Distribution Agreement

*In presenting this thesis or dissertation as a partial fulfillment of the requirements for an advanced degree from Emory University, I hereby grant to Emory University and its agents the non-exclusive license to archive, make accessible, and display my thesis or dissertation in whole or in part in all forms of media, now or hereafter known, including display on the world wide web. I understand that I may select some access restrictions as part of the online submission of this thesis or dissertation. I retain all ownership rights to the copyright of the thesis or dissertation. I also retain the right to use in future works (such as articles of books) all or part of this thesis or dissertation.*

_____ _____

Lamya M. Khoury Date

Approval Sheet

# Sociodemographic Determinants of Parental Reporting Accuracy of Human Papillomavirus (HPV) Vaccination Status in Male and Female Adolescents: National Immunization Survey-Teen (NIS-Teen) 2012

By

Lamya M. Khoury
MD, MPH

Department of Epidemiology

_____

Julie Gazmararian
Faculty Thesis Advisor

_____

Lauri Markowitz
Thesis Field Advisor

_____

Shannon Stokley
Thesis Field Advisor

# Sociodemographic Determinants of Parental Reporting Accuracy of Human Papillomavirus (HPV) Vaccination Status in Male and Female Adolescents: National Immunization Survey-Teen (NIS-Teen) 2012

By

Lamya M. Khoury

BS in Psychology
Brown University
2008

Faculty Thesis Advisor: Julie Gazmararian, PhD, MPH

An abstract of

A thesis submitted to the Faculty of the Rollins School of Public Health of Emory University

In partial fulfillment of the requirements for the degree of Master of Public Health in Epidemiology

2015

# Sociodemographic Determinants of Parental Reporting Accuracy of Human Papillomavirus (HPV) Vaccination Status in Male and Female Adolescents: National Immunization Survey-Teen (NIS-Teen) 2012

By Lamya M. Khoury

**Background:** Vaccination for human papillomavirus (HPV) is an important preventative tool to reduce morbidity and mortality due to cervical cancer, other HPV-associated cancers, and genital warts. Many surveillance tools use parental report to assess vaccination status, thus it is important to understand the accuracy of these reports. The present study investigates sociodemographic and other factors that contribute to HPV vaccine reporting accuracy.

**Methods:** Data come from the 2012 National Immunization Survey-Teen (NIS-Teen), a nationally representative survey of vaccine coverage in adolescents aged 13-17. Parental report of HPV vaccination status was compared to the gold standard of provider reports from medical records. Concordance was examined as a function of various socioeconomic factors, in particular the teenager's race/ethnicity and gender. Additionally, association between reporting accuracy and time interval since vaccine series initiation was examined.

**Results:** A total of 17,138 participants were included in the present study, including 8,165 females and 8,973 males. Overall concordance between provider and parent report of vaccine series initiation was good, with a weighted kappa of 0.721, sensitivity of 0.819 (95% CI 0.798, 0.840) and a specificity of 0.900 (95% CI 0.891, 0.910). Reporting accuracy was found to be better for parents of male children compared with females (chi square = 9.83, $p = 0.0074$), as well as for non-Hispanic white teens as compared with non-Hispanic black, Hispanic, and other race/ethnicities (chi square = 44.29, $p < 0.0001$). Finally, time interval since vaccine series initiation was significantly associated with variation in reporting accuracy, with the lowest false negative reporting shown after three years since initiation (chi square = 12.85, $p = 0.0051$).

**Conclusions:** The present study shows higher rates of false negative than false positive parental reports overall, with poorest reporting accuracy in socio-demographically disadvantaged groups. This suggests HPV vaccine uptake may be higher than suggested by findings from studies using parental report. The finding of decreased false negative reporting with increased time interval since vaccine series initiation was unexpected, and further investigation is needed to better understand this relationship.

# Sociodemographic Determinants of Parental Reporting Accuracy of Human Papillomavirus (HPV) Vaccination Status in Male and Female Adolescents: National Immunization Survey-Teen (NIS-Teen) 2012

By

Lamya M. Khoury

ScB in Psychology
Brown University
2008

Faculty Thesis Advisor: Julie Gazmararian, PhD, MPH

A thesis submitted to the Faculty of the Rollins School of Public Health of Emory University

In partial fulfillment of the requirements for the degree of Master of Public Health in Epidemiology

2015

Table of Contents

# I. Background / Literature Review

Infection with human papillomavirus (HPV) is an important contributor to morbidity and mortality worldwide; it is the most common sexually transmitted infection in the United States, with prevalent infections in approximately 39.2 million women and 39.9 million men as of 2008.[1] While a large portion of those individuals with infection have no symptoms at all and will clear the infection without incident, some will go on to experience more serious complications. Low-risk types (e.g. types 6 and 11) often cause benign papillomatous overgrowths of epithelium, such as anal and/or genital warts, while high-risk types (e.g. 16 and 18) are associated with malignant growth and invasive cancers.[2]

While it has a major causal role in virtually all cervical cancers, HPV is an important cause of many other kinds of cancers as well, including cancers of the penis, vulva, vagina, anus, and oropharynx (base of the tongue and tonsils).[3] For example, it is estimated that 12 to 35% of oropharyngeal cancers worldwide are attributable to HPV infection, and in the United States the proportion of oropharyngeal cancers attributable to HPV infection is about 72%.[4] The burden of disease due to many of these cancers is on the rise in the United States; between 2000 and 2009, incidence rates have increased for HPV-associated cancers of vulva in women, with an average annual incidence increase of 1.4% in white women and 0.9% in black women. Incidence of HPV-associated oropharyngeal cancer has increased by 3.9% annually on average in white men and 1.7% in white women, and HPV-associated anal cancer has increased on average by 3.7% annually in white women, 2.5% in black women, 2.8% in white men, and 5.6% in black men.[5]

There are persistent socioeconomic, racial/ethnic, and regional disparities in burden of cervical cancer, both globally and within the United States. Age-adjusted cervical cancer incidence in the US is 1.5 and 2 times higher in African American and Hispanic women, respectively, compared with Caucasian women.[6] In addition, the Southern US has also been found to have higher rates of cervical carcinoma compared with other census regions.[7]

### A. Prevalence of HPV Infection

Worldwide, the estimated prevalence of cervicovaginal HPV infection in women without cervical abnormalities is approximately 11-12%, with substantial regional variation; the geographical areas with the highest burdens of infection in women are the Caribbean (35.4%) and Eastern Africa (33.4%).[8] Genital HPV infection in men has shown to correlate generally well with the prevalence of genital HPV infection in women in the same geographic region.[9]

There are less data available on global HPV prevalence in other body sites where infection is a major risk factor for cancers. HPV infection in the peri-anal region and anal canal is observed in both sexes, with prevalence high particularly in HIV positive men who have sex with men (MSM).[10] National US prevalence of oral HPV infection in cancer-free subjects aged 14-69 is estimated to be about 6.9% overall, with higher prevalence observed in men compared with women, as well in smokers compared with never-smokers.[11]

The five most common types of HPV worldwide and their respective estimated prevalence among women with no cervical abnormality are HPV-16 (3.2%), HPV-18 (1.4%), HPV-52 (0.9%), HPV-31 (0.8%), and HPV-58 (0.7%).[8] Together, HPV types 16

and 18 account for approximately 70% of cervical cancers and 50% of high-grade cervical lesions, and they are also an important cause of non-cervical HPV associated cancers.[12] The proportions of HPV-16 or 18 attributable cancers of the oropharynx, anus, vulva, and penis range from 48 to 79%.[4]

In the United States, prevalence estimates of detectable HPV infection in women before the introduction of vaccination varied considerably by age; peak prevalence was 53.8% among 20 to 24-year-olds, whereas among 15 to 19-year-olds and 50 to 59-year-olds, the respective prevalences were 32.9% and 38.8%.[13] Approximately 21.9% of women were estimated to be infected with more than one HPV subtype,[13] and the majority of genital infections occur in the first few years after sexual debut.[14]

Some studies suggest racial and socioeconomic differences in HPV type attribution in women with pre-cancerous cervical lesions. Among women with high-grade cervical lesions, white women are more likely to have HPV 16/18 positivity than Black or Hispanic women, who have higher positivity of other types detected in lesions.[15] However, no differences in type attribution are observed between racial groups among women with cervical cancer.[16] One currently accepted explanation for these findings is that pre-cancerous lesions due to non-HPV-16/18 subtypes are more likely to regress than those due to HPV 16/18.

### B. HPV Vaccine

The introduction of HPV vaccination in the United States in 2006 was an important step to decreasing the burden of disease due to HPV infection and its sequelae. There are three vaccines currently available in the United States, the bivalent, quadrivalent, and nonavalent vaccines. The bivalent vaccine targets two high-

risk types, HPV-16 and 18, while the quadrivalent vaccine targets the same two high-risk types as well as two low-risk types, HPV-6 and 11. The nonavalent vaccine, approved in December 2014, targets five additional high-risk types, HPV 31, 33, 45, 52 and 58.[17] Recommended initially for girls only, since October 2011 the Advisory Committee for Immunization Practices (ACIP) has recommended routine HPV vaccination with three doses administered over six months for both females and males aged 11-12. For those who did not receive vaccination when they were younger, the ACIP recommends vaccination for females aged 13-26 and males aged 13-21. Additionally, the ACIP recommends vaccination of previously unvaccinated males who are immunocompromised and MSM through age 26.[18] As of February 2015, the vaccines recommended for females are the bivalent, quadrivalent, and nonavalent vaccines, whereas only the quadrivalent and nonavalent vaccines are recommended for males.[19]

### C. Vaccine Coverage

According to the 2012 National Immunization Survey (NIS)-Teen, overall provider-reported vaccination coverage in teenagers aged 13 to 17 with at least one dose of HPV vaccine was 53.8% among females and 20.8% among males. About one third of female teens in this study received the three recommended doses or more, whereas only 6.8% of males received three or more doses. Male vaccine coverage in 2012 was improved from one year earlier in 2011, when 8.3% of males had received at least one dose and 1.3% had received three or more doses. However, the percentage of females who received at least one dose was unchanged from the previous year, and while not statistically significant, fewer females received three or more doses in 2012 (33.4%)

compared with 2011 (34.8%). Overall, vaccine coverage for HPV in US teens in 2012 was substantially lower than for other age-appropriate recommended vaccines, such as the vaccine for tetanus, diphtheria, and acellular pertussis (Tdap) and the meningococcal vaccine.[20] Of note, estimates of vaccination coverage were significantly higher in 2013 compared with 2012.[21]

### D. Disparities in Vaccine Uptake

Data from the 2012 NIS-teen shows substantial variation in HPV vaccine uptake in US adolescents across poverty level, geographical region, as well as between different racial groups. The pattern of vaccine uptake variation also depends on how coverage is defined, with vaccine initiation defined as having received at least one vaccine dose, and vaccine completion either defined as receiving three or more doses or using more stringent criteria that takes into account timing of the three doses in relation to the interview date. Receiving three or more vaccine doses appeared more likely in those living below federal poverty level for family size and number of children, for both females and males. However, when series completion was defined as receiving three doses limited to those who had received at least one dose 24 or more weeks before the interview date, series completion was found to be higher for those at or above the poverty level compared with those below, for both males and females.[20]

Vaccine initiation was higher in black and Hispanic males compared with white males in 2012, while in females, initiation was found to be higher among Hispanics only compared to white females. Hispanic males were more likely to have received three or more doses compared with white males. However, when the more stringent criteria for series completion were applied to those who had initiated the series 24 or

more weeks before the interview date, only black males were found to have lower series completion compared with white males, while both black and Hispanic females had lower series completion compared with white females.[20] Data from the 2012 National Health Interview Survey indicates similarly low coverage rates for HPV vaccines in young women aged 19-26; coverage was much lower for black, Hispanic, and Asian women, compared with white young women.[22]

These recent data contribute to a large body of literature showing slightly inconsistent trends. In a recent systematic review and meta analysis of 29 publications related to 27 studies of HPV uptake distribution in females only, black women 18 years or younger were less likely to initiate HPV vaccination compared with white young women (combined OR: 0.89, 95% CI 0.82-0.97). In the same meta-analysis, young females without health insurance were less likely to initiate the vaccine series compared to those who were insured (combined OR 0.56, 95% CI 0.40-0.78); however this meta-analysis did not show strong evidence of association of family income or parental education with vaccine initiation. While this review did not calculate similar combined estimates for series completion, most studies included in the meta-analysis indicated decreased completion among young black women compared with white women, and two studies provided strong support for decreased vaccine completion among young women with lower family income.[23]

Several studies have explored explanations for low vaccination coverage, both overall and within certain sociodemographic groups, to understand how to best target interventions and increase vaccine uptake. Barriers to vaccination have been found to occur at a variety of levels, from parental concerns, to healthcare professionals, to

systemic obstacles. One study showing lower vaccine series completion in black and Hispanic adolescent females compared with whites indicated that the most common reasons for non-vaccination cited by mothers were concerns about vaccine safety, danger to daughter, and provider non-recommendation.[24] Others have suggested that that social disparities in uptake may in part arise from differences in parental/guardian knowledge as well as health professional recommendation.[25]

Barriers to vaccination may also differ depending on the gender of the child, given the relatively recent inclusion of boys in recommendations from ACIP. For example, one study found that parents of boys were more likely than parents of girls to indicate their main reason for non-vaccination was not receiving a provider's recommendations, while parents of adolescent girls were more likely to report concerns about vaccine safety or side effects as their main reason.[26]

### E. Validity of Parent Report

To better understand the uptake and success of vaccine implementation efforts, parental report is one of the most common ways of measuring vaccine initiation and completion. The accuracy and ability to draw conclusions from these data depends on the accuracy with which they capture true vaccine uptake. Reporting bias is a potential problem in these approaches, particularly if accuracy differs by sociodemographic groups and patient characteristics.

Using 2008 NIS-Teen data, Dorell et al were the first to examine concordance of parent and provider reports for several adolescent aged vaccines. Overall, they found that HPV vaccination was reported with a high level of accuracy, with minimal net reporting bias.[27] Another study examined HPV vaccine reporting accuracy using 2010

NIS-Teen data, looking at sensitivity and specificity of parental report of vaccine initiation across a variety of sociodemographic factors. The highest reporting sensitivities were found for maternal reports (compared with paternal), non-hispanic white, older mothers, and higher maternal education attainment.[28]

Most recently, parent reporting accuracy was investigated in the 2010 NIS-teen survey; not only did this study measure concordance of parent and provider report of vaccine initiation, but they also made attempts to capture over and under reporting of vaccine uptake (false positives and negatives, respectively). Results indicated that, overall, parent reports were fairly accurate; but receiving one or more doses was more likely to be under-reported in disadvantaged groups (e.g. non-white, lower SES, lower maternal education, public insurance). These results suggest that these differences in underreporting of vaccine by social group might exaggerate apparent disparities in vaccine uptake.[29]

## F. Rationale for Present Study

The overall goal of the present study is to further understand how sociodemographic factors influence parental reporting accuracy by evaluating NIS-Teen national data from 2012. The primary research question to be addressed is how the accuracy of parental reports may differ between racial and ethnic groups. We expect to find that sociodemographic factors that represent racial and economically disadvantaged groups will be associated with higher rates of reporting bias. A secondary research question will examine how gender of the teenager impacts parental reporting accuracy. Given that recommendations for adolescent males were added in 2011, we hypothesize that parental reporting in 2012 for males will be less

accurate than for females. Finally, the relationship between time interval since vaccine initiation and recall accuracy will be explored. As recall bias is expected to increase over time, we expect that longer time intervals between vaccination and interview date will be associated with decreased accuracy.

# II. Methods

## A. Study Design

Data for this analysis are from the 2012 National Immunization Survey-Teen (NIS-Teen), a nationally representative survey of adolescent vaccine coverage conducted annually since 2006 by the Centers for Disease Control and Prevention (CDC). These data are cleaned, de-identified, and made publically available through the CDC. The target population is children aged 13-17 living in non-institutionalized households in all fifty states, the District of Columbia, five major cities which are federal awardees (Chicago, Philadelphia, New York City, Houston, and San Antonio), or the U.S. Virgin Islands at the time of interview.

The NIS-Teen survey identifies adolescents aged 13-17 as an add-on to the NIS survey, which targets younger children aged 19-35 months. First, a random-digit-dialed household survey screens for the presence of an adolescent between 13-17 in the household. In 2012, independent samples were drawn from both landline and cell-phone sampling frames. Household interviews began on January 5, 2012 and ended on February 18, 2013. If there was more than one teen in the household, then one of those children was chosen at random, and the adult who was most knowledgeable about the teen's vaccination status was administered a computer-assisted telephone interview. All participants were asked if they possessed an immunization card, and if yes were instructed to read responses directly from the card. If not, teen's vaccination status was reported based on parental recall alone. Second, after consent of the adolescent's parent or guardian was obtained, a mailed healthcare provider survey was used to collect vaccination histories from medical records. Provider data collection

began in January 2012 and continued through April 2013. Additional details about data collection and preparation have been thoroughly documented.[30]

## B. Study Population

The total sample for 2012 NIS-Teen included 32,825 teens aged 13-17 for which household interviews were conducted. The present study excludes those participants without adequate provider data (n = 13,079; 39.8%), for a variety of reasons (such as absence of parental consent to contact healthcare provider, or provider lacking medical records for the teen). Those from the US Virgin Islands estimation area were also excluded (n = 1,033; 3.1%). There were 19,199 participants after these initial exclusion criteria were applied; of these, participants whose responses were inconsistent within household responses or missing (including "don't know" or "refused" responses) on household questions of HPV vaccination status were excluded from the analysis (n = 2,061; 10.7%). The final analytic dataset included 17,138 participants.

## C. Primary Measures

The primary outcome of interest is HPV vaccination status; for the purposes of the present study, vaccine initiation is defined as receiving at least one dose, and vaccine completion is defined as receiving three or more doses of either bivalent or quadrivalent HPV vaccine. The gold standard measure for vaccination status is the provider reported number of doses received, using data obtained from medical records. The reference measures compared with the gold standard are household report, with those who used immunization card examined separately from those whose responses were based on recall alone. Accuracy between parent and provider

report is limited to number of vaccine doses reported, and does not include the vaccination dates reported. Those who responded "received all doses" on either parental or provider report are coded as reporting receiving three or more doses. Participants were categorized as either concordant, false negative, or false positive cases based on the level of agreement between parental and provider reports for vaccine series initiation status.

The primary exposures of interest are parental report of the adolescent's race/ethnicity (Non-Hispanic white, Non-Hispanic black, Hispanic, or other) and gender. An additional exposure examined among those who initiated the series before the interview is the time interval between provider-reported vaccine initiation and time of interview, determined by calculating the difference between parent-reported age at time of interview and provider-reported age at first vaccine dose administration. The interval variable is categorized as less than one year, one to less than two years, two to less than three years, or three or more years. Additional covariates and sociodemographic indicators that are examined include parent report of adolescent's age at time of interview, health insurance type (categorized as private, public/Medicaid, other, or no reported coverage), poverty level relative to federal poverty line (FPL; calculated from parent reported household income and categorized as <100%, 100-199%, 200-299%, or >300%), maternal education (<12 years, 12 years, >12 years non-college graduate, or college graduate), census region (Northeast, Midwest, South, or West), mother's current marital status (married or unmarried), and number of children under 18 in the household (one, two-three, four or more).

## D. Analysis

The primary analysis calculated kappa estimates of parental and provider agreement on vaccine initiation and completion, as well as sensitivity, specificity, positive- and negative-predictive values. These were calculated for the sample overall as well as by gender. Bivariate analyses were performed to examine socio-demographic differences in response concordance, false negative, and false positive reporting of vaccine initiation; Wald chi square testing was performed to assess for statistical significance, again for the sample overall and for each gender separately. Among those who had initiated vaccination, bivariate analyses examined the relationship between reporting concordance and the time interval from first vaccination and time of survey completion, both overall and stratified by gender. Finally, a logistic regression model to predict variation in reporting accuracy was fit using those sociodemographic factors found to be most important after bivariate testing. All analyses were performed using SAS version 9.4 software, using adjustments for the complex survey design including appropriate weights, and an alpha value of 0.05 was set to determine statistical significance.

## III. Results

There were 17,138 participants included in the present study; of these, 8,165 (49.0%) were female and 8,973 (51.0%) were male. The immunization card group included 4,348 participants, and the recall only group included 12,790 participants. Provider reported vaccine initiation (at least one dose) was reported for 35.7% of the participants overall, 52.8% of females, and 20.1% of males; provider reported vaccine completion (three or more doses) was reported in 20.0% of participants overall, 35.0% of females, and 6.4% of males.

The overall level of agreement between parent and provider reporting for both vaccine initiation and vaccine completion was examined for the sample overall (table 1) and stratified by gender (tables 2 and 3). Overall level of agreement between parent and provider reported vaccine initiation was good (weighted kappa = 0.72). Overall sensitivity of parent reported vaccine initiation was 0.82 (95% CI: 0.80, 0.84), and overall specificity was 0.90 (95% CI: 0.89, 0.91). Weighted kappa estimates of parental-provider agreement were 0.72 for female teens and 0.65 for male teens. Sensitivity of parent reported vaccine initiation in female teens was 0.85 (95% CI: 0.82, 0.87), and the sensitivity in male teens was 0.75 (95% CI: 0.71, 0.79). Specificity of parent reported vaccine initiation in females was 0.87 (95% CI: 0.85, 0.89), and for males the specificity was 0.92 (95% CI: 0.91, 0.93). When immunization card and recall only groups were examined separately, the parents who responded with the aid of an immunization card had a significantly higher specificity for vaccine initiation (0.96; 95% CI 0.95, 0.98) than those who used recall only (0.88; 95% CI 0.87, 0.90).

Overall, kappa estimates were lowest in the recall only group, with a value of 0.69 for vaccine initiation overall, 0.69 for females, and 0.60 for males.

The distribution of sociodemographic characteristics, the corresponding percentages of concordant, false negative, and false positive cases, and the Wald chi square value for each variable were examined (table 4). Overall, parents of female teens were more likely to report immunization initiation status inaccurately, compared with parents of male teens, in both immunization card group (Chi square = 6.60, p = 0.0371) and recall only group (Chi square = 9.83, p = 0.0074). Reported race/ethnicity was significantly associated with variation in reporting accuracy in both groups, with the lowest concordance rates in parents of Non-Hispanic black and Hispanic teens (card group chi square = 22.21, p = 0.0011; recall only group chi square = 44.29, p < 0.0001).

Other sociodemographic variables that showed significant relationship with reporting accuracy in the immunization card group were household poverty status relative to FPL (chi square = 13.60, p = 0.0347), maternal education (chi square = 23.25, p = 0.0007), and maternal marital status (chi square = 6.83, p = 0.0330). In the recall only group, variables associated with reporting accuracy included household poverty status (chi square = 43.59, p < 0.0001), maternal education (chi square = 48.59, p < 0.0001), maternal marital status (chi square = 8.33, p = 0.0155), census region (chi square = 15.95, p = 0.0141), insurance type (chi square = 36.06, p < 0.0001), and teenager's age (chi square = 17.87, p = 0.0222). For these variables, lowest concordance was observed in those with lower household incomes, lower levels of maternal education, currently unmarried mothers, the Southern region of the United

States, in those with public or no reported insurance coverage, and in teenagers aged 13 compared with older teenagers. Number of children less than 18 in the household did not associate significantly with reporting accuracy in either group.

The same sociodemographic variables and reporting accuracy rates were examined in female and male teens (tables 6 and 7, respectively). Results for females followed the same pattern as in the overall analysis, with the exception that no significant variation was found for reporting accuracy by census region in females only. In males, results also followed a similar pattern except that no significant variation was found for maternal marital status and teen's age. However, census region was a significant contributor to reporting accuracy for males, with lowest concordance in the Northeast in this sub-analysis.

There was a significant relationship between time interval since vaccine initiation and reporting accuracy when genders were collapsed, but not when stratified by gender (table 7). These data indicate that overall rates of false negative reporting vary significantly as time since vaccine series initiation increases, for both immunization card group (chi square = 12.85, p = 0.0051) and recall only group (chi square = 14.36, p = 0.0025). The highest rate of false negative reporting appears to occur among those with less than three years since vaccine series initiation in both groups. However, when time interval was examined separately by genders, it was not found to be significantly associated with reporting concordance. In males, those with longer time intervals had more false negatives, though this finding was not significant; in females, those with intervals greater than three years had lowest rates of false negatives, although again this was not a significant finding.

Logistic regression analysis showed significant contributions of many sociodemographic variables in predicting false negative reporting, and a small number of variables also significantly predicted false positive reports (table 8). In the immunization card group, parents of non-Hispanic black teens were more likely to have false negative reports of vaccine initiation compared with non-Hispanic white teens (OR 3.36; 95% CI 1.28, 8.85), and higher levels of maternal education significantly predicted fewer false negatives compared with fewer than twelve years of education (for college grads: OR 0.20; 95% CI 0.07, 0.57). Significant predictors of false positive reports in the immunization card group includes those whose race/ethnicity was categorized as "other" compared with non-Hispanic whites (OR 1.27; 95% CI 0.08, 0.93); additionally, currently married mothers had decreased false positive reporting compared with unmarried mothers (OR 0.46; 95% CI 0.23, 0.93).

In the recall only group, predictors of false negative reporting were similar to the immunization card group, with additional significant findings for gender, race/ethnicity and insurance. Parents who relied on recall alone were more likely to have false negative reports of vaccine initiation for female teens than for males (OR 1.82; 95% CI 1.26, 2.64). Increased false negative reporting was found for Hispanic teens compared with non-Hispanic white teens (OR 1.98; 95% CI 1.29, 3.02), and decreased rate of false negative reporting in those with private insurance compared with public insurance or Medicaid (OR 0.54; 95% 0.35, 0.85). Those factors found significant in predicting false positive reporting in the immunization card group were not significant in the recall only group; however, in the recall group, parents of non-Hispanic black teens had increased false positive reporting compared with non-

Hispanic whites (OR 1.58; 95% CI 1.07, 2.34), and those with private insurance had decreased false positive reporting compared with public insurance or Medicaid (OR 0.59; 95% CI 0.43, 0.82).

## IV. Discussion

The present study adds to the body of literature on parental reporting accuracy of HPV vaccination in teenagers by examining sociodemographic determinants of reporting bias in the 2012 NIS-teen data. Overall agreement between parent and provider report of HPV vaccination status was good, with parents generally more likely to incorrectly under-report their child's vaccination status than to over-report it. The present study found significant variation in parental reporting accuracy by a variety of factors, most notably by teenager's gender and race/ethnicity, and maternal education, insurance level, and marital status. Parents were less likely to accurately report vaccination status in female compared with male teenagers, and socio-demographic measures of disadvantage (non-white race/ethnicity, lower levels of maternal education, no or public insurance, and unmarried single mothers) were also linked with greater reporting inaccuracy. The current study's findings suggest a stronger relative role for social factors like education and racial minority status than economic and financial factors in predicting parental reporting accuracy.

The present findings of greater reporting inaccuracy in sociodemographic groups associated with disadvantage are consistent with previous studies using NIS-teen data. One of the major additions to the literature by Attanasio et al was investigating false negative and false positive reporting separately; not only did they find greater levels of false negative compared with false positive reporting, they also demonstrated that variables like race/ethnicity, income, education, and insurance status were strong predictors of false negative reporting.[29] The current study confirms

these findings in a more recent national dataset, and goes further to investigate how reporting bias varies by gender and time interval since vaccine initiation.

The present study contributes to the literature by showing significant differences in parental reporting accuracy depending on gender of the child, with more accurate reporting in parents of male teenagers. In particular, parents who relied on recall alone were more likely to under report vaccination in female teens than in male teens. The finding of greater reporting bias for female teens compared with males was contrary to what was hypothesized. This may imply important gender disparities despite the relative novelty of HPV vaccination initiatives for males. It is possible that parental recall is better for male teens than for females in part because of the more recent recommendation and because few males have received the vaccine.

Finally, the present study examines how the interval of time between vaccine initiation and survey reporting may impact the accuracy of parental reporting. Our hypothesis was that the longer period of time that had elapsed since vaccination, the less accurate the parental reports would be. In fact, our findings suggest the opposite; the fewest relative false negative reporting was found at time intervals of three or more years since vaccine series initiation. Although not statistically significant when stratified by gender, this drop in false negative reporting at three or more years out was seen in females only, with false reporting of male vaccination appearing to increase at greater time intervals as hypothesized. It is important to note that males are more likely to have a shorter time interval since vaccination than females, with only 42 male participants with a time interval of three or more years from vaccine initiation. This group would have been vaccinated before recommendations were in

place for male teens, representing a very different group than those males vaccinated after routine vaccination recommendations were made, as well as than those females vaccinated three or more years prior. In addition to gender differences, time interval since vaccine initiation is greater in those who have completed the series, who are in turn more likely to accurately report vaccination status. Future study of this relationship between interval and response accuracy may better capture a true relationship if analysis examines the time interval since the last, rather than the first, dose received.

### A. Strengths and Limitations

There are at least three strengths in the present study. First, data are derived from a large, nationally representative sample of teenagers in the United States in 2012, with analyses using appropriate weighting adjustments for the complex survey design. Second, it is the first study of its kind using data since the inclusion of adolescent boys in HPV vaccine recommendations in 2011, and thus the first to have the capacity to examine and detect gender differences. Finally, the inclusion of cellular phone based sampling in addition to landline phones enhances the ability of these data to capture nationally representative patterns.

There are at least three limitations in the present analysis. First, the analysis was limited to those respondents for whom adequate provider data was available, creating a potential selection bias towards those most likely to have reliable provider data. The presence or absence of adequate provider data can be seen itself as an indicator of socioeconomic advantage or disadvantage, respectively, implying a potential under-representation of those with lower socioeconomic status and

decreased access to medical care. Second, the exclusion of participants with incomplete or inconsistent measures of parental reporting of HPV vaccination may have contributed to additional selection bias in the findings presented. Finally, the ability to interpret gender differences is limited by the overall lower vaccination rates in male teens compared to female teens, especially since these data were collected in the very first year after the introduction of male-specific HPV vaccine recommendations.

### B. Implications and Future Directions

Overall, these findings are reassuring in that they suggest that studies which use parental report to measure HPV vaccination uptake are more likely to be under-reporting than over-reporting true vaccination status. We show that markers of sociodemographic disadvantage associate with greater reporting inaccuracy. Maternal education level and race/ethnicity appeared to be the strongest predictor of recall accuracy, particularly for false negative reporting. These findings suggest that studies that utilize parental recall in less educated and socially underserved populations are more likely to inaccurately measure true vaccine uptake, and they imply the potential for differential recall bias in studies examining vaccine uptake disparities. Future studies should further investigate the relationship between time interval since vaccination and recall bias, especially examining time since last, rather than first, vaccine. As vaccination uptake increases, particularly in males, further studies may be able to better compare reporting bias between teen genders.

## V. References

[1] Satterwhite CL, Torrone E, Meites E, et al. Sexually transmitted infections among US women and men: prevalence and incidence estimates, 2008. *Sexually Transmitted Diseases* 2013;40:187–93.

[2] Doorbar J, Quint W, Banks L, et al. The Biology and Life-Cycle of Human Papillomaviruses. *Vaccine* 2012; 30S: F55-F70.

[3] Forman D, de Martel C, Lacey CJ, et al. Global Burden of Human Papillomavirus and Related Diseases. *Vaccine* 2012; 30 (5): F12-F23.

[4] Saraiya M, Unger ER, Thompson TD et al. Nationwide Assessment of HPV Types in Cancers in the U.S: Implications for Current HPV 16/18 and Candidate 9-valent Vaccines. *Journal of the National Cancer Institute* 2015; in press.

[5] Jemal A, Simard EP, Dorell C, et al. 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* 2013; 105:175-201.

[6] Watson M, Saraiya M, Benard V, et al. Burden of cervical cancer in the United States, 1998-2003. *Cancer* 2008; 113: 2855-64.

[7] Benard VB, Thomas CC, King J, et al. Vital Signs: Cervical Cancer Incidence, Mortality, and Screening – United States, 2007-2012. *Morbidity and Mortality Weekly Report (MMWR)* November 7, 2014; 63 (44): 1004-1009.

[8] Bruni L, Diaz M, Castellsague X, Ferrer E, Bosch FX, de Sanjose S. Cervical human papillomavirus prevalence in 5 continents: meta-analysis of 1 million women with normal cytological findings. *Journal of Infectious Disease* 2010; 202: 1789-99.

[9] Franceschi S, Castellsague X, Dal Maso L, et al. Prevalence and determinants of human papillomavirus genital infection in men. *British Journal of Cancer* 2002; 86(5): 705-11.

[10] Machalek DA, Poynten M, Jin F, et al. Anal human papillomavirus infection and associated neoplastic lesions in men who have sex with men; a systematic review and meta-analysis. *The Lancet Oncology* 2012; 13(5): 487-500.

[11] Gillison ML, Broutian T, Pickard RKL, et al. Prevalence of oral HPV infection in the United States, 2009-2010. *Journal of the American Medical Association (JAMA)* 2012; 307(7): 693-703.

[12] Serrano B, Alemany L, Tous S, et al. Potential impact of a nine-valent vaccine in human papillomavirus related cervical disease. *Infectious Agents and Cancer* 2012;

7:38.

[13] Hariri S, Unger ER, Sterneberg M, et al. Prevalence of Genital Human Papillomavirus Among Females in the United States, the National Health and Nutrition Examination Survey, 2003-2006. The *Journal of Infectious Diseases* 2011; 204(4): 566-73.

[14] Winer RL, Feng Q, Hughes JP, O'Reilly S, Kiviat NB, and Koutsky LA. Risk of female human papillomavirus acquisition associated with first male sex partner. *The Journal of Infectious Diseases* 2008; 197: 279-82.

[15] Hariri S, Unger ER, Powell SE, et al. Human Papillomavirus Genotypes in High-Grade Cervical Lesions in the United States. *The Journal of Infectious Diseases*. 2012; 206:1878-86.

[16] Saraiya et al. Population-Based HPV Genotype Attribution in HPV-Associated Cancers, United States. Presented to Advisory Committee on Immunization Practices, Atlanta, GA, February 2014.

[17] Joura EA, Giuliano AR, Iversen O-E et al. A 9-Valent HPV Vaccine against Infection and Intraepithelial Neoplasia in Women. *The New England Journal of Medicine* 2015; 372 (8): 711-723.

[18] Dunne EF, Markowitz LE, Chesson H. Recommendations on the Use of Quadrivalent Human Papillomavirus Vaccine in Males – Advisory Committee on Immunization Practices (ACIP), 2011. *MMWR* 2011; 60 (50); 1705-1708.

[19] Petrosky E, Bocchini J, Hariri S, et al. Use of 9-Valent Human Papillomavirus (HPV) Vaccine: Updated HPV Vaccination Recommendations of the Advisory Committee on Immunization Practices. *MMWR* 2015; 64: 300-4

[20] Curtis CR, Dorell C, Yankey D, et al. National and State Vaccination Among Adolescents Aged 13-17 Years – United States, 2012. *MMWR* 2013; 62 (34): 685-693.

[21] Stokley S, Jeyrajah J, Yankey D et al. Human Papillomavirus Vaccination Coverage Among Adolescents, 2007-2013, and Postlicensure Vaccine Safety Monitoring, 2006-2014—United States. *MMWR* 2014; 63 (29): 620-624.

[22] Schmidt S and Parsons HM. Vaccination Interest and Trends in Human Papillomavirus Vaccine Uptake in Young Adult Women Aged 18 to 26 Years in the United States: An Analysis using the 2008-2012 National Health Interview Survey. *American Journal of Public Health* 2014; 104 (5): 946-953.

[23] Fisher H, Trotter CL, Audrey S, MackDonald-Wallis K, and Hickman M. Inequalities in the uptake of Human Papillomavirus Vaccination: a systematic review and meta-analysis. *International Journal of Epidemiology* 2013; 42: 896-908.

[24] Kester LM, Zimet GD, Fortenberry JD, Kahn JA, Shew ML. A national study of HPV Vaccination of Adolescent Girls: Rates, Predictors, and Reasons for Non-Vaccination. *Maternal and Child Health Journal* 2013; 17: 879-885.

[25] Polonijo AN and Carpiano RM. Social inequalities in adolescent human papillomavirus (HPV) vaccination: A test of fundamental cause theory. *Social Science & Medicine* 2013; 82: 115 – 125.

[26] Gilkey MB, Moss JL, McRee A, Brewer NT. Do correlates of HPV vaccine initiation differ between adolescent boys and girls? *Vaccine* 2012; 30: 5928-5934.

[27] Dorrell CG, Jain N, an Yankey D. Validity of Parent-Reported Vaccination Status for Adolescents Aged 13-17 Years: National Immunization Survey-Teen 2008. *Public Health Reports* 2011; 126 (2): 60-69.

[28] Ojha RP, Tota JE, Offutt-Powell TN, et al. The accuracy of human papillomavirus vaccination status based on adult proxy recall or household immunization records for adolescent females in the United States: results from the national Immunization Survey-Teen. *Annals of Epidemiology* 2013; 23: 281-285.

[29] Attanasio L and McAlpine D. Accuracy of Parental Reports of Children's HPV Vaccine Status: Implications for Estimates of Disparities, 2009-2010. *Public Health Reports* 2014; 129: 237-244.

[30] Centers for Disease Control and Prevention. National Immunization Survey-Teen: A User's Guide for the 2012 Public-Use Data File. Presented by NORC at the University of Chicago, September 2013.

# VI. Tables

Table 1. Weighted accuracy of parent-reported HPV vaccine status among female and male teens with complete household surveys and adequate provider data: NIS-Teen 2012

| Parent-reported HPV vaccine status | Provider-reported HPV Vaccination Status | | Kappa | Sensitivity (95% CI) | Specificity (95% CI) | PPV[a] (95% CI) | NPV[b] (95% CI) |
|---|---|---|---|---|---|---|---|
| Total (n = 17,138) | No (n) | Yes (n) | | | | | |
| At least 1 dose | | | 0.721 | 0.819 | 0.900 | 0.827 | 0.896 |
| No | 10,042 | 817 | | (0.798, 0.840) | (0.891, 0.910) | (0.811, 0.844) | (0.883, 0.908) |
| Yes | 984 | 5,295 | | | | | |
| 3 or more doses | | | 0.648 | 0.673 | 0.948 | 0.758 | 0.922 |
| No | 13,068 | 913 | | (0.642, 0.704) | (0.940, 0.955) | (0.728, 0.787) | (0.914, 0.931) |
| Yes | 640 | 2,517 | | | | | |
| Immunization card (n = 4,348) | | | | | | | |
| At least 1 dose | | | 0.838 | 0.862 | 0.963 | 0.932 | 0.922 |
| No | 2763 | 151 | | (0.826, 0.898) | (0.951, 0.975) | (0.911, 0.954) | (0.901, 0.943) |
| Yes | 93 | 1341 | | | | | |
| 3 or more doses | | | 0.776 | 0.775 | 0.969 | 0.875 | 0.939 |
| No | 3387 | 123 | | (0.712, 0.839) | (0.951, 0.987) | (0.808, 0.942) | (0.919, 0.959) |
| Yes | 70 | 768 | | | | | |
| Recall only (n = 12,790) | | | | | | | |
| At least 1 dose | | | 0.690 | 0.808 | 0.884 | 0.801 | 0.888 |
| No | 7,279 | 666 | | (0.783, 0.832) | (0.872, 0.896) | (0.781, 0.820) | (0.873, 0.903) |
| Yes | 891 | 3,954 | | | | | |
| 3 or more doses | | | 0.609 | 0.641 | 0.942 | 0.721 | 0.918 |
| No | 9,681 | 790 | | (0.606, 0.676) | (0.934, 0.950) | (0.688, 0.753) | (0.908, 0.928) |
| Yes | 570 | 1,749 | | | | | |

[a] Positive Predictive Value

[b] Negative Predictive Value

Table 2. Weighted accuracy of parent-reported HPV vaccine status among female teens with complete household surveys and adequate provider data: NIS-Teen 2012

| Parent-reported HPV vaccine status | Provider-reported HPV Vaccination Status | | Kappa | Sensitivity (95% CI) | Specificity (95% CI) | PPV[a] (95% CI) | NPV[b] (95% CI) |
|---|---|---|---|---|---|---|---|
| Total (n = 8,165) | No (n) | Yes (n) | | | | | |
| At least 1 dose | | | 0.717 | 0.848 | 0.871 | 0.883 | 0.833 |
| No | 3,411 | 497 | | (0.824, 0.871) | (0.853, 0.889) | (0.867, 0.900) | (0.883, 0.908) |
| Yes | 444 | 3,813 | | | | | |
| 3 or more doses | | | 0.611 | 0.677 | 0.912 | 0.792 | 0.850 |
| No | 4,896 | 746 | | (0.643, 0.711) | (0.896, 0.927) | (0.759, 0.824) | (0.832, 0.869) |
| Yes | 409 | 2,114 | | | | | |
| Immunization card (n = 1,998) | | | | | | | |
| At least 1 dose | | | 0.809 | 0.878 | 0.935 | 0.941 | 0.868 |
| No | 931 | 82 | | (0.834, 0.923) | (0.909, 0.962) | (0.916, 0.966) | (0.822, 0.915) |
| Yes | 52 | 933 | | | | | |
| 3 or more doses | | | 0.741 | 0.785 | 0.939 | 0.880 | 0.885 |
| No | 1,318 | 247 | | (0.711, 0.858) | (0.897, 0.981) | (0.801, 0.959) | (0.842, 0.927) |
| Yes | 48 | 639 | | | | | |
| Recall only (n = 6,167) | | | | | | | |
| At least 1 dose | | | 0.692 | 0.839 | 0.854 | 0.868 | 0.823 |
| No | 2,480 | 415 | | (0.812, 0.867) | (0.832, 0.876) | (0.848, 0. 888) | (0.793, 0.852) |
| Yes | 392 | 2,880 | | | | | |
| 3 or more doses | | | 0.572 | 0.644 | 0.905 | 0.764 | 0.842 |
| No | 3,675 | 656 | | (0.606, 0.683) | (0.889, 0.920) | (0.729, 0.798) | (0.821, 0.862) |
| Yes | 361 | 1,475 | | | | | |

[a] Positive Predictive Value

[b] Negative Predictive Value

Table 3. Weighted accuracy of parent-reported HPV vaccine status among male teens with complete household surveys and adequate provider data: NIS-Teen 2012

| Parent-reported HPV vaccine status | Provider-reported HPV Vaccination Status | | Kappa | Sensitivity (95% CI) | Specificity (95% CI) | PPV[a] (95% CI) | NPV[b] (95% CI) |
|---|---|---|---|---|---|---|---|
| Total (n = 8973) | No (n) | Yes (n) | | | | | |
| At least 1 dose | | | 0.650 | 0.749 | 0.917 | 0.702 | 0.933 |
| No | 6,631 | 320 | | (0.705, 0.792) | (0.906, 0.929) | (0.665, 0.738) | (0.920, 0.946) |
| Yes | 540 | 1,482 | | | | | |
| 3 or more doses | | | 0.611 | 0.653 | 0.972 | 0.621 | 0.976 |
| No | 8,172 | 167 | | (0.580, 0.726) | (0.966, 0.978) | (0.552, 0.690) | (0.970, 0.982) |
| Yes | 231 | 403 | | | | | |
| Immunization card (n = 2,350) | | | | | | | |
| At least 1 dose | | | 0.831 | 0.823 | 0.978 | 0.912 | 0.953 |
| No | 1,832 | 69 | | (0.763, 0.882) | (0.967, 0.990) | (0.868, 0.956) | (0.936, 0.970) |
| Yes | 41 | 408 | | | | | |
| 3 or more doses | | | 0.774 | 0.737 | 0.989 | 0.855 | 0.977 |
| No | 2,166 | 33 | | (0.613, 0.862) | (0.980, 0.997) | (0.753, 0.956) | (0.964, 0.989) |
| Yes | 22 | 129 | | | | | |
| Recall only (n = 6,623) | | | | | | | |
| At least 1 dose | | | 0.603 | 0.727 | 0.900 | 0.653 | 0.928 |
| No | 4,799 | 251 | | (0.675, 0.780) | (0.886, 0.915) | (0.610, 0.696) | (0.911, 0.944) |
| Yes | 499 | 1,074 | | | | | |
| 3 or more doses | | | 0.558 | 0.622 | 0.968 | 0.554 | 0.975 |
| No | 6,006 | 134 | | (0.533, 0.710) | (0.961, 0.975) | (0.471, 0.637) | (0.969, 0.982) |
| Yes | 209 | 274 | | | | | |

[a] Positive Predictive Value

[b] Negative Predictive Value

Table 4. Sociodemographic characteristics associated with concordance of Parent-reported HPV initiation status with provider-reported status: NIS-teen 2012

| | Total (n = 17,138) | Immunization Card (n = 4,348) | | | | Recall Only (n = 12,790) | | | |
|---|---|---|---|---|---|---|---|---|---|
| Sociodemographic Characteristic | n (%) | Concordant cases (%) | False-positive cases (%) | False-negative cases (%) | Chi square, p-value | Concordant cases (%) | False-positive cases (%) | False-negative cases | Chi square , p-value |
| Teen's gender | | | | | 6.60, p = 0.0371 | | | | 9.83, p = 0.0074 |
| Male | 8,973 (51.0) | 95.3 | 1.7 | 2.9 | | 88.7 | 7.5 | 3.8 | |
| Female | 8,165 (49.0) | 93.3 | 2.6 | 4.1 | | 86.9 | 6.4 | 6.7 | |
| Teen's race/ethnicity | | | | | 22.21, p = 0.0011 | | | | 44.29, p < 0.0001 |
| Non-Hispanic White | 11,767 (56.6) | 95.9 | 1.7 | 2.4 | | 90.3 | 6.3 | 3.4 | |
| Non-Hispanic Black | 1,662 (13.8) | 88.5 | 5.0 | 6.5 | | 81.6 | 9.9 | 8.5 | |
| Hispanic | 2,170 (20.9) | 89.2 | 3.2 | 7.6 | | 82.4 | 8.3 | 9.4 | |
| Other | 1,539 (8.7) | 92.7 | 2.2 | 5.1 | | 85.0 | 6.6 | 8.4 | |
| Household Povety Status | | | | | 13.60, p = 0.0347 | | | | 43.59, p < 0.0001 |
| <100% FPL[a] | 2,476 (22.9) | 86.6 | 4.3 | 9.1 | | 78.6 | 10.4 | 11.0 | |
| 100-199% FPL | 2,817 (20.3) | 93.9 | 2.7 | 3.4 | | 86.5 | 8.0 | 5.5 | |
| 200-299% FPL | 2,580 (13.6) | 94.8 | 2.3 | 2.9 | | 89.8 | 6.7 | 3.5 | |
| > 300% FPL | 8, 415 (37.3) | 96.0 | 1.5 | 2.6 | | 90.8 | 5.6 | 3.7 | |
| Missing (excluded) | 850 (6.0) | | | | | | | | |
| Mother's Education | | | | | 23.25, p = 0.0007 | | | | 48.38, p < 0.0001 |
| < 12 Years | 1,496 (12.7) | 81.4 | 4.6 | 14.1 | | 77.1 | 10.8 | 12.1 | |
| 12 Years | 3,131 (23.9) | 92.7 | 2.5 | 4.7 | | 84.3 | 8.7 | 7.0 | |
| > 12 Years, Non college graduate | 4,876 (27.5) | 95.4 | 2.4 | 2.2 | | 88.6 | 7.1 | 4.3 | |
| College graduate | 7,635 (35.9) | 96.0 | 1.6 | 2.4 | | 91.3 | 5.2 | 3.4 | |
| Census region | | | | | 5.93, p = 0.4310 | | | | 15.95, p = 0.0141 |
| Northeast | 3,199 (16.8) | 95.0 | 2.2 | 2.8 | | 89.3 | 5.9 | 4.9 | |
| Midwest | 3,821 (22.2) | 95.1 | 2.0 | 2.8 | | 89.9 | 6.1 | 4.0 | |
| South | 6,081 (36.8) | 93.8 | 2.3 | 4.0 | | 86.1 | 8.1 | 5.7 | |
| West | 4,037 (24.1) | 94.1 | 2.0 | 3.9 | | 87.4 | 6.8 | 5.8 | |
| Insurance Type | | | | | 10.99, p = 0.0889 | | | | 36.06, p < 0.0001 |
| Private | 11,430 (66.1) | 95.6 | 1.7 | 2.7 | | 90.3 | 6.0 | 3.7 | |
| Public/Medicaid | 2,489 (22.6) | 89.5 | 4.6 | 5.9 | | 81.4 | 9.8 | 8.8 | |
| Other | 862 (5.4) | 95.6 | 1.5 | 3.0 | | 90.2 | 6.3 | 3.5 | |
| No reported coverage | 573 (5.1) | 91.2 | 1.5 | 7.3 | | 82.1 | 9.9 | 8.0 | |
| Missing (excluded) | 89 (0.8) | | | | | | | | |
| Teen's mother married currently | | | | | 6.83, p = 0.0330 | | | | 8.33 p = 0.0155 |
| No | 4,323 (34.7) | 90.6 | 3.3 | 6.1 | | 84.2 | 8.5 | 7.4 | |
| Yes | 12,815 (65.3) | 95.2 | 1.9 | 2.9 | | 89.3 | 6.4 | 4.4 | |
| Teen's age (years) | | | | | 7.26, p = 0.5092 | | | | 17.87, p = 0.0222 |
| 13 | 3, 506 (20.4) | 94.5 | 2.3 | 3.2 | | 86.0 | 8.0 | 6.0 | |
| 14 | 3,534 (19.5) | 94.8 | 1.6 | 3.6 | | 88.4 | 6.6 | 5.1 | |
| 15 | 3,476 (21.1) | 94.2 | 2.0 | 3.8 | | 88.5 | 6.7 | 4.8 | |
| 16 | 3,419 (20.2) | 94.0 | 2.7 | 3.4 | | 87.5 | 7.2 | 5.2 | |
| 17 | 3, 203 (18.8) | 94.4 | 2.2 | 3.4 | | 88.8 | 6.3 | 4.9 | |
| Number of children < 18 years in household | | | | | 1.70 p = 0.7903 | | | | 7.82, p = 0.0983 |
| One | 6,622 (31.8) | 95.2 | 2.0 | 2.8 | | 88.1 | 6.7 | 5.1 | |
| Two or Three | 8,855 (55.5) | 94.1 | 2.1 | 3.8 | | 88.2 | 6.9 | 4.9 | |
| Four or more | 1,661 (12.7) | 92.8 | 2.8 | 4.4 | | 84.6 | 8.1 | 7.2 | |

[a] Federal Poverty Line

Table 5. Sociodemographic characteristics associated with concordance of Parent-reported HPV initiation status with provider-reported status for Female Teens: NIS-teen 2012

| | Total (n = 8,165) | Immunization Card (n =1,998) | | | | Recall Only (n = 6,167) | | | |
|---|---|---|---|---|---|---|---|---|---|
| Sociodemographic Characteristic | n (%) | Concordant cases (%) | False-positive cases (%) | False-negative cases (%) | Chi square, p-value | Concordant cases (%) | False-positive cases (%) | False-negative cases (%) | Chi square , p-value |
| Teen's race/ethnicity | | | | | 11.16, p = 0.0842 | | | | 30.22, p < 0.0001 |
| Non-Hispanic White | 5,539 (56.2) | 95.2 | 1.9 | 2.9 | | 89.2 | 6.2 | 4.6 | |
| Non-Hispanic Black | 795 (14.1) | 85.4 | 8.1 | 6.5 | | 82.3 | 7.4 | 10.3 | |
| Hispanic | 1,070 (20.5) | 87.2 | 3.8 | 9.1 | | 82.1 | 6.8 | 11.1 | |
| Other | 761 (9.2) | 92.9 | 2.7 | 4.4 | | 82.9 | 5.4 | 11.7 | |
| Household Povety Status | | | | | 11.51, p = 0.0744 | | | | 24.42, p = 0.0004 |
| <100% FPL | 1,218 (23.1) | 82.7 | 5.3 | 11.9 | | 77.6 | 8.0 | 14.4 | |
| 100-200% FPL | 1,370 (20.8) | 93.7 | 4.3 | 2.0 | | 86.3 | 6.7 | 7.0 | |
| 200-299% FPL | 1,230 (13.5) | 94.4 | 2.1 | 3.5 | | 89.6 | 5.7 | 4.7 | |
| > 300% FPL | 3,936 (36.4) | 95.3 | 1.6 | 3.1 | | 89.7 | 5.8 | 4.4 | |
| Missin (excluded) | 411 (6.2) | | | | | | | | |
| Mother's Education | | | | | 15.03, p = 0.0203 | | | | 33.52, p < 0.0001 |
| < 12 Years | 739 (12.8) | 78.8 | 5.5 | 15.8 | | 75.4 | 8.4 | 16.2 | |
| 12 Years | 1,515 (23.4) | 91.2 | 3.3 | 5.5 | | 83.6 | 7.4 | 8.9 | |
| > 12 Years, Non college graduate | 2,336 (28.7) | 95.4 | 2.8 | 1.8 | | 87.5 | 6.9 | 5.6 | |
| College graduate | 3,575 (35.2) | 95.1 | 1.9 | 3.0 | | 90.8 | 5.0 | 4.3 | |
| Census region | | | | | 5.57, p = 0.4736 | | | | 9.00, p = 0.1740 |
| Northeast | 1,528 (17.1) | 95.5 | 2.7 | 1.8 | | 89.8 | 4.9 | 5.4 | |
| Midwest | 1,813 (22.3) | 93.6 | 2.7 | 3.7 | | 88.7 | 5.9 | 5.4 | |
| South | 2,949 (37.0) | 92.7 | 2.6 | 4.6 | | 85.2 | 7.4 | 7.3 | |
| West | 1,875 (23.7) | 92.3 | 2.4 | 5.2 | | 85.4 | 6.3 | 8.2 | |
| Insurance Type | | | | | 12.82, p = 0.0465 | | | | 19.71, p = 0.0032 |
| Private | 5,420 (66.6) | 94.5 | 2.0 | 3.4 | | 89.2 | 5.8 | 5.0 | |
| Public/Medicaid | 1,182 (22.6) | 89.6 | 4.5 | 5.9 | | 80.6 | 8.5 | 10.8 | |
| Other | 397 (5.2) | 97.4 | 0.9 | 1.7 | | 90.1 | 6.0 | 3.9 | |
| No reported coverage | 292 (5.1) | 86.5 | 2.7 | 10.8 | | 82.1 | 5.5 | 12.4 | |
| Missing (excluded) | 37 (0.6) | | | | | | | | |
| Teen's mother married currently | | | | | 4.02, p = 0.1341 | | | | 6.05, p = 0.0486 |
| No | 2,111 (35.7) | 87.5 | 4.5 | 8.1 | | 82.9 | 7.4 | 9.7 | |
| Yes | 6,054 (64.3) | 94.5 | 2.2 | 3.3 | | 88.5 | 5.9 | 5.5 | |
| Teen's age (years) | | | | | 5.79, p = 0.6702 | | | | 17.55, p = 0.0250 |
| 13 | 1,715 (21.2) | 94.3 | 2.1 | 3.6 | | 85.2 | 7.2 | 7.6 | |
| 14 | 1,639 (18.7) | 94.1 | 1.5 | 4.4 | | 88.5 | 5.4 | 6.1 | |
| 15 | 1,669 (21.0) | 92.3 | 3.5 | 4.2 | | 87.4 | 6.5 | 6.1 | |
| 16 | 1,667 (20.8) | 93.7 | 2.9 | 3.4 | | 86.6 | 6.6 | 6.8 | |
| 17 | 1,475 (18.3) | 91.9 | 3.1 | 5.0 | | 86.9 | 6.0 | 7.1 | |
| Number of children < 18 years in household | | | | | 1.84, p = 0.7660 | | | | 6.79 p = 0.1475 |
| One | 3,196 (32.5) | 94.7 | 2.1 | 3.2 | | 87.0 | 6.4 | 6.6 | |
| Two or Three | 4,157 (54.3) | 92.8 | 2.6 | 4.6 | | 87.6 | 6.2 | 6.3 | |
| Four or more | 812 (13.2) | 90.5 | 4.5 | 5.0 | | 83.1 | 7.2 | 9.7 | |

[a] Federal Poverty Line

Table 6. Characteristics associated with concordance of Parent-reported HPV initiation status with provider-reported status for Male Teens: NIS-teen 2012

| | Total (n = 8,973) | Immunization Card (n = 2,350) | | | | Recall Only (n = 6,623) | | | |
|---|---|---|---|---|---|---|---|---|---|
| Sociodemographic Characteristic | n (%) | Concordant cases (%) | False-positive cases (%) | False-negative cases (%) | Chi square, p-value | Concordant cases (%) | False-positive cases (%) | False-negative cases (%) | Chi square , p-value |
| Teen's race/ethnicity | | | | | 14.95, p = 0.0210 | | | | 16.96, p =0.0095 |
| Non-Hispanic White | 6,228 (57.0) | 96.5 | 1.6 | 1.9 | | 91.3 | 6.4 | 2.4 | |
| Non-Hispanic Black | 867 (13.5) | 91.4 | 2.2 | 6.5 | | 81.0 | 12.1 | 6.9 | |
| Hispanic | 1,100 (21.2) | 91.2 | 2.7 | 6.1 | | 82.6 | 9.7 | 7.7 | |
| Other | 778 (8.3) | 92.6 | 1.6 | 5.9 | | 87.1 | 7.8 | 5.1 | |
| Household Povety Status | | | | | 14.23, p = 0.0275 | | | | 22.02, p = 0.0012 |
| <100% FPL | 1,258 (22.6) | 90.2 | 3.4 | 6.4 | | 79.6 | 12.7 | 7.7 | |
| 100-200% FPL | 1,447 (19.8) | 94.1 | 1.2 | 6.5 | | 86.7 | 9.3 | 1.4 | |
| 200-299% FPL | 1,350 (13.7) | 95.2 | 2.4 | 2.4 | | 90.0 | 7.6 | 2.5 | |
| > 300% FPL | 4,479 (38.1) | 96.5 | 1.3 | 2.1 | | 91.7 | 5.3 | 2.9 | |
| Missing (excluded) | 439 (5.7) | | | | | | | | |
| Mother's Education | | | | | 11.69, p = 0.0698 | | | | 27.03, p = 0.0001 |
| < 12 Years | 757 (12.7) | 84.4 | 3.5 | 12.1 | | 77.9 | 10.7 | 11.4 | |
| 12 Years | 1,616 (24.4) | 94.0 | 1.9 | 4.1 | | 84.6 | 8.4 | 7.0 | |
| > 12 Years, Non college graduate | 2,520 (26.3) | 95.4 | 2.1 | 2.4 | | 89.4 | 5.7 | 4.9 | |
| College graduate | 4,060 (36.6) | 96.8 | 1.3 | 1.9 | | 90.0 | 3.9 | 6.1 | |
| Census region | | | | | 3.15, p = 0.7897 | | | | 19.64, p = 0.0032 |
| Northeast | 1, 671 (16.6) | 94.6 | 1.9 | 3.5 | | 78.7 | 13.0 | 8.3 | |
| Midwest | 2,008 (22.2) | 96.5 | 1.5 | 2.0 | | 84.9 | 9.9 | 5.2 | |
| South | 3,132 (36.7) | 94.7 | 2.0 | 3.4 | | 89.8 | 7.2 | 3.0 | |
| West | 2,162 (24.5) | 95.5 | 1.7 | 2.9 | | 91.9 | 5.4 | 2.7 | |
| Insurance Type | | | | | n/a | | | | 20.14, p = 0.0027 |
| Private | 6,010 (66.7) | 96.5 | 1.3 | 2.2 | | 91.3 | 6.1 | 2.6 | |
| Public/Medicaid | 1,307 (22.7) | 89.3 | 4.7 | 5.9 | | 82.1 | 11.0 | 6.9 | |
| Other | 465 (5.6) | 94.2 | 1.9 | 3.9 | | 90.3 | 6.5 | 3.2 | |
| No reported coverage | 281 (5.0) | 96.8 | 0.0 | 3.2 | | 82.1 | 14.2 | 3.7 | |
| Missing (excluded) | 52 (1.0) | | | | | | | | |
| Teen's mother married currently | | | | | 3.07, p = 0.2162 | | | | 4.11, p = 0.1279 |
| No | 2,212 (33.7) | 93.2 | 2.3 | 4.5 | | 85.4 | 9.5 | 5.1 | |
| Yes | 6,761 (66.3) | 95.7 | 1.6 | 2.6 | | 89.9 | 6.8 | 3.3 | |
| Teen's age (years) | | | | | 13.43, p = 0.0985 | | | | 10.02, p = 0.2636 |
| 13 | 1,791 (19.7) | 94.8 | 2.4 | 2.8 | | 86.9 | 8.7 | 4.4 | |
| 14 | 1,895 (20.2) | 95.4 | 1.7 | 2.9 | | 88.2 | 7.6 | 4.1 | |
| 15 | 1,807 (21.2) | 95.9 | 0.7 | 3.5 | | 89.5 | 6.9 | 3.6 | |
| 16 | 1,752 (19.6) | 94.2 | 2.5 | 3.4 | | 88.4 | 7.8 | 3.8 | |
| 17 | 1,728 (19.3) | 96.5 | 1.4 | 2.1 | | 90.4 | 6.6 | 3.0 | |
| Number of children < 18 years in household | | | | | 4.67, p = 0.3233 | | | | 2.72, p = 0.6061 |
| One | 3,426 (31.1) | 95.6 | 1.8 | 2.5 | | 89.2 | 7.1 | 3.8 | |
| Two or Three | 4,698 (55.6) | 95.2 | 1.8 | 3.0 | | 88.8 | 7.6 | 3.6 | |
| Four or more | 849 (12.2) | 94.8 | 1.3 | 3.9 | | 86.1 | 9.1 | 4.9 | |

[a] Federal Poverty Line

Table 7. Relationship between time since vaccine series initiation and concordance of parent-reported HPV initiation status with provider-reported status: NIS-teen 2012

| Interval between first dose and interview (years) | Total (n = 6,112) | Immunization Card (n = 1,492) | | | | Recall Only (n = 4,620) | | | |
|---|---|---|---|---|---|---|---|---|---|
| Overall | n (%) | Concordant Cases (%) | False-negative cases (%) | Chi square | p-value | Concordant Cases (%) | False-negative cases (%) | Chi square | p-value |
| | | | | 12.85 | 0.0051 | | | 14.36 | 0.0025 |
| < 1 | 976 (14.7) | 88.3 | 11.7 | | | 85.6 | 14.4 | | |
| 1-<2 | 1,563 (25.7) | 86.9 | 13.1 | | | 83.9 | 16.1 | | |
| 2-<3 | 1,219 (22.0) | 88.1 | 11.9 | | | 83.5 | 16.5 | | |
| 3+ | 2,354 (37.7) | 93.7 | 6.3 | | | 87.7 | 12.3 | | |
| Males Only | n = 1,802 | n = 477 | | | | n = 1,325 | | | |
| | | | | 0.85 | 0.8365 | | | 2.38 | 0.4974 |
| < 1 | 628 (32.1) | 86.9 | 13.1 | | | 83.8 | 16.2 | | |
| 1-<2 | 746 (41.4) | 85.5 | 14.5 | | | 81.1 | 18.9 | | |
| 2-<3 | 386 (23.7) | 85.6 | 14.4 | | | 79.6 | 20.4 | | |
| 3+ | 42 (2.7) | 63.6 | 36.4 | | | 54.8 | 45.2 | | |
| Females Only | n = 4,310 | n = 1,015 | | | | n = 3,295 | | | |
| | | | | 7.46 | 0.0592 | | | 5.74 | 0.1250 |
| < 1 | 348 (7.7) | 91.1 | 8.9 | | | 88.8 | 11.2 | | |
| 1-<2 | 817 (19.3) | 88.2 | 11.8 | | | 86.5 | 13.5 | | |
| 2-<3 | 833 (21.3) | 89.3 | 10.7 | | | 85.2 | 14.8 | | |
| 3+ | 2,312 (51.7) | 94.3 | 5.7 | | | 88.3 | 11.7 | | |

Table 8. Multivariate Logistic Regression

| Predictor Variable | Immunization Card (n= 3,860) | | Recall only (n = 10,764) | |
|---|---|---|---|---|
| | False Negative | False Positive | False Negative | False Positive |
| | OR[a] (95% CI) | OR (95% CI) | OR (95% CI) | OR (95% CI) |
| Gender | | | | |
| Male (ref) | 1.00 | 1.00 | 1.00 | 1.00 |
| Female | 1.56 (0.81, 3.00) | 1.79 (0.83, 3.86) | 1.82 (1.26, 2.64)* | 0.89 (0.69, 1.14) |
| Race/Ethnicity | | | | |
| Non-Hispanic White (ref) | 1.00 | 1.00 | 1.00 | 1.00 |
| Non-Hispanic Black | 3.36 (1.28, 8.85)* | 1.36 (0.39, 4.67) | 1.91 (1.18, 3.11)* | 1.58 (1.07, 2.34)* |
| Hispanic | 1.15 (0.46, 2.83) | 0.61 (0.15, 2.45) | 1.98 (1.29, 3.02)* | 0.85 (0.59, 1.21) |
| Other | 1.96 (0.74, 5.16) | 0.27 (0.08, 0.93)* | 1.82 (1.00, 3.31) | 0.98 (0.61, 1.58) |
| Household Poverty Level | | | | |
| < 100% FPL[b] (ref) | 1.00 | 1.00 | 1.00 | 1.00 |
| 100-199% FPL | 0.58 (0.17, 1.97) | 0.57 (0.19, 1.73) | 0.60 (0.33, 1.08) | 1.16 (0.76, 1.78) |
| 200-299% FPL | 0.72 (0.20, 2.51) | 0.81 (0.16, 4.11) | 0.91 (0.45, 1.85) | 1.04 (0.65, 1.66) |
| >300% FPL | 0.91 (0.26, | 0.81 (0.19, 3.40) | 0.88 (0.46, 1.66) | 1.15 (0.74, 1.78) |
| Mother's Education | | | | |
| < 12 years (ref) | 1.00 | 1.00 | 1.00 | 1.00 |
| 12 years | 0.24 (0.09, 0.66)* | 0.27 (0.07, 1.10) | 0.70 (0.40, 1.23) | 0.95 (0.58, 1.54) |
| > 12, non-college grad | 0.09 (0.03, 0.30)* | 1.14 (0.27, 4.93) | 0.34 (0.19, 0.63)* | 0.73 (0.44, 1.20) |
| College Grad | 0.20 (0.07, 0.57)* | 0.66 (0.15, 2.93) | 0.41 (0.21, 0.79)* | 0.66 (0.39, 1.11) |
| Insurance Type | | | | |
| Public (ref) | 1.00 | 1.00 | 1.00 | 1.00 |
| Private | 0.99 (0.34, 2.94) | 0.32 (0.11, 0.89) | 0.54 (0.35, 0.85)* | 0.59 (0.43, 0.82)* |
| Other | 0.75 (0.18, 3.01) | 0.75 (0.14, 3.87) | 0.76 (0.34, 1.71) | 0.60 (0.33, 1.09) |
| No reported coverage | 0.85 (0.20, 3.64) | 0.71 (0.13, 3.97) | 0.76 (0.37, 1.58) | 1.49 (0.85, 2.62) |
| Mother married currently | | | | |
| No (ref) | 1.00 | 1.00 | 1.00 | 1.00 |
| Yes | 0.94 (0.39, 2.25) | 0.46 (0.23, 0.93)* | 1.12 (0.75, 1.69) | 0.95 (0.69, 1.30) |

* $p < 0.05$

[a] Odds Ratio, reference = concordant cases

[b] Federal Poverty Line