ABSTRACT

Title of thesis: COMPLIANCE WITH AGE AT INITIATION OF HUMAN PAPILLOMAVIRUS VACCINE SERIES BY SOCIOECONOMIC STATUS, RACE/ETHNICITY, AND HEALTH INSURANCE COVERAGE AMONG 13-17 YEAR-OLD FEMALES WHO RECEIVED AT LEAST ONE HPV VACCINE SHOT: UNITED STATES, 2011

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Human Papillomavirus (HPV) vaccine has been shown to prevent cervical cancer. Numerous studies have examined factors associated with HPV vaccine series initiation, but little is known about factors associated with age of initiation of HPV vaccine. Using cross-sectional data from the 2011 National Immunization Survey-Teen, this study examined the relationship between Advisory Committee on Immunization Practices' recommended age at initiation of the HPV vaccine series and socioeconomic status, race/ethnicity, and health insurance among 13-17 year-old females who received at least one HPV vaccine shot (n=5,965). On-time initiation of HPV vaccine series was significantly associated with having public health insurance (AOR: 1.825, 95% CI: 1.266, 2.631). Females with college-graduated mothers (AOR: 0.669, 95% CI: 0.487, 0.918) or household income greater than $75,000 (AOR: 0.746, 95% CI: 0.568, 0.98) were less likely to initiate on-time. Research is needed to further investigate the reasons for late initiation among these subgroups.

COMPLIANCE WITH AGE AT INITIATION OF HUMAN PAPILLOMAVIRUS VACCINE SERIES BY SOCIOECONOMIC STATUS, RACE/ETHNICITY, AND HEALTH INSURANCE COVERAGE AMONG 13-17 YEAR-OLD FEMALES WHO RECEIVED AT LEAST ONE HPV VACCINE SHOT: UNITED STATES, 2011

By

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LIST OF ABBREVIATIONS

ACA	Affordable Care Act
ACIP	Advisory Committee on Immunization Practices
AOR	Adjusted Odds Ratio
CDC	Centers for Disease Control and Prevention
CHIP	Children's Health Insurance Program
CI	Confidence Interval
DHHS	U.S. Department of Health and Human Services
FDA	U.S. Food and Drug Administration
HIM	Health insurance module
HPV	Human Papillomavirus
NCHS	National Center for Health Statistics
NCIRD	National Center for Immunizations and Respiratory Diseases
NIS-Teen	National Immunization Survey – Teen
OMB	Office of Management and Budget
OR	Odds Ratio
QALY	Quality-adjusted life year
VFC	Vaccines for Children Program

CHAPTER 1: INTRODUCTION

Human Papillomavirus (HPV) is one of the most common sexually transmitted diseases in the United States (U.S.) and worldwide (1). Approximately 20 million people are currently infected with HPV in the U.S. and about six million more are infected each year (2). About half of these infections are among 15-24 year-old young adults (2). More than half of sexually active men and women are infected with HPV at some time in their lives (2).

Furthermore, being infected with HPV is the greatest risk factor for cervical cancer (3). According to the World Health Organization (WHO), cervical cancer is the third most common type of cancer among women worldwide (4). Centers for Disease Control and Prevention (CDC) estimates that the U.S. spends more than $4 billion in direct health care costs for treatment of HPV-related diseases each year (1). Other studies estimate that the cost per quality-adjusted life year (QALY) gained by HPV vaccination of 12 year-old females ranges from $3,000 to $43,600 per person (1, 5, 6). With rising healthcare expenditures in the U.S., using HPV vaccination as a preventive health measure offers our nation an enormous cost-saving opportunity.

Advisory Committee on Immunization Practices (ACIP) Recommendations for HPV vaccination

The U.S. Food and Drug Administration (FDA) approved two HPV vaccines, “Gardasil” in 2006 and “Cervarix” in 2009, to protect against high-risk HPV types (HPV-6, HPV -11, HPV-16, and HPV-18) which caused approximately 70% of occurrences of cervical cancer in the U.S. (2, 7, 8). As a result, the CDC’s Advisory Committee on Immunization Practices (ACIP) recommended the routine use of HPV vaccination among 9-26 year old females and males. The ACIP recommendation for female use of HPV vaccination was released in 2007 with an additional update in 2010 (9). Recommendations for males did not appear until the end of 2011

(9). All recommendations were based on series of clinical trials, where HPV vaccines were proven to be safe and effective for these age groups.

The ACIP recommended that the first HPV shot of a three-dose vaccine series be initiated by 11 or 12 years of age (1, 10, 11, 12). Each 0.5 milliliter-dose should be administered over a six-month period: the second dose is to be 1-2 months after the first dose and the third dose is to be given 6 months after the first dose (10, 11). It is highly recommended that children initiate HPV vaccination before they become sexually active and contract HPV infections (10, 11). Delaying initiation of the HPV vaccine series decreases protection against the HPV infection and can lead to the development of cervical cancer and serious HPV-related diseases in adulthood (9). Despite these recommendations, CDC estimates that only 30% of U.S. females received three doses of the HPV vaccine by ages 13-15 in 2011 (13, 14).

HPV vaccination is most effective if initiated prior to exposure to HPV infection (10, 12). Data from the 2003 National Survey of Adolescents and Young Adults suggests that there is low opportunity for HPV exposure at 11 years of age or younger since sexual experience is still very low (52). By the age 14, there is a significant increase in opportunity for HPV infection exposure (52). Therefore, compliance with ACIP recommendations for age at initiation of HPV vaccine series is extremely beneficial.

Research has shown that HPV vaccine does not treat infection for people who have already been infected with HPV (72). Although some people may already have acquired one or more type of HPV infection, HPV vaccine could still protect them from other types of HPV infection (2, 7, 8, 72).

Importance of Timing of the HPV vaccine series

Timing of initiation of the HPV vaccine series may be more essential than completing all three HPV vaccine doses, according to previous randomized controlled studies (69, 70). Study findings confirmed that earlier initiation of HPV vaccination for females were more effective compared to later initiation of HPV vaccination (68). Furthermore, they found that females who received two doses of HPV vaccination gained a similar protective effect as those who received three doses (68, 69, 70). The risk for HPV infection decreased tremendously after receiving only two doses of HPV vaccination (69, 70). Compared to females with no vaccination, females who received two doses of HPV vaccination had 0.29 (95% CI, 0.21, 0.40) odds for the HPV infection risk, whereas females who received all three doses of HPV vaccination had 0.18 (96% CI: 0.15, 0.22) odds for the HPV infection risk (69).

Racial/ethnic disparities in the HPV vaccine series initiation in the United States

In the U.S., the number of cervical cancer cases and deaths significantly decreased over the past several years (15). This decrease is thought to be due to the success of public health preventions and wide-scale implementation of Pap smear screenings (15). Despite this reduction, non-Hispanic Blacks and Hispanics are less likely than non-Hispanic Whites to initiate the HPV vaccination series (18, 19, 20, 21).

Disparities in the utilization of preventive services exist between whites and racial/ethnic minorities (75, 76, 77). Compared to Whites, Hispanics, Asians, and Blacks are less likely to use preventive services, including cervical cancer screening (75, 76, 77). Additionally, racial/ethnic minorities are less likely than whites to have health insurance, as were people with low SES compared to people with high SES (77).

CHAPTER 2: RESEARCH QUESTIONS AND HYPOTHESES

The overall goal of this thesis was to assess compliance with ACIP recommendation regarding age at initiation of the HPV vaccine series, and identify related socioeconomic status (SES), racial/ethnic, and health insurance coverage factors. This study aimed to:

1) Compare age at initiation of HPV vaccine series with ACIP recommendations among 13-17 year-old females who received at least one dose of the HPV vaccine series.
2) Examine variations in compliance with ACIP recommendations for age at initiation of the HPV vaccine series by SES, race/ethnicity, and health insurance coverage. The association was assessed by the following questions:
    a. Was initiating the HPV vaccine series at the ACIP-recommended age associated with SES?

        H_0: SES was not associated with timely initiation of the HPV vaccine series. People with higher SES were as likely to report having received their first HPV shot on-time as people with lower SES.

        H_1: SES was associated with timely initiation of the HPV vaccine series. People with higher SES were more likely to report having received their first HPV shot on-time compared to people with lower SES.

    b. Was initiating the HPV vaccine series at the ACIP-recommended age associated with race/ethnicity?

        H_0: Race/ethnicity was not associated with timely initiation of the HPV vaccine series. Racial/ethnic minorities were as likely to report having received their first HPV shot on-time as non-Hispanic Whites.

        H_1: Race/ethnicity was associated with timely initiation of the HPV vaccine series. Racial/ethnic minorities were less likely to report having received their first HPV shot on-time compared to non-Hispanic Whites.

c. Was initiating the HPV vaccine series at the ACIP-recommended age associated with having health insurance coverage?

   H_0: Having health insurance coverage was not associated with timely initiation of the HPV vaccine series.

   H_1: Having health insurance coverage was associated with timely initiation of the HPV vaccine series.

The study population for the 2011 NIS-Teen survey was 13 - 17 year-old children at the time of the interview in 2011. Since the ACIP recommendation for male use of the HPV vaccine did not appear until the end of 2011, we excluded all males as well as any out of range ages from the analysis. This study's inclusion and exclusion criteria, data source, and sample size (n= 5,965) are discussed in more detail in the methods section.

CHAPTER 3: BACKGROUND: REVIEW OF LITERATURE

Factors associated with HPV vaccine uptake in the United States

In addition to race/ethnicity and SES, infrequent healthcare visits and lack of health insurance coverage have been frequently cited as barriers to receiving timely vaccinations (16, 17, 20, 22, 24, 54, 66). The HPV vaccine is one of the most expensive vaccines with an estimated cost of $390 total ($130 per dose) to administer three HPV vaccine shots over a six-month period (54, 66). In the U.S., private health insurance covered the cost of vaccinations for many individuals. Public health insurance, such as Medicaid and the Vaccines for Children Program (VFC), covered vaccinations for low-income individuals (54). Individuals without health insurance coverage were the most likely to face the high cost of vaccination. This may be their greatest barrier to receiving HPV vaccination (54). The implementation of the Patient Protection and Affordable Care Act (ACA) is expected to decrease the number of uninsured individuals and consequently lead to an increase in HPV vaccine uptake (25).

A systematic review of 25 published peer-reviewed studies on "factors associated with HPV vaccine uptake in teenage girls" found that higher HPV vaccine series initiation was associated with socioeconomic status, race/ethnicity, and health insurance coverage (20). Having some type of health insurance coverage, whether private or public, was associated with higher HPV vaccine series rates compared to not having health insurance coverage. Interestingly, the HPV vaccine series initiation rate was highest among people with public health insurance, compared to those with private health insurance. Other factors associated with HPV vaccine uptake included age, vaccination history of other childhood vaccines, and healthcare utilization (20).

In 2013, Fisher supported some of Kessels' findings with a more comprehensive systematic review and meta-analysis of the literature regarding racial/ethnic and SES differences in HPV vaccine uptake (21). Incorporating more recent published articles, Fisher's updated review strengthened some of Kessels' findings on disparities in HPV vaccine initiation experienced by racial/ethnic minorities and people without health insurance coverage (21). Interestingly, Fisher did not find a significant association for HPV vaccine initiation and mother's education and income (21).

National pattern for HPV vaccine and other childhood vaccines in the U.S.

In general, the same patterns are found for uptake of childhood vaccines with the exception of HPV (74). In the U.S., vaccination coverage was comparable for Tdap, MenACWY, MMR, hepatitis B, and varicella across poverty levels and racial/ethnic groups. Coverage for all of these vaccines was lower for those with low SES as well as those who are racial/ethnic minorities (74). However, HPV vaccination coverage did not follow this pattern. Higher HPV vaccination coverage was observed for people living below poverty level (74). Both Hispanic males and females had higher initiation rates for HPV vaccine while HPV vaccine series completion was lower among Hispanics and blacks, compared to whites (74).

Efforts to increase HPV vaccine uptake in the United States

Public programs exist to offer assistance to individuals who do not have health insurance, based on specific eligibility criteria. These programs include the Vaccines for Children Program (VFC), Immunization Grant Program (Section 317), Medicaid, Children's Health Insurance Program (CHIP), and Patient Protection and Affordable Care Act (ACA) (26, 27, 28, 29).

Vaccines for Children Program (VFC). This program covers vaccines recommended by the ACIP, including children younger than 19 years old who do not have health insurance and

those who are categorized as "underinsured" (27, 30, 31, 32). Underinsured children are defined as children who have private health insurance that does not cover vaccination (27, 31, 32). Free vaccines are also offered to children who are Medicaid-eligible and have American Indian or Alaskan Native background (27, 31, 32). Because the VFC Program supplies vaccines to all states, it has increased vaccine uptake among eligible children younger than 19 years old while lowering vaccine prices for all states (30).

Immunization Grant Program (Section 317). Federal grants are distributed to state and local government public health agencies to subsidize vaccine costs and to help cover children younger than 19 years old who are not eligible for the VFC program (28). This program attempts to close the gap for children who were not covered under VFC, but require assistance paying for vaccines.

Medicaid. Medicaid covers HPV vaccination for 19-20 year-old adolescents who are eligible to receive Medicaid (27).

Children's Health Insurance Program (CHIP). This program provides health insurance coverage to approximately 8 million children whose families do not qualify for Medicaid but are not able to afford private health insurance (33).

Patient Protection and Affordable Care Act of 2010 (ACA). ACA requires most health insurance plans to provide 100% coverage for HPV vaccines without any cost-sharing to any enrollees starting September 23, 2010 (27, 34, 35). This means that most private health insurance plans are mandated to cover HPV vaccine with no co-pay or deductibles after the implementation of the ACA (27, 34, 35, 73). Newly eligible people for Medicaid in states that chose to expand coverage are also covered for the HPV vaccine series without any cost-sharing expenses (27). Other significant reforms, such as individual mandate, health insurance exchange, and

prohibition to deny coverage due to pre-existing conditions, took effect starting January 1, 2014 (27, 34, 35, 73). The implementation of the ACA narrows the gaps in HPV vaccination funding and is expected to increase access to preventive services including access to the HPV vaccine in the U.S. While the ACA requires that most U.S. citizens and legal residents have health insurance coverage or pay penalty fees, some people are still left out of the health insurance system (37). People who are not required to have health insurance coverage include those who are a part of any religion opposing a health insurance plan, undocumented immigrants, in prison, a member of any Indian tribe, have family income below the tax return filing threshold, and paying more than 8% of total income for a health insurance plan (37). It is estimated that full implementation of the ACA still leaves about 23 million people without health insurance (38, 39, 61, 71). Access still remains one of the most difficult challenges for these subgroups of the U.S. population (38, 39, 71).

Furthermore, having health insurance coverage did not necessarily mean one has access to healthcare (71). According to Penchansky and Thomas, access to healthcare includes availability, accessibility, accommodation, affordability, and acceptability (40). Health insurance coverage only contributes to a portion of an individual's overall health and well-being (71). Having health insurance coverage does not necessarily determine ultimate health outcomes (71).

Gaps in the literature

Numerous studies, such as those discussed in Kessels' and Fisher's systematic reviews, have examined factors associated with initiation of the HPV vaccination series, but little is known about factors associated with timely HPV vaccine uptake (20, 21). This study focuses on the importance of compliance with ACIP recommendation regarding age of initiation or on-time vaccination initiation.

This study builds on prior research studies examining factors associated with initiation of HPV vaccine. New knowledge from this study could equip us with better knowledge on timely initiation of HPV vaccine series. Population-targeted interventions could be developed to address disparities in timely HPV vaccination initiation in the U.S.

CHAPTER 4: METHODS

The National Immunization Survey –Teen (NIS-Teen) was used to conduct this cross-sectional study (2011). The 2011 NIS-Teen was conducted jointly by the National Center for Immunizations and Respiratory Diseases (NCIRD) and the National Center for Health Statistics (NCHS) (41).

The 2011 NIS –Teen Survey collected data from both households and vaccination providers (42). The first part of the two-phase survey was the random-digit-dialing telephone survey with randomly selected households in all 50 states and the District of Columbia (42). Participant's consent was obtained from parents or guardians of eligible children in order to contact their vaccination providers. The second phase of the survey was to perform a record check with the vaccination providers through mail survey questionnaire (42). The purpose of sending the mail surveys to the vaccination providers was to collect children's immunization data from their medical records and to assure the accuracy and precision of overall vaccination coverage estimates (42).

In order to reduce measurement error, the 2011 NIS-Teen staff collected the children's date of birth instead of directly asking for the age of the children during the first phase of the study (42). Various methods were used to minimize bias. Computer-assisted telephone interviewing (CATI) software was used to calculate children's age and determine their eligibility (42). The 2011 NIS-Teen also collected dates of vaccine shots from the second phase of the study. Vaccination dates were used with the children's dates of birth to calculate the age of children in years at the reported vaccination dates (42).

Study Population

The study population for the 2011 NIS-Teen was 13-17 year-old children at the time of the interview in the 2011 calendar year (42). Children ages 13-17 years during the 2011 data collection were required to have their birth year between 1993 and 1999 in order to be included in the survey study (42). The 2011 NIS-Teen was conducted in conjunction with the 2011 NIS. While the 2011 NIS obtained vaccination coverage rates among children who were between 19 and 35 months old for vaccinations, such as DTtaP, polio, measles, Flu, and other required childhood vaccinations, the 2011 NIS – Teen obtained vaccination coverage rates for older children (41). The 2011 NIS-Teen identified households containing one or more children who were 13-17 years of age (41). Interviews were conducted with household adults who were most knowledgeable about the children's vaccination records (41). After the completion of the household portion, the 2011 NIS-Teen also contacted the children's vaccination providers to request information on vaccinations from the children's medical records (41). The 2011 NIS-Teen response rate for the telephone household survey was 57.2 %, and the percentage of children with adequate provider data was 61.5 % (42).

The criteria for inclusion in this research study were (n=5,965):

A. Being female,

B. Between 13-17 years of age by the time of the interview in 2011,

C. At least one HPV shot was received, and

D. The first HPV shot was received between 9 -17 years of age.

Although the HPV vaccine series had been approved for 9-26 year-old children and adults, the 2011 NIS-Teen only collected data for those 13-17 years of age. Therefore, our study

was limited to those females who received at least one HPV shot and the first HPV shot was received between the ages of 9 -17.

ACIP recommends that the HPV vaccination series can be started beginning at 9 years of age, but has not issued a recommendation for children younger than 9 years of age (7, 8, 43, 44). Therefore, children who reported having received at least one shot of the HPV vaccine series when they were less than 9 years of age were excluded from our study. The 2011 NIS – Teen staff completed data collection around the time that the ACIP released their recommendation for males in December 2011 (10, 11, 12). Because the ACIP recommendation for males was released after 2011 NIS-Teen data collection occurred, males were excluded from our study. The final sample size for this study is 5,965.

Human Subjects & Ethical Issues

The 2011 NIS public-use data file was used for this secondary data analysis study. The 2011 NIS – Teen staff have taken various steps to ensure that participants' sensitive information and confidentiality were protected from the beginning to the end of the survey (42). The 2011 NIS-Teen staff also received prior human subjects' approval from the Office of Management and Budget before starting their survey study (42).

During the data collection phase, the 2011 NIS-Teen staff sent advance notification letters, provided an overview of the study, and obtained informed oral consent from the participants. These steps were taken in order to protect participants' confidentiality and ensure them that their participation was entirely voluntary (42). Once participants were identified as having the most knowledge in the household in regards to the eligible children's vaccine history, they were asked for informed consent to participate in the 2011 NIS-Teen (42). At the end of the

interview, the 2011 NIS-Teen interviewers asked the participants for permission to contact the children's vaccination providers (42).

Before the 2011 NIS – Teen public-use data files can be published on the CDC's website, they had to go through an extensive process to protect participants' privacy and data confidentiality (42). In accordance with the NCHS's established standards for the release of all NCHS survey data, the 2011 NIS-Teen public-use data files were required to undergo a comprehensive review by the NCHS Disclosure Review Board (42). The 2011 NIS –Teen public-use data file webpage clearly indicates that the dataset can be used only for research purposes. Any violators of the privacy and confidentiality of the participants can be punished by law (45, 46).

In December of 2013, the University of Maryland Institutional Review Board (IRB) reviewed this thesis' "Human Subject Determination" Form and declared it "exempt." Since the 2011 NIS-Teen data was available to the public, the UMD IRB determined that this thesis meets at least one of the federal exempt categories criteria. Therefore, there is no requirement for annual review or expiration date listed on the final approval letter.

Dependent Variable

The outcome of interest was compliance regarding age at initiation of the HPV vaccine series. Based on the ACIP recommendation, those who received the first dose of HPV vaccination at or before 12 years of age were considered "on-time" initiators. Those who received the first dose of HPV vaccination after the age of 12 were considered "late" initiators.

Based on the preliminary analyses of the dependent variables of this dataset, provider-reported data were more complete than household-reported data. Provider data (n=7470), which included all children who received at least one HPV vaccine shot in 2011 NIS-Teen, had a

considerably larger sample size, compared to the provider data (n=2172). Therefore, the provider-reported data from the 2011 NIS-Teen Survey were used for the data analysis (42).

Independent Variables

Race/Ethnicity. Race/ethnicity information was collected in the 2011 NIS-Teen with multiple categories. In compliance with the Office of Management and Budget's (OMB) standards for federal statistics reporting and the classification of race/ethnicity in the United States, the 2011 NIS Teen collected data on race/ethnicity groups as follows: Hispanic, Non-Hispanic White Only, Non-Hispanic Black Only, Alaska Native, Asian, Native Hawaiian/Pacific Islander, Other, Do not know, and Refused. The 2011 NIS – Teen had recoded race/ethnicity variables and categorized into Hispanic, Non-Hispanic White Only, Non-Hispanic Black Only, and Non-Hispanic Other and Multi-Racial (16, 42, 47).

Socioeconomic Status. SES was determined by using the children's "mother's educational level" and "poverty status." Mother's education was sorted into four categories: college graduate, greater than 12 years but not completed college, 12 years, and less than 12 years.

Poverty status took into account the household income and number of people in the household. Based on the 2009 Census poverty thresholds, the 2011 NIS-Teen divided the poverty status into three categories (42). The categories were: 1) Those who are living at or above the federal poverty level and having a household income greater than $75,000 (Above poverty level, >&75K), 2) Those living at or above the federal poverty level and having a household income less than or equal to $75,000 (Above poverty level ≤$75K), and 3) Those living below the federal poverty level (Below poverty level) (42).

Health insurance coverage. Information on health insurance coverage was gathered from the Health Insurance Module (HIM) in the NIS-Teen Survey. Response categories were included in the 2011 NIS-Teen survey as follows:

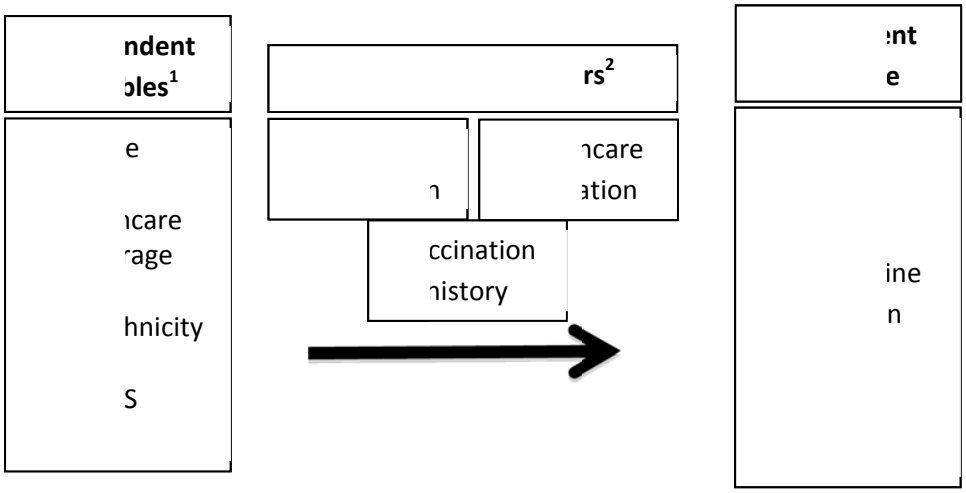
a. Through employer or union (Private)
b. Medicaid (Public)
c. Child Health Insurance Plan-CHIP (Public)
d. Medicaid or CHIP (Public)
e. Indian Health Service (Other)
f. Military Health Care, Tricare, Champus, or Champ-VA (Other)
g. Other Health Insurance (Other)
h. Uninsured (No insurance)

Based on previous studies using NIS-Teen datasets to examine health insurance coverage variables and Census Bureau's definitions of health insurance (16, 48, 56, 57), I re-categorized the health insurance coverage information as follows: Private, Public, Other, and None.

Potential Confounders and Effect Modifiers

From the existing literature, potential confounders for initiating HPV vaccine were family composition, previous vaccination history of other childhood vaccines, parent's HPV vaccine-related beliefs, attitudes, and intentions, having HPV-related knowledge, healthcare utilization, and having a healthcare provider as a source of information (20, 21). In this thesis, only potential confounding variables that were available in the NIS-Teen dataset were tested and controlled during the statistical analysis. These variables also met criteria for confounding (associated with both the exposure and the outcome while not a part of the causal pathway). From Figure 1, these variables include family composition (marital status, number of children in household under age 18), healthcare utilization (number of primary care visits in past 12 months), and previous vaccination history of childhood vaccines (number of hepatitis B vaccine shot).

Figure 1: Factors associated with initiation of the HPV vaccine series



[1]Factors associated with initiation of HPV vaccine based on previous literature, and independent variables of interest in this study
[2]Factors associated with initiation of HPV vaccine based on previous literature, and potential confounders in this study
Source: (20, 21)

Family composition. Family composition was examined using "Mother's Marital Status" and "Number of children in household under age 18." Mother's marital status was categorized into: Single and Married. In this study, the "single" category included all those who were widowed, divorced, separated, and never married as well as those whose husbands had deceased. Number of children in household was categorized into: 1, 2-3, and 4 or more.

Healthcare utilization. Healthcare utilization was also a potential confounder. Use or access to healthcare was the variable used for healthcare utilization. It was determined through the question "During the past 12 months, how many times has [Teen] seen a doctor or other healthcare professional about [his/her] health at a doctor's office, a clinic, or some other places?" (42.) The number of primary care visits was categorized into: 0, 1, 2-3, 4-5, and 6 or more.

Previous vaccination history of childhood vaccines. "Previous vaccination history of other childhood vaccines" variable was examined using the number of Hepatitis B vaccine shots reported in the 2011 NIS-Teen. Although information on several childhood vaccines (Hepatitis

A, Hepatitis B, Tdap, Meningococcal, MMR, Varicella zoster, Influenza) was available through the 2011 NIS-Teen, Hepatitis B vaccination history was chosen and used as a proxy for "previous vaccination history of childhood vaccines" (20, 21). Several peer-reviewed studies have found that vaccination history of hepatitis B to be the strongest predictor of HPV vaccine series initiation among females (49, 55). Hepatitis B vaccine protects against Hepatitis B viral infection, which is another type of sexually transmitted infection (STI) (50). Hepatitis B infection is prevalent among sexually active individuals and those who use drug needles (78). However, the source of infection is still unknown for 30% of those who currently have Hepatitis B infection today (78). Having Hepatitis B infection could lead to serious diseases, such as liver cancer and cirrhosis. Similar to the HPV vaccine's numbers of dosage, Hepatitis B vaccine is given in a three-dose series over a 6-month period (50). The current Hepatitis B vaccination was used since in 1986 and in 2005, ACIP updated to its recommendation to include all children and adolescents ages < 19 years (50, 78). "Number of Hepatitis B vaccine" in this study was categorized into: 0, 1-2, 3, and 4 or more.

Statistical Analysis

For this thesis, the CDC public data file was downloaded and SAS version 9.3 was used. In the preliminary analyses, frequency distributions and univariate analyses were conducted to examine associations between on-time initiation of the first HPV shot and mother's education, poverty level, race/ethnicity, and health insurance coverage. Descriptive statistics were used to provide a quantitative description of the study sample and examine the distribution of independent variables, dependent variables, and covariates. SES, race/ethnicity, health insurance coverage and other socio-demographic variables are presented in Table 1.

Data were analyzed using SAS 9.3 survey procedures, and applying appropriate sampling weights because of the complex survey design. PROC SURVEYFREQ was used to examine the relationships between all variables and on-time vaccination. The Rao-Scott Chi-Square (χ^2) Test was performed to examine significant differences between those who have initiated the HPV vaccine series "on-time" and those who initiated it "late." Unadjusted logistic regression models were run for these variables separately. Then, multivariate logistic regression analysis was conducted to examine effects of independent variables on on-time initiation of HPV vaccine series while controlling for confounders. Adjusted odds ratios and 95% confidence intervals were calculated.

Additionally, the complex sampling design was accounted for and addressed in the statistical analysis, as recommended in the 2011 NIS-Teen Data User's Guide (42). The 2011 NIS-Teen had already made an adjustment to the weights in order to account for differences among various groups. According to the 2011 NIS-Teen Data User's Guide, children who had access to regular healthcare services were more likely to be captured in the provider data, compared to those who did not have regular healthcare services (42, 51). This group traditionally came from a wealthier population and had been over-represented in the provider data; therefore weights were developed and adjusted by the 2011 NIS-Teen in order to achieve an accurate representation of the survey's target population. The weight variable "PROVWT_D" was therefore used to adjust for the dual sample frame of landline and cell phones, and take into account these differences in the population (42).

To evaluate confounding and effect modifications, stratified analyses were performed for all potential confounders using PROC SURVEYLOGISTIC in SAS version 9.3. These variables included family composition (marital status, number of children in household under age 18),

healthcare utilization (number of primary care visits in past 12 months), and previous vaccination history of childhood vaccines (number of hepatitis B vaccine shots). Additional criteria for assessing confounders used to test potential confounders included: 1) Confounding variable was associated with the exposure, 2) Confounding variable was associated with the outcome, and 3) Confounding variable was not part of the causal pathway between the exposure and the outcome. For example, one of the variables representing family composition was "mother's marital status." Mother's marital status was categorized into: single or married. For example, mother's marital status was stratified by race/ethnicity, poverty level, mother's education, and health insurance coverage. To examine variables for confounding, the crude ORs was compared with the adjusted ORs. If the adjusted ORs were at least 10% different from the crude ORs, we determined the variable as a confounder. To examine variables for effect modification, we looked at the stratified ORs in the subgroup and determined if they are different from one another.

To evaluate for multicollinearity, PROC REG and Variance Inflation Factor (VIF) were used in SAS 9.3. As the degree of VIF increases, the estimates from the logistic regression model become unstable. The result from the multicollinearity test indicated that none of our variables have VIF values greater than 10 (Appendix D). Therefore, multicollinearity is not a problem in this study.

Lastly, sensitivity analyses were performed using the same SAS procedures but without 12 and 13 age groups. Since the majority of the study sample received the first HPV shot at the ages of 12 and 13 (age 12 = 1,598 and age 13 = 1,321), we took out these age groups and ran the same procedures. We redefined those who received the first HPV shot between ages 9-11 year-olds as "on-time" and ages 14-17 year-olds as "late." The results of the sensitivity analyses were compared to the original results for comparison.

CHAPTER 5: RESULTS

Descriptive statistics: Socio-demographic characteristics and distribution of age at initiation of HPV vaccines series

Among 13-17 year old females who had received at least one HPV vaccine shot during 2011 (n=5,965), 47.7% reported having received the first shot between 9-12 years of age or on-time (Table 1).

Table 2 presents socio-demographic and health care characteristics for 13-17 year old females who had received at least one HPV vaccine shot in 2011. On-time initiation ranged from 49% for non-Hispanic Whites to 55% for Hispanics. Females who lived in households with more children were more likely to initiate their HPV vaccine series on-time. In addition, females who lived in households with higher incomes, and higher maternal education were less likely to initiate their HPV vaccine series on-time compared to females in lower socioeconomic status households. For example, 46.8% of females who lived in a household with an income over $75,000 had received their first HPV shot on-time compared to 54.3% of females living below the federal poverty level. Similarly, females with private health insurance coverage (32.4%) were the least likely to start their HPV vaccine series on-time than any other insurance group, including those without health insurance (43.7%). Females who had not received a Hepatitis B vaccine shot were also less likely to initiate their HPV vaccine series on-time (35.7%) compared to females who had received one or more Hepatitis B shots (45.5% to 56.7%).

Table 1: Weighted Percentages and Numbers of on-time and late initiators among 13-17 year-old females who received at least one HPV vaccine shot in the United States, 2011

Age in years at time of first HPV vaccine shot	Number in sample	[3]Weighted Frequency	[3]Weighted Percent
[1]On-time			
9	56	71911	1.3%
10	193	179472	3.3%
11	1145	1002414	18.2%
12	1598	1377741	24.9%
Total	**2992**	**2631538**	**47.7%**
[2]Late			
13	1321	1283229	23.3%
14	914	860268	15.6%
15	442	417087	7.6%
16	216	257253	4.7%
17	80	68561	1.2%
Total	**2973**	**2886398**	**52.3%**
Total	5965	5517935	100%

[1]Compliance of age at initiation of the HPV vaccine, defined as "on-time" vaccination based on the ACIP recommendation that the first of the three-dose HPV vaccine be given to girls by the ages of 11 or 12 years old. Children who received the first dose of HPV vaccination before or at the age of 12 are considered "on-time."
[2] Children who received the first dose of HPV vaccination after the age of 12 are considered "late."
[3]Weight was used to adjust for the dual sample frame of landline and cellphone and take into account these differences in the population.

Table 2: Socio-demographic and health care characteristics of 13-17 year-old females who received at least one HPV vaccine shot in the United States, 2011

Variables	On-time Initiators (n=2,992)				Late Initiators (n=2,973)				Total Initiators (n=5,965)		
	Number in sample	Unweighted %	*Weighted %	† p-value	Number in sample	Unweighted %	*Weighted %	† p-value	Number in sample	% On-time	†p-value
Race/Ethnicity				<.0001				<.0001			<.0001
Hispanic	546	18.6%	26.2%		441	15%	25.4%		987	55.6%	
Non-Hispanic White	1856	61.2%	50.9%		1932	64.3%	49.9%		3788	49%	
Non-Hispanic Black	321	11.2%	15.6%		318	11.2%	15.7%		639	50.2%	
Non-Hispanic Other and Multi-Racial	269	9%	7.4%		282	9.5%	8.9%		551	48.8%	
Mother's marital status				<.0001				<.0001			<.0001
*Single	848	28.3%	36.4%		828	27.9%	37.18%		1676	50.6%	
Married	2144	71.7%	63.7%		2145	72.1%	62.8%		4289	49.9%	
Number of children in the household under age 18				<.0001				<.0001			<.0001
1	1020	33.9%	27.1%		1333	44.6%	33.6%		2353	43.3%	
2-3	1649	55.2%	58.3%		1400	47.4%	53.3%		3049	54.1%	
>=4	323	10.9%	14.7%		240	8%	13.1%		563	57.4%	
***Poverty status				<.0001				<.0001			<.0001
Above poverty level >$75K	1219	40.5%	30.1%		1384	45.9%	32.7%		2603	46.8%	
Above poverty level ≤$75K	1087	36.4%	35.4%		998	34.2%	38.6%		2085	52.1%	
Below poverty level	578	19.5%	29.8%		487	16.2%	24.3%		1065	54.3%	
Mother's education				0.0003				<.0001			<.0001
<12 years	373	12.6%	19.3%		304	10.2%	15.1%		677	55.1%	
12 years	592	20.1%	24.4%		556	18.8%	25%		1148	51.6%	
>12 years, non-college graduate	851	28.4%	27.8%		766	25.9%	26.2%		1617	52.6%	
College graduate	1176	39%	28.5%		1347	45.1%	33.7%		2523	46.6%	
Health Insurance Coverage				<.0001				<.0001			<.0001
Private	1076	54.8%	43%		1701	58.4%	46.9%		3316	32.4%	
Public	1076	35.8%	48.1%		884	29.6%	39.6%		1960	54.9%	
Other	80	3%	1.9%		96	3.4%	2.9%		176	45.5%	
None	185	6.3%	6.8%		238	8.4%	10.3%		423	43.7%	

Variables	On-time Initiators (n=2,992)				Late Initiators (n=2,973)				Total Initiators (n=5,965)		
	Number in sample	Unweighted %	*Weighted %	†p-value	Number in sample	Unweighted %	*Weighted %	†p-value	Number in sample	% On-time	†p-value
Number of Primary Care Visits in past 12 months				<.0001				<.0001			<.0001
0	392	13.5%	14.6%		328	11.1%	13%		720	54.4%	
1	771	25.9%	26.4%		734	24.7%	24.3%		1505	51.2%	
2-3	1121	37.2%	34%		1150	38.6%	38.4%		2271	49.4%	
4-5	408	13.2%	13.7%		412	13.7%	13%		810	50.4%	
>=6	288	9.5%	10%		329	11.3%	10.8%		617	46.7%	
Number of Hepatitis B vaccine shots				<.0001				<.0001			<.0001
0	106	4.3%	4.8%		191	8.2%	7.8%		297	35.7%	
1-2	65	2.6%	2.3%		78	3%	2.8%		143	45.5%	
3	2638	87.1%	87.2%		2564	84.2%	85.4%		5202	50.7%	
>=4	183	6.1%	5.7%		140	4.9%	4%		323	56.7%	

* Weight was used to adjust for the dual sample frame of landline and cellphone and take into account these differences in the population.
** In this study, "single" includes all those who are widowed, divorced, separated, and never married as well as those whose husbands are deceased.
*** Poverty status is based on the 2009 Census poverty thresholds to calculate income-to-poverty ratio.
† P-value indicates the probability of the observed chi square if there are no true differences between categories.

Univariate analyses of on-time HPV vaccine series among 13-17 year-old females

Crude odds ratios (OR) were calculated to describe on-time initiators who have at least one HPV vaccine shot (Table 3). Additionally, 95% confidence intervals (CI) were used to estimate the precision of the OR. A wider CI showed low level of precision or confidence of the OR while a narrower CI showed greater precision of the OR. If the CI did not include 1, the OR was characterized as statistically significant.

In the univariate analysis, several variables were significant predictors of having received on-time first HPV vaccine series (Table 3). Those with public health insurance coverage had 1.826 (95% CI: 1.274, 2.619) odds of initiating on-time when compared to those with no health insurance coverage (Table 3). Females also had greater odds of initiating on-time if they received at least three Hepatitis B vaccine shots (3 Hepatitis B vaccine shots: 1.655, 95% CI: 1.035, 2.647; 4 or more Hepatitis B vaccine shots: 2.343, 95% CI: 1.258, 4.363) (Table 3). Interestingly, females were less likely to initiate on-time if their households were above the poverty level compared to females whose households were below the poverty level (above poverty level >$75K: 0.746, 95% CI: 0.568, 0.98); above poverty level ≤$75K: 0.750, 95%CI: 0.585, 0.961). Females with mothers who had more than 12 years of education, non-college graduate, had 0.664 (95% CI: 0.489, 0.903) odds of having on-time first HPV vaccine shot when compared to those whose mothers had less than 12 years of education (Table 3).

Several factors previously found to be associated with HPV initiation in other studies (race/ethnicity, mother's marital status, and private health insurance coverage) were not statistically significant in the analysis (Table 3). Race/ethnicity was not a significant predictor of on-time initiation. Hispanics had 1.011 (95% CI: 0.781, 1.310) odds to initiate on-time when compared to non-Hispanic Whites (Table 3). Non-Hispanic Blacks had 0.971 (95% CI: 0.731,

1.289) odds of having an on-time first HPV vaccine shot when compared to non-Hispanic Whites (Table 3). Females with married mothers had 1.036 (95% CI: 0.846, 1.270) odds to initiate on-time when compared to females with single mothers (Table 3). Although not significant, females with private health insurance coverage had greater odds of being on-time (OR: 1.379, 95%: 0.978, 1.945) when compared to females with no health insurance coverage (Table 3).

Table 3: Univariate analysis of on-time HPV vaccine initiation among 13-17 year-old females who received at least one HPV vaccine shot in the United States, 2011

Variables	*Weighed Crude Odds Ratio (OR) (95% CI)	†p-value
Race/Ethnicity		0.7032
Hispanic	1.011 (0.781,1.310)	
Non-Hispanic White Only	Reference	
Non-Hispanic Black Only	0.971 (0.731,1.289)	
Non-Hispanic Other and Multi-Racial	0.811 (0.569,1.156)	
**Mother's marital status		0.7311
Single	Reference	
Married	1.036 (0.846,1.270)	
Number of children in the household under age 18		0.0081
1	0.720 (0.508,1.021)	
2-3	0.976 (0.696,1.370)	
>=4	Reference	
***Poverty status		0.1121
Above poverty level >$75K	**0.749 (0.575,0.975)**	
Above poverty level ≤$75K	**0.750 (0.585,0.961)**	
Below poverty level	Reference	
Mother's education		0.0426
<12 years	Reference	
12 years	0.767 (0.546,1.076)	
>12 years, non-college graduate	**0.664 (0.489,0.903)**	
College graduate	0.833 (0.606,1.147)	
Health Insurance Coverage		<.0001
Private	1.379 (0.978,1.945)	
Public	**1.826 (1.274,2.619)**	
Other	0.986 (0.546,1.781)	
None	Reference	
Number of Primary Care Visits in past 12 months		0.3355
0	Reference	
1	0.970 (0.698-1.348)	
2-3	0.789 (0.577-1.078)	
4-5	0.945 (0.647-1.379)	
>=6	0.835 (0.569-1.224)	
Number of Hepatitis B vaccine shots		0.0441
0	Reference	
1-2	1.295 (0.652,2.572)	
3	**1.655 (1.035,2.647)**	
>=4	**2.343 (1.258,4.363)**	

* Weight was used to adjust for the dual sample frame of landline and cellphone and take into account these differences in the population.

**In this study, "single" includes all those who are widowed, divorced, separated, and never married as well as those whose husbands are deceased.

***Poverty status is based on the 2009 Census poverty thresholds to calculate income-to-poverty ratio.

† Overall p-values for each variable indicate significant association between each variable and on-time initiation of HPV vaccine.

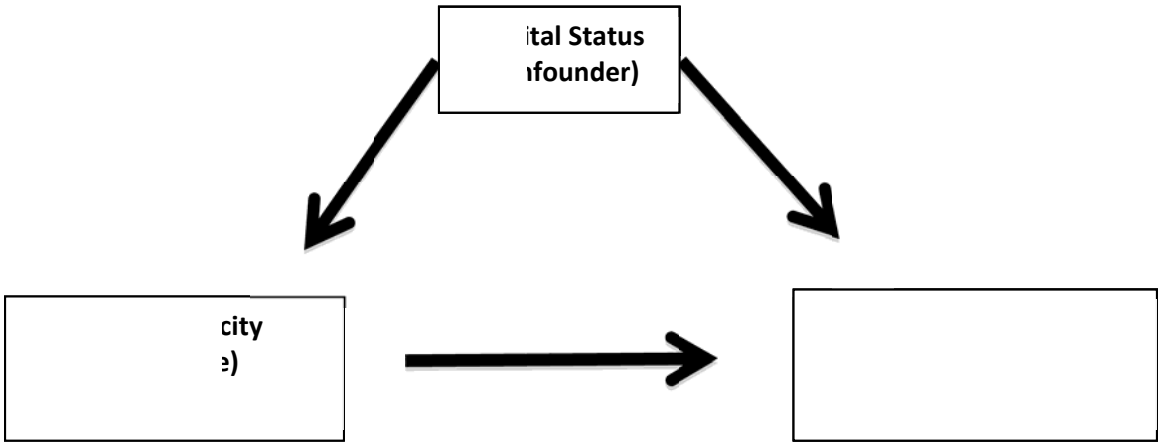
Confounders for association between race/ethnicity, socioeconomic status, and health insurance status and on-time initiation of first HPV vaccine shot among 13-17 year-old females

Hispanics with married mothers had 1.170 (95% CI: 0.841, 1.628) odds of having an on-time first HPV shot than non-Hispanic Whites with married mothers (Table 4A). Hispanics with single mothers had 0.784 (95% CI: 0.510, 1.205) odds of having on-time first HPV shot than non-Hispanic Whites with single mothers (Table 4A). The crude odds ratio for Hispanics having higher odds than non-Hispanic Whites for on-time initiation of HPV vaccine series was 1.011 (95% CI: 0.781, 1.310) in Table 3. Since there were at least 10% differences between the crude odds ratio and the adjusted odds ratio, we considered the variable of "mother's marital status" as a confounder. The variable "marital status" was included in the multivariate logistic regression.

Additionally, previous literature had noted that family composition was associated with higher prevalence rates of HPV initiation (20, 21). Children who do not receive HPV vaccination were associated to having married mothers (20, 21). Since literature indicated that there was an association between the outcome (on-time initiation of HPV vaccination) and the confounding variable (mother's marital status), mother's marital status met the second criteria for confounder.

For the third criteria for confounding, marital status was not a part of the causal pathway between the exposure (marital status) and the outcome (on-time initiation of HPV vaccine series). For example, race/ethnicity did not cause someone's marital status to be either single or married. Likewise, someone's marital status did not cause either an on-time or late initiation of the first HPV vaccine shot. Therefore, marital status was not in the causal pathway between the exposure and the outcome, confirming the third criteria for confounder (Figure 2).

Figure 2: Confounding variable assessment for marital status and exposure (race/ethnicity) and outcome (on-time initiation of the HPV vaccine series)



The same test was used to assess each of the confounding variables in Tables 4A, 4B, 4C, and 4D. After examining each confounding variable, all of the crude ORs were at least 10% (at least 0.01) different from the adjusted ORs. Therefore, these variables were all determined to fit the criteria for confounder and were adjusted for in the final analysis of this study. There was no evidence for any effect modifiers, based on our stratified analyses (Table 4A, 4B, 4C, and 4D).

Table 4A: Stratified analysis of on-time initiation of first HPV vaccine by mother's marital status and race/ethnicity, mother's education, health insurance coverage, and poverty status in the United States, 2011

Variables: Mother's Marital Status by exposures of interest	Mother's Marital Status *Weighted Adjusted OR (95%CI)	
	Single	Married
Race/ethnicity		
Hispanic	0.784 (0.510,1.205)	1.170 (0.841,1.628)
Non-Hispanic White	Reference	Reference
Non-Hispanic Black	0.923 (0.617,1.381)	0.962 (0.619,1.494)
Non-Hispanic Other and Multi-Racial	0.790 (0.436,1.433)	0.815 (0.524,1.266)
Mother's education		
<12 years	Reference	Reference
12 years	0.778 (0.475,1.273)	0.716 (0.450,1.140)
>12 years, non-college graduate	1.189 (0.739,1.912)	**0.622 (0.405,0.956)**
College graduate	**0.565 (0.336,0.951)**	**0.613 (0.407,0.921)**
Health Insurance Coverage		
Private	**1.953 (1.108,3.443)**	1.075 (0.687,1.684)
Public	**2.062 (1.214,3.503)**	**1.7 (1.040,2.779)**
Other	0.903 (0.211,3.862)	0.852 (0.434,1.673)
None	Reference	Reference
Poverty status		
Above poverty level >$75K	0.648 (0.401,1.048)	0.750 (0.520,1.082)
Above poverty level ≤$75K	**0.676 (0.467,0.978)**	0.798 (0.537,1.187)
Below poverty level	Reference	Reference

*Estimated using the logistic regression with four variables including race/ethnicity, mother's education, health insurance coverage, and poverty status

Table 4B: Stratified analysis of on-time initiation of first HPV vaccine by number of children under 18 in household, race/ethnicity, mother's education, health insurance coverage, and poverty status in the United States, 2011

Variables: Number of children under 18 in household by exposures of interest	Number of children under 18 in household *Weighted Adjusted OR (95%CI)		
	1	2-3	>=4
Race/ethnicity			
Hispanic	**1.684 (1.067,2.658)**	0.904 (0.646,1.265)	0.596 (0.298,1.190)
Non-Hispanic White	Reference	Reference	Reference
Non-Hispanic Black	1.023 (0.656,1.596)	0.785 (0.521,1.183)	1.524 (0.709,3.273)
Non-Hispanic Other and Multi-Racial	0.882 (0.516,1.505)	0.697 (0.419,1.158)	1.471 (0.658,3.287)
Mother's education			
<12 years	Reference	Reference	Reference
12 years	**0.419 (0.234,0.750)**	1.004 (0.632,1.595)	0.794 (0. 329,1.915)
>12 years, non-college graduate	0.769 (0.439,1.347)	0.846 (0.554,1. 294)	0.945 (0.398,2.240)
College graduate	0.619 (0.439,1.347)	0.743 (0.497,1. 109)	0.478 (0.173,1.316)
Health Insurance Coverage			
Private	**2.056 (1.168,3.618)**	1.111 (0.704,1.756)	1.457 (0.508,4.181)
Public	**2.199 (1.197,4.040)**	1.426 (0.878,2.313)	**2.792 (1.060,7.356)**
Other	1.679 (0.669,4.211)	0.788 (0.340,1.826)	0.858 (0.162,4.541)
None	Reference	Reference	Reference
Poverty status			
Above poverty level >$75K	0.724 (0.463,1.132)	0.906 (0.642,1.278)	0.714 (0.371,1.371)
Above poverty level ≤$75K	0.773 (0.488,1.222)	0.951 (0.660,1.370)	**0.397 (0.186,0.847)**
Below poverty level	Reference	Reference	Reference

*Estimated using the logistic regression with four variables including race/ethnicity, mother's education, health insurance coverage, and poverty status

Table 4C: Stratified analysis of on-time initiation of first HPV vaccine by number of primary care visits in the past 12 months, race/ethnicity, mother's education, health insurance coverage, and poverty status in the United States, 2011

Variables: Number of primary care visits in the past 12 months by exposures of interest	Number of primary care visits in the past 12 months *Weighted Adjusted OR (95%CI)				
	0	1	2-3	4-5	>=6
Race/ethnicity					
Hispanic	0.845 (0.443,1.613)	1.396 (0.835,2.334)	0.810 (0.521,1.260)	1.462 (0.741,2.887)	0.555 (0.249,1.236)
Non-Hispanic White	Reference	Reference	Reference	Reference	Reference
Non-Hispanic Black	0.601 (0.277,1.304)	0.968 (0.560,1.674)	0.790 (0.494,1.262)	1.561 (0.727,3.350)	1.352 (0.557,3.279)
Non-Hispanic Other and Multi-Racial	0.419 (0.175,1.000)	1.239 (0.654,2.346)	0.912 (0.542,1.536)	0.587 (0.193,1.788)	0.759 (0.300,1.917)
Mother's education					
<12 years	Reference	Reference	Reference	Reference	Reference
12 years	0.712 (0.310,1.635)	1.2 (0.595,2.422)	0.629 (0.359,1.103)	0.521 (0.196,1.390)	1.022 (0.391,2.673)
>12 years, non-college graduate	1.251 (0.554,2.824)	0.838 (0.427,1.644)	0.802 (0.468,1.375)	0.494 (0.224,1.092)	1.613 (0.642,4.056)
College graduate	0.838 (0.389,1.805)	0.907 (0.491,1.675)	0.618 (0.364,1.050)	**0.321 (0.148,0.697)**	1.081 (0.436,2.679)
Health Insurance Coverage					
Private	2.153 (0.662,7.00)	1.525 (0.728,3.195)	1.376 (0.822,2.304)	0.640 (0.267,1.533)	1.847 (0.706,4.833)
Public	2.921 (0.879,9.703)	1.897 (0.868,4.144)	1.700 (0.983,2.941)	0.978 (0.384,2.492)	2.517 (0.952,6.652)
Other	0.811 (0.180,3.655)	0.908 (0.302,2.731)	2.012 (0.785,5.159)	0.545 (0.102,2.914)	0.856 (0.106,6.888)
None	Reference	Reference	Reference	Reference	Reference
Poverty status					
Above poverty level >$75K	1.136 (0.606,2.130)	0.642 (0.385,1.068)	0.701 (0.472,1.039)	0.583 (0.280,1.212)	1.133 (0.566,2.269)
Above poverty level ≤$75K	1.383 (0.707,2.706)	**0.504 (0.291,0.875)**	0.733 (0.477,1.126)	0.646 (0.302,1.383)	1.246 (0.626,2.478)
Below poverty level	Reference	Reference	Reference	Reference	Reference

*Estimated using the logistic regression with four variables including race/ethnicity, mother's education, health insurance coverage, and poverty status

Table 4D: Stratified analysis of on-time initiation of first HPV vaccine by number of Hepatitis B shots, race/ethnicity, mother's education, health insurance coverage, and poverty status in the United States, 2011

Variables: Number of Hepatitis B shots by exposures of interest	Number of Hepatitis B shots *Weighted Adjusted OR (95%CI)			
	0	1-2	3	>=4
Race/ethnicity				
Hispanic	0.633 (0.198,2.026)	1.168 (0.319,4.270)	0.973 (0.736,1.287)	**3.021 (1.114,8.193)**
Non-Hispanic White	Reference	Reference	Reference	Reference
Non-Hispanic Black	0.428 (0.118,1.551)	1.350 (0.402,4.536)	0.988 (0.723,1.350)	1.922 (0.546,6.769)
Non-Hispanic Other and Multi-Racial	0.605 (0.109,3.366)	1.627 (0.248,10.688)	0.812 (0.569,1.157)	1.319 (0.429,4.060)
Mother's education				
<12 years	Reference	Reference	Reference	Reference
12 years	1.189 (0.334,4.232)	1.343 (0.274,6.581)	0.733 (0.504,1.066)	0.931 (0.26,3.338)
>12 years, non-college graduate	2.551 (0.783,8.311)	0.656 (0.15,2.875)	0.77 (0.537,1.104)	0.878 (0.316,2.444)
College graduate	0.858 (0.23,3.207)	0.831 (0.205,3.37)	**0.63 (0.446,0.889)**	0.884 (0.323,2.417)
Health Insurance Coverage				
Private	1.44 (0.364,5.698)	2.9 (0.3,28.017)	1.262 (0.861,1.849)	2.266 (0.611,8.4)
Public	2.506 (0.687,9.145)	3.534 (0.384,32.53)	**1.615 (1.08,2.416)**	**4.726 (1.242,17.9)**
Other	**37.836 (3.26,439.7)**	-	0.846 (0.452,1.583)	3.346 (0.446,25.1)
None	Reference	Reference	Reference	Reference
Poverty status				
Above poverty level >$75K	1.009 (0.27,3.77)	0.736 (0.19,2.854)	**0.720 (0.553,0.938)**	0.71 (0.275,1.835)
Above poverty level ≤$75K	2.015 (0.692,5.87)	1.432 (0.417,4.924)	**0.687 (0.515,0.916)**	0.707 (0.27,1.85)
Below poverty level	Reference	Reference	Reference	Reference

*Estimated using the logistic regression with four variables including race/ethnicity, mother's education, health insurance coverage, and poverty status

Association between compliance with ACIP recommendations for age at initiation of the HPV vaccine series and socioeconomic status, race/ethnicity, and health insurance coverage

Multivariate analysis was conducted to further evaluate the relationship between the exposure variables (mother's education, poverty status, race/ethnicity, and health insurance coverage) and on-time initiation of HPV vaccine series while controlling for confounders (Table 5). Variables were added to the multivariate logistic regression model to test for associations with the on-time initiation of first HPV shot and socioeconomic status, race/ethnicity, and health insurance coverage. All analyses incorporated the sample weight and survey design measures to ensure accurate interpretation of data.

Socioeconomic status: On-time initiation of HPV vaccine series

In the univariate analysis, those who were above poverty level, ≤$75K had 0.75 (95% CI: 0.585, 0.961) odds of initiating on-time, compared to those below poverty level (Table 3). Females who were above poverty level, >$75K had 0.749 (95% CI: 0.575, 0.975) odds of initiating on-time, compared to those below poverty level (Table 3). After adjusting for marital status, number of children in the household under age 18, number of primary care visits in past 12 months, and number of Hepatitis B vaccine shots in the multivariable analysis, females who were above poverty level, >$75K had 0.746 (95% CI: 0.568, 0.980) odds of initiating on-time, compared to those below poverty level (Table 5).

Using the "mother's education" variable, those whose mothers were college graduates had 0.833 (95% CI: 0.489, 0.903) odds to initiate on-time compared to those whose mothers have less than 12 years of education in the univariate analysis (Table 3). In the multivariate analysis (after adjusting for marital status, number of children in the household under age 18, number of primary care visits in past 12 months, and number of Hepatitis B vaccine shots), females whose mothers were college graduates had 0.669 (95% CI: 0.487, 0.918) odds of

initiating on-time compared to those whose mothers had less than 12 years of education (Table 5).

Race/ethnicity: On-time initiation of HPV vaccine series

Non-Hispanic Blacks and non-Hispanic Others and Multi-Racial were slightly less likely to initiate the HPV vaccine series on-time, compared to non-Hispanic Whites. In the univariate analysis, non-Hispanic Blacks had 0.971 (95% CI: 0.731, 1.289) odds of initiating on-time than non-Hispanic Whites (Table 3). Non-Hispanic Others and Multi-Racial had 0.811 (95% CI: 0.569, 1.156) odds of initiating on-time compared to non-Hispanic Whites (Table 3). Hispanics had 1.011 (95% CI: 0.781, 1.310) odds of initiating on-time compared to non-Hispanic Whites (Table 3).

In the multivariate analysis, Hispanics had 0.981 (95% CI: 0.753, 1.277) odds of initiating on-time HPV vaccination compared to non-Hispanic Whites (Table 5). Non-Hispanic Blacks had 0.969 (95% CI: 0.721, 1.302) while non-Hispanic Others and Multi-Racial had 0.828 (95% CI: 0.589, 1.165) odds of initiating on-time HPV vaccination compared to non-Hispanic Whites (Table 5).

Health insurance coverage: On-time initiation of HPV vaccine series

Public health insurance coverage appeared to have a significant association with on-time initiation of HPV vaccine series. In the univariate analysis, females with public health insurance coverage had 1.826 (95% CI: 1.274, 2.619) odds of initiating on-time than those with no health insurance (Table 3). Females who had private health insurance coverage were 1.379 (95% CI: 0.978, 1.945) odds to initiate on-time, compared to those with no health insurance (Table 3). Those with health insurance coverage in the category of others had 0.970 (95% CI: 0.546, 1.781) odds of initiating on-time compared to those with no health insurance (Table 3).

Similar results were reported in the multivariate analysis. Females with public health insurance coverage had 1.825 (95% CI: 1.266, 2.631) odds of initiating on-time than females with no health insurance (Table 5). Females who had private health insurance coverage were 1.355 (95% CI: 0.948, 1.937) odds to initiate on-time, compared to females with no health insurance (Table 5). Females with other health insurance coverage had 0.964 (95% CI: 0.524, 1.774) odds of initiating on-time than females with no health insurance (Table 5).

Table 5: Multivariate analysis of on-time HPV vaccine initiation among 13-17 year-old females who received at least one HPV vaccine shot in the United States, 2011

Variables	*Adjusted OR (AOR)	95% Confidence Interval (CI)
Race/Ethnicity		
Hispanic	0.981	(0.753,1.277)
Non-Hispanic White	Reference	Reference
Non-Hispanic Black	0.969	(0.721,1.302)
Non-Hispanic Other and Multi-Racial	0.828	(0.589,1.165)
Poverty status		
Above poverty level >$75K	**0.746**	**(0. 568,0.980)**
Above poverty level ≤$75K	0.77	(0. 585,1.014)
Below poverty level	Reference	Reference
Mother's education		
<12 years	Reference	Reference
12 years	0.781	(0.557,1.095)
>12 years, non-college graduate	0.837	(0.606,1.157)
College graduate	**0.669**	**(0.487,0.918)**
Health Insurance Coverage		
Private	1.355	(0.948,1.937)
Public	**1.825**	**(1.266,2.631)**
Other	0.964	(0.524,1.774)
None	Reference	Reference

*Adjusted for 4 confounders, including marital status, number of children in the household under age 18, Number of Primary Care Visits in past 12 months, and Number of Hepatitis B vaccine shots

Sensitivity Analysis: Redefined "on-time" as 9-11 years olds and "late" as 14-17 years olds

The majority of this study sample received their first HPV vaccine shot at the ages of 12 and 13 (age group 12 = 1,598; age group 13 = 1,321), according to Table 1. Sensitivity analyses were performed to exclude the age groups 12 and 13 in the study sample.

Similar results were found for the weighted percentages of on-time and late initiators in the sensitivity analysis compared to the original analysis. Among females who received at least one HPV vaccine shot during 2011 (n=3,046), 43.9% reported having received the first shot on-time while 56.1% reported having received the first shot late (Table 6A).

Table 6A: Sensitivity analysis for weighted percentages and numbers of on-time and late initiators among 13-17 year-old females who received at least one HPV vaccine shot in the United States, 2011 (excluded 12 – 13 age groups)

Sensitivity Analysis			
Age in years at time of first HPV vaccine shot	Number in sample	[3]Weighted Frequency	[3]Weighted Percent
[1]On-time			
9	56	71911	2.5%
10	193	179472	6.3%
11	1145	1002414	35.1%
Total	**1394**	**1253797**	**43.9%**
[2]Late			
14	914	860268	30.1%
15	442	417087	14.6%
16	216	257253	9%
17	80	68561	2.4%
Total	**1652**	**1603169**	**56.1%**
Total	3046	2856966	100%

[1]Compliance of age at initiation of the HPV vaccine, defined as "on-time" vaccination based on the ACIP recommendation that the first of the three-dose HPV vaccine be given to girls by the ages of 11 or 12 years old. Children who received the first dose of HPV vaccination before or at the age of 12 are considered "on-time."
[2] Children who received the first dose of HPV vaccination after the age of 12 are considered "late."
[3]Weight was used to adjust for the dual sample frame of landline and cellphone and take into account these differences in the population.

Interesting and contrasting results were found for three variables in the sensitivity analysis when we excluded 12 and 13 year olds. Those who were above poverty level >$75K had 1.344 (95% CI: 1.035, 1.745) odds of initiating on-time, compared to those below poverty level (Table 6B). Those whose mothers were college graduates had 1.418 (95% CI: 1.067, 1.885) odds

of initiating on-time compared to those whose mothers have less than 12 years of education in the univariate analysis (Table 6B). Private health insurance coverage appeared to have a significant association with on-time initiation of HPV vaccine series instead of public health insurance coverage in the original multivariate analysis. In the sensitivity analysis, females who had private health insurance coverage had 1.382 (95% CI: 1.024, 1.866) odds of initiating on-time, compared to those with no health insurance (Table 6B).

Table 6B: Sensitivity analysis for multivariate analysis of on-time HPV vaccine initiation among 13-17 year-old females who received at least one HPV vaccine shot in the United States, 2011 (excluded 12 – 13 age groups)

Sensitivity Analysis		
Variables	***Adjusted OR (AOR)**	**95% Confidence Interval (CI)**
Race/Ethnicity		
Hispanic	1.062	(0.841,1.341)
Non-Hispanic White	Reference	Reference
Non-Hispanic Black	0.853	(0.648,1.122)
Non-Hispanic Other and Multi-Racial	1.145	(0.835,1.570)
Poverty status		
Above poverty level >$75K	**1.344**	**(1.035, 1.745)**
Above poverty level ≤$75K	1.184	(0. 924,1.519)
Below poverty level	Reference	Reference
Mother's education		
<12 years	Reference	Reference
12 years	1.302	(0.954,1.778)
>12 years, non-college graduate	1.289	(0.956,1.737)
College graduate	**1.418**	**(1.067,1.885)**
Health Insurance Coverage		
Private	**1.382**	**(1.024,1.866)**
Public	0.963	(0.710,1.307)
Other	1.382	(0.785,2.320)
None	Reference	Reference

*Adjusted for 4 confounders, including marital status, number of children in the household under age 18, Number of Primary Care Visits in past 12 months, and Number of Hepatitis B vaccine shots

CHAPTER 6: DISCUSSION

This study was one of the first studies focusing on timely initiation of the HPV vaccination series. Unlike much of the published research where the focus was mainly on initiation and completion of the HPV vaccination series, this study focused on compliance with ACIP recommendation regarding age at initiation.

Consistent with previous studies, females who had health insurance coverage were more likely to initiate on-time than those who did not have health insurance coverage (20, 21). Possible reasons for this finding could be that those with public health insurance may be more likely to go to a community clinic, where there have been efforts to increase HPV vaccination (20, 21). Public health insurance coverage, such as Vaccines for Children Program (VFC), Immunization Grant Program (Section 317), Medicaid, and Children's Health Insurance Program (CHIP) have helped to increase vaccine uptake for individuals who do not have health insurance (26, 27, 28, 29).

Consistent with previous studies, we found that females whose mothers were college-educated were significantly less likely to initiate on-time compared to those whose mothers had less than 12 years of education (63, 65, 66). We also found that females whose family income were above poverty level were significantly less likely to initiate on-time compared to those who live below poverty level. Although women with higher SES are more likely to use preventive services compared to their counterparts (75, 76, 77), several research studies have found that women with higher SES are also more likely to refuse or delay their children's vaccination (62, 63, 65, 66). Possible reasons for this finding could be that parents with higher education and income have heard, read, and/or saw negative aspects about the HPV vaccine in the news through outlets, such as television, radio, Internet, or newspapers (62). Those with higher

education may be more likely to obtain a lot of information through various media channels (62). Information regarding HPV vaccination through these channels may be incorrect. Misinformation could lead to confusion and even fear of obtaining HPV vaccination (62). Other reasons for delaying HPV vaccination are related to knowledge and belief of vaccine necessity (62). Some parents question the effectiveness of the HPV vaccine, believing that their children are not sexually active, or have concerns about lasting health problems (62). Because higher SES mothers tend to wait longer before allowing their children to initiate HPV vaccine, it could also provide an explanation why we see a difference in findings when the 12 and 13 year olds were dropped from the analysis.

Our study did not find race/ethnicity to be significantly associated with timely initiation of HPV vaccine series (20, 21). Focused on factors associated with overall initiation of HPV vaccination, Kessels and Fishers' studies found that Whites were more likely to initiate the HPV vaccine series compared to Hispanics and Blacks (20, 21). Kessels and Fishers' findings are inconsistent with a more recent study, where they found that Hispanics and Blacks were more likely to initiate the HPV vaccine series. More recent studies also found that White parents are most likely to delay and refuse the HPV vaccine series for their children (62, 63, 65). The inconsistencies across studies' results for the association between race/ethnicity and HPV vaccine initiation could explain the reason why we did not find a significant result for race/ethnicity in this study. High refusal of all childhood vaccines among White mothers who were college-educated and earned high incomes has been previously noted (63, 67). They may have lower perceived need for HPV vaccination due to higher access to regular cervical cancer screening (63, 67).

Implications and Future Research

The importance of HPV vaccination, especially on-time vaccination, deserves much attention by healthcare providers, parents, public health officials, policy makers, and all other HPV vaccination stakeholders. CDC estimates that only 30% of U.S. females received all three HPV doses by 13-15 years of age (13, 14). Of those who received at least one HPV vaccine shot, this study found that less than half (47.7%) complied with ACIP recommendation and received the first shot on-time (Table 1). To increase on-time HPV vaccination rates, evidence-based strategies should be adopted (74). For instance, healthcare providers should provide strong, clear, and consistent ACIP recommendation for HPV vaccine to parents (74). Policy makers can also address out-of-pocket expenses in the existing public insurance programs. These expenses could be associated with transportation fees or missed workday's compensation (74).

Future research is also needed to investigate the reason why we see contrasting results between analyses defining "on-time" initiators as 9-12 year-olds and in accordance to ACIP-recommended age at initiation (1, 10, 11, 12) versus analyses that excluded children age 12 year-olds. Multivariate analysis found that people who initiated on time are more likely to have public health insurance. People who live above poverty and whose mothers finished college are less likely to be on time. In contrast, sensitivity analysis excluding age 12 year-olds found higher SES and those with private health insurance are more likely to be on time, compared to their counterpart. Results vary based on how "on-time" initiation is defined.

Further research is required to explore barriers associated with specific populations identified in this study as having lower on-time initiation. People who initiated on time are more likely to have public health insurance. People who live above poverty and whose mothers finished college are less likely to be on time. We need more research to focus in this area and dig deeper into the reasons why we see lower on-time initiation rates among these subgroups.

Targeted interventions and policies can be developed to increase on-time initiators of HPV vaccination in the U.S.

Strengths

There were several strengths in using the NIS –Teen dataset. In the U.S., the 2011 NIS – Teen dataset has been one of the best public health surveillance tools available for vaccination data. It provides us with a large, nationally representative sample size of children in the U.S. as well as information on the HPV vaccine uptake (42).

Additionally, the 2011 NIS-Teen has a strong and comprehensive survey study design using random-digit-dial telephone survey for the households combined with the mail survey for the vaccination providers (42). Vaccination information from the providers is more likely to be up-to-date, complete, and reliable than household-reported information (53). The combination of the household-reported data and the provider-reported data provides a unique step to validate and ensure the accuracy of the HPV vaccination data.

Limitations

Several limitations of this study exist. First, this study's analysis was limited by the variables included in the 2011 NIS-Teen Public Use Data File. The 2011 NIS-Teen only asked questions of mothers' marital status and education but not fathers'. We were not able to exclude children who already have HPV infection at the time of the study. The 2011 NIS-Teen only asked parents and providers to provide dates when children received HPV vaccination, but no biological samples were collected to check for their HPV infection status.

Second, the nature of the cross-sectional study design inhibited the ability to make direct causal inferences. Although direct causal relationships cannot be inferred from this cross-sectional study, this study still provides us with useful insight of the associations between our

independent variables (mother's education, poverty status, race/ethnicity, health insurance status) and dependent variable (on-time initiation of HPV vaccination).

Lastly, this study was limited to the most recent publically available data from the NIS – Teen at the time of my proposal defense. NIS-Teen surveys were also conducted during 2012 and 2013, but the 2012 NIS-Teen dataset was not available for public use until the end of December 2013. This limitation hindered our ability to assess more recent changes in HPV vaccination. With the implementation of the ACA, we are expecting rapid changes in health insurance coverage and many routine preventive services in the United States (27, 34, 35).

Public Health Significance

Timeliness for initiating the HPV vaccine series is essential in order to prevent cervical cancer (10, 47, 68, 69, 70). It is crucial to follow the ACIP recommendation regarding age at initiation of HPV vaccine series (HPV vaccination should be started at 11 or 12 years of age, but it can be started 9 years of age) to ensure that vaccinations are given at the correct timeline for optimal protection (47). Vaccinations are some of the most important public health tools available for preventing diseases (31, 32). Not only does vaccination protect children from developing potentially serious diseases, but they also protect the community by reducing the spread of infectious diseases (31, 32).

Healthy People 2020 recognizes the importance of HPV vaccination through two objectives to increase HPV vaccination uptake (IID-11.4) and to reduce HPV infection (STI-9) (13, 14). To achieve these objectives, compliance with ACIP recommendation regarding age at initiation will help increase overall HPV vaccination rates, increase protection against HPV infection, and potentially decrease the risk of cervical cancer in adulthood (13, 14). Because the most effective time to vaccinate is prior to exposure of HPV infection, late initiation of HPV

vaccination leaves children with a longer window of vulnerability to contract HPV infection (52, 68, 69, 70).

APPENDICES

Appendix A: List of Variables used in this study, NIS-Teen, 2011

Variable Name	Description	Label in dataset	Type	How variables are categorized in NIS-Teen 2011 dataset	How I categorized variables for this study
HPV_AGE1	Age in provider reports	Age of teens in years of PROVIDER-reported first human papillomavirus shot	Categorical	0-18 (Mean: 13.0, Median: 13.0, Min: 0.0, Max: 18.0, STD Dev.: 1.7)	Age in years at time of first HPV shot: - 9 -10 -11 -12 -13 -14 -15 -16 -17
HPVI_AGE_SC1	Age in household reports	Age of teen in years at Household-reported first human papillomavirus shot	Categorical	N/A	N/A
AGE	Age, at the time of interview	Age in years of selected teen	Categorical	13, 14, 15, 16, 17	Age: -13 -14 -15 -16 -17
SEX	Sex	Gender of child	Categorical	1=Male 2=Female 77=Don't Know, 99=Refused	Sex: -Male -Female
RACEETHK	Race/Ethnicity	Race/Ethnicity Of Teen With Multi-race Category (Recode)	Categorical	1= Hispanic, 2=Non-Hispanic White Only, 3=Non-Hispanic Black Only, 4=Non-Hispanic Other + Multiple Race 77=Don't Know, 99=Refused	Race/Ethnicity: -Hispanic -Non-Hispanic White Only (reference) -Non-Hispanic Black Only -Non-Hispanic Other And Multi-Racial

MARITAL2	Mother's Marital Status	Marital Status Of Mother (Recode)	Categorical	1=Married, 2=Never Married/Widowed/Divorced/Separated/Decreased 77=Don't Know, 99=Refused	Mother's Marital Status: - Single* (reference) - Married
CHILDNM	Number Of Children In The Household Under Age 18	Number Of Children Under 18 Years Of Age In HH (Recode)	Categorical	1=One, 2= Two Or Three, 3=Four Or More 77=Don't Know, 99=Refused	Number Of Children In The Household Under Age 18: - 1 - 2-3 - ≥4 (reference)
INCPOV1	Poverty Status	Poverty Status	Categorical	1=Above Poverty > $75k, 2=Above Poverty <= $75k, 3=Below Poverty, 4=Unknown 77=Don't Know, 99=Refused	Poverty Status: - Above Poverty Level >$75k - Above Poverty Level ≤$75k - Below Poverty Level (reference)
EDUC1	Mother's Education	Education Level Of Mother With 4 Categories (Recode)	Categorical	1=Less Than 12 Years, 2=12 Years, 3=More Than 12 Years, Non-College Grad, 4=College Graduate 77=Don't Know, 99=Refused	Mother's Education: - <12 Years (reference) - 12 Years - >12 Years, Non-College Graduate - College Graduate
TIS_INS_1	Health insurance coverage	Is teen covered by health insurance provided through employer or union? (Private)	Categorical	1=Yes, 2=No, 77=Don't Know, 99= Refused	N/A
TIS_INS_2		Is the teen covered by any Medicaid plan? (Public)			
TIS_INS_3		Is The Teen Covered By S-Chip? (Public)			
TIS_INS_3A		Is The Teen Covered By Any Medicaid Plan Or S-Chip?			

		(Public)			
TIS_INS_4_5		Is the teen covered by Indian health service, Military health care, Tricare, Champus, or Champ-VA (Other)			
TIS_INS_6		Is The Teen Covered By Any Other Health Insurance Or Health Care Plan (Other)			
TIS_INS_11		Since age 11, was there any time when the teen was not covered by health insurance? (None)			
INS_TYPE	Health insurance coverage (re-categorization)	Using definition from the U.S. Census Bureau and suggestion from CDC data manager, this variable was categorized into private, public, other, and none	Categorical	None =0 Public =1 Private = 2 Other = 3 77=Don't Know, 99=Refused	Health Insurance Coverage: -Private -Public -Other - None (reference)
VISITS	Number Of Primary Care Visits In Past 12 Months	In Past 12 Months Number Of Times Teen Has Seen A Doctor Or Other Health Care Professional	Categorical	1= None, 2=1, 3= 2-3, 4=4-5, 5=6-7, 6=8-9, 7=10-12, 8=13-15, 9=16+, 77=Don't Know, 99=Refused	N/A

VISITS_VAR	Number Of Primary Care Visits In Past 12 Months (re-categorization)	In Past 12 Months Number Of Times Teen Has Seen A Doctor Or Other Health Care Professional	Categorical	1= 0, 2=1, 3= 2-3, 4=4-5, 5=6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16+, 77=Don't Know, 99=Refused	Number Of Primary Care Visits In Past 12 Months: - 0 (reference) - 1 - 2-3 - 4-5 - 6+
P_N13HEPB	Number Of Hepatitis B Vaccine Shots	Number Of Hepatitis B-Containing Shots By Age 13 Years Determined From Provider Info, Excluding Any Vaccinations After The RDD Interview Date.	Categorical	0=0, 1=1, 2=2, 3=3, 4=4, 5=5, 6=6, 7=7, 77=Don't Know, 99=Refused	N/A
P_N13HEPB_VAR	Number Of Hepatitis B Vaccine Shots (re-categorization)	Number Of Hepatitis B-Containing Shots By Age 13 Years Determined From Provider Info, Excluding Any Vaccinations After The RDD Interview Date.	Categorical	1=0, 2= 1, 2, 3=3, 4=4,5,6,7, 77=Don't Know, 99=Refused	Number of Hepatitis B vaccine shots: - 0 (reference) - 1-2 - 3 - 4+
COMPSTATUS	Compliance Status	If variable "Hpv_Age1" is between 9-12 then variable "CompStatus"="On-time". If variable "Hpv_Age1" is between 12-17, then variable "CompStatus"="Late".	Categorical	"On-time" = 1 "Late" = 0	"On-time" = 9, 10, 11, 12 "Late" = 13, 14, 15, 16, 17
PROVWT_D	Weight variable used to adjust for the dual sample frame of landline and cell phones (42)	N/A	N/A	N/A	N/A

Appendix B: Weighted Frequencies by age group among NIS-Teen, 2011

AGE IN YEARS OF SELECTED TEEN		
AGE	Frequency	Percent
13	7602	19.55%
14	7894	19.89%
15	7827	20.22%
16	8030	20.80%
17	7514	19.53%
Total	38867	100%

Appendix C: Weighted Frequencies by sex among NIS-Teen, 2011

GENDER OF SELECTED TEEN		
SEX	Frequency	Percent
Male	20809	52.23%
Female	19030	47.77%
Total	39839	100%

Appendix D: Test for Multicollinearity for Variables of Mother's education, Poverty status, Race/ethnicity, and Health insurance status

Parameter Estimates								
Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Tolerance	Variance Inflation
Intercept	Intercept	1	0.55673	0.03662	15.20	<.0001	.	0
RACEETHK	RACE/ETHNICITY OF TEEN WITH MULTIRACE CATEGORY (RECODE)	1	-0.01559	0.00808	-1.93	0.0538	0.99345	1.00659
EDUC1	EDUCATION LEVEL OF MOTHER WITH 4 CATEGORIES (RECODE)	1	-0.01978	0.00721	-2.74	0.0061	0.73696	1.35692
INCPOV1	POVERTY STATUS	1	0.01912	0.00875	2.18	0.0290	0.73965	1.35199
INS_TYPE		1	0.00035871	0.00219	0.16	0.8702	0.99279	1.00726

Appendix E: MPH Competencies address in thesis

Competencies for MPH in Epidemiology	Thesis	Addressed in this Thesis
1) Demonstrate the importance of epidemiology for informing scientific, ethical, economic, and political discussion of health issues.	✓	Epidemiologic analysis of variables associated with compliance at age at initiation in the HPV vaccine series and the public health significance of this study with suggestions for possible policy applications
2) Assess a public health problem in terms of magnitude, person, time and place.	✓	Examine factors associated with on-time initiation of HPV vaccine series among 13-17 year-old females in the U.S. in 2011
3) Distinguish the basic terminology and definitions of epidemiology.	✓	Statistical analysis and interpretation of results.
4) Discriminate key sources of data for epidemiological purposes.	✓	Use of 2011 NIS-Teen, strengths, and limitations
5) Calculate basic epidemiology measures.	✓	Descriptive statistics displaying socio-demographic characteristics in the sample among 13-17 year-old females who received at least one HPV vaccine shot
6) Identify the principles and limitations of public health screening programs.	✓	Preventive services for cervical cancer, such as Pap smear test and HPV vaccine
7) Evaluate strengths and limitations of epidemiologic reports.	✓	Strengths and weaknesses in introduction and discussion sections
8) Draw appropriate inferences from epidemiologic data.	✓	Results and discussion sections
9) Explain criteria for causality	✓	Results and discussion sections (e.g. limitations)
10) Calculate advanced epidemiologic measures.	✓	Univariate analysis, stratified analysis, and multivariate analysis to calculate odds ratios. Confidence interval is also included.
11) Communicate epidemiologic information to lay and professional audiences.	✓	Written thesis report; oral thesis defense and final presentation of results and public health significance to audiences
12) Compare basic ethical and legal principles pertaining to the collection, maintenance, use and dissemination of epidemiologic data.	✓	Discuss NIS-teen confidentiality and voluntary topics; obtain IRB approval before data analysis process.
13) Design, analyze, and evaluate an epidemiologic study.	✓	Design, conduct and write up thesis
14) Design interventions to reduce prevalence of major public health problems.	✓	Discuss public health significance, future research and policy interventions to increase compliance to age at initiation of HPV vaccine series

REFERENCES

1. Centers for Disease Control and Prevention. Advisory Commitee on Immunization Practices (ACIP): Quadrivalent Human Papillomavirus Vaccine.*MMWR Morb Mortal Wkly Rep 2007;*56(RR02): 1-24.

2. Division of STD Prevention. HPV Vaccine Information for Clinicians – Fact Sheet [Internet]. 2012 [cited 2013 Oct 15]. Available from: http://www.cdc.gov/std/hpv/stdfact-hpv-vaccine-hcp.htm.

3. Emory University. Cervical Cancer: Risk Factors [Internet]. CancerQuest; 2012 [cited 2013 April 10]. Available from: http://www.cancerquest.org/cervical-cancer-risks.html.

4. World Health Organization. Human papillomavirus (HPV) [Internet]. 2010 [cited 2013 Oct 15]. Available from: http://www.who.int/immunization/topics/hpv/en.

5. Kim J, Goldie S. Health and Economic Implications of HPV Vaccination in the United States. N Engl J Med 2008;359: 821-32.

6. Sanders G, Taira A. Cost Effectiveness of a Potential Vaccine for Human Papillomavirus. Emerging Infectious Diseases. 2003;9(1): 37-48.

7. U.S. Food and Drug Administration. Cervarix [Internet]. 2013 [cited 2013 Oct 15]. Available from: http://www.fda.gov/biologicsbloodvaccines/vaccines/approvedproducts/ucm186957.htm.

8. U.S. Food and Drug Administration. Gardasil [Internet]. 2013 [cited 2013 Oct 15]. Available from: http://www.fda.gov/BiologicsBloodVaccines/Vaccines/ApprovedProducts/ucm094042.htm.

9. National Center for Immunization and Respiratory Diseases. Human Papillomavirus (HPV) ACIP Vaccine Recommendations [Internet]. 2013 [cited 2013 Oct 15]. Available from: http://www.cdc.gov/vaccines/hcp/acip-recs/vacc-specific/hpv.html.

10. Centers for Disease Control and Prevention. FDA Licensure of Bivalent Human Papillomavirus Vaccine (HPV2, Cervarix) for Use in Females and Updated HPV Vaccination Recommendations from the Advisory Committee on Immunization Practices (ACIP).*MMWR Morb Mortal Wkly Rep.* 2010;*59(20):626–629.*

11. Centers for Disease Control and Prevention. FDA Licensure of Quadrivalent Human Papillomavirus Vaccine (HPV4, Gardasil) for Use in Males and Guidance from the Advisory Committee on Immunization Practices (ACIP). *MMWR Morb Mortal Wkly Rep.* 2010;59(20):630-632.

12. Centers for Disease Control and Prevention. Recommendations on the use of

quadrivalent human papillomavirus vaccine in males—Advisory Committee on Immunization Practices (ACIP) .*MMWR Morb Mortal Wkly Rep.* 2011;*60(50):1705–1708.*

13. U.S. Department of Health and Human Services. About Health People. [Internet]. 2012 [cited 2013 Oct 15]. Available from: http://www.healthypeople.gov/2020/about/default.aspx.

14. National Immunization Survey (NIS). DATA2020 Search Results: Immunization and Infectious Diseases -IID-11.4 Increase the vaccination coverage level of 3 doses of human papillomavirus (HPV) vaccine for females by age 13 to 15 years [Internet]. 2011 [cited 2014 Feb 7]. Available from: http://www.healthypeople.gov/2020/Data/SearchResult.aspx?topicid=23&topic=Immunization%20and%20Infectious%20Diseases&objective=IID-11.4&anchor=567809.

15. National Institutes of Health. Cervical Cancer. *NIH Consensus Statement [Internet].* 1996;14(1):1–38. [cited 2013 Oct 30]. Available from: http://www.cdc.gov/cancer/cervical/statistics.

16. Niccolai L, Mehta N, Hadler J. Racial/Ethnic and Poverty Disparities in Human Papillomavirus Vaccination Completion. Am J Prev Med. 2011;41(4):428-433. doi: 10.1016/j.amepre.2011.06.032.

17. Downs L, Smith J, Scarinci I, Flowers L, Parham,G. The disparity of cervical cancer in diverse populations. Gynecologic Oncology. 2008;109(2), Supplement:S22-S30, Available from: http://www.sciencedirect.com/science/article/pii/S009082580800005X.

18. Cook RL, Zhang J, Mullins J, Kauf T, Brumback B, Steingraber H. Factors associated with initiation and completion of human papillomavirus vaccine series among young women enrolled in Medicaid. Journal of Adolescent Health. 2010;47(6):596–9.

19. Chao C, Velicer C, Slezak JM, Jacobsen SJ. Correlates for human papillomavirus vaccination of adolescent girls and young women in a managed care organization. American Journal of Epidemiology. 2010;171(3):357–67.

20. Kessels SJ, Marshall HS, Watson M, Braunack-Mayer AJ, Reuzel R, Tooher, RL. Factors associated with HPV vaccine uptake in teenage girls: a systematic review. Vaccine. 2012;30(24): 3546-56. doi: 10.1016/j.vaccine.2012.03.063.

21. Fisher, H., Trotter, C., Audrey, S., Macdonald-Wallis, K., & Hickman, M. Inequalities in the uptake of Human Papillomavirus Vaccination: a systematic review and meta-analysis. International Journal of Epidemiology. 2013; 42:896–908. doi:10.1093/ije/dyt049.

22. Dombkowski KJ, Lantz PM, Freed GL. Role of health insurance and a usual source of medical care in age-appropriate vaccination. Am J Public Health. 2004;94(6):960–6.

23. Smith PJ, Stevenson J, Chu SY. Associations between childhood vaccination coverage, insurance type, and breaks in health insurance coverage. Pediatrics. 2006;117(6):1972–8.

24. Rosenthal SL, Weiss TW, Zimet GD, Ma L, Good MB, Vichnin MD. Predictors of HPV vaccine uptake among women aged 19-26: importance of a physician's recommendation. Vaccine. 2011;29(5):890-5. doi: 10.1016/j.vaccine.2009.12.063.

25. U.S. Department of Health and Human Services. About the Law [Internet]. 2013 [cited 2013 Oct 15]. Available from: http://www.hhs.gov/healthcare/rights/index.html.

26. American Cancer Society. Human Papilloma Virus (HPV), Cancer, HPV Testing, and HPV Vaccines [Internet]. 2013 [cited 2013 Oct 1]. Available from: http://www.cancer.org/cancer/cancercauses/othercarcinogens/infectiousagents/hpv/humanpapillomavirusandhpvvaccinesfaq/hpv-faq-vaccine-cost.

27. Kaiser Family Foundation. The HPV Vaccine: Access and Use in the U.S [Internet]. 2013 [cited 2013 Dec 5]. Available from: http://kff.org/womens-health-policy/fact-sheet/the-hpv-vaccine-access-and-use-in.

28. Centers for Disease Control and Prevention (CDC). Immunization Grant Program (Section 317) [Internet]. 2007 [cited 2013 Dec 5]. Available from: http://www.cdc.gov/vaccines/programs/vfc/downloads/grant-317.pdf.

29. U.S. Department of Health and Human Services (DHHS). Biden Announces $2.3 Billion in Recovery Act Funds to Help Care for Children, Prevent Disease [Internet]. 2009 [cited 2013 Dec 5]. Available from: http://www.hhs.gov/news/press/2009pres/04/20090409a.html.

30. Centers for Disease Control and Prevention (CDC). Advisory Commitee on Immunization Practices (ACIP): Quadrivalent Human Papillomavirus Vaccine [Internet]. 2007 [cited 2013 Oct 1]. Available from: http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5602a1.htm.

31. National Center for Immunization and Respiratory Diseases. How Vaccines Prevent Disease [Internet]. 2012 [cited 2013 Oct15]. Available from: http://www.cdc.gov/vaccines/vac-gen/howvpd.htm#why.

32. National Center for Immunization and Respiratory Diseases. Vaccines and Preventable Diseases: HPV Vaccine - Questions & Answers [Internet]. 2012 [cite 2013 Oct 1]. Available from: http://www.cdc.gov/vaccines/vpd-vac/hpv/vac-faqs.htm.

33. Centers for Medicare & Medicaid Services. Children's Health Insurance Program (CHIP) [Internet]. 2013 [cited 2013 October 1]. Available from: http://www.medicaid.gov/Medicaid-CHIP-Program-Information/By-Topics/Childrens-Health-Insurance-Program-CHIP/Childrens-Health-Insurance-Program-CHIP.html.

34. Kaiser Family Foundation. Preventive Services Covered by Private Health Plans under the Affordable Care Act [Internet]. 2011 [cited 2013 Dec 5 2013]. Available from: http://kff.org/health-reform/fact-sheet/preventive-services-covered-by-private-health-plans.

35. U.S. Government Printing Office (GPO). H.R.3590: An Act Entitled The Patient Protection and Affordable Care Act [Internet]. 2010 [cited 2013 Dec 5]. Available from: http://www.gpo.gov/fdsys/pkg/BILLS-111hr3590enr/pdf/BILLS-111hr3590enr.pdf.

36. Democratic Policy & Communications Center (DPCC). The Patient Protection and Affordable Care Act Section-by-Section Analysis [Internet]. 2010 [cited 2013 December 5]. Available from: http://www.dpc.senate.gov/healthreformbill/healthbill05.pdf.

37. Kaiser Family Foundation. The Requirement to Buy Coverage Under the Affordable Care Act [Internet]. 2013 [cited 2013 Dec 5]. Available from: http://kff.org/infographic/the-requirement-to-buy-coverage-under-the-affordable-care-act.

38. Moy B, Polite B, Halpern M, Stranne S, Winer E, Wollins D, Newman L. American Society of Clinical Oncology Policy Statement: Opportunities in the Patient Protection and Affordable Care Act to Reduce Cancer Care Disparities. American Society of Clinical Oncology. 2011;29(28): 3816-3824. doi: 10.1200/JCO.2011.35.8903.

39. Rosenbaum S. The Patient Protection And Affordable Care Act: Implications For Public Health Policy And Practice. Public Health Reports. 2011;126.

40. Penchansky R, Thomas JW. The Concept of Access: Definition and Relationship to Consumer Satisfaction. Medical Care. 1981;19(2):127-140.

41. Centers for Disease Control and Prevention. About the National Immunization Survey [Internet]. 2013 [cited 2013 Oct 15]. Available from: http://www.cdc.gov/nchs/nis/about_nis.htm.

42. Centers for Disease Control and Prevention. Data User's Guide for the 2011 NIS-Teen Public-Use Data File. The 2011 National Immunization Survey – Teen [Data file]. 2012 [cited 2013 Oct 15]. Available from: ftp://ftp.cdc.gov/pub/Health_Statistics/NCHS/Dataset_Documentation/NIS/NISteenPUF11_DUG.pdf.

43. Merck & Co., Inc. Highlights of Prescribing Information: Gardasil [Internet]. 2011 [cited 2013 Oct 15]. Available from: http://www.merck.com/product/usa/pi_circulars/g/gardasil/gardasil_pi.pdf.

44. GlaxoSmithKline Biologicals. Highlights of Prescribing Information: Cervarix [Internet]. 2011 [cited 2013 Oct 15]. Available from: http://us.gsk.com/products/assets/us_cervarix.pdf.

45. National Center for Health Statistics. Summary of NCHS Surveys and Data Collection Systems [Internet]. 2012 [cited 2013 Oct 31]. Available from: http://www.cdc.gov/nchs/data/factsheets/factsheet_summary.htm.

46. National Center for Health Statistics. How NCHS Protects Your Privacy: Confidentiality and Security of Information Collected by The National Center for Health Statistics [Internet]. 2012 [cited 2013 Oct 30]. Available from: http://www.cdc.gov/nchs/about/policy/confidentiality.htm.

47. Luman E, Barker L, Shaw K, McCauley M, Buehler J, Pickering L. Timeliness of Childhood Vaccinations in the United States. JAMA. 2005;293 (10):1204-1211.

48. U.S. Census Bureau. CPS Health Insurance Definitions [Internet]. 2012 [cited 2014 Mar 12]. Available from: http://www.census.gov/hhes/www/hlthins/methodology/definitions/cps.html.

49. Jain N, Euler GL, Shefer A, Lu P, Yankey D, Markowitz L. Human papillomavirus (HPV) awareness and vaccination initiation among women in the United States, National Immunization Survey-Adult 2007. Prev Med. 2009;48(5): 426-31. doi: 10.1016/j.ypmed.2008.11.010.

50. Mast E, Margolis HS, Fiore AE, Brink EW, Goldstein ST, Wang SA, Moyer LA, Bell BP, Alter MJ, Advisory Committee on Immunization Practices (ACIP). A comprehensive immunization strategy to eliminate transmission of hepatitis B virus infection in the United States: recommendations of the Advisory Committee on Immunization Practices (ACIP) part 1: immunization of infants, children, and adolescents [Internet]. MMWR Recomm Rep. 2005;54(RR-16):1-31. Available from: http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5416a1.htm

51. Coronado VG, Maes EF, Rodewald LE, Chu S, Battaglia MP, Hoaglin DC, Merced NL, Yusuf H, Cordero JF, Orenstein WA. Risk factors for underimmunization among 19-35 month-old children in the United States: National Immunization Survey, July 1996-June 1998. Unpublished manuscript cited in 2011 NIS- Teen PUF Data User's Guide. Centers for Disease Control and Prevention, Atlanta. 2000 [cited 2013 Nov 1]. Available from: ftp://ftp.cdc.gov/pub/Health_Statistics/NCHS/Dataset_Documentation/NIS/NISteenPUF11_DUG.pdf

52. Hoff T, Greene L, Davis J. National Survey of Adolescents and Young Adults: Sexual Health Knowledge, Attitudes and Experiences [Internet]. Menlo Park, CA: Henry J. Kaiser Family Foundation; 2003 [cited 2013 Oct 15]. Available from: http://kff.org/hivaids/report/national-survey-of-adolescents-and-young-adults.

53. National Center for Health Statistics. Frequently Asked Questions for the National Immunization Survey: Why does the study request information from medical providers? [Internet]. 2013 [cited 2013 Nov 2]. Available from: http://www.cdc.gov/nchs/nis/nis_faq.htm#WHY%20MEDICAL%20PROVIDER.

54. Smith PJ, Stevenson J, Chu SY. Associations between childhood vaccination coverage, insurance type, and breaks in health insurance coverage. Pediatrics. 2006;117(6):1972–8.

55. Smith LM, Brassard P, Kwong JC, Deeks SL, Ellis AK, Lévesque LE. Factors associated with initiation and completion of the quadrivalent human papillomavirus vaccine series in an Ontario cohort of grade 8 girls. BMC Public Health. 2011;11:645. doi: 10.1186/1471-2458-11-645.

56. Paul L. Reiter, Melissa B. Gilkey, Noel T. Brewer. HPV vaccination among adolescent males: Results from the National Immunization Survey-Teen, Vaccine. 2013;31(26:2816-2821, ISSN 0264-410X. Available from: http://dx.doi.org/10.1016/j.vaccine.2013.04.010.

57. Jain N, Singleton JA, Montgomery M, Skalland B. Determining accurate vaccination coverage rates for adolescents: the National Immunization Survey-Teen 2006. 2009; 124(5):642-51. Available from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2728656.

58. Bryant CM. Understanding the intersection of race and marriage: Does one model fit all? Psychological Science Agenda. American Psychological Association. 2010 [cited 2014 April 7]. Available from: https://www.apa.org/science/about/psa/2010/10/race-marriage.aspx.

59. Jolley D, Douglas KM. The Effects of Anti-Vaccine Conspiracy Theories on Vaccination Intentions. PLoS ONE. 2014;9(2):e89177. doi:10.1371/journal.pone.0089177.

60. Behrmann J. The anti-vaccination movement and resistance to allergen-immunotherapy: a guide for clinical allergists. Allergy, Asthma & Clinical Immunology. 2010;6:26. doi:10.1186/1710-1492-6-26.

61. Buettgens M, Hall MA. Who Will be Uninsured After Health Insurance Reform? Urban Institute. 2014 [cited 20 April 2014]. Available from: http://www.rwjf.org/en/research-publications/find-rwjf-research/2011/03/who-will-be-uninsured-after-health-insurance-reform-.html.

62. Dorell C, Yankey D, Jeyarajah J, Stokley S, Fisher A, Markowitz L, Smith P J. Delay and Refusal of Human Papillomavirus Vaccine for Girls, National Immunization Survey–Teen, 2010. Clinical pediatrics. 2014. doi:0009922813520070.

63. Bednarczyk RA, Curran EA, Orenstein WA, Omer SB Health Disparities in Human Papillomavirus Vaccine Coverage: Trends Analysis From the National Immunization Survey–Teen, 2008–2011. Clinical Infectious Diseases. 2014;*58*(2):238-241.

64. Hofstetter AM, Stockwell MS, Al-Husayni N, Ompad D, Natarajan K, Rosenthal S L, Soren K. HPV vaccination: Are we initiating too late?. Vaccine. 2014;*32*(17):1939-1945.

65. Jeudin P, Liveright E, del Carmen MG, Perkins RB. Race, Ethnicity, and Income Factors Impacting Human Papillomavirus Vaccination rates. Clinical therapeutics. 2014;*36*(1): 24-37.

66. Rambout L, Tashkandi M, Hopkins L, Tricco AC. Self-reported barriers and facilitators to preventive human papillomavirus vaccination among adolescent girls and young women: A systematic review. Preventive medicine. 2014;*58*:22-32.

67. Smith PJ, Chu SY, Barker LE. Children who have received no vaccines: who are they and where do they live?. Pediatrics. 2004;114(1):187-195.

68. Lincoff N. Study: Two Doses of HPV Vaccine as Effective as Three. Healthline News: 2014 [cited 2014 April 25]. Available from: http://www.healthline.com/health-news/children-two-doses-hpv-vaccine-effective-three-043013.

69. Herweijer E, Leval A, Ploner A, et al. Association of Varying Number of Doses of Quadrivalent Human Papillomavirus Vaccine With Incidence of Condyloma. JAMA. 2014;311(6):597-603. doi:10.1001/jama.2014.95.

70. Dobson SR, McNeil S, Dionne M, Dawar M, Ogilvie G, Krajden M, ... Young E. Immunogenicity of 2 Doses of HPV Vaccine in Younger Adolescents vs 3 Doses in Young WomenA Randomized Clinical TrialImmunogenicity of HPV Vaccine in Girls vs Women. JAMA. 2013;*309*(17), 1793-1802.

71. Katz MH. Health Insurance Is Not Health Care. JAMA internal medicine. 2014. Available from: http://archinte.jamanetwork.com/article.aspx?articleID=1857087&utm_source=dlvr.it&utm_medium=twitter&utm_campaign=feed_posts.

72. National Cancer Institute (NCI). Human Papillomavirus (HPV) Vaccines: Should the vaccines be given to people who are already infected with HPV? 2011 [cited 2014 May 26]. Available from: http://www.cancer.gov/cancertopics/factsheet/prevention/HPV-vaccine.

73. U.S. Centers for Medicare & Medicaid Services. What are my preventive care benefits? 2011. Available from: https://www.healthcare.gov/what-are-my-preventive-care-benefits/#part=3.

74. Centers for Disease Control and Prevention (CDC). National and State Vaccination Coverage Among Adolescents Aged 13–17 Years — United States, 2012. *MMWR Morb Mortal Wkly Rep.* 2013 Sep 13;62(36):733-40. Available from: http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6234a1.htm.

75. Partnership for Prevention. Preventive Care: A National Profile on Use, Disparities, and Health Benefits. 2007. Available from: http://www.rwjf.org/content/dam/farm/reports/reports/2007/rwjf13325.

76. Multuck M. Use of Clinical Preventive Services and Prevalence of Health Risk Factors Among Adults Aged 50–64: National and State-Level Racial/Ethnic, Socioeconomic, and Health Insurance Coverage Status Disparities. AARP Public Policy Insitute. 2013. Available from: http://www.aarp.org/health/health-insurance/info-08-2013/use-of-clinical-preventive-services-and-prevalence-AARP-ppi-health.html.

77. Agency for Healthcare Research and Quality (AHRQ). Disparities in Healthcare Quality Among Racial and Ethnic Groups: Selected Findings from the 2011 National Healthcare Quality and Disparities Reports. Fact Sheet. 2012 Sep. Available from: http://www.ahrq.gov/qual/nhqrdr11/nhqrdrminority11.htm.

78. National Network for Immunization Information (NNii). Why is Hepatitis B Immunization Recommended for All Infants, Children, and Adolescents? 2008. Available from: http://www.immunizationinfo.org/issues/general/why-hepatitis-b-immunization-recommended-all-infants-children-and-adolescents.