Fall 11-18-2013

An Analysis of Selected Predictive Factors Associated with Adolescent HPV Vaccination Initiation and Completion Rates in the United States: 2011 National Immunization Survey - Teen

Kristen Oliver

ABSTRACT

KRISTEN BRADBURN OLIVER
An Analysis of Selected Predictive Factors Associated with Adolescent HPV Vaccination Initiation and Completion Rates in the United States: 2011 National Immunization Survey - Teen
(Under the direction of Christine Stauber, Faculty Member)

Background
Human papillomavirus (HPV) is the most common sexually transmitted infection in the United States, and adolescents have the highest incidence. To decrease the burden of HPV and HPV-associated cancers, two vaccines were developed and require a 3 dose series. This study assesses factors that may predict whether a teen will either initiate or complete the vaccine series.

Methods
National Immunization Survey -Teen 2011 data was used to assess demographic (age, sex, and race/ethnicity) and socioeconomic (poverty and insurance status) factors as they related to vaccine initiation and completion. Bivariate and multivariate analyses were used to determine strength of association.

Results
Females were more likely than males to initiate and complete the series. Compared to whites, Hispanic teens were 1.5 times more likely to initiate but less likely to complete. Blacks were least likely to complete. Teens below the poverty line were more likely to initiate compared to teens above poverty but less likely to complete. Teens with at least one form of health insurance were 1.2 times more likely to complete than those with no insurance.

Conclusion
HPV vaccination rates are increasing and need to continue to do so. Emphasis needs to be placed on completing the series to confer complete resistance. This is especially true for blacks and Hispanics who are at a higher risk of HPV-related morbidities.

AN ANALYSIS OF SELECTED PREDICTIVE FACTORS ASSOCIATED WITH ADOLESCENT HPV VACCINATION INIATION AND COMPLETION RATES IN THE UNITED STATES: 2011 NATIONAL IMMUNIZATION SURVEY-TEEN

by

KRISTEN BRADBURN OLIVER
B.A., RHODES COLLEGE
M.ED., GEORGIA STATE UNIVERSITY

A Thesis Submitted to the Graduate Faculty
of Georgia State University in Partial Fulfillment
of the
Requirements for the Degree

MASTER OF PUBLIC HEALTH

ATLANTA, GEORGIA

An Analysis of Selected Predictive Factors Associated with Adolescent HPV Vaccination Initiation and Completion Rates in the United States: 2011 National Immunization Survey-Teen

by

Kristen Bradburn Oliver

Approved:

Committee Chair: Christine Stauber, PhD

Committee Member: Sheryl Strasser, PhD

Date: November 18, 2013

ACKNOWLEDGEMENTS

I would like to sincerely thank my thesis committee members, Dr. Christine Stauber and Dr. Sheryl Strasser. This process would not have been possible without their guidance, support, and time.

In addition, I would like to thank my husband, Charles Oliver, for his constant support and encouragement, as well as his technical review of this thesis.

Author's Statement

In presenting this thesis as partial fulfillment of the requirements for an advanced degree from Georgia State University, I agree that the Library of the University shall make it available for inspection and circulation in accordance with its regulations governing materials of this type. I agree that permission to quote from, to copy from, or to public this thesis may be granted by the author or, in her absence, by the professor under whose direction it was written, or in her absence, by the Associate Dean, College of Health and Human Sciences. Such quoting, copying, or publishing must be solely for scholarly purposes and will not involve potential financial gain. It is understood that any copying from or publication of this dissertation which involves potential financial gain will not be allowed without written permission of the author.

_____

Signature of Author

Notice to Borrowers

All theses deposited in the Georgia State University Library must be used in accordance with the stipulations prescribed by the author in the preceding statement.

The author of this thesis is:
Kristen B. Oliver
c/o School of Public Health
Georgia State University
P.O. Box 3995
Atlanta, Georgia 30302-3995

The Chair of the committee for this thesis is:
Christine Stauber, PhD
School of Public Health
Georgia State University
P.O. Box 3995
Atlanta, Georgia 30302-3995

Users of this thesis who not regularly enrolled as students at Georgia State University are required to attest acceptance of the preceding stipulation by signing below. Libraries borrowing this thesis for the use of their patrons are required to see that each user records here the information requested.

NAME OF USER	ADDRESS	DATE	TYPE OF USE (EXAMINATION ONLY OR COPYING)

Curriculum Vitae

Name: Kristen B. Oliver
Address: 4438 Lake Ivanhoe Drive, Tucker, GA 30084
Phone: 404-433-2966
Email: kristenoliver20@gmail.com

Education

2000 – Bachelor of Arts in Biology, Rhodes College
2002 – Master of Education in Secondary Science Education, Georgia State University

Professional Experience

GRADY HEALTH SYSTEMS, ATLANTA, GA
CENTER FOR CLINICAL PERFORMANCE IMPROVEMENT INTERN Sep 2013 – Dec 2013

- Developed work-flow of Grady primary care clinic for program improvement analysis. Abstracted and analyzed data regarding complications associated with surgical procedures to determine effectiveness of providers. Assisted in writing annual quality report for Chief of Psychiatry.

GEORGIA DEPARTMENT OF PUBLIC HEALTH, ATLANTA, GA
HEALTH PROMOTIONS INTERN, SICKLE CELL Jun 2013 – Sep 2013

- Developed comprehensive healthcare provider contact list for the State of Georgia. Assisted in development of healthcare provider survey to determine current gaps in sickle cell disease management. Collected data regarding healthcare provider recommendation of and health promotion materials regarding Hydroxyurea, Transcranial Doppler screening, and immunizations for sickle cell patients. Researched current education materials available for the three treatments. Wrote patient education materials to be distributed to healthcare providers by DPH. Wrote Sickle Cell Awareness Month article for DPH weekly newsletter.

CENTERS FOR DISEASE CONTROL & PREVENTION, ATLANTA, GA
OFFICE OF TRAINING, EDUCATION, AND COMMUNICATION INTERN May 2012 – Aug 2012

- Wrote quarterly newsletter outlining recent and upcoming communication events and successes. Created refugee medical checklist by consulting with subject matter expert. Developed FAQ sheet to accompany DGMQ's newly launched media library. Created a detailed health education conferences and workshops document. Prepared communication materials currently posted on CDC website. Organized and tabulated statistics on internal training sessions. Participated in seminars on health literacy and plain language.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

INTRODUCTION

1.1 Background

Human papillomaviruses (HPVs) are a group of approximately 150 related viruses, which attack the body's epithelial cells, such as those found on the skin, mouth, and genitals. More than 40 of these viruses are classified as genital human papillomaviruses and can be spread through skin-to-skin contact during vaginal, anal, and oral sex [1]. Most sexually active men and women will be infected with one or more genital HPVs at some point in their lives [2]. Because most infected persons exhibit no symptoms, these 40 HPVs are unknowingly spread and make up the most prevalent sexually transmitted infection in the United States [2]. Approximately half of the new HPV infections each year are found among young people (ages 15-24), even though they only make up a quarter of the sexually active population [2].

Sexually transmitted HPVs are divided into two categories based on oncogenic, or cancer-causing, properties. Low-risk HPVs do not cause cancer but can cause skin warts on or around the genitals or anus. High-risk HPVs can cause cancer if the body does not rid itself of the virus. Common HPV-associated cancers are cervical, anal, vaginal, vulvar, penile, and oropharyngeal. [4]

HPVs are highly preventable by abstaining from sexual contact or correct and consistent use of condoms for those who are sexually active. To decrease the burden of HPV and associated cancers, two vaccines were developed, targeting the most common genital HPVs. Quadrivalent Gardasil ®, approved by the FDA on June 8, 2006, prevents infections with HPV high-risk types 16 and18, as well as low-risk types 6 and 11 [4].

Bivalent Cervarix ®, approved by the FDA on October 16, 2009, prevents infections with HPV high-risk types 16 and 18 [5]. Both vaccines require a 3 dose series given over a 6-month period [4].

The Advisory Committee on Immunization Practices (ACIP) has established vaccination guidelines for both quadrivalent (HPV4) and bivalent (HPV2) vaccines, which were licensed for use among females aged 9 – 26 years for prevention of vaccine HPV-type-related cervical cancer, cervical cancer precursors, and anogenital warts [4]. Ideally, the vaccine series should be completed before the onset of sexual activity and HPV exposure. The committee recommends routine vaccination of females aged 11 or 12 with 3 doses of either vaccine. In 2011, the quadrivalent vaccine was licensed for use among males aged 11 to 12. [3]

1.2 Purpose of Study

The United States government has made HPV and its associated cancers a priority by including them in several Healthy People 2020 objectives.

Immunization and Infectious Diseases Objectives:

- IID-11: Increase routine vaccination coverage for adolescents [6].
- IID-11.4: Increase the vaccination coverage level of three doses of HPV vaccine for females by age 13-15 years. The target is 80% coverage of females, an increase from the 16.6% coverage in 2009 [6].

Sexually Transmitted Diseases Objectives:

- STD-9: Decrease proportion of females with HPV infection [7].

Cancer Objectives:

- C-4: Decrease death rate from cancer of uterine cervix rate by 10%. Target is 2.2/100, 000 [8].
- C-10: Decrease invasive uterine cervical cancer rates by 10%. Target is 7.1/100,000 [8].

Adolescents have the highest incidence of HPV infections in the United States compared to other age groups [2]. If they are underutilizing vaccination opportunities to decrease HPV infection and potential cancer morbidity, it is important to examine factors that may predict initiation and completion of the vaccine series. Understanding these characteristics can lead to the development of successful public health practices, targeting specific populations in order to increase vaccination coverage in the United States.

1.3 Research Questions

To further investigate predictors of why adolescents in the United States aged 13 to 17 in the 2011 National Immunization Survey – Teen initiated or completed the human papilloma virus vaccine series, the following questions will be examined:

1. Is race/ethnicity associated with initiation or completion of the HPV vaccine series among adolescents in the United States?
2. Is gender associated with initiation or completion of the HPV vaccine series among adolescents in the United States?

3. Is age associated with initiation or completion of the HPV vaccine series among adolescents in the United States?
4. Is poverty status associated with initiation or completion of the HPV vaccine series among adolescents in the United States?
5. Is health insurance status associated with initiation or completion of the HPV vaccine series among adolescents in the United States?

CHAPTER II

REVIEW OF THE LITERATURE

2.1 HPV Virology and Immunology

Human papillomaviruses are non-enveloped, double-stranded DNA viruses in the family *Papillomaviridae*. Isolates of HPV are classified as "types" and numbers are assigned based on order of discovery [9]. All HPVs have an 8 kb circular genome enclosed in a capsid shell composed of the major (L1) and minor (L2) capsid proteins. The genome encodes several early genes that enable viral transcription and replication and interact with the host genome. Immortalization and transformation functions are associated with the E6 and E7 early genes, which code for the primary oncoproteins found in high-risk types of HPV [10].

Members of the *Papillomaviridae* family infect cells located in the basal layer of the epithelium. By using the cellular replication machinery of the differentiating cells, the viral genome is amplified. Infection causes non-dividing epithelial cells to maintain an active state of cell division. This often results in a thickened epithelial lesion. As the cells exfoliate from the epithelium, the virus is shed [4]. Because they are restricted to the epithelium, HPV infections often go unnoticed by the host's immune system [11].

The majority of HPV infections are transient and asymptomatic, causing no clinical problems. With the median duration of new infections at 8 months, 70% of HPV infections clear within one year and 90% clear within 2 years [12]. HPV infections cannot be treated. While HPV-associated lesions are typically addressed through cryotherapy, electrocautery, laser therapy, and surgical excision, this does not eliminate the infection from the host [13].

2.2 Epidemiology of HPV Infection in the United States

Genital HPV infection is primarily transmitted by genital contact, usually though sexual intercourse [14]. Transmission of HPV through other types of genital contact (oral-genital, manual-genital, genital-genital) has been identified but is less common [15]. Nonsexual transmission of genital HPV can include mother to her newborn baby [16].

Incidence and prevalence of HPV is limited, since HPV is not a reportable disease. For many infected with HPV, no symptoms develop, therefore no diagnosis is attempted. It is estimated 14.1 million new infections occur in the United States each year [17]. With 79 million currently infected, the highest prevalence is among women 20-24 years of age [17]. The most consistent predictors of infection have been measures of sexual activity, most importantly the number of sexual partners, both lifetime and recent [12].

2.3 Epidemiology of HPV-Associated Cancers

2.3.1 Cervical Cancers

Cervical cancers are divided into two categories: squamous cell cancers and adenocarcinomas. Three fourths of cervical cancers in the United States are squamous cell, while the remaining one fourth are adenocarcinomas [4]. These cancers develop slowly, over decades, and are often preceded by high-grade cervical lesions detected though routine Papanicolaou (Pap) smears [18]. Cervical lesions are classified as cervical intraepithelial neoplasias (CIN) grades 1, 2, or 3, based on the increasing degree of abnormality of cervical cells. CIN 1 spontaneously clears in 60% of cases and

progresses to cancer in only 1% of patients. CIN 2 and 3 are less likely to clear spontaneously and more likely to progress to cancer without treatment [4].

In 2009, the incidence rate of cervical cancer was 8.1 per 100, 000 [19]. (Note all rates will be presented in this paper per 100,000.) With the introduction of the Pap smear in the 1940's, cervical cancer incidence rates have decreased approximately 75% and death rates approximately 70% [4]. Early detection allows for treatment before cervical lesions progress to cancer. Interestingly, the decrease in incidence is attributed to squamous cell carcinoma, as the incidence of adenocarcinoma has remained relatively stable [4].

There are documented racial and ethnic disparities in invasive cervical cancer (ICC) rates. Blacks are twice as likely and Hispanic whites are two to three times as likely as whites to be diagnosed with ICC [18]. Hispanic whites have the highest age-adjusted incidence rate of cancer overall (24.2), as well as the highest incidence rates for both squamous cell carcinoma and adenocarcinoma (18.3 and 4.6, respectively) [18]. Whites have the lowest rate of cervical cancer overall (10.8) and squamous cell carcinoma (7.2) [18]. Blacks have the lowest rate of adenocarcinoma (2.3) [18]. In a study of county demographics, incidence rates seemed to be higher in counties with lower mean annual household incomes and higher proportions of people living below the poverty level [18].

Human papillomavirus types 16, 18, 31, and 45 are the most common culprits for cervical cancer diagnoses [20]. HPV types 16 and 18 account for 70% of cervical cancers and 50% of precancerous lesions worldwide [20]. These two high-risk types are

found in high-grade cervical lesions and linked to 68% of squamous cell cancers and 83% of adenocarcinomas [4].

2.3.2 Other HPV-Associated Cancers

Cervical cancer is not the only cancer associated with HPV infection. Other cancers linked to HPV are oropharyngeal, anal, penile, vulvar, and vaginal. In 2009, all HPV-associated cancers accounted for 3.3% and 2.0% of total cancer cases among women and men, respectively, in the United States [20]. Overall, oropharyngeal and cervical cancers were the two most common HPV-associated cancers, where 37.3% were oropharyngeal and 32.7% were cervical [20]. For women, 53.4% of these cancers were cervical. For men, 78.2% of these cancers were oropharyngeal [20].

Data collected between 2005 and 2009 regarding incidence rates of the different HPV-associated cancers showed several differences based on sex, race/ethnicity, and socioeconomic status [20]. Oropharyngeal cancers rates were highest among white and black men (8.5 and 7.9) [20]. Anal and vulvar cancers were highest among white women (2.6 and 2.5) [20]. Vaginal cancers were highest among black women (0.8). Penile cancers were highest among American Indian and Alaska Native (AI/AN) men (2.0) [20]. Asian-Pacific Islander (API) men and women have the lowest rates of all cancers, except vaginal, in which AI/AN women have the lowest rate [20].

As stated before, cervical cancer rates are declining in the United States. However, a disturbing trend of increased rates of other HPV-associated cancers is starting to emerge. Anal and oropharyngeal cancer age-adjusted rates climbed between 2000 and 2009. The average annual percent change (APC) for anal cancers has had a statistically

significant increase for white men (2.6), white women (3.7), black men (5.6) and black women (2.5) [20]. The APC for oropharyngeal cancers has significantly increased for white men (3.9) and white women (1.7) [20]. The overall incidence rate of anal cancer has increased twofold from 1975 to 2009 in both men and women. The burden of this cancer is highest among women [20].

2.4 Overview of Available Vaccines

Two vaccines were developed to target the most common genital HPVs. Quadrivalent (HPV4) *Gardasil* ® by Merck & Company prevents infections with HPV high-risk types 16 and18, as well as low-risk types 6 and 11 [4]. Bivalent (HPV2) *Cervarix* ® by GlaxoSmithKline prevents infections with HPV high-risk types 16 and 18 [5]. Both vaccines require a 3 dose series given over a 6-month period [4].

Both vaccines contain virus-like particles (VLPs) composed of empty capsids formed by self-assembly of viral L1 proteins, which were created through recombinant DNA technology. The VLPs do not contain viral DNA and are not infectious. The capsids are geometrically similar to native HPV virions and elicit the host immune system to create neutralizing antibodies. The HPV4 vaccine uses full-length L1 protein from HPV types 6, 11, 16, and 18. Its proprietary adjuvant is composed of amorphous aluminum hydroxyphosphate sulfate. The HPV2 vaccine uses C-terminally truncated L1 protein from HPV types 16 and 18. Its proprietary adjuvant is composed of monophosphoryl-lipid A absorbed to aluminum chloride. [21]

Both vaccines require intramuscular injection of a three dose series administered at months 0, 2, and 6 [21]. The Advisory Committee on Immunization Practices (ACIP) recommends either HPV2 or HPV4 to be administered to females aged 11 or 12 years.

Only HP4 is recommended for males aged 11 or 12. Vaccination is acceptable for children as young as 9 years of age, and catch-up is recommended for adolescents aged 13 – 26. ACIP recommends 11-12 years in order to fully vaccinate teens before sexual debut [22]. Even though providers recommend annual well checkup visits until the age of 21, studies have shown that frequency of these visits falls after the age of 12, possibly due to completion of vaccines required for school attendance [23]. Also, in 2009, the Youth Behavioral Risk Survey showed 5.9% of respondents had their first sexual experience before the age of 13 [22].

2.4.1 HPV4 / Gardasil®

For HPV-naïve women in trial studies, the vaccine efficacy over an average 3.6-year follow-up was 98-100% against cervical lesions (CIN 1-3 or Adenocarcinoma in situ) related to vaccine-type HPV and 95-96% against external genital lesions (vulvar intraepithelial neoplasia (VIN) 1-3, vaginal intraepithelial neoplasia (VaIN) 1-3, or warts) [21]. For all women included in trial studies, regardless of previous HPV exposure, the vaccine efficacy was 45-69% against cervical lesions and 76-80% against genital lesions related to vaccine-type HPV [21]. There seems to be cross-protection against non-vaccine-type HPV abnormalities. The vaccine efficacy for HPV-naïve women was 43% for any type HPV related CIN 2 or worse and 55-83% for any external lesion [21]. For all women studied, the efficacy was 19% for any CIN 2 or worse and 30-62% for any external lesion [21].

In women with previous HPV exposure but no active infection, the quadrivalent vaccine was shown to protect against reinfection or reactivation of the HPV type to which

she had previously been exposed [21]. A natural infection that had been cleared, however, was found to not protect against reinfection of the same HPV type. The vaccine was, also, able to protect these women against the vaccine types to which she had not yet been exposed [21]. Women with active vaccine-type HPV infections or existing HPV-related lesions do not benefit from receipt of the vaccine. While HPV4 targets HPV types 6, 11, 16, and 18, the vaccine was found to provide cross-protection against persistent infection and lesions caused by other types of high-risk HPV, including 31, 33, 45, 52, and 58 [21].

2.4.2 HPV2 / Cervarix ®

For women HPV-naïve in trial studies, the vaccine efficacy was 93-100% against vaccine-type associated CIN 2 or worse [23]. For incident and persistent infections, the vaccine was 95-100% effective [23]. Similar to the quadrivalent vaccine, the bivalent vaccine is effective in the reduction of reinfection or reactivation of previously acquired vaccine-type infections and not effective for women with an active HPV infection [23]. Cross-protection against other high-risk types of HPV is also conferred with this vaccine, namely 31, 33, and 45 [23].

The bivalent vaccine elicits a higher immune response to HPV types 16 and 18, the two most common oncogenic HPV types, than the quadrivalent vaccine [24]. Neutralizing antibody titers against types 16 and 18 were between 4 and 9 times higher in women having received the bivalent vaccine [24].

2.4.3 Vaccine Efficacy in the United States

In a recent study, data collected from the annual National Health and Nutrition Examination Surveys (NHANES) was used to determine the vaccine's efficacy thus far in the United States [25]. Vaccine-type HPV prevalence was determined among females aged 14 – 19 years between 2003 and 2010. Prevalence before the vaccine was introduced (2003-2006) was compared with prevalence after the vaccine was introduced (2007-2010). Vaccine-type HPV prevalence fell from 11.5% (95% CI 9.2-14.4) in the pre-vaccine era to 5.1% (95% CI 3.8-6.6) in the vaccine era [25]. This decline of 56% (95% CI 38-69) was the only significant change in prevalence among the different age groups studied. Despite low vaccine uptake, the vaccine is proving to be effective in the prevention of vaccine-type HPV in the United States among girls aged 14 – 19 years [25].

2.5 Barriers to Vaccine Initiation and Completion

2.5.1 Physician Barriers

Association between provider recommendation and HPV vaccine initiation has been clearly established [26]. While the vaccine is acceptable for children as young as 9 years old, ACIP asks providers to recommend the series to 11 and 12 year olds at their annual well checkup visit. This age group is targeted for several reasons. First, this group is, for the most part, not sexually active, and ACIP believes this vaccine needs to be completed before sexual debut. Second, this age group is still coming to the provider for well checkups [22]. A recent study shows that the number of annual well checkups decreases sharply after 12 years of age, where one-third of 13 to 17 year olds had no well checkup. Another 40% had only one well checkup visit during that same time [27].

Third, these providers, typically pediatricians, are most experienced with vaccine administration [22].

Many providers have admitted to not recommending the HPV vaccine series to 11 and 12 year olds for several of their own reasons. There are many vaccines to administer at this well checkup. There is an assumption that adding another vaccine may be overwhelming to the family. Providers feel they don't have the time to explain the need for this vaccine especially since is not mandatory [22]. Many providers admit having difficulty discussing this vaccine with parents of younger children, since it deals with a disease associated with sexual activity [28]. If a parent hesitates when approached, the provider will not push the subject further [26]. Because of these reasons, many providers tend to recommend the HPV vaccine to older girls [28].

2.5.2 Parental Barriers

When providers address the subject of HPV vaccination it is, at times, met with negative parental attitudes. Parents may choose to not vaccinate their adolescent for a variety of reasons: mainly vaccine safety and efficacy [28]. Often, the HPV vaccine will be the only vaccine refused at a well checkup, therefore this refusal cannot be attributed to an overall negative attitude toward vaccines. It is, also, not uncommon for parents to ask to delay vaccination for a year or two. Reasons for this delay can typically be attributed to perceived lack of adolescent sexual activity and low risk of HPV infection [28].

When parents decide to vaccinate their adolescent, the number of shots needed for complete immunity poses an issue. Future scheduling, time, transportation, and cost are

all barriers for the second and third shots. Since the second shot is two months after the first and the third four months after that, remembering to schedule an appointment with the provider often slips through the cracks. If that barrier is overcome, parents have to find time to take their child back to the provider's office; this could be time from work or other, more pressing, family obligations. If a parent can find time to return for the final two shots, transportation may not be available or difficult to come by. Even though this vaccine series is typically covered by insurance (VFC, Medicaid, and private), a well-visit co-pay could pose an issue for the parent [29].

2.5.3 Adolescent Barriers

Studies have shown teens play a minimal role in the decision to receive, delay or refuse the HPV vaccine, deferring to their parent and provider. The United States adolescent population is at a higher risk of acquiring HPV than any other age group [28]. However, a recent study shows that only 21-46% of young women perceive themselves at risk for HPV infection [30]. Their lack of risk awareness and desire to advocate for themselves could be seen as a barrier to vaccine receipt.

2.6 Disease Status and Vaccine Uptake

While a recent study shows that HPV vaccine coverage is increasing, half of the adolescent population still remains unvaccinated. Completion rates lag for those in the populations at highest risk for HPV morbidity [31]. Black and Hispanic women and women living in greater poverty experience the highest incidence and mortality rates due to cervical cancer. Previous research shows significant disparities in HPV vaccine

completion rates based on race/ethnicity. The populations at greatest risk of cervical cancer are not fully protected against the virus [29]. According to the CDC, 31.7% of blacks and 41.6% of Hispanics completed the vaccine series in 2011. The same report shows that 39.0% of adolescents below the poverty line and 33.4% at or above the poverty line completed the series [32].

2.7 Summary

The HPV vaccine series is still relatively new, and knowledge of issues regarding initiation and completion continue to evolve. This study looks at specific demographic and socioeconomic factors that were involved with adolescents receiving this vaccine in 2011, the most recent year of published data. It is with the hope of developing public health initiatives in light of the above barriers associated with initiation and completion of the HPV vaccine series that this study is being conducted.

CHAPTER III

METHODS

3.1 Data Source

The data in this study were obtained from the 2011 National Immunization Survey (NIS)-Teen. The NIS is a publicly available database, containing de-identified information and is sponsored by the National Center for Immunizations and Respiratory Diseases (NCIRD). It is conducted jointly by NCIRD and the National Center for Health Statistics (NCHS) of the Centers for Disease Control and Prevention (CDC). The NIS annual survey is used to assess progress towards goals of increased childhood vaccinations set by the Childhood Immunization Initiative (CII), which was established in 1996 by President Bill Clinton. NIS is targeted to children aged 19-35 months living in the United States at the time of the survey. NIS-Teen was developed in 2006 for children aged 13 to 17 to measure progress toward Healthy People 2010 goals to increase routine vaccination coverage levels for adolescents. [33]

Data collected are used to produce estimates of vaccination coverage rates for all childhood vaccinations recommended by the Advisory Committee on Immunization Practices (ACIP). This two-part list-assisted random-digit-dialing (RDD) telephone survey starts collecting data by interviewing households in all 50 States, the District of Columbia, U.S. Virgin Islands, and selected large urban areas each quarter. For the second part of the survey, to assure accuracy and precision of vaccination data collected, parents and guardians of NIS-eligible children are then asked for consent to contact children's vaccination providers via mail. Survey participation is voluntary and confidential. [33]

In 2011, the survey design was altered to account for the increased number of households in the United States without a landline telephone. Data is now collected on both landlines and cell phones. The cell phone sample was selected from all banks of cell phone numbers, not just those containing at least one directory-listed residential telephone number; therefore the cell phone sample is considered to be RDD without list assistance. The U.S. Virgin Islands landline interviews are also RDD without list assistance and no cell phone data was collected. Both landline and cell-phone interviews began January 6, 2011 and ended February 8, 2012. [33]

3.2 Study Population

The target population for NIS-Teen was children aged 13 to 17 years old living in non-institutionalized households in the United States at the time of the interview. If a household with a 19-35 month old child is identified and the NIS interview is completed, the household is then screened for the presence of any 13-17 year old children. Households that do not have a 19-35 month old child are immediately screened for the presence of any 13-17 year old children. If household contains one or more children in the appropriate age range, a teen is randomly chosen and the adult who is most knowledgeable about the teen's vaccination is interviewed. With the parent or guardian's consent, NIS-Teen will follow-up via mail with the teen's vaccination provider, requesting information on the patient's vaccination status from medical records. [33]

3.3 Study Measures and Variables

Two dependent variables were chosen for this study. The first dependent variable assessed adolescents who initiated the HPV vaccine series. Data regarding the total number of HPV shots received during the study period were re-coded to reflect this variable. If a teen had no HPV shots, he or she was considered to not have initiated the vaccine series. If a teen had one or more HPV shots, he or she was considered to have initiated the series. The second dependent variable assessed adolescents who completed the HPV vaccine series after having initiated the series. Data regarding the total number of HPV shots received during the study period were re-coded to reflect this variable. If a teen had one or two HPV shots, he or she was considered to have initiated but not completed the vaccine series. If a teen had three or more HPV shots, he or she was considered to have completed the vaccine series.

Five independent variables were chosen for this study. The three demographic variables were sex, age, and race/ethnicity. The two socioeconomic variables were poverty status and health insurance status. Race/ethnicity was coded as non-Hispanic white, non-Hispanic black, Hispanic, and non-Hispanic other race and multi-race. The Hispanic category included teens who were identified as Mexican, Mexican-American, Central American, South American, Puerto Rican, Cuban, or other Spanish-Caribbean. Non-Hispanic other race and multi-race included Native American, Alaskan native, Asian, Native Hawaiian, Pacific Islanders, and those who identified teens as "Other."

Poverty status was re-coded by NIS into three groups: above poverty and more than $75K, above poverty but less than or equal to $75K, and below poverty. These

numbers are based on the 2009 Census poverty threshold of $14,787 in a two-person household with 1 child under the age of 18 [34].

Health insurance was re-coded into a dichotomous variable in the current study. If the teen was covered by any of the following: employer or union health insurance, Medicaid, S-CHIP, Indian Health Services, Military/Tricare/CHAMPUS/CHAMP-VA, or other form of health insurance, he or she was considered to have health insurance. All other teens were considered to be without health insurance.

3.4 Statistical Analysis

Descriptive statistics were created to describe the population sample. Using binary logistic regression analysis, odds ratios were calculated along with 95% confidence intervals and p-value. A p-value of <0.05 was considered a statistically significant association between each demographic and socioeconomic variables as they relate to either initiation or completion of the HPV vaccine series.

Multivariate logistic regression analysis was also performed where all demographic and socioeconomic variables were considered at once. Odds ratios were calculated along with 95% confidence intervals and p-value, where a p-value of <0.05 was considered a statistically significant association.

CHAPTER IV

RESULTS

4.1 Frequencies and Descriptive Statistics

Frequencies and descriptive statistics about the study sample are detailed in Tables 1 through 3. The sample size of the 2011 NIS-Teen included 39 839 adolescents, where 52.2% were male and 47.8% were female. Data regarding HPV vaccination was available for 38 136 adolescents and 28 191 (73.9%) of those adolescents had not initiated the HPV vaccination series.

The following information describes adolescents who had at least one HPV shot in 2011 (Tables 2 and 3). Females were most likely to initiate (84.2%) and complete (93.3%) the vaccine series. While there was a relatively even distribution of the five age groups, 16 year olds were the most represented (20.7%) and 17 year olds were the least represented (19.3%). Seventeen year olds were most likely to initiate (22.7%) and complete (25.5%) the vaccine series, while 13 year olds were least likely to initiate (15.3%) and complete (12.5%). The majority of teens were non-Hispanic white (64%), while the least represented race/ethnicity was non-Hispanic other race and multi-race (8.5%). White teens were more likely to initiate (62.9%) and complete (68.4%) the vaccine series, while non-Hispanic other race and multi-race were least likely to initiate (8.3%) and complete (7.8%).

Of those surveyed where information on income and health insurance was obtained, the majority of the study population reported an annual family income above the U.S. 2009 Census Bureau poverty threshold and greater than $75,000 (40.7%) and reported having one or more form of health insurance (61.8%). Teens above the poverty

threshold and greater than $75,000 were more likely to initiate (45.1%) and complete (48.1%) the vaccine series, while those below the poverty limit were least likely to initiate (16.9%) and complete (14.6%). Teens with at least one form of health insurance were most likely to initiate (63.4%) and complete (65.8%) the vaccine series.

Table 1. HPV Vaccine Receipt Data

Receipt of at least one HPV vaccine shot	N (%)
Yes	9945
No	28191
Total	38136*

*1703 members of the NIS-Teen 2011 vaccination study population were excluded due to lack of information regarding HPV vaccine status.

Table 2. Demographic Characteristics and Vaccination Status of NIS-Teen 2011 HPV Vaccination Study Population

Demographic Characteristic	N (%)	Did Not Initiate Series N (%)	Initiated Series N (%)	Completed Series N (%)
		28191 (73.9) out of 38136*	9945 (26.1) out of 38136*	5201 (52.3) out of 9945
SEX				
Male	20809 (52.2)	18299 (64.9)	1571 (15.8)	349 (6.7)
Female	19030 (47.8)	9892 (35.1)	8374 (84.2)	4852 (93.3)
Total	39839	28191	9945	5201
AGE				
13	7802 (19.6)	5950 (21.1)	1518 (15.3)	651 (12.5)
14	8108 (20.4)	5966 (21.2)	1853 (18.6)	887 (17.1)
15	7997 (20.1)	5535 (19.6)	2109 (21.2)	1130 (21.7)
16	8243 (20.7)	5654 (20.1)	2211 (22.2)	1205 (23.2)
17	7689 (19.3)	5086 (18.0)	2254 (22.7)	1328 (25.5)
Total	39839	28191	9945	5201
RACE/ETHNICITY				
Non-Hispanic White	25809 (64.8)	18837 (66.8)	6259 (62.9)	3559 (68.4)
Non-Hispanic Black	4938 (12.4)	3481 (12.3)	1114 (11.2)	419 (8.1)
Hispanic	5693 (14.3)	3520 (12.5)	1745 (17.5)	818 (15.7)
Non-Hispanic & Multi-race	3399 (8.5)	2353 (8.3)	827 (8.3)	405 (7.8)
Total	39839	28191	9945	5201

*1703 members of the NIS-Teen 2011 vaccination study population were excluded due to lack of information regarding HPV vaccine status.

Table 3. Socioeconomic Characteristics and Vaccination Status of NIS-Teen 2011 HPV Vaccination Study Population

Demographic Characteristic	N (%)	Did Not Initiate Series N (%)	Initiated Series N (%)	Completed Series N (%)
POVERTY STATUS				
Above Poverty (> $75K)	16234 (40.7)	11595 (43.8)	4248 (45.1)	2380 (48.1)
Above Poverty (=> $75K)	15438 (38.8)	11231 (42.5)	3583 (38.0)	1845 (37.3)
Below Poverty	5747 (14.4)	3631 (13.7)	1593 (16.9)	720 (14.6)
Unknown	2420 (6.1)			
Total	39839	26457	9424	4945
INSURANCE				
Has no insurance	15208 (38.2)	10736 (38.1)	3640 (36.6)	1781 (34.2)
Has at least one form of insurance	24631 (61.8)	17455 (61.9)	6305 (63.4)	3420 (65.8)
Total	39839* (100)	28191	9945	5201

*1703 members of the NIS-Teen 2011 vaccination study population were excluded due to lack of information regarding HPV vaccine status.

4.2 Demographic characteristics

Bivariate analysis using logistic regression assessed the association of demographic characteristics with the initiation and completion of the HPV vaccine series. The results are shown in Tables 4 and 5. In this study, sex played a significant role in both the initiation (OR=9.9, p=<0.001) and completion (OR=4.8, p=<0.001) of the vaccine series. When compared with the 13 year olds, each increasing age group showed an increase in the odds of both initiating and completing the vaccine series. Compared to non-Hispanic whites, Hispanic teens were 1.5 times more likely to initiate the vaccine series (p=<0.001), but they were less likely to complete the series (OR=0.70, p=<0.001).

Blacks were least likely to complete (OR=0.46). White teens were most likely to complete the vaccine series compared to all race/ethnicity categories.

Table 4. Bivariate Analysis Using Logistic Regression Assessing the Association of Demographic Characteristics and Vaccination Initiation of NIS-Teen 2011 HPV Vaccination Study Population

Variable	OR	CI	p-value
SEX			
Male	REF	REF	REF
Female	9.86	9.29-10.46	<0.001
AGE			
13	REF	REF	REF
14	1.23	1.14-1.33	<0.001
15	1.5	1.34-1.61	<0.001
16	1.54	1.43-1.66	<0.001
17	1.74	1.62-1.88	<0.001
RACE/ETHNICITY			
Non-Hispanic White	REF	REF	REF
Non-Hispanic Black	0.96	0.90-1.04	0.32
Hispanic	1.49	1.40-1.59	<0.001
Non-Hispanic & Multi-race	1.06	0.97-1.15	0.19

Table 5. Bivariate Analysis Using Logistic Regression Assessing the Association of Demographic Characteristics and Vaccination Completion of NIS-Teen 2011 HPV Vaccination Study Population

Variable	OR	CI	p-value
SEX			
Male	REF	REF	REF
Female	4.82	4.25-5.48	<0.001
AGE			
13	REF	REF	REF
14	1.22	1.07-1.40	0.004
15	1.54	1.35-1.76	<0.001
16	1.6	1.40-1.82	<0.001
17	1.91	1.67-2.18	<0.001
RACE/ETHNICITY			
Non-Hispanic White	REF	REF	REF
Non-Hispanic Black	0.46	0.40-0.52	<0.001
Hispanic	0.67	0.60-0.75	<0.001
Non-Hispanic & Multi-race	0.73	0.63-0.84	<0.001

Additional analysis of the demographic characteristics influencing HPV vaccination initiation and completion was performed by including all independent variables in a multivariate logistic regression model. Results are presented in Tables 8 and 9. Sex and age remained statistically significant predictors of both vaccine initiation and completion. Females were 10.3 times more likely to initiate and 4.8 times more likely to complete the vaccine series. As age increases, so too does the odds of an adolescent initiating or completing the series compared to 13 year olds. However, in the multivariate model, the odds of a 14-yearold completing the series was no longer statistically significant. Regarding race/ethnicity, the odds of a black adolescent initiating the series (0.90, p=0.021) now becomes statistically significant. Non-Hispanic

other race and multi-race still were not significantly more or less likely than whites to initiate HPV vaccine. With the multivariate analysis, Hispanics are even more likely to initiate the series (OR=1.6, p=<0.001) but still less likely to complete the series (OR=0.80, p=<0.001) compared to whites.

4.3 Socioeconomic characteristics

Bivariate analysis using logistic regression assessed the association of socioeconomic characteristics with the initiation and completion of the HPV vaccine series. The results are shown in Tables 6 and 7. With regard to poverty status, teens falling below the poverty line were more likely to initiate the vaccine series (OR=1.2, p=<0.001) compared to teens above the poverty threshold and greater than $75,000. However, they were less likely to complete the vaccine series (OR=0.65, p=<0.001). Health insurance had a significant role in the completion of the vaccine series, as teens with at least one form of health insurance were 1.2 times more likely to complete than those with no insurance (p=<0.001).

Table 6. Bivariate Analysis Using Logistic Regression Assessing the Association of Socioeconomic Characteristics and Vaccination Initiation of NIS-Teen 2011 HPV Vaccination Study Population

Variable	OR	CI	p-value
POVERTY STATUS			
Above Poverty (> $75K)	REF	REF	REF
Above Poverty (=> $75K)	0.87	0.83-0.92	<0.001
Below Poverty	1.2	1.12-1.28	<0.001
INSURANCE			
Has no insurance	REF	REF	REF
Has at least one form of insurance	1.07	1.02-1.12	0.009

Table 7. Bivariate Analysis Using Logistic Regression Assessing the Association of Socioeconomic Characteristics and Vaccination Completion of NIS-Teen 2011 HPV Vaccination Study Population

Variable	OR	CI	p-value
POVERTY STATUS			
Above Poverty (> $75K)	REF	REF	REF
Above Poverty (=> $75K)	0.83	0.76-0.91	<0.001
Below Poverty	0.65	0.58-0.73	<0.001
INSURANCE			
Has no insurance	REF	REF	REF
Has at least one form of insurance	1.24	1.14-1.34	<0.001

Additional analysis of the socioeconomic characteristics influencing HPV vaccination initiation and completion was performed by including all independent variables in a multivariate logistic regression model. Results are presented in Tables 8

and 9. Regarding initiation of the series, both poverty status and health insurance status remained statistically significant where adolescents below poverty and having at least one form of health insurance were most likely to initiate. However, poverty status is no longer significant when it comes to completion of the series.

Table 8. Multivariate Analysis Using Logistic Regression Assessing the Association of Demographic and Socioeconomic Characteristics and Vaccination Initiation of NIS-Teen 2011 HPV Vaccination Study Population

Variable	OR	CI	p-value
SEX			
Male	REF	REF	REF
Female	10.29	9.67-10.94	<0.001
AGE			
13	REF	REF	REF
14	1.28	1.18-1.40	<0.001
15	1.62	1.49-1.76	<0.001
16	1.74	1.60-1.89	<0.001
17	2	1.84-2.18	<0.001
RACE/ETHNICITY			
Non-Hispanic White	REF	REF	REF
Non-Hispanic Black	0.9	0.83-0.98	0.021
Hispanic	1.56	1.45-1.69	<0.001
Non-Hispanic & Multi-race	1.02	0.93-1.13	0.656
POVERTY STATUS			
Above Poverty (> $75K)	REF	REF	REF
Above Poverty (=> $75K)	0.85	0.80-0.90	<0.001
Below Poverty	1.2	1.10-1.31	<0.001
INSURANCE			
Has no insurance	REF	REF	REF
Has at least one form of insurance	1.18	1.11-1.24	<0.001

Table 9. Multivariate Analysis Using Logistic Regression Assessing the Association of Demographic and Socioeconomic Characteristics and Vaccination Completion of NIS-Teen 2011 HPV Vaccination Study Population

Variable	OR	CI	p-value
SEX			
Male	REF	REF	REF
Female	4.61	4.05-5.26	<0.001
AGE			
13	REF	REF	REF
14	1.19	1.02-1.37	0.023
15	1.45	1.25-1.67	<0.001
16	1.51	1.31-1.73	<0.001
17	1.76	1.53-2.03	<0.001
RACE/ETHNICITY			
Non-Hispanic White	REF	REF	REF
Non-Hispanic Black	0.52	0.45-0.60	<0.001
Hispanic	0.8	0.71-0.91	<0.001
Non-Hispanic & Multi-race	0.75	0.64-0.88	<0.001
POVERTY STATUS			
Above Poverty (> $75K)	REF	REF	REF
Above Poverty (=> $75K)	0.95	0.86-1.04	0.268
Below Poverty	0.92	0.81-1.06	0.24
INSURANCE			
Has no insurance	REF	REF	REF
Has at least one form of insurance	1.15	1.05-1.26	0.003

Table 10. Poverty Status and Race/Ethnicity of NIS-Teen 2011 HPV Vaccination Study Population

Poverty Status	Teens Above Poverty (> $75K) N (%)	Teens Above Poverty (=> $75K) N (%)	Teens Below Poverty N (%)	Total
Non-Hispanic White	12657 (52)	9796 (40)	1838 (8)	24291
Non-Hispanic Black	1027 (22)	2138 (46)	1440 (31)	4605
Hispanic	1226 (23)	2236 (42)	1888 (35)	5350
Non-Hispanic & Multi-race	1324 (42)	1268 (40)	581 (18)	3173
Total				37419*

*Total represents 94% of the NIS-Teen Vaccine study population

Table 11. Medicaid Insurance Status and Race/Ethnicity of NIS-Teen 2011 HPV Vaccination Study Population

	Teens with Any Medicaid Health Insurance N (%)	Total
Non-Hispanic White	1634 (14)	11700
Non-Hispanic Black	731 (44)	1663
Hispanic	930 (34)	2732
Non-Hispanic & Multi-race	323 (25)	1271
Total	3618	17471*

*Total represents 44% of the NIS-Teen Vaccine study population

Table 12. Vaccines for Children Status and Race/Ethnicity of NIS-Teen 2011 HPV Vaccination Study Population

	Teens who are VFC Eligible N (%)	Total
Non-Hispanic White	3129 (20)	15922
Non-Hispanic Black	1323 (56)	2400
Hispanic	1737 (56)	3226
Non-Hispanic & Multi-race	1017 (52)	1947
Total		23564*

*Total represents 59% of the NIS-Teen Vaccine study population

CHAPTER V

DISCUSSION AND CONCLUSION

5.1 Discussion

More than 40 genital human papillomaviruses (HPV) account for the most common STI in the United States, which disproportionality affects adolescents [2]. Several types of HPVs have been shown to cause different forms of cancer, mainly cervical. Two vaccines, Gardasil® and Cervarix®, were developed to promote immunity from the most common types of HPVs in order to prevent HPV-type-related cervical cancer, cervical cancer precursors, and anogenital warts. The Advisory Committee on Immunization Practices (ACIP) asks physicians to recommend either vaccine to adolescents between the ages of 11 and 12 in order to complete vaccination before sexual debut [4]. The Healthy People 2020 target is to have 80% of female adolescents complete the three dose series by the ages 13-15 [26]. The Centers for Disease Control and Prevention (CDC) recognizes the yearly increase in vaccine coverage since 2006; however, the numbers continue to fall short of the Healthy People 2020 goals [30].

The purpose of this work was to examine the association between specific demographic and socioeconomic characteristics with both initiation and completion of the human papillomavirus vaccine series. Studies on the characteristics that describe the adolescent population that completed the series will allow public health and health care professionals implement appropriate interventions aimed at improving adolescent vaccination rates.

Demographic Characteristics

Sex

In this study, sex was clearly associated with both initiation and completion of the vaccine series where females were 10.3 times more likely than males to initiate and 4.6 times more likely to complete. However, it was important to note that it was not until late 2011 that ACIP began recommending adolescent males receive the vaccine. Statistics regarding gender should be reassessed after at least one full year of implementation of male recommendations. It should be noted that there was a 55% change in the odds ratio between initiation and completion for males. This shows that males were doing a great job of completing the series if they initiated the process. No current studies look at the association between sex and initiation or completion rates.

Age

There was also a significant association between age and receipt of the HPV vaccine. As age increased from 13 to 17, the likelihood of both initiation and completion increased. Healthy People 2020 aimed to have girls complete the series by ages 13 to 15, so the findings here are troubling. Based on provider surveys, this age difference may be associated with parents delaying vaccine initiation or provider preference to recommend to older patients due to the sexual association to this vaccine [28]. Previous studies also showed providers prefer to strongly recommend the HPV vaccine to older adolescents (6). Vadaparampil, et al., found 34.6% of providers "always" recommend the vaccine to early adolescents, 50% to middle adolescents, and 52.7% to late adolescents [22]. Kester, et al., found that only 56% of 11 to 12 year old girls received a recommendation for the

HPV vaccine from their healthcare provider [31]. A recent study showed younger girls (ages 9-13 years old) had higher levels of HPV antibodies than older girls (aged 16-26 years old) after receiving the vaccine [36]. This should encourage providers to strongly recommend this vaccine to their younger patients.

Race/Ethnicity

Based on the analysis, Hispanics were more likely than whites to initiate the series. This was good news, since they were at highest risk of invasive cervical cancer [18]. However, the news was short-lived, since they were less likely than whites to complete the series. While it was less likely for black adolescents to initiate the series, their odds of initiation were not statistically different from that of their white counterparts. It was the completion rate that was of concern. They were half as likely to complete the vaccine series, which was necessary to confer the necessary resistance to the virus. This information was troubling since blacks are twice as likely as whites to be diagnosed with cervical cancer [18]. The initiation results were different than previous studies using 2008 and 2009 NIS-Teen data, which showed race/ethnicity was not associated with initiation rates [26, 31]. However, the completion results in this analysis were consistent with those previous studies, which showed blacks and Hispanics were less likely than whites to complete the series [26, 31].

Studies showed that providers vary their recommendation of the HPV vaccine. One study, using 2009 NIS-Teen data, showed providers were less likely to recommend the vaccine to blacks compared to whites [37]. Another showed Hispanic providers were more likely to always recommend the vaccine to early adolescent Hispanic patients

compared to non-Hispanic providers [22]. Some clinicians did not encourage the vaccine if they perceived the patient to be at low risk of HPV infection [28]. These could be reasons behind the variance in initiation and completion rates based on race/ethnicity.

Socioeconomic Characteristics

Poverty Status

While poverty status was not associated with the completion of the series, it was associated with initiation. Adolescents below the 2009 poverty level were more likely to initiate the series compared to those above poverty. This was consistent with other studies, showing income and insurance were significantly associated with initiation. Patients in the lowest income group and Medicaid eligible had a higher initiation rate [26].

A crosstab was run to determine if poverty status may be linked to race/ethnicity rates of initiation and completion for this study. However, Table 10 showed there was very little difference between Hispanic and black adolescents in each of the three poverty categories. Therefore, it was not believed that race/ethnicity played a role in poverty status' association with initiation and completion.

Health Insurance Status

Health insurance status was often related to poverty status, as lower incomes can provide eligibility to Medicaid, SCHIP, and/or Vaccines for Children (VFC).

It was of no surprise that this analysis showed having health insurance was associated with both initiation and completion of the vaccine series. This was consistent with

previous studies [26]. This study, however, did not break out the different forms of insurance available to the patients. Other studies look at private/employer insurance compared to that of Medicaid and VFC. VFC eligible, insured girls were more likely to initiate yet less likely to complete the series compared to girls with private insurance [37]. Another study showed individuals with Medicaid or SCHIP were more likely to receive the vaccine [37]. However, those with public insurance are 24% less likely to complete the series when compared to those with private insurance, specifically those who are VFC eligible [29].

While VFC may be influential in promoting initiation, it falls short of facilitating completion, which puts economically vulnerable populations at greater risk of HPV-related morbidities [29]. One hypothesis behind VFC's success in vaccine initiation is that patients, when they come in contact with the healthcare system for well or sick visits, are offered the vaccine. Since it bears little or no cost, the patient is likely to accept the vaccine [29]. Another study shows that VFC providers are more likely than non-VFC providers to always recommend the vaccine [22].

A crosstab was run to determine if health insurance status may be linked to race/ethnicity rates of initiation and completion for this study. However, Tables 11 and 12 showed there was very little difference between Hispanic and black adolescents who were Medicaid beneficiaries or VFC eligible who initiated the vaccine series.

5.2 Study Limitations

The results of this study are subject to some limitations. This study only extracted data on vaccination status from a parent's or guardian's recall and on-hand shot card

based on telephone surveys, and responses from participants may reflect recall bias. Analysis using only the population with verification from the provider was not incorporated.

Even though NIS has begun using cellular telephones in their random-digit dialing survey, the number of households using only cellular telephones may not be accurately represented in the survey population. Of those adolescents who were a part of NIS-Teen 2011, 1 703 were excluded from the study population due to lack of information regarding HPV vaccine status. Due to lack of information regarding household income, 2 255 additional teens were excluded from any analysis regarding poverty status.

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

5.3 Recommendations

5.3.1 Increase Efficacy of Provider Influence

Studies have shown that provider recommendation is the most influential force behind parental acceptance of the HPV vaccine [26]. As discussed before, providers

often have difficulty either presenting or convincing parents to begin the vaccine regimen between the ages of 11 and 12 [28]. There are three things providers can do in order to help begin the discussion and ensure compliance with the vaccine dosage.

Parents should be sent an informational handout covering HPV, its associated cancers, and proven efficacy of available vaccines. This can be sent via mail or email before the clinic visit or provided to the parent upon arrival at the provider's office. This will give parents more knowledge about the importance of this vaccine and time to digest presented information. The provider can, then, spend time answering important questions, as opposed to explaining the vaccine from the beginning.

Part of this handout and the provider discussion must emphasize the importance of the three doses needed for complete immunization. One dose does not confer complete resistance to vaccine-type HPV. When parents are more aware of the need for all three doses, they are more likely to prioritize getting back to the provider for future doses. For many parents, remembering the dosing schedule is lost in a laundry list of their adolescent's needs. A reminder or recall system needs to be in place to allow parents adequate notice to schedule the next vaccine.

If parents ask to delay the vaccine for a few years, providers should point out the number of adolescent well checkups decreases significantly after the 11 and 12 year old well checkups [27]. School vaccines are no longer needed, so parents rarely take their teen to a provider unless sick. Because the number of visits is typically lower, the opportunities for vaccination decrease. If parents choose to delay, it will increase the burden to get their child to a provider to receive future vaccines. The goal is to have 80%

of adolescent females immunized by the ages 13 to 15, which is typically before sexual debut.

5.3.2 Increase Adolescent Participation in Vaccination Decision

Many teens are unaware of HPV or its available vaccines [31]. Hearing about it for the first time from a provider can be confusing, and teens will defer to their parents' decision. Teens need to be able to advocate for themselves, but they need to be educated in order to do so. Looping back to the recommendation where providers send an informational handout prior to the clinic visit, teens should take the time to learn from this handout alongside their parent. Risks and consequences are difficult for the adolescent mind, thus the handout needs to present these in plain language for both adults and adolescents to grasp. Statistics regarding higher risk of HPV infection for adolescents and asymptomatic nature of most HPV infections is important for the teens in order to understand they have a higher risk of contracting this virus than any other age group. Perhaps if teens can gain a better understanding of the benefits surrounding the HPV vaccine, they will want to advocate for themselves, requesting permission to have the vaccine or, at least, a frank conversation about receiving it in the future.

5.3.3 Reduce Other Barriers for Vaccination Completion

When teens, parents, and providers do agree to begin the vaccination process, the final two doses can present a barrier to completion of the series. Not only do parents have to remember to schedule the provider visit, they have to take time out of their

schedule to get the teen back for a follow-up appointment. Transportation is not readily available for many teens and their parents, thus preventing further dose administration.

School or neighborhood-based programs could reduce the barrier caused by transportation and time. By having vaccine providers come to a school, after-school program or, neighborhood, the need to remember to schedule a visit and find time and transportation for the visit is removed. More teens could be fully immunized.

5.3.4 Longitudinal Study for Vaccine Initiation

Many parents choose to delay the HPV vaccine for many reasons, not the least of which is belief that their child is not yet sexually active [28]. Further research needs to be conducted with parents to assess future vaccination behavior. Questions to be addressed are whether the teen is vaccinated in future visits and at what age does the parent consent to vaccination. Longitudinal studies can be set up in pediatric practices where parents who choose to delay or refuse the vaccine are enrolled. If the teen is eventually vaccinated, parents can be surveyed to determine why they now believe the vaccine to be appropriate and the age of the teen at the time of vaccination. If the teen is not vaccinated, parents can be surveyed to determine reasons. Information gathered from this kind of study can help tailor provider and public health officials' efforts in convincing parents to make the decision to vaccinate against HPV in a timely manner.

5.4 Conclusion

Each year both HPV vaccines have been on the market, vaccination rates have continued to increase. Healthy People 2020 aims to have 80% of adolescent girls

covered with three doses of either vaccine between the ages of 13 and 15. In order to achieve these goals, the vaccination initiation rates need to continue, but more importantly, the completion rates need to be 100% of those who initiate. Completion rates are lower for blacks and Hispanics who are a higher risk of HPV-related morbidities than their white counterparts. Public health officials need to work with providers to recommend the vaccine at an earlier age, impart the importance of receiving all three doses, and prove the effectiveness of both vaccines in reducing HPV incidence and thus, HPV-related morbidities. Officials also need to find ways to reduce barriers to receipt of the second two doses of the vaccine and help facilitate increasing rates of completion in the United States.

REFERENCES

1. Centers for Disease Control and Prevention. (1999). Prevention of genital HPV infection and sequelae: report of an external consultant's meeting. Retrieved from http://www.cdc.gov/std/hpv/HPVSupplement99.pdf
2. Centers for Disease Control and Prevention. (2013). *Incidence, Prevalence and Cost of Sexually Transmitted Infections in the United States* [Fact Sheet]. Retrieved from http://www.cdc.gov/std/stats/sti-estimates-fact-sheet-feb-2013.pdf
3. Morbidity and Mortality Weekly Report (MMWR). (2011). Recommendations on the Use of Quadrivalent Human Papillomavirus Vaccine in Males – Advisory Committee on Immunization Practices (ACIP), 2011. *CDC, 60 (50).* Retrieved from http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6050a3.htm
4. Morbidity and Mortality Weekly Report (MMWR). (2007). Quadrivalent Human Papillomavirus Vaccine – Recommendations of the Advisory Committee on Immunization Practices (ACIP). *CDC, 56 (RR02).* Retrieved from http://www.cdc.gov/mmwr/preview/mmwrhtml/rr56e312a1.htm
5. Morbidity and Mortality Weekly Report (MMWR). (2010). 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). *CDC, 59 (20).* Retrieved from http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5920a4.htm
6. Immunization and infectious diseases objectives. (Updated April, 24 2013). Healthy People 2020. Retrieved from http://www.healthypeople.gov/2020/topicsobjectives2020/objectiveslist.aspx?topicId=23
7. Sexually transmitted diseases objectives. (Updated April, 24 2013). Healthy People 2020. Retrieved from http://www.healthypeople.gov/2020/topicsobjectives2020/objectiveslist.aspx?topicId=37
8. Cancer objectives. (Updated April, 24 2013). Healthy People 2020. Retrieved from http://www.healthypeople.gov/2020/topicsobjectives2020/objectiveslist.aspx?topicId=5
9. deVilliers, E., Fauquet, C., Broker, T., Bernard, H., & Zur, H. (2004). Classification of papillomaviruses. *Virology*, 234, 17-27.
10. Duensing, D., & Munger, K. (2004). Mechanisms of genomic instability in human cancer: insight from studies with human papillomavirus oncoprotiens. *International Journal of Cancer*, 109, 157-62.
11. Stanley, M. (2006). Immune responses to human papillomavirus. *Vaccine*, 24, S16-S22.
12. Ho, G., Bierman, R., Beardsley, L., Chang, C., & Burke, R. (1998). Natural history of cervicovaginal papillomavirus infection in young women. *New England Journal of Medicine*, 338, 423-8.
13. Centers for Disease Control and Prevention. (2002). *Sexually transmitted diseases treatment guidelines*. Retrieved from http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5106a1.htm

14. Koutsky, L. (1997). Epidemiology of genital human papillomavirus infection. *American Journal of Medicine*, 102, 3-8.
15. Winer, R., Lee, S., Hughes, J., Adam, D., Kivat, N., & Koutsky, L. (2003). Genital human papillomavirus infection: incidence and risk factors in a cohort of female university students. *American Journal of Epidemiology*, 157, 218-26.
16. Watts, D., Koutsky, L., Holmes, K., Goldman D., Kuypers, J., & Kiviat, N. (1998). Low risk of perinatal transmission of human papillomavirus: results from a prospective cohort study. *American Journal of Obstetrics and Gynecology*, 178, 365-73.
17. Centers for Disease Control and Prevention. (2013). Self-Study STD Modules for Clinicians: Genital Human Papillomavirus (HPV) Infection. Retrieved from http://www2a.cdc.gov/stdtraining/self-study/hpv/cdc_self_study_hpv_epidemiology.html
18. McDougall, J., Madeline, M., Daling, J., & Li, C. (2007). Racial and ethnic disparities in cervical cancer incidence rates in the United States, 1992-2003. *Cancer Causes Control*, 18, 1175
19. Haririm, S., Unger, E., Powell, S., Bauer, H., Bennett, N., Bloch, K., … Markowitz, L. (2012). Human papillomavirus genotypes in high-grade cervical lesions in the United States. *Journal of Infectious Disease*, 206, 1878-86.
20. Jemal, A., Simard, E., Dorell, C., Noone, A., Markoqitz, L., Kohler, B., … Edwards, B. (2013). Annual report to the nation on the status of cancer, 1975-2009, featuring the burden and trends in human papillomavirus (HPV)-associated cancers and HPV vaccination coverage levels. *Journal of the National Cancer Institute*, 105, 175-201.
21. McCormack, P., & Joura, E. (2010). Quadrivalent Human Papillomavirus (Types 6, 11, 16, 18) Recombinant Vaccine (Gardasil®). *Drugs*, 70(18), 2449-74.
22. Vadaparampil, S., Kahn, J., Salmon, D., Lee, J., Quinn, G., Roetzheim, R., … Giuliano, A. (2011). Missed clinical opportunities: provider recommendations for HPV vaccination for 11-12 year old girls are limited. *Vaccine*, 29, 8634-41.
23. Nordin, J., Solberg, L., & Parker, E. (2010). Adolescent primary care visit patterns. *Annals of Family Medicine*, 8 (5), 511-16.
24. McKeage, K., & Romanowski, B. (2011). AS04-Adjuvanted Human Papillomavirus (HPV) Types 16 and 18 Vaccine (Cervarix®). *Drugs*, 71(4), 465-88.
25. Markowitz, L., Hariri, S., Lin, C., Dunne, E., McQuillan, G., & Unger, E. (2013). Reduction in human papillomavirus (HPV) prevalence among young women following HPV vaccination introduction in the United States, National Health and Nutrition Examination Surveys, 2003-2010. *Journal of Infectious Diseases*, 208, 385-93.
26. Dorell, C., Yankey, D., Santibanze, T, & Markowitz, L. (2011). Human papillomavirus vaccination series initiation and completion, 2008-2009. *Pediatrics*, 128, 830-839.
27. Nordin, J., Solberg, L., & Parker, E. (2010). Adolescent primary care visit patterns. Annals of Family Medicine, 8(5), 511-516.

28. Hughes, C., Jones, A., Feemster, K., & Fiks, A. (2011). HPV vaccine decision making in pediatric primary care: a semi-structured interview study. *BMC Pediatrics,* 11(74).
29. Niccolai, L., Mehta, N., & Hadler, J. (2011). Racial/Ethnic and poverty disparities in human papillomavirus vaccination completion. *American Journal of Preventive Medicine*, 41(4), 428-433.
30. Oscarsson, M., Hannerfors, A., & Tyden, T. (2012). Young women's decision-making process for HPV vaccination. *Sexual & Reproductive Healthcare*, 3, 141-146.
31. Kester, L., Zimet, G., Fortenberry, J., Kahn, J., & Shew, M. (2013). A national study of HPV vaccination of adolescent girls: rates, predictors, and reasons for non-vaccination. *Maternal and Child Health Journal*, 17, 879-885.
32. Morbidity and Mortality Weekly Report (MMWR). (2012). National and state vaccination coverage among adolescents aged 13-17 years – United States, 2011. *CDC,* 61(34).
33. Centers for Disease Control and Prevention. (2012). *Data user's guide for the 2011 NIS public-use data file*. Retrieved from ftp://ftp.cdc.gov/pub/Health_Statistics/NCHS/Dataset_Documentation/NIS/NISPUF11_DUG.PDF
34. United States Census Bureau. (Updated Sep 12, 2012). Poverty thresholds 2009. Retrieved from http://www.census.gov/hhes/www/poverty/data/threshld/thresh09.html
35. U.S. Department of Health and Human Services (DHHS). National Center for Health Statistics. The 2011 National Immunization Survey, Hyattsville, MD: Centers for Disease Control and Prevention, 2012.
36. Dobson, S., McNeil, S., Dionne, M, Dawar, M., Ogilvie, G., Krajden, M., … & Young, E. (2013). Younger adolescents vs 3 doses in young women: a randomized clinical trial. *Journal of the American Medical Association*, 309 (17), 1793-1802.
37. Ylitalo, K., Lee, H., & Mehta, N. (2013). Health care provider recommendation, human papillomavirus vaccination, and race/ethnicity in the US national immunization survey. *American Journal of Public Health*, 103(1), 164-169.