Who Gets a Provider Recommendation? Reducing Missed Opportunities to Promote the HPV Vaccine to Male and Female Teens in the U.S.

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Abstract

Objectives. To address low adolescent HPV vaccination rates, the President's Cancer Panel called for increasing communication to reduce missed vaccination opportunities. Therefore, we examined the association between receiving a provider recommendation for the HPV vaccine and subsequent initiation of the vaccine series among teens aged 13-17. Furthermore, we sought to identify important subgroups less likely to by impacted by provider recommendations.

Methods. We analyzed provider-verified vaccination data from the CDC's 2014 National Immunization Survey for Teens (n=19,125). Log-binomial regression models assessed prevalence ratios of vaccination among teens whose parents reported receiving a provider recommendation compared to those who did not. Chi-square analyses identified differences in groups with/without provider recommendation.

Results. Overall, teens who received a recommendation were more likely to initiate vaccination compared those missing this communication (PR:2.7; 95% CI:2.4-2.9). Females with recommendation were twice as likely to vaccinate (PR:1.9; 95% CI:1.7-2.2), and males with recommendation were three times more likely (PR:3.3; 95% CI:2.9-3.8), although less males received recommendations (53% vs. 74% in females). In addition, teens in Southern states and those without an 11/12-year-old wellness exam were less likely to receive a recommendation.

Conclusions. Provider recommendation is significantly associated with teen initiation of the HPV vaccine. Encouraging providers to share clear, timely recommendations for the vaccine is a simple and cost-effective intervention to improve vaccination rates among adolescents in the U.S. Intervention efforts can be targeted to subgroups we have identified as less likely to have received such recommendations, including males and teens in the South, to improve nationwide vaccination rates.

Introduction

Cancer is the second leading cause of death in the United States, and the experience of cancer illness is a significant health burden for many individuals. Yet, some cancers are almost entirely preventable through adoption of health behaviors such as vaccination. The introduction of the HPV vaccine in 2006 presented a significant advance for public health, requiring only short-term behavior change to protect against development of several cancers across a lifetime. This study examines factors associated with provider communication and uptake of the HPV vaccine among American adolescents to prevent cervical, anal, penile, and head/neck cancers, with the goal of identifying promising areas for intervention to increase population-level HPV vaccination rates.

Background on the HPV Vaccine

Human papillomavirus (HPV) is the most common sexually transmitted disease in the United States, and the majority of sexually active men and women will experience an HPV infection during their lifetimes. When an infection persists, it can serve as an etiological cause of cervical, anal, penile, and head/neck cancers[1] As a result, preventing HPV infection can dramatically reduce cancer incidence for both men and women. An important form of primary prevention, the HPV vaccine, has proved to successfully prevent infection of the most common cancer-causing strains of the virus. The vaccine is FDA-approved for use in individuals ages 9 to 26, but is most effective when administered to girls and boys before sexual activity (and exposure to HPV) begins. Consequently, the Advisory Committee on Immunization Practices (ACIP) strongly recommends vaccination for girls and boys ages 11-12.[2] Additionally, catch-up vaccines are recommended for males up to age 21 and for females up to age 26.[2] Despite these recommendations, many young people fail to receive the vaccine, and rates for teens remain far

below the public health target of 80% coverage established by the national Healthy People 2020 initiative.[3] Currently, only 60% of females aged 13-17 and 41.7% of boys 13-17 have received at least one dose of the HPV vaccine.[4] Thus, it is imperative that public health practitioners identify key barriers and facilitators that impact use of this important cancer prevention tool in the U.S. in order to increase national HPV vaccination rates for teens.

The Role of Provider Recommendation

Communication with a provider can be an important facilitator of HPV vaccine initiation for adolescents. When a provider talks with teens and their families about the HPV vaccine, this communication generally equates to a provider's recommendation for the vaccine.[5] A growing number of studies support provider recommendation as a key factor affecting whether a teen receives the HPV vaccine.[6–10] Simply put, when a doctor talks about and recommends the HPV vaccine to a family, the teen is more likely to receive it. While this body of literature has provided substantial evidence that provider recommendation matters, it has also introduced new questions that remain unanswered. First, the vast majority of research examining provider recommendation and HPV vaccine has focused on female populations,[6–10] while few studies have examined recommendation of the vaccine among males[11] or compared provider recommendation across female and male populations.[12–14] More research is needed to examine characteristics associated with provider recommendation and whether recommendation patterns differ for male and female patients.

Additionally, there is reason to consider that even among girls or boys only, not all teens are equally likely to receive a recommendation. A limitation of much of the past research is that provider recommendation is included as a covariate in models featuring HPV vaccination as the outcome. Although the impact of provider recommendation on vaccination has been

demonstrated, few studies have gone on to characterize who is actually receiving such recommendations (i.e., in terms of gender, age, income, family demographics, insurance, prior vaccination, and access to healthcare). In other words, a crucial unanswered question is *which* boys or *which* girls are more/less likely to get a provider recommendation? Given that recommendation practices may vary among patients, several studies have studied HPV vaccine communication practices reported by providers and found recommendations to vary according to provider specialty (e.g., pediatrics or gynecology), age of the patient, or patient's eligibility for government-subsidized vaccine programs (e.g., Vaccines for Children).[15–17] Yet, few studies have focused on characteristics of patient populations that are associated with provider recommendation.[13,18]

Emerging research is just beginning to identify differences in provider recommendations based on characteristics, such as ethnicity/race and sex.[19] For instance, using the 2009 NIS-Teen Ylitalo and colleagues found that among adolescent females, racial minorities were less likely to receive a provider recommendation, compared to non-Hispanic whites.[19] Of this small but growing body of literature, only one study could be located that examined characteristics linked to provider recommendation among both boys and girls.[13] Recently, Gilkey et al. found more boys than girls reported not receiving a provider recommendation.[13] If provider recommendation can increase HPV vaccination, it is essential to continue to identify subgroups in the population who are and are not receiving recommendations.

Finally, although a provider recommendation may often contribute to successful health behavior, recommendation itself not always a sure path to vaccination. In other words, what factors are associated with non-adherence when a provider recommendation fails to translate into HPV vaccine initiation? In response, the present study seeks to examine the prevalence of

provider recommendation among both girls and boys and identify additional characteristics associated with receiving a recommendation in both populations. Lastly, the study will identify subgroups for whom a provider recommendation does not impact HPV vaccine initiation and examine reasons why some teens may fail to initiate the vaccine even when recommended. The current study utilizes the 2014 National Immunization Survey – Teen (NIS-T)[20] to address these questions and accomplish the following specific aims outlined below. This work can provide an evidence base for future interventions designed to reduce barriers and increase vaccination behavior.

Aim 1: Determine the association between provider recommendation and HPV vaccine initiation in a nationally representative sample of adolescent girls and boys.

Aim 2: Determine sociodemographic and health behavior characteristics associated with receipt of a provider recommendation and whether these differ among girls and boys.

Aim 3: Among teens who receive a provider recommendation for the vaccine, identify characteristics of subgroups for whom recommendation is not associated with actual HPV vaccine initiation and explore reasons for the lack of impact.

Method

The present study makes use of the National Immunization Survey for Teens (NIS-Teen),[21] an annual cross-sectional survey of households conducted by the Centers for Disease Control and Prevention (CDC) to monitor vaccination coverage across the United States adolescent population since 2006. The objective of the NIS-Teen is to survey a sample of adolescents aged 13 to 17 years old at time of interview to estimate rates of recommended, booster, and catch-up vaccines. Data from these surveys is made publically available to researchers on the CDC website.[21]

The NIS/NIS-Teen survey consists of two data collection phases: a telephone survey and a mailed provider verification survey.[20] Households in all fifty U.S. states, the District of

Columbia, and selected U.S. territories (rotated each year) with land or cellular telephone lines are eligible to be sampled for participation in the first phase of the survey. For 2014, the territory Puerto Rico was included in the sample. Individuals are recruited via random digit-dialing to participate in a telephone survey. Households reached via phone are screened to determine if at least one teen aged 13 to 17 resides in the home. If more than one teen is in the home, one teen is selected at random for inclusion in the sample. The adult most familiar with the teen's vaccination history participates in the survey interview. Questions measure the teen's health and vaccination history, whether the teen received a provider recommendation for the HPV vaccine, and sociodemographic information about the teen and his/her mother. Consent is also requested to obtain the teen's vaccination history from a healthcare provider.

If consent is obtained, the healthcare provider is then mailed a questionnaire to verify the teen's vaccination history. As a result, only a subset of all teens included in the telephone survey is included in the second phase of data collection. For 2014, a total of 38,703 were included in the telephone survey and 54.4% or 21,057 also completed the provider verification phase of data collection.[22] The analytic sample for the present study consisted of adolescents aged 13 to 17 residing in the fifty U.S. states and the District of Columbia, with provider-verified data. Adolescents from Puerto Rico were excluded as these individuals were missing all data for several key variables, including geographic region. Additional details about the analytic sample are provided in Figure 1.

Survey weights

Given the complex nature of the NIS-Teen survey design, recommended weights are provided as variables in the dataset. All analyses were conducted in STATA v.14 using "svy" commands, along with appropriate procedures for analysis of complex survey data (e.g., use of

design-based adjusted chi-square tests, etc.). NIS-Teen provides several weighting options based on the analytic sample. The weight variable corresponding to the subset of the data described above was used for all analyses. Following best practices outlined in the NIS-Teen codebook and user guide,[20] all analyses in the present study used the following set up for weighting the dataset: The unique teen identifier variable "seqnumt" was used as the primary sampling unit, or PSU; the variable "provwt_d" as the survey weight; and the variable "stratum" as the stratum indicator. The weight variable was then normalized by dividing each weight value for "provwt_d" by the mean weight for this variable. This step allowed calculation of weighted counts for the sample, as reported in Tables 1a and 3.

Measures

Provider recommendation was defined as parental or guardian recall of having received a recommendation for the HPV vaccine from a healthcare provider, measured by the single survey item "Had or has a doctor or other healthcare professional ever recommended that the teen receive HPV shots?" (*no = 0, yes = 1*). HPV vaccine initiation was defined as receiving at least one dose of the vaccine, verified by a healthcare provider. Vaccine initiation, rather than completion, was the focus of this study as initiation constitutes a fundamentally different health behavior from continuation or completion of a vaccine series.[23] Additionally, within the age range of adolescents in the study, it is likely that some individuals would not have had the opportunity to receive all three vaccines prior to participating in the interview. Thus, initiation encompassed more appropriate assessment of HPV vaccination behavior for this population. Initiation was assessed as a dichotomous variable, *0 = has not initiated (< 1 HPV shots), 1 = has initiated the HPV vaccine series (=> 1 shot)*.

Covariates were identified a priori from the list of available variables measured in the dataset, based on findings from previous analyses of NIS-Teen datasets.[24,23] Covariates included the age of the teen at time of interview, race/ethnicity of teen, poverty status, insurance type, geographic region of residence, mother's age, mother's education, and four measures of healthcare history: the number of visits to a doctor or other healthcare provider in the past 12 months, time since the teen's last visit to a doctor, and provider-verified history of hepatitis B and Tdap vaccination. Insurance was assessed through multiple questions in the NIS-Teen survey. To simplify interpretation, I developed a composite categorical variable for insurance, following general categories used in previous studies.[11] Each individual was coded as having one of the following insurance types: private (through parent employer or union), public (Medicare/caid, S-chip, military, or American Indian coverage), other, multiple coverage (defined as having both private and public insurance), no insurance, or unknown/unreported insurance status. The two vaccination variables were selected from a variety of possible vaccines which also included seasonal influenza, meningitis, and hepatitis A, and varicella (chicken pox). Vaccination rates were relatively similar across these vaccine types. To reduce the potential for collinearity if all vaccines were to be included, hepatitis B was selected for its biological similarity to the HPV vaccine (that is, it is a vaccine given to prevent viral infection that can be sexually transmitted and which can lead to cancer development if untreated). Tdap was included as a booster shot is recommended for adolescents during the same developmental time frame (age 11-12) that the HPV vaccine should be administered.

In addition to individual covariates, previous studies utilizing NIS-Teen data have reported interactions between race and insurance type. Therefore, a race-by-insurance interaction

term was initially included in order to investigate whether insurance type moderated the association between race and provider recommendation.[24,25]

Analysis

All analyses were survey set using procedures described above. First, a description of the sample was obtained by cross-tabulating each variable across the entire sample and stratified by male/female sex to produce weighted counts and percentages. Next, log-binomial regression was selected in order to estimate prevalence rate ratios. This approach was selected over logistic regression, based on the high prevalence of the outcome, as the odds ratios produced by logistic regression produce more extreme estimates when an outcome is common in the population. However, the log binomial model failed to converge for the adjusted model including provider recommendation, HPV vaccine initiation, and all covariates. Thus, Poisson regression with robust variance estimation was utilized in place of the log binomial approach for all of the final models reported.

First, bivariate models assessed crude prevalence ratios among levels of each covariate (age, race/ethnicity, insurance, geographic region, mother's age and education, number of doctor's visits in the last year, time since last doctor's visit, and history of Hepatitis B and Tdap booster vaccination) with provider recommendation. Next, an adjusted model examined the unique associations of each covariate with provider recommendation in a multiple regression model, which included all possible covariates with provider recommendation.

Next, this procedure was repeated to examine bivariate associations between provider recommendation and additional covariates with HPV vaccination initiation. An adjusted model assessed the independent association between provider recommendation and HPV vaccine initiation, controlling for all covariates in the final model. All covariates were included in the

final adjusted model, regardless of statistical significance, based a priori on previous literature and/or hypothesized clinically relevant relationships between each variable and the outcome. Additionally, controlling for a wide range of potential confounders allowed for a more precise estimate of the unique relationship between provider recommendation and HPV vaccine initiation.

Informed by previous literature,[14] I anticipated qualitative differences in associations of characteristics, provider recommendation, and HPV initiation by sex, as vaccination policy has differed for females and males over time (i.e., females had more opportunity for "exposure" to a provider recommendation than boys). Given this expectation, in addition to models run using the full combined sample of teens (as reported in Tables 3-4), alternate models reporting estimates for boys and girls separately are provided in Appendices A and B.

The analyses described above can provide insight into factors associated with teenage HPV vaccine initiation. In addition to these variables, the NIS-Teen also collectively qualitative data to better understand the reasons why parents choose not to initiate the HPV vaccine for teens. To this end, the NIS-Teen gathers and categorizes parent-provided reasons for non-vaccination among parents who recall receiving a provider recommendation for the HPV vaccine and at the same time, self-report that they have no intention or are unsure of whether they will initiate the vaccine for their teen in the next 12 months. To summarize this data, I calculated the frequency of top reasons selected by parents of girls and boys who did not intend to pursue the vaccine over the next year.

Sensitivity analysis. Sensitivity analyses allow researchers to investigate potential biases that may arise due to measurement of key variables, such as the outcome HPV vaccine initiation. In the NIS-Teen dataset, HPV vaccination is able to be assessed in two ways. First, vaccination

is measured through a self-reported item, which asks the parent or guardian to recall if the teen has received one or more HPV shots. Second, HPV vaccination is assessed through provider verification of the teen's medical history via mailed questionnaire. Following procedures outlined by the NIS-Teen data user's guide and previous NIS-Teen research,[20,26] the present study used the second, provider-verified measure for the primary outcome in all analyses. This analytic decision held potential for introducing a response bias. As only two-thirds of adolescents in the study had verified vaccination histories, this left open the possibility that teens without provider verification may differ by provider recommendation status, HPV vaccine initiation, or key characteristics such as race, insurance or geographic region. A sensitivity analysis was conducted to examine whether the results would differ by measurement of the outcome. The distribution of variables for adolescents with provider verified HPV vaccine outcomes was compared to the distribution for adolescents with self-reported HPV vaccination outcome to assess the stability of the findings.

Results

Sample Demographics

Characteristics of the sample are presented in Table 1. The unweighted analytic sample for Aim 1 contained 19,125 adolescents (weighted n = 18,948). Approximately half (50.5%) were males, and the sample was equally distributed across ages 13 to 17 for both boys and girls. Over half of the sample identified as non-Hispanic White (55.5%), 13.8% as non-Hispanic Black, 22.2% Hispanic, and 8.7% other or multiple races. Almost one quarter of teens (22.3%) had a reported household income below the 2011 poverty threshold.

Most teens had insurance coverage, with almost half reporting a form of private insurance, including employer- or union-based coverage (46.9%), followed by public insurance,

including Medicaid, S-chip, military, and American Indian insurance plans (30.2%), other forms of coverage (3.9%), and multiple (10.1%) forms of coverage. Less than ten percent reported either no coverage or did not provide information about insurance status. More participants resided in Southern states (38.0%) compared to the Northeast (16.4%), Midwest (21.8%), and Western regions (23.7%) of the country.

The majority of teens' mothers were aged 35 or older (90.9%) and had attended some college (26.1%) or completed a college degree (38.0%). In terms of medical history, most teens had seen a doctor within the last two years, and almost half had seen a doctor two or more times in the last twelve months (46.4%). Boys reported slightly less visits to the doctor in the past twelve months compared to girls. Over ninety percent of teens were up to date on their Hepatitis B and Tdap booster vaccines, as verified by a healthcare provider. Among all teens, 63.9% had a parent or guardian recall receiving a recommendation for the HPV vaccine from a healthcare provider. Provider recommendation differed by sex, as 74.2% of girls received a recommendation compared to only 53.7% of boys. Overall, 51.7% of teens had initiated the HPV vaccine, although initiation was more prevalent in girls (60.6%) than boys (43.0%).

Next, we sought to examine the impact of provider recommendation on HPV vaccine initiation in this sample. Table 2 reported prevalence ratios for HPV vaccine initiation among teens who did and did not receive a provider recommendation. Overall, provider recommendation was associated with HPV vaccine initiation. Teens who received a recommendation were almost three times more likely to vaccinate than those without a recommendation (PR: 2.7, CI: 2.4-2.9). The independent effect of provider recommendation was slightly attenuated but still strong in the adjusted model, which accounted for all covariates from

Table 1 (PR: 2.4, CI: 2.2-2.6). Provider recommendation had a stronger independent association with HPV vaccine initiation for males (3.0, CI: 2.6-3.4) than females (1.8, CI: 1.6 -2.0).

Given that provider recommendation had a significant independent effect on HPV vaccine initiation, we examined characteristics that were associated with whether or not a teen received a provider recommendation. Males were less likely to receive a recommendation than females (PR: .73, CI: .70, .76). Additionally, 15- and 17-year-olds were more likely to receive a provider recommendation, compared to 13-year-olds (15 years: PR: 1.10, CI: 1.03, 1.17; 17 years: PR: 1.07, CI: 1.01, 1.14). Across all teens, there were no differences in provider recommendation rates by race/ethnicity or insurance type. Provider recommendation differed by poverty status. Teens with household incomes over $75,000 were more likely to receive a recommendation compared to teens below the poverty line (PR: 1.13, CI: 1.04, 1.22). Geographic region was associated with provider recommendation for two regions. Among all teens, those living in the South were 5% less likely to receive a provider recommendation compared to the Northeast (PR: .95, CI: .90, .99). Among boys only, those in the Midwest were even less likely to receive a recommendation compared to the Northeast (PR: .86, CI: .79, .94).

Although mother's age did not impact receipt of a provider recommendation for the HPV vaccine, girls with mothers who had completed college were 19% more likely to receive one (PR: 1.19, CI: 1.06, 1.32). The amount of time since the teen's last visit to a healthcare provider was associated with provider recommendation. Teens who had not been to a provider for 1 to 2 years were 11% less likely to have received a provider recommendation (PR: .89, CI: .86, .93), and those with a lapse of 3 or more years since last visit were 29% less likely to receive a recommendation (PR: .71, CI: .60, .82). Among boys only, the number of visits to a healthcare provider in the past 12 months was positively associated with provider recommendation. Those

with one visit were 34% more likely to report a recommendation (PR: 1.34, CI: 1.15, 1.55), while the effect was even stronger among boys with 2-3 visits (PR: 1.42, CI: 1.23, 1.64) and 4 or more visits in the past year (PR: 1.59, CI: 1.36, 1.86). Past vaccinations were associated with provider recommendation for HPV vaccine. Boys who had received a Hepatitis B shot were 1.46 times more likely to receive a recommendation (PR: 1.46, CI: 1.18, 1.82), and all teens who had a Tdap shot were 1.44 times more likely to have a recommendation (PR: 1.44, CI: 1.31, 1.59).

Although receiving a provider recommendation was strongly associated with initiating the HPV vaccine, not all teens with a recommendation vaccinated. Aim 3 sought to characterize subgroups of teens for whom provider recommendation was less likely to be linked to vaccine initiation. Table 4 presents prevalence rate ratios of HPV vaccine initiation among teens that received provider recommendations.

Males with a recommendation were 9% less likely to initiate HPV vaccination compared to females (PR: .91, CI: .87, .95). Compared to 13 year olds, all older age groups were more likely to initiate the HPV vaccine, with this impact strongest among the oldest age group, 17-year-olds (PR: 1.24, CI: 1.15, 1.35). Among girls, there were no differences in HPV vaccine initiation by race/ethnicity. However, Hispanic boys with a recommendation were more likely to initiate the vaccine than Whites (PR: 1.26, CI: 1.14, 1.38). Poverty status, insurance type, and geographic region were not significantly associated with HPV vaccine initiation.

Older age of a teen's mother was associated with lower HPV vaccine initiation among girls. Those with mothers age 35-44 (PR: .89, CI: .81, .96) and 45 or older (PR: .88, CI: .80, .98) were 11-12% less likely to get the vaccine than girls with mothers younger than 35. Mother's education level impacted HPV vaccination among boys. Those with mothers who had attended some college (PR: .85, CI: .75, .95) or completed a college degree (PR: .87, CI: .78, .98) were

also less likely to initiate the vaccine than boys whose mothers had completed less than 12 years of school. The amount of time since a teen's last visit to a healthcare provider also impacted HPV vaccine initiation. Teens who had not been to the doctor for 1-2 years (PR: .89, CI: .85, .94) or 3 or more years (PR: .70, CI: .58, .85) were significantly less likely to initiate HPV vaccination. However, the number of visits to a healthcare provider within the last year was only associated with HPV vaccination among girls. Those who had 1 visit (PR: 1.13, CI: 1.04, 1.24), 2-3 visits (PR: 1.17, CI: 1.08, 1.27), or 4 or more visits (PR: 1.21, CI: 1.10, 1.33) were more likely to initiate the vaccine compared to girls who had not been to a provider within the past year. Finally, girls who received the Hepatitis B shot were 43% more likely to start the HPV vaccine (PR: 1.43, CI: 1.16, 1.77). Among all teens with a provider recommendation, those who had a Tdap shot were over twice as likely to initiate the HPV vaccine (PR: 2.17, CI: 1.80, 2.61).

Qualitative Reasons for Not Vaccinating Teens

Parents who received a provider recommendation in support of the HPV vaccine but did not vaccinate their teens were asked if how likely they would be to initiate the vaccine in the next twelve months. Parents who responded "not likely" or "unsure" were then asked to select one or more reasons to explain this response. Table 5 presents the frequencies of reasons given by parents of teens who received a provider recommendation but did not vaccinate. Frequencies for each of 25 reasons ranged from less than one percent to 20.0%. Among girls, the top reasons for not initiating the vaccine included concerns about vaccine safety and side effects (18.9%), deeming the vaccine not needed or not necessary (16.9%), noting that the vaccine was not recommended (10.4%), and lack of knowledge about the vaccine (8.0%). The top four reasons were the same for boys, although frequencies of these reasons differed: not necessary (20.0%), lack of knowledge (11.7%), safety concerns (11.6%), and not recommended (10.5%).

Sensitivity Analysis

A sensitivity analysis was conducted to examine the possibility of a response bias in the outcome variable due to use of provider-verified data only. Analyses were re-run with the alternate measure for the outcome, parent-reported HPV vaccine initiation, in place of provider data. Point estimates did not change for the majority of covariates. However, use of the parent recall data resulted higher estimates of both Hepatitis B and Tdap vaccination than in the verified data only. This finding is not surprising, as parents are may be likely to overestimate the degree to which their children are up to date on vaccines when other behaviors are consistent with good health (e.g. attending routine doctor's exams) or report positive vaccination behaviors as a result of a social desirability bias. More importantly, sensitivity analysis revealed a recall bias in the alternate measure, such that HPV vaccine initiation was more likely to be underreported by parental recall, compared to provider-verified records. Among all parents, 28% incorrectly stated that their teen had not received any HPV shots, when provider records verified that these teens had indeed initiated the vaccine. This misclassification was smaller among parents who reported receiving a provider recommendation for the vaccine. Ultimately, using the alternate parental recall measure to assess the outcome led to a substantial overestimation of the association between provider recommendation and HPV vaccine initiation (aPR: 5.84, CI: 5.07, 6.72), so the original provider-verified outcome was retained for all reported analyses.

Discussion

Across the U.S., HPV vaccine initiation rates among teens remain far below the benchmark established by Healthy People 2020 and lag behind rates of similar developed countries.[27] Past research has found that provider recommendation plays a substantive role in whether individuals initiate the HPV vaccine during crucial adolescent years. Yet, little is known

about the factors that influence whether a teen receives a provider recommendation for the vaccine and how recommendation differs among girls and boys. While two previous studies have found differences in rates of provider recommendation by sex.[13,14] no study to date has characterized the unique factors associated with whether girls and boys receive a provider, nor examined the characteristics of teens for whom provider recommendation does not translate to vaccination. To this end, the present study estimated the strength of association between provider recommendation and HPV vaccine initiation in a population-based sample of U.S. teens for the year 2014 (Aim 1), determined sociodemographic and health behavior characteristics associated with receipt of a provider recommendation among girls and boys (Aim 2), and identified subgroups of teens for whom a provider recommendation is less likely to impact HPV vaccine initiation (Aim 3).

In line with previous studies, results indicated that provider recommendation had a strong association with HPV vaccine initiation for all teens.[18,19,25,26] In a multivariate model controlling for a variety of established demographic and health behavior characteristics including age, race, insurance, geographic region, and vaccination history, teens who received a provider recommendation were over two and half times more likley to vaccinate. The effect of provider recommendation was stronger among boys than girls. However, consistent with past research, boys in this sample were less likely to receive a provider recommendation at all.[13] Thus, public health practitioners should consider interventions aimed at increasing provider conversations about the HPV vaccine with boys during early adolescent years to enhance HPV vaccine initiation rates at the population-level.

Additionally, the study identified subgroups of boys and girls who were less likely to receive a provider recommendation. Teens with household incomes below the poverty line were

less likely to receive a provider recommendation compared to those with incomes over $75,000. However, the present study also examined numerous, previously unstudied characteristics associated with provider recommendation in boys and girls, including geographic region. Additionally, teens in the South had lower rates of provider recommendation compared to teens in the Northeast. Notably, provider recommendation rates were also low among boys in the Midwest. Many past efforts to improve HPV vaccination rates have focused on racial and ethnic subgroups. However, the present study found no differences in provider recommendation by teen race or Hispanic ethnicity, consistent with recent findings from Gilkey and colleagues.[25] In light of the evidence, practitioners should consider intervention strategies to increase provider recommendations among other subgroups of teens beyond race/ethnicity, for instance by targeting communication between providers and teens in low-income households or among teens in regions of the country with lower rates of provider recommendation. Finally, teens with longer lapses since their last visit to a healthcare provider were less likely to receive a provider recommendation than teens who had visited a provider with the past year. Thus, it is crucial for providers to view all visits as opportunities to spark discussions about the HPV vaccine, particularly for teens with less consistent healthcare contact throughout adolescence.

Although provider recommendation was strongly associated with HPV vaccine initiation, this impact was not universal; almost one third of teens with a provider recommendation did not initiate the HPV vaccine. Even when recommended by a provider, HPV vaccine initiation continued to be more common among girls than boys. HPV vaccination did not differ by race or ethnicity among girls. In contrast, among boys with a provider recommendation, the Hispanic subgroup was more likely to initiate the vaccine than White teens. Consistent with recent CDC reports, HPV vaccination was also more common among older teens.[4] Yet, the ACIP

recommends vaccinating at earlier ages, before sexual activity is likely to occur, for maximum protection against HPV. Provider communication during 11-12 year old wellness visits can serve as a crucial intervention point for shifting initiation of the HPV vaccination to adolescents at younger ages.

Among teens who had not been vaccinated and did not have intentions to do so, parent responses provided several key insights. Although frequencies of these reasons varied between boys and girls, the top reasons for both sexes similarly consisted of concerns about vaccine safety, a lack of knowledge about the vaccine, feeling that it was not necessary, and reporting that it was not recommended. This list stood out in contrast to HPV vaccination themes common in mainstream news reporting, which has drawn attention to perceived barriers to vaccination such as anti-vaccination beliefs and concerns about increased sexual activity associated with the vaccine.[28] The current study suggests that these reasons account for only a small percentage (less than 1% each) of the reasons why teens do not receive the HPV vaccine, even when it is recommended. More often, misconceptions, concerns, or lack of information about the vaccine may be primary reasons why parents do not initiate the HPV vaccine for both male and female teens.

The present study was subject to several limitations, which must be noted. First, the data was cross-sectional, limiting the ability to draw causal inferences about the relationships between variables. Although a strong association was observed between recommendation and vaccination, it was not possible to determine whether provider recommendations were received prior to (and led to) HPV vaccine initiation. Future research should consider longitudinal study designs to assess the temporal relationship between provider communication and subsequent HPV vaccine behavior.

Second, the study relied on a self-reported measure of provider recommendation. In light of the number of vaccines and other routine medical decisions parents must consider throughout a child's early and adolescent years, it is possible that some parents did not remember receiving a provider recommendation, leading to recall bias resulting in underreport of this communication. It is possible that a less subjective measure, such as cross-checking recommendation status with the healthcare provider, would result in more precise estimation of the true prevalence of provider recommendation in this population. Nonetheless, prevalence rates for provider recommendation followed a distribution for boys and girls comparable to past research, reducing concern about recall bias for this measure in the present study.[13,29]

Finally, although the study focused on whether provider recommendations were received by teens and their parents, we did not evaluate the content of these interactions. A recent study has suggested that the quality of a recommendation message may moderate the relationship between receipt of a provider recommendation and HPV vaccine initiation, with lower-quality recommendations associated with more modest rates of HPV vaccination.[13] It is likely that the quality of recommendations varied across individuals and subgroups in the present study. As a result, lower quality communication may have attenuated the reported impact of provider recommendation in the reported results. Future studies should incorporate measures of message quality to evaluate not only whether providers are communicating with teens about the HPV vaccine, but what information is being conveyed, in order to more fully understand the impact of provider recommendation on this health behavior and guide future provider-based interventions.

Despite these limitations, the study also holds several key strengths, making clear contributions to the literature on provider recommendation and HPV vaccination. First, the study used a large, nationally representative dataset weighted based on demographic results of the most

recent U.S. census. Accordingly, findings from the study are likely to be generalizable to American teens at a population level. Second, although recent research has examined covariates of HPV vaccination among male and female adolescent populations,[13,14] this is the first study to examine a range of teen characteristics associated with boys' and girls' receipt of a provider recommendation in the context of the HPV vaccine. In particular, research on characteristics associated with HPV vaccination (especially the role of provider recommendation) for males post-FDA approval, is sparse. This study is among the first to offer insight into a complex and unique array of factors associated with the vaccine in a nationally representative sample of male adolescents. Third, the study utilized a relatively objective measure of HPV vaccine initiation, number of shots received as verified by healthcare provider report. Comparison to parental recall measures in a sensitivity analysis demonstrated that the study measure presented a more conservative estimate of the association between provider recommendation and HPV vaccine initiation than the overestimations resulting from an alternate analysis featuring self-report of the HPV vaccine.

In sum, the study extends existing support for provider recommendation as an important factor associated with HPV vaccination by identifying more detailed information about the subpopulations of teens who are more and less likely to receive crucial communication from a provider regarding the vaccine. Additionally, to our knowledge, this is the first study to evaluate not only differences in provider recommendation rates, but also key characteristics association with provider recommendation among both girls and boys. As a result, findings may be used to tailor interventions aimed at promoting provider recommendations in unique ways for adolescent boys and girls. Importantly, results of this study enhance the evidence base for future public health communication interventions. Currently, HPV vaccination rates in the U.S. lag far behind

those of other developed nations, such as Australia, which saw a rapid and substantial uptake of the HPV vaccine shortly after launching a national HPV vaccination program for 12-13 year olds in 2007.[27] Researchers have attributed the success in Australia in large part to a comprehensive strategy that engaged government, community, and healthcare providers. More recently, practitioners have renewed the call for diverse and comprehensive efforts to promote the HPV vaccine in the U.S. through campaigns that engage patients, providers, schools, and healthcare systems.[30] In fact, the 2012-2013 President's Cancer Panel Annual report called for public health officials to "develop, test, disseminate, and evaluate the impact of integrated, comprehensive communication strategies for physicians and other relevant health professionals" and noted that providers should encourage HPV vaccination when administering other routine vaccinations.[31] Provider recommendation should comprise a key element of such an approach. Encouraging providers to share clear, timely recommendations for the vaccine is a simple and cost-effective health communication intervention to improve vaccination rates among adolescents in the U.S.

Such intervention efforts may be particularly effective when targeted toward subgroups we have identified as less likely to have received such recommendations, including males and teens in the South, to improve nationwide vaccination rates. Now public health practitioners and healthcare providers have an opportunity to work together to take up this call and facilitate communication efforts to improve nationwide HPV vaccination and ultimately, cancer prevention.

Connections to MPH Goals Analysis

The present study has provided an opportunity to address and strengthen key areas identified over the course of the academic year through my goals analysis plan. In particular, I noted early on in the MPH program that I aimed to use the capstone as a chance to achieve the

following two goals: To strengthen my quantitative research skills and to build a long-term research program in public health communication. To this end, I believe the capstone project has been a success. I have expanded my ability to conduct complex survey analyses in STATA, while at the same time advancing my knowledge of an important area of public health communication, provider recommendation and vaccine-based cancer prevention. I look forward to building upon this capstone experience as I conclude my academic year at Johns Hopkins and pursue a career as a professional public health communication researcher.

References

1. HPV | HPV and Cancer | Human Papillomavirus | CDC. http://www.cdc.gov/hpv/parents/cancer.html. Accessed April 27, 2016.
2. Human Papillomavirus Vaccination: Recommendations of the Advisory Committee on Immunization Practices (ACIP). http://www.cdc.gov/mmwr/preview/mmwrhtml/rr6305a1.htm. Accessed April 27, 2016.
3. Immunization and Infectious Diseases | Healthy People 2020. https://www.healthypeople.gov/2020/topics-objectives/topic/immunization-and-infectious-diseases/objectives. Accessed April 27, 2016.
4. Reagan-Steiner S, Yankey D, Jeyarajah J, et al. National, Regional, State, and Selected Local Area Vaccination Coverage among Adolescents Aged 13-17--United States, 2014. *Mmwr*. 2015;64(29):784-792. http://www.ncbi.nlm.nih.gov/pubmed/26225479.
5. Rosenthal S l., Weiss T w., Zimet G d., Ma L, Good M b., Vichnin M d. Predictors of HPV vaccine uptake among women aged 19–26: Importance of a physician's recommendation. *Vaccine*. 2011;29(5):890-895. doi:10.1016/j.vaccine.2009.12.063.
6. Bednarczyk R a., Curran E a., Orenstein W a., Omer SB. Health disparities in Human Papillomavirus vaccine coverage: Trends analysis from the National Immunization Survey-Teen, 2008-2011. *Clin Infect Dis*. 2014;58(2):238-241. doi:10.1093/cid/cit707.
7. Caskey R, Lindau S, Alexander G. Knowledge and early adoption of the HPV vaccine among girls and young women: results of a national survey. *J Adolesc Heal*. 2009;45(5):453-462. doi:10.1016/j.jadohealth.2009.04.021.
8. Kessels SJM, Marshall HS, Watson M, Braunack-Mayer AJ, Reuzel R, Tooher RL. Factors associated with HPV vaccine uptake in teenage girls: A systematic review. *Vaccine*. 2012;30(24):3546-3556. doi:10.1016/j.vaccine.2012.03.063.
9. 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. *Matern Child Health J*. 2013;17(5):879-885. doi:10.1007/s10995-012-1066-z.
10. Smith PJ, Stokley S, Bednarczyk RA, Orenstein WA, Omer SB. HPV vaccination coverage of teen girls: The influence of health care providers. *Vaccine*. 2016;34(13):1604-1610. doi:10.1016/j.vaccine.2016.01.061.
11. Reiter PL, Gilkey MB, Brewer NT. HPV vaccination among adolescent males: results from the National Immunization Survey-Teen. *Vaccine*. 2013;31(26):2816-2821. doi:10.1016/j.vaccine.2013.04.010.
12. Gilkey MB, Moss JL, McRee A-L, Brewer NT. Do correlates of HPV vaccine initiation differ between adolescent boys and girls? *Vaccine*. 2012;30(41):5928-5934. doi:10.1016/j.vaccine.2012.07.045.
13. Gilkey MB, Calo WA, Moss JL, Shah PD, Marciniak MW, Brewer NT. Provider communication and HPV vaccination: The impact of recommendation quality. *Vaccine*. 2016;34(9):1187-1192. doi:10.1016/j.vaccine.2016.01.023.
14. Lindley MC, Jeyarajah J, Yankey D, Curtis CR, Markowitz LE, Stokley S. Comparing Human Papillomavirus Vaccine Knowledge and Intentions Among Parents of Boys and Girls. *Hum Vaccin Immunother*. 2016;5515(April):00-00. doi:10.1080/21645515.2016.1157673.
15. Bynum SA, Malo TL, Lee JH, Guiliano AR, Vadaparampil ST. HPV vaccine information-seeking behaviors among us physicians: Government, media, or colleagues? *Vaccine*.

2011;29(32):5090-5093. doi:10.1016/j.vaccine.2011.04.134.
16. Vadaparampil ST, Malo TL, Kahn JA, et al. Physicians' Human Papillomavirus Vaccine Recommendations, 2009 and 2011. *Am J Prev Med*. 2014;46(1):80-84. doi:10.1016/j.amepre.2013.07.009.
17. Young JL, Jd RGB, Korte JE, Stoler MH, Guterbock TM, Rice LW. Original Study Human Papillomavirus Vaccination Recommendation May be Linked to Reimbursement : A Survey of Virginia Family Practitioners and Gynecologists. *J Pediatr Adolesc Gynecol*. 2016;24(6):380-385. doi:10.1016/j.jpag.2011.06.016.
18. Lau M, Lin H, Flores G. Factors associated with human papillomavirus vaccine-series initiation and healthcare provider recommendation in US adolescent females : 2007 National Survey of Children's Health ☙. *Vaccine*. 2012;30(20):3112-3118. doi:10.1016/j.vaccine.2012.02.034.
19. Ylitalo KR, Lee H, Mehta NK. Health care provider recommendation, human papillomavirus vaccination, and Race/Ethnicity in the US national immunization survey. *Am J Public Health*. 2013;103(1):164-169. doi:10.2105/AJPH.2011.300600.
20. U.S. Department of Health and Human Services (DHHS) NC for HS. National Immunization Survey-A User's Guide for the 2014 Public-Use Data File. 2015;(October).
21. NIS - Datasets for the National Immunization Survey - Teen. http://www.cdc.gov/nchs/nis/data_files_teen.htm. Accessed April 27, 2016.
22. Centers for Disease Control and Prevention. National Immunization Survey. *Centers Dis Control Prev*. 2015. http://www.cdc.gov/vaccines/imz-managers/coverage/nis/child/index.html.
23. Reiter PL, Gilkey MB, Brewer NT. HPV vaccination among adolescent males: Results from the National Immunization Survey-Teen. *Vaccine*. 2013;31(26):2816-2821. doi:10.1016/j.vaccine.2013.04.010.
24. Cosides O. *Factors associated with missed opportunities for HPV vaccination among vaccine-accepting adolescent boys and girls in the National Immunization Survey -Teen 2011-2012*. [Thesis]. Johns Hopkins Bloomberg School of Public Health; 2015;(May).
25. Gilkey MB, Calo WA, Moss JL, Shah PD, Marciniak MW, Brewer NT. Provider communication and HPV vaccination : The impact of recommendation quality. *Vaccine*. 2016;34(9):1187-1192. doi:10.1016/j.vaccine.2016.01.023.
26. Reiter PL, McRee A-L, Gottlieb SL, Brewer NT. Correlates of receiving recommended adolescent vaccines among adolescent females in North Carolina. *Hum Vaccin*. 2011;7(1):67-73. http://search.ebscohost.com/login.aspx?direct=true&db=cmedm&AN=21263224&site=ehost-live&scope=cite.
27. Garland SM, Eundem FA, Rcpa F. The Australian Experience With the Human Papillomavirus Vaccine. *Clin Ther*. 2014;36(1):17-23. doi:10.1016/j.clinthera.2013.12.005.
28. Krakow M, Rogers B. Collateral Damage and Critical Turning Points: Public Health Implications of HPV Vaccine News Coverage for Boys and Men in 2011. *Health Commun*. 2016;0236(January):1-8. doi:10.1080/10410236.2015.1038773.
29. Dorell C, Yankey D, Kennedy A, Stokley S. Factors that influence parental vaccination decisions for adolescents, 13 to 17 years old: National Immunization Survey-Teen, 2010. *Clin Pediatr (Phila)*. 2013;52(2):162-170. doi:10.1177/0009922812468208.
30. Beavis AL, Levinson KL. Preventing Cervical Cancer in the United States : Barriers and

Resolutions for HPV vaccination. *Front Oncol.* 2016;6(February):1-9. doi:10.3389/fonc.2016.00019.

31. Accelerating HPV Vaccine Uptake: Urgency for Action to Prevent Cancer: Appendix B: Panel Recommendations and Responsible Stakeholders. http://deainfo.nci.nih.gov/advisory/pcp/annualReports/HPV/AppendixB.htm#sthash.fhIxBgg2.YRDjU8Ok.dpbs. Accessed April 26, 2016.

Table 1. Weighted distribution of teen characteristics, provider recommendation, and HPV vaccine initiation among all teens and by sex, 2014 NIS-Teen

Variable	All weighted n (weighted %)	Female weighted n (weighted %)	Males weighted n (weighted %)
Total	18,948	9386 (49.5%)	9562 (50.5%)
Age			
13	3792 (20.0)	1878 (20.0)	1915 (20.0)
14	3745 (19.8)	1839 (19.6)	1906 (19.9)
15	3725 (19.7)	1824 (19.4)	1901 (19.9)
16	3919 (20.7)	1873 (20.0)	2047 (21.4)
17	3767 (19.9)	1974 (21.0)	1793 (18.8)
Race/ethnicity			
White	10458 (55.2)	5035 (53.6)	5423 (56.7)
Black	2624 (13.8)	1375 (14.6)	1250 (13.1)
Hispanic	4206 (22.2)	2134 (22.7)	2072 (21.7)
Other/Multi	1659 (8.7)	842 (9.0)	817 (8.6)
Poverty status			
< pov level	4219 (22.3)	2195 (23.4)	202 (21.2)
At pov <=75k	6701 (35.4)	3246 (34.6)	3455 (36.1)
>75k	7042 (37.2)	3443 (36.7)	3599 (37.6)
Unreported	986 (5.2)	502 (5.4)	484 (5.1)
Insurance [a]			
Private	8883 (46.9)	4303 (45.8)	4580 (47.9)
Public	5715 (30.2)	2846 (30.3)	2870 (30.0)
Other	677 (3.6)	305 (3.3)	372 (3.9)
Multiple	1909 (10.1)	995 (10.6)	914 (9.6)
None	843 (4.5)	486 (5.2)	357 (3.7)
Unknown	920 (4.9)	451 (4.8)	469 (4.9)
Geographic region [b]			
Northeast	3117 (16.4)	1540 (16.4)	1577 (16.5)
Midwest	4138 (21.8)	2060 (22.0)	2078 (21.7)
South	7207 (38.0)	3576 (38.1)	3631 (38.0)
West	4486 (23.7)	2210 (23.5)	2277 (23.8)
Mother's age			
<= 34	1724 (9.1)	920 (9.8)	804 (8.4)
35 - 44	8260 (43.6)	3942 (42.0)	4318 (45.2)
>= 45	8963 (47.3)	4524 (48.2)	4439 (46.4)
Mother's education level			
<12 years	2445 (12.9)	1278 (13.6)	1167 (12.2)
High school	4358 (23.0)	2143 (22.8)	2215 (23.2)
Some college	4952 (26.1)	2445 (26.0)	2508 (26.2)
College grad	7192 (38.0)	3520 (37.5)	3672 (38.4)
Number of doctor visits in the past year			
None	3027 (16.1)	1346 (14.5)	1681 (17.7)

1	5499 (29.3)	2557 (27.5)	2942 (30.9)
2-3	8716 (46.4)	4568 (49.2)	4148 (43.6)
4 +	1551 (8.3)	811 (8.7)	740 (7.8)
Time since last doctor visit [c]			
<1 year	8560 (46.0)	4228 (45.9)	4333 (46.1)
1-2 years	9082 (48.8)	4519 (49.0)	4563 (48.5)
3 + years	980 (5.3)	473 (5.1)	506 (5.4)
Hepatitis B vaccination			
No	1021 (5.4)	458 (4.9)	563 (5.9)
Yes	17927 (94.6)	8928 (95.1)	8999 (94.1)
Tdap vaccination			
No	1769 (9.3)	859 (9.2)	909 (9.5)
Yes	17,179 (90.7)	8527 (9.1)	8652 (90.5)
Provider recommendation			
No	6845 (36.1)	2422 (25.8)	4423 (46.3)
Yes	12,103 (63.9)	6964 (74.2)	5138 (53.7)
HPV vaccine initiation (1 or more shots)			
No	9152 (48.3)	3697 (39.4)	5454 (57.0)
Yes	9796 (51.7)	5689 (60.6)	4107 (43.0)

Notes. Sample size unweighted n = 19,125; weighted n = 18,948. All = full sample of boys and girls.

[a.] Insurance was categorized following guidelines from the U.S. Census Bureau (https://www.census.gov/hhes/www/hlthins/methodology/definitions/cps.html), which defines public insurance as Medicaid, S-Chip, military, and American Indian health coverage. Private insurance included individuals who only reported private insurance and no other categories. Multiple insurance included individuals who responded yes to at least two of the three categories: private, public, and other.

b. Geographic region includes all 50 states and Washington, D.C. Puerto Rico and other U.S. territories are not included.

c. For the variable "time since last doctor's visit," 311 teens were missing data.

Table 2. Prevalence ratios for HPV vaccine initiation by provider recommendation status, for all teens and among females and males, 2014 NIS-Teen

Provider Recommendation	**All Teens (weighted n = 18,948)**	**Females (weighted n = 9386)**	**Males (weighted n = 9562)**
Crude PR			
No	Ref	Ref	Ref
Yes	2.7 (CI: 2.4 – 2.9)	1.9 (CI: 1.7 – 2.2)	3.3 (CI: 2.9 – 3.8)
Adjusted PR			
No	Ref	Ref	Ref
Yes	2.4 (CI: 2.2 – 2.6)	1.8 (CI: 1.6 – 2.0)	3.0 (2.6 – 3.4)

* Note: Adjusted models included the following covariates: age, race, poverty status, insurance, region, mother's age, mother's education, time since last doctor's exam, number of visits to healthcare provider in past 12 months, prior Hepatitis B shot, prior Tdap shot.

Table 3. Prevalence ratios for receiving a provider recommendation for the HPV vaccine by teen sociodemographic and health behavior characteristics, 2014 NIS-Teen

	All teens with Provider-verified records (weighted n = 18,948)	
Variable	**All PR**	**All aPR**
Provider Recommendation	(weighted n / %)	
No	6845 (36.1%)	
Yes	12,103 (63.9%)	
Sex		
Female	Ref	Ref
Male	.72 (.69, .76) *	.73 (.70, .76) *
Age		
13	Ref	Ref
14	1.04 (.97, 1.11)	1.03 (.97, 1.10)
15	1.09 (1.02, 1.16) *	1.10 (1.03, 1.17) *
16	1.02 (.95, 1.09)	1.04 (.97, 1.11)
17	1.07 (1.00, 1.15) *	1.07 (1.01, 1.14) *
Race/Ethnicity		
White	Ref	Ref
Black	.96 (.90, 1.02)	1.03 (.97, 1.11)
Hispanic	.95 (.90, 1.02)	1.06 (.99, 1.12)
Other/Multi	.91 (.84, .99) *	.96 (.89, 1.03)
Poverty Status		
< pov level	Ref	Ref
At pov level <= 75k	1.04 (.97, 1.11)	1.02 (.95, 1.10)
>75k	1.21 (1.14, 1.28) *	1.13 (1.04, 1.22) *
Unknown	.86 (.74, .99)	.86 (.75, .99) *
Insurance		
Private	Ref	Ref
Public	.91 (.87, .96) *	1.17 (.95, 1.09)
Other	1.00 (.90, 1.11)	1.09 (1.01, 1.19) *
Multiple	1.00 (.93, 1.06)	1.04 (.98, 1.11)
None	.76 (.64, .90) *	.92 (.79, 1.08)
Unreported	.67 (.65, .69) *	.89 (.78, 1.02)
Geographic Region		
Northeast	Ref	Ref
Midwest	.89 (.85, .94) *	.95 (.90, .99) *
South	.84 (.79, .88) *	.89 (.84, .93) *
West	.94 (.88, 1.01)	1.02 (.96, 1.08)
Mother's Age		

<= 34 years	Ref	Ref
35 to 44 years	.97 (.90, 1.06)	.96 (.89, 1.03)
>= 45 years	1.07 (.99, 1.15)	.98 (.91, 1.06)
Mother's Education Level		
< 12 years	Ref	Ref
High school	1.08 (.99, 1.19)	1.07 (.98, 1.17)
Some college	1.12 (1.03, 1.23) *	1.08 (.99, 1.18)
College grad	1.25 (1.15, 1.35) *	1.14 (1.04, 1.25) *
Time since last visit		
0 to <1 year	Ref	Ref
1-2 years	.86 (.83, .90) *	.89 (.86, .93) *
3 + years	.61 (.52, .72) *	.71 (.60, .82) *
# Visits to Doctor in Past Year		
None	Ref	Ref
1	1.29 (1.18, 1.41) *	1.15 (1.06, 1.25) *
2-3	1.40 (1.29, 1.52) *	1.21 (1.12, 1.31) *
4 or more	1.49 (1.35, 1.63) *	1.28 (1.17, 1.40) *
Hepatitis B vaccination		
No	Ref	Ref
Yes	1.35 (1.18, 1.53) *	1.22 (1.09, 1.37) *
Tdap vaccination		
No	Ref	Ref
Yes	1.58 (1.42, 1.76) *	1.44 (1.31, 1.59) *

* $p < .05$

Table 4. Among teens who received a provider recommendation, characteristics associated with initiating the HPV vaccine, 2014 NIS-Teen

	All Teens who received a provider recommendation (weighted n = 12,103)	
Variable	**PR**	**All aPR**
Sex		
Female	Ref	Ref
Male	.92 (.87, .96)	.91 (.87, .95) *
Age		
13	Ref	Ref
14	1.12 (1.03, 1.22)	1.12 (1.04, 1.22) *
15	1.19 (1.10, 1.29)	1.22 (1.13, 1.31) *
16	1.19 (1.10, 1.29)	1.22 (1.13, 1.32) *
17	1.20 (1.10, 1.30)	1.24 (1.15, 1.35) *
Race/Ethnicity		
White	Ref	Ref
Black	1.08 (1.01, 1.16)	1.06 (.99, 1.14)
Hispanic	1.21 (1.14, 1.28)	1.13 (1.06, 1.21) *
Other/Multi	1.10 (1.01, 1.19)	1.09 (1.01, 1.18) *
Poverty Status		
< pov level	Ref	Ref
At pov level <= 75k	.88 (.82, .94)	.95 (.89, 1.01)
> pov >75k	.85 (.80, .90)	.97 (.90, 1.06)
Unknown	.77 (.66, .89)	.84 (.72, .98) *
Insurance		
Private	Ref	Ref
Public	1.14 (1.08, 1.20)	1.06 (.99, 1.13)
Other	1.06 (.96, 1.18)	1.07 (.96, 1.19)
Multiple	1.12 (1.05, 1.21)	1.07 (1.00, 1.15)
None	1.15 (1.00, 1.33)	1.09 (.95, 1.26)
Unreported	1.18 (1.06, 1.32)	1.11 (.99, 1.23)
Geographic Region		
Northeast	Ref	Ref
Midwest	.97 (.91, 1.03)	1.02 (.96, 1.08)
South	.98 (.92, 1.04)	.99 (.94, 1.05)
West	1.06 (.99, 1.14)	1.06 (.99, 1.14)
Mother's Age		
<= 34 years	Ref	Ref
35 to 44 years	.89 (.83, .96)	.91 (.85, .98) *
>= 45 years	.90 (.84, .97)	.94 (.87, 1.02)

Mother's Education Level		
< 12 years	Ref	Ref
High school	.90 (.84, .98)	.94 (.87, 1.16)
Some college	.84 (.78, .91)	.89 (.83, .97)
College grad	.82 (.77, .88)	.90 (.83, .97)
None	Ref	Ref
1	1.13 (1.02, 1.25)	1.13 (1.04, 1.24) *
2-3	1.18 (1.08, 1.30)	1.17 (1.08, 1.27) *
4 or more	1.24 (1.12, 1.38)	1.21 (1.10, 1.33) *
0 to <1 year	Ref	Ref
1-2 years	.89 (.85, .93)	.89 (.85, .94) *
3 + years	.70 (.58, .85)	.70 (.58, .85) *
Hepatitis B vaccination		
No	Ref	Ref
Yes	1.48 (1.26, 1.75)	1.34 (1.14, 1.56) *
Tdap vaccination		
No	Ref	Ref
Yes	2.31 (1.91, 2.78)	2.17 (1.80, 2.61) *

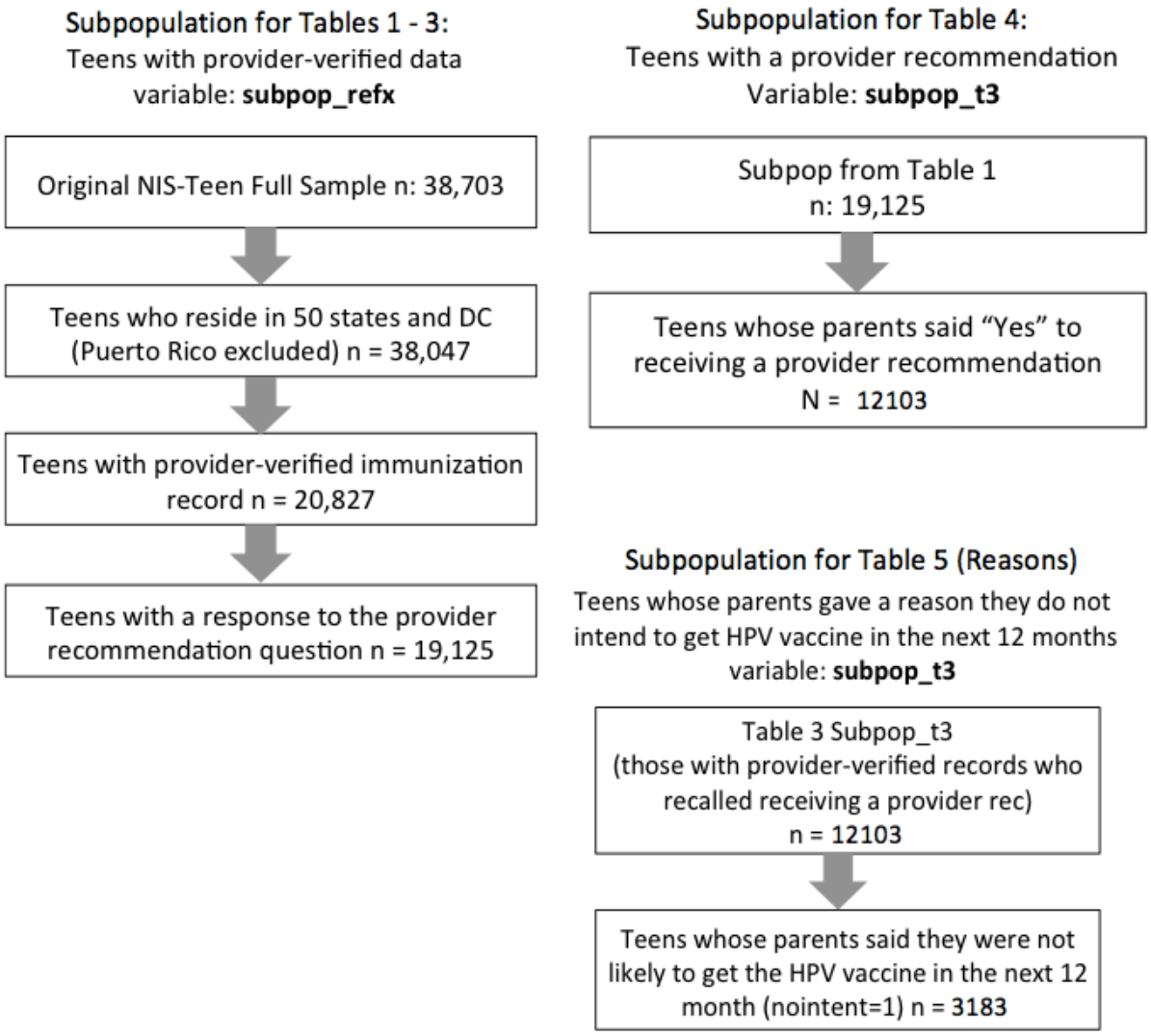
* $p < .05$

Table 5. Among parents who received a provider recommendation, reasons given for not intending to get HPV vaccine for teen in the next 12 months

Total, all teens (weighted n = 2839)	Females (weighted n = 1532)	Males (weighted n = 1307)
18.3% Not needed /unnecessary	18.9% Safety concern / side effects	20.0% Not needed /unnecessary
15.5% Safety concern / side effects	16.9% Not needed /unnecessary	11.7% Lack of knowledge
10.5% Not recommended	10.4% Not recommended	11.6% Safety concern / side effects
9.7% Lack of knowledge	8.0% Lack of knowledge	10.5% Not recommended
8.3% Not sexually active	7.7% Not sexually active	9.0% Not sexually active
7.5% Already up to date	7.7% Already up to date	7.4% Already up to date
5.2% Other reason	6.2% Other reason	6.5% Not appropriate age
4.5% Not appropriate age	4.2% No reason given / no to all listed reasons	4.2% No reason given / no to all listed reasons
4.2% No reason given / no to all listed reasons	4.0% More info / new vaccine	3.9% Other reason
3.4% More info / new vaccine	2.8% Not appropriate age	2.7% More info / new vaccine
2.2% Family/parental decision	2.2% Handicapped / special needs or illness	2.7% Handicapped / special needs or illness
1.5% Costs	2.0% Family/parental decision	2.4% Family/parental decision
1.4% Child fearful	1.9% Costs	1.5% No doctor or doctor's visit not scheduled
1.3% Handicapped / special needs or illness	1.6% Child fearful	1.2% Child fearful
1.1% Not school required	1.3% Not school required	1.0% Not school required
1.0% Child should decide	1.2% Child should decide	0.9% Child should decide
1.0 No doctor or doctor's visit not scheduled	0.6% No doctor or doctor's visit not scheduled	0.9% Costs
0.8% Religious / orthodox	0.3% Religious / orthodox	1.3% Religious / orthodox
0.7% Child is male	0% Child is male	1.5% Child is male
0.6% Increased sexual activity concern	0.8% Increased sexual activity concern	0.4% Increased sexual activity concern
0.5% Don't believe in immunizations	0.4% Don't believe in immunizations	0.7% Don't believe in immunizations
0.3% Effectiveness concern	0.5% Effectiveness concern	0.2% College shot
0.1% College shot	0.2% Refused to provide reason	0.2% Time
0.1% Time	0.1% Already sexually active	0.1% Effectiveness concern
0.1% Already sexually active	0.07% Not available	0.03% Refused to provide reason
0.1% Refused to provide reason	0.01% Time	0.07% Not available
0.07% Not available	0.01% College shot	<0.01% Already sexually active

Note. Parents were asked "How likely are you to get the HPV vaccine for your teen in the next 12 months? Only parents who responded "not too likely," "not likely at all," or "don't know/not sure" to the question were then asked to provide a reason. Parents were allowed to provide more than one reason. Percentages reflect one or more reasons provided per parent. For table 5, 3,183 parents of teens 1) had not received any HPV shots, and 2) responded to the question about likelihood of receiving HPV shots in the next 12 months. Not all parents selected a reason for not vaccinating. Thus, the final n = 2939 for Table 4 for the number of reasons provided by parents in the sample.

Figure 1. Flowchart of Analytic Populations for Tables 1-5



Appendix A

Table 3a. Prevalence ratios for receiving a provider recommendation for the HPV vaccine by teen sociodemographic and health behavior characteristics, among females and males, 2014 NIS-Teen

	Females (weighted n = 9386)		**Males** (weighted n = 9562)	
Variable	**Fem PR**	**Fem aPR**	**Male PR**	**Male aPR**
Age				
13	Ref	Ref	Ref	Ref
14	1.03 (.96, 1.11)	1.03 (.96, 1.11)	1.04 (.93, 1.17)	1.02 (.92, 1.13)
15	1.08 (1.00, 1.17)	1.10 (1.02, 1.17)	1.09 (.98, 1.22)	1.10 (.99, 1.21)
16	1.06 (.98, 1.14)	1.06 (.98, 1.14)	.99 (.88, 1.11)	1.02 (.91, 1.14)
17	1.11 (1.03, 1.20)	1.12 (1.04, 1.21)	.99 (.88, 1.11)	1.01 (.91, 1.14)
Race/Ethnicity				
White	Ref	Ref	Ref	Ref
Black	.92 (.85, .99)	1.00 (.92, 1.08)	.98 (.88, 1.09)	1.09 (.97, 1.21)
Hispanic	.92 (.86, .99)	1.04 (.97, 1.11)	.98 (.88, 1.09)	1.08 (.97, 1.20)
Other/Multi	.89 (.81, .97)	.93 (.86, 1.01)	.93 (.80, 1.09)	.99 (.87, 1.13)
Poverty status				
< pov level	Ref	Ref	Ref	Ref
At pov level <= 75k	1.08 (1.00, 1.17)	1.05 (.96, 1.13)	1.00 (.90, 1.12)	1.09 (.96, 1.21)
>75k	1.25 (1.16, 1.34)	1.15 (1.04, 1.27)	1.18 (1.07, 1.30)	1.08 (.97, 1.20)
Unknown	.85 (.71, 1.01)	.85 (.72, 1.02)	.88 (.70, 1.12)	.99 (.87, 1.13)
Insurance				
Private	Ref	Ref	Ref	Ref
Public	.90 (.85, .95)	1.03 (.96, 1.11)	.92 (.84, 1.00)	.99 (.88, 1.10)
Other	.99 (.91, 1.08)	1.05 (.97, 1.14)	1.04 (.86, 1.25)	1.15 (1.01, 1.32)
Multiple	.96 (.88, 1.04)	1.04 (.96, 1.12)	1.01 (.90, 1.12)	1.05 (.95, 1.17)
None	.73 (.59, .89)	.90 (.74, 1.10)	.75 (.56, 1.01)	.94 (.72, 1.22)
Unreported	.72 (.62, .86)	.82 (.69, .98)	.87 (.71, 1.08)	.97 (.79, 1.20)
Geographic region				
Northeast	Ref	Ref	Ref	Ref
Midwest	.97 (.92, 1.03)	1.01 (.96, 1.07)	.80 (.73, .87)	.86 (.79, .94)
South	.90 (.85, .95)	.94 (.89, .99)	.76 (.70, .83)	.82 (.76, .89)
West	.97 (.90, 1.05)	1.03 (.96, 1.11)	.91 (.81, 1.01)	1.03 (.90, 1.19)
Mother's age				
<= 34 years	Ref	Ref	Ref	ref
35 - 44 years	.98 (.91, 1.07)	.93 (.86, 1.01)	1.01 (.87, 1.117)	.98 (.85, 1.13)
>= 45 years	1.05 (.97, 1.14)	.93 (.85, 1.01)	1.12 (.97, 1.28)	1.03 (.90, 1.19)
Mother's education				
< 12 years	Ref	Ref	Ref	Ref

High school	1.10 (.99, 1.24)	1.09 (.97, 1.22)	1.08 (.92, 1.26)	1.07 (.92, 1.25)
Some college	1.18 (1.06, 1.31)	1.11 (1.00, 1.24)	1.07 (.92, 1.24)	1.06 (.92, 1.24)
College grad	1.30 (1.17, 1.44)	1.19 (1.06, 1.32)	1.20 (1.05, 1.38)	1.09 (.93, 1.28)
# Visits to doctor in past year				
None	Ref	Ref	Ref	Ref
1	1.12 1.02, 1.23)	1.00 (.92, 1.09)	1.51 (1.30, 1.75)	1.34 (1.15, 1.55)
2-3	1.20 (1.10, 1.30)	1.06 (.98, 1.14)	1.61 (1.40)	1.42 (1.23, 1.64)
4 or more	1.23 (1.11, 1.35)	1.07 (.98, 1.18)	1.80 (1.53, 2.11)	1.59 (1.36, 1.86)
Time since last visit				
0 to <1 year	Ref	Ref	Ref	Ref
1-2 years	.90 (.86, .94)	.91 (.88, .96)	.81 (.76, .88)	.86 (.80, .92)
3 + years	.74 (.61, .90)	.80 (.66, .96)	.46 (.35, .61)	.59 (.46, .76)
Hepatitis B vaccination				
No	Ref	Ref	Ref	Ref
Yes	1.08 (.97, 1.20)	1.06 (.95, 1.17)	1.78 (1.40, 2.26)	1.46 (1.18, 1.82)
Tdap vaccination				
No	Ref	Ref	Ref	Ref
Yes	1.39 (1.23, 1.56)	1.32 (1.18, 1.48)	1.89 (1.58, 2.27)	1.69 (1.42, 2.00)

Appendix B

Table 4a. Among teens who received a provider recommendation, characteristics associated with initiating the HPV vaccine in females and males, 2014 NIS-Teen

		Females (weighted n = 6964)		Males (weighted n = 5138)
Variable	**PR**	**aPR**	**PR**	**aPR**
Sex				
Female	Ref	Ref	Ref	Ref
Male				
Age				
13	Ref	Ref	Ref	Ref
14	1.11 (1.00, 1.23)	1.13 (1.02, 1.25)	1.14 (1.00, 1.31)	1.10 (.98, 1.25)
15	1.15 (1.04, 1.27)	1.21 (1.10, 1.33)	1.25 (1.10, 1.42)	1.21 (1.07, 1.37)
16	1.18 (1.07, 1.31)	1.24 (1.13, 1.37)	1.21 (1.07, 1.37)	1.19 (1.05, 1.34)
17	1.20 (1.09, 1.33)	1.29 (1.17, 1.43)	1.17 (1.02, 1.34)	1.29 (1.05, 1.37)
Race/Ethnicity				
White	Ref	Ref	Ref	
Black	1.11 (1.02, 1.20)	1.07 (.99, 1.16)	1.03 (.90, 1.17)	1.05 (.91, 1.20)
Hispanic	1.12 (1.03, 1.22)	1.04 (.96, 1.14)	1.34 (1.24, 1.45)	1.26 (1.14, 1.38)
Other/Multi	1.08 (.98, 1.18)	1.09 (.99, 1.20)	1.12 (.97, 1.29)	1.11 (.97, 1.27)
Poverty status				
< pov level	Ref	Ref	Ref	Ref
At pov level <= 75k	.88 (.82, .96)	.97 (.88, 1.07)	.88 (.80, .97)	.94 (.85, 1.04)
> pov >75k	.86 (.80, .93)	.94 (.87, 1.02)	.84 (.76, .92)	.97 (.84, 1.11)
Unknown	.79 (.67, .95)	.88 (.73, 1.05)	.73 (.57, .93)	.76 (.58, 1.01)
Insurance				
Private	Ref	Ref	Ref	Ref
Public	1.12 (1.04, 1.20)	1.06 (.96, 1.11)	1.17 (1.07, 1.27)	1.06 (.94, 1.19)
Other	1.01 (.89, 1.16)	1.02 (.90, 1.16)	1.14 (.97, 1.33)	1.14 (.96, 1.34)
Multiple	1.19 (1.10, 1.29)	1.14 (1.06,1.23)	1.01 (.88, 1.16)	.96 (.84, 1.10)
None	1.04 (.84, 1.27)	1.08 (.90, 1.30)	1.36 (1.17, 1.57)	1.18 (1.00, 1.39)
Unreported	1.14 (1.00, 1.31)	1.09 (.96, 1.25)	1.25 (1.05, 1.48)	1.09 (.92, 1.29)
Geographic region				
Northeast	Ref	Ref	Ref	Ref
Midwest	.98 (.91, 1.06)	1.03 (.96, 1.11)	.93 (.85, 1.03)	1.00 (.90, 1.10)
South	.96 (.89, 1.04)	.99 (.91, 1.06)	.99 (.90, 1.09)	1.00 (.91, 1.10)
West	1.06 (.96, 1.16)	1.06 (.98, 1.16)	1.08 (.96, 1.20)	1.06 (.95, 1.17)
Mother's age				
<= 34 years	Ref	Ref	Ref	ref
35 to 44 years	.88 (.80, .96)	.89 (.81, .96)	.92 (.81, 1.05)	.96 (.86, 1.08)
>= 45 years	.88 (.80, .96)	.88 (.80, .98)	.95 (.84, 1.07)	1.04 (.92, 1.18)
Mother's education				
< 12 years	Ref	Ref	Ref	Ref
High school	.93 (.83, 1.04)	.95 (.86, 1.05)	.87 (.78, .97)	.93 (.85, 1.03)

Some college	.02 (.82, 1.02)	.93 (.84, 1.03)	.74 (.66, .83)	.85 (.75, .95)
College grad	.86 (.78, .96)	.92 *.83, 1.02)	.77 (.70, .84)	.87 (.78, .98)
# Visits to doctor in past year				
None	Ref	Ref	Ref	Ref
1	1.15 (1.01, 1.32)	1.14 (1.01, 1.29)	1.10 (.96, 1.26)	1.10 (.98, 1.23)
2-3	1.27 (1.12, 1.44)	1.23 (1.10, 1.37)	1.06 (.93, 1.21)	1.08 (.96, 1.21)
4 or more	1.32 (1.15, 1.51)	1.25 (1.10, 1.41)	1.15 (.98, 1.35)	1.15 (1.00, 1.32)
Time since last visit				
0 to <1 year	Ref	Ref	Ref	Ref
1-2 years	.90 (.84, .95)	.92 (.87, .98)	.87 (.80, .94)	.85 (.79, .91)
3 + years	.65 (.51, .84)	.68 (.54, .87)	.78 (.59, 1.04)	.76 (.59, .97)
Hepatitis B vaccination				
No	Ref	Ref	Ref	Ref
Yes	1.60 (1.28, 2.00)	1.43 (1.16,1.77)	1.32 (1.03, 1.69)	1.18 (.94, 1.49)
Tdap vaccination				
No	Ref	Ref	Ref	Ref
Yes	2.40 (1.89, 3.05)	2.24 (1.77,2.83)	2.18 (1.61, 2.96)	2.06 (1.53, 2.76)