodic care are less frequent for school-aged children than for infants and preschool children [14].

Socioeconomic Characteristics

Poverty Status

Results from this analysis revealed that after adjusting for other variables, poverty status was only a statistically significant for receipt of influenza vaccination for teens who reported living above poverty but less than or equal to $75,000. Teens who lived above poverty but reported annual household income of less than $75,000 were less likely than teens in the referent group (above poverty but reported an annual household income of more than $75,000) to receive in the influenza vaccine. Although teens who lived below poverty were also found to be less likely to receive the influenza vaccine compared with the referent group, this association was not statistically significant. Although cost is not a barrier for vaccinations for the majority of children in the U.S. [56], the findings from this study are consistent with previous findings that lower income levels contribute to the inability of obtaining health insurance, and the cost to families is a barrier to the delivery of immunization [58]. Costs to vaccinate can also exist in the form of the lost time and cost of transportation, which disproportionately affects low-income parents, required to vaccine [14]. These results also suggests that teens who lived above poverty but less than $75,000 may not have qualified for government funded healthcare and benefits though they were also not financially stable enough to afford the vaccine. Further research should investigate the association between household income and influenza vaccination, as well as assess the expense to receive vaccines, including lost time and transportation costs, for families.

Health Insurance Status

Results from this analysis revealed that after adjusting for other variables, having one or more form of health insurance was a statistically significant predictor for receipt of influenza vaccine. These results support the hypothesis that an important barrier to preventive health services such as influenza vaccination is the lack of access to care. Most health insurance plans cover the costs of vaccination and the federal government provides free vaccines through the Vaccines for Children (VFC) program [56]. However, similar to the findings from the poverty status variable, there remains a population of children and young adults who may neither be covered by health insurance nor eligible to receive free VFC vaccines. Approximately 11% of young children and 21% of adolescents fall outside the care of private health insurance and government programs [56]. In addition, even with the assistance of the VFC program, families may need to pay a moderate VFC administrative fee in order to receive the vaccine [58]. It should be noted, however, that health insurance status was not available on approximately 20% of the study population and further research is needed in order to better address the association between health insurance and influenza vaccination. Evaluation of the type of health insurance (private, public, military etc,) and if the teen's insurance had covered the cost of the vaccine are also important components to consider.

Household-reported Health Status

Asthma

Results from the analysis revealed that having asthma was a statistically significant predictor for receipt of influenza vaccination. Individuals with asthma are at increased risk of complications from influenza infection, and the vaccination of adults and children with asthma has been recommended for many years [41]. These findings are consistent with previous research which has discussed the association between asthma status and influenza vaccine status. These findings may reflect better knowledge of vaccination recommendations or they also may reflect having access to care and providers who would remind the families about vaccinations [17]. It is important to note that the percentage of asthmatic teens who receive the influenza vaccine can still be improved. Healthy People 2010 National Objectives aimed for influenza vaccination of at least 60% of adults aged 18-64 with asthma and other underlying health conditions, but studies have shown that vaccination coverage among adults with asthma is low [41]. Although the teens in this study were not part of that particular Healthy People 2010 objective's age group or risk group, it is important for both public health professionals and health care providers to keep in mind when developing intervention strategies that adolescents will soon enter that recommended age-risk group, and that perhaps intervention targeting adolescents or even younger children may help with vaccination coverage for reaching Healthy People 2020 objectives. Further research should seek to survey the role of physician recommendations, recall/reminder systems, and influenza vaccination in the asthmatic teen population. The severity of asthma in teens should also be assessed as one study has suggested low vaccination rates might be attributed to providers who may not remember to vaccinate patients with milder asthma against influenza [17].

Underlying Health Conditions

Results from the analysis revealed that having been told by a health professional that he or she had one of the underlying health conditions surveyed was a statistically significant predictor for receipt of influenza vaccination. Similar to findings of the asthma status, these findings may reflect better knowledge of vaccination recommendations or they also may reflect already requiring or having access to care [17]. It is also possible that teens who reported having underlying health conditions were under the care of medical specialists or enrolled in health care maintenance organizations with successful immunization strategies which remind teens and their families with vaccination updates. For example, one study has found that diagnosis-based billing data accurately identified children who had high risk health conditions and needed annual influenza vaccination, and registry-driven reminders/calls significantly increased influenza immunization in targeted children [59]. The NIS-Teen only assessed whether the teen had underlying health conditions but did not ask respondents to identify the specific health conditions. Further research should seek to identify which specific health conditions (lung diseases versus heart conditions) are more likely to be strong predictors for receipt of influenza vaccine. The availability of any vaccine recall/reminder program in place should also be assessed.

Number of Missed School Days Due to Illness or Injury

Results from the analysis revealed all subcategories of number of missed school days, except for 1-9 days, were statistically significant predictors for receipt of influenza vaccination in this study population. Teens who missed thirty of more school days were the most likely to receive the influenza vaccination more school days were more likely to receive the influenza vaccine when compared with teens who did not miss any days of school. Although the literature has shown that vaccination can reduce student and teacher absenteeism, and that that influenza-like illness increases the economic burden among households with school-aged children and leads to more lost school [60], data on the number of missed school days due to illness or injury as a predictor for influenza vaccination is limited. It is possible that the school absenteeism was a proxy for underlying health condition or that vaccine acceptance was linked with amount of absenteeism caused by influenza-like illness prior to the survey [61]. However, it is important to note the survey did not distinguish between illness or injury in the study, and the proportion of the two categories is unknown. It is also unclear the type or pattern (consecutive versus intermittent) of the illness the teen reported experiencing and if the illness reported were attributed any significant underlying health conditions. Perhaps a more appropriate variable might have assessed the number of missed school days due to influenza-like illness. Further research is needed to better understand the association between the number of missed school days and influenza vaccination.

Maternal Socio-demographic Characteristics

Mother's Age

Results from this analysis revealed that maternal age was a statistically significant predictor for receipt of influenza vaccination in this study population. Teens who had mothers in the 35 to 44 and 45 and older age groups were less likely to receive the influenza vaccine compared with the referent 34 and younger age group. Previous studies have revealed mixed findings for the association between maternal age and immunization [62]. Some studies have indicated that children of younger mothers are at increased risk of underimmunization while other studies have shown no association [62]. One study, however, has shown that maternal age was an important facto associated with up-to-date vaccination coverage of children 19-35 months of age in the U.S. for children born to mothers age 26 and younger [62]. One possibility for the findings in this study is that mothers in the older age groups were adolescents themselves during the 1976 swine influenza epidemic and may have recall the increased frequency of Guillain-Barré Syndrome associated with the vaccine [13]. A parent's personal experiences with the influenza vaccination could certainly have shaped their attitudes about vaccination for the adolescents in this study. Another possibility is that an older mother may indicate the possibility of the mother having more children in the household. Having additional children may require additional support and encouragement regarding vaccination [24]. Further studies should assess the association between maternal age, maternal experiences with vaccination, and receipt of influenza vaccination.

Mother's Education Level

Although odds ratios from the bivariate analysis suggested that teens who had mothers who obtained higher levels of education were more likely to receive the influenza vaccination, results from the multivariate analysis revealed that that maternal education level was not a statistically significant predictor for receipt of influenza vaccination in this study population. Previous studies have shown mixed findings. In one study, it was found that lower maternal education is associated with undervaccination and improving the educational status of both parents could potentially improve the immunization coverage of children [24, 63].Another study has found that children of mothers who were less educated were more likely to have completed the childhood 4:3:1:3 series [64]. It is also important to recognize that education level also may have been proxy for socioeconomic status since higher education levels could indicated higher paying jobs. Additional research in needed to assess the association between maternal education level and receipt of influenza vaccination.

Mother's Marital Status

Results from this analysis revealed that after adjusting for other variables, mother's marital status was not a statistically significant predictor for receipt of influenza vaccination. Studies have suggested that those who are separated or divorced suffered the most negative health outcomes as well were more likely to have children who were undervaccinated [24, 65]. Although results from this study did not find statistical significance in mother's marital status, it is still important for public health practitioners to recognize that mothers are influential in the vaccination of their children and that public health interventions should still address maternal concerns and barriers [24]. Further studies should seek to investigate the association of parental marital status, medical care, and receipt of influenza vaccination.

5.2 Study Limitations

The results of this study are subject to some limitations. First, this study only extracted data on influenza vaccination status data from a parent's or guardian's recall based on telephone surveys, and responses from participants may reflect recall bias. Analysis using only the population with vaccination shot card or verification from provider was not incorporated for this study. In addition, although mothers are influential in the vaccination of their children and although a higher percentage of respondents were mothers, the actual impact of maternal socio-demographic characteristics in this study population is unknown.

In addition, another component to the recall bias is that the NIS survey was conducted throughout the calendar year and included three different influenza vaccination seasons (2006-2007, 2007-2008 and 2008-2009 seasons). The influenza vaccine is administered annually in a fairly limited time period, and it is possible that respondents who were surveyed closer to the influenza season were more likely to recall the status of the teen's immunization status. Also, because ACIP recommendation to vaccinate children ages 5-18 had not been included until the 2008-2009 influenza season [66], there could have been differences in the response of households between the different seasons, but the impact of the changes in recommendation to providers and parents was not assessed. Secondly, although the data on type, place, and month of influenza vaccination can be important in assessing trends, the reason for the large portion of missing data in this study population is unknown. Lastly, because the NIS is a telephone survey, vaccination, demographic, and socioeconomic data on households that strictly use cellular telephones would not have been captured.

Another limitation is the design of the study itself. Although associations of many socio-demographic characteristics and household-reported health status with influenza vaccine receipt could be assessed, the cross-sectional design of the study was not strong enough to enable an analysis of direct causation for these variables and vaccine prevalence. Second, unlike other vaccines (HPV, MMR, etc) surveyed in the NIS, the reasons for decline of receipt of the influenza vaccine were not assessed. The reason for not incorporating a "reasons for decline of receipt" section in the survey is unknown.

Although health insurance status was found to be a significant predictor, a large percentage of data on health insurance status was not available either due to unknown or non-response. Questions from the health insurance status section were addresses towards the end of the interview, and some respondents who did not complete the demographic section earlier in the survey did not reach the health insurance questions. The NIS researchers also addressed the possibility that respondents who began the health insurance questions may have broke off the interview prior to concluding the survey. It is also unknown whether the teen's health insurance covered the entire or a portion of the cost of receiving the vaccine.

The household-reported health status variables also present a limitation. The data collected on asthma status and underlying health conditions were self-reported and responses were not verified by licensed health professionals or the teen's health care providers. Also, the data collected on number of missed school days due to illness or injury was not verified by school officials. Respondents may have reported the teen as having an underlying health condition when in fact he or she may have a medical issue not known to put them at high risk for influenza complication. Therefore, errors due to both recall and information bias were both possible and unavoidable. As mentioned earlier, the number of missed school days did not distinguish between illness or injury and the proportion of the two components is unknown. It is quite possible those who reported a significant number of missed school days were mainly attributed to extensive injuries.

5.3 Recommendations

Additional research is needed to address the limitations mentioned above. Additional studies should evaluate the population with shot cards, include questions which directly assess the reasons for or against influenza vaccination, and questions which survey provider recommendations and parental knowledge of influenza vaccines.

A follow-up study on the population with vaccination shot cards and provider verification should be considered. Verification of vaccination status from primary care providers or health departments would help reduce the recall bias but would also confirm other important factors related to influenza vaccination such as place and time of vaccination. Verification of underlying health condition by the health a health care provider not only could also help reduce recall bias, but also would help improve our understanding of the adolescent population who is at high-risk for influenza vaccination.

The NIS surveyed reasons for the decline of the receipt of the meningitis, Human Papillomavirus, and tetanus vaccines. These included not believing in vaccines, costs, safety concerns, and lack of knowledge, etc. and should also be addressed with the influenza vaccine. The fear of needles or injection has been also cited as a reason for declining receipt of influenza vaccination and should be considered in future research[39]. It is also unknown the population of teens who declined of the receipt of the influenza vaccine due to contraindication. Additional investigation should also seek reasons for the large amount of data on type, month, and place of influenza vaccine was not collected. It may also help to survey those who did receive the influenza vaccination and determine reasons the teens and families pursued receipt of influenza vaccination. Additional research which assesses reasons for or against influenza vaccination in combination with socio-demographic characteristics and health status would assist public health professionals and medical professional in recognizing both strategies to enhance vaccination as well as areas for improvement in vaccination coverage.

Another important aspect to socio-demographic characteristics would be the actual costs, time, and transportation needs in order to access preventative health services and vaccination. Assessing the distance and availability of facilities which offer health care services would also be helpful. Although VFC and many health insurance policies cover the costs of vaccinations, the survey does not capture whether parental inconvenience was a barrier to vaccination in this study population. Children of parents of low-income working families may be especially vulnerable to under-vaccination or lack of vaccination as it is often the parents who must take the time to schedule medical appointments, drive their children to the clinic or hospital in order to receive the vaccines, and follow-up with any post-vaccination adverse events.

The survey also did not assess whether providers recommended the vaccine to the teen. Previous studies have shown that recommendations from primary care providers increased childhood influenza vaccination rates [47]. Health care providers may not be vaccinated for influenza themselves and may not proactively recommend the influenza vaccine [14]. Recall or reminder systems established by the provider could also be considered a form of recommendation from health care providers. Although assessing recommendations by health care providers would not include families who do not have access to care, additional research on whether health care providers recommend the vaccine in combination with socio-demographic characteristics should still highlight opportunities to enhance vaccination education to both parents and health care providers.

Finally, another unfortunate known barrier to influenza vaccination is the belief by parents that the vaccine causes the disease [47]. Parental knowledge of the types of vaccination available (shot versus mist), when to obtain the vaccination, and the benefits and risks of influenza vaccination should be assessed. Parental knowledge and perceptions that obtaining the influenza vaccine is beneficial increases childhood influenza vaccination rates[47]. The limited data collected on influenza vaccine type, the month and place the vaccine was administered highlights opportunities to assess important trend in influenza vaccination and identify gaps in parental knowledge.

5.4 Conclusion

The 2009 H1N1 virus caused the first influenza pandemic since 1968, and contrary to what had been predicted, North America, not Southeast Asia was the epicenter of the pandemic. This highlights the need for pandemic response preparedness by public health professionals, health care providers, media, policy makers, as well as the general public. Ensuring an adequate vaccination supply and providing updated vaccination recommendations should also be a priority in preparing for both influenza epidemics and pandemics. Although influenza-associated pediatric mortality is rare, the disease still contributes to relatively high rates of emergency department visits, outpatient visits, and hospitalizations [11, 67]. Influenza vaccination rates among both healthy adolescents and adolescents with underlying health condition are still low.

Given the findings of significant associations between socio-demographic characteristics and household-reported health status in this study and that adolescents are the next generation of parents, further research needs to consider adolescent socio-demographic factors as a determinant when surveying immunization coverage against influenza. Although the current influenza vaccine recommendations now include all individuals ages 6 months and older, it should still be important to recognize and reduce health disparities and inequalities which contribute to non-vaccination or under-vaccination. Improved understanding of demographic and socioeconomic characteristics, as well as existing underlying health conditions, will facilitate the path to improving interventions, vaccination rates, and subsequent reduction in the burden of disease.

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