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**Impact of health care access on delayed or missed adolescent vaccinations for Tdap,
Meningococcal, and HPV vaccines among U.S. adolescents, NIS-Teen 2018**

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Abstract

Background: Adolescent vaccination coverage varies considerably between Tdap, meningococcal, and HPV vaccines. While evidence suggests that health care access affects vaccination coverage, evidence does not explain whether access drives delayed or no vaccination. This study evaluates whether measures of health care access are associated with delayed vaccination or not being vaccinated by age 17 years for Tdap, meningococcal, and HPV vaccines when controlling for sociodemographic factors as proxies for vaccine hesitancy. The secondary objective assesses whether health care access measures had consistent associations across the different vaccines.

Methods: Using current ACIP recommendations, ‘on-time’, ‘delayed’, and ‘missed’ status by age 17 were defined for Tdap, meningococcal, and HPV vaccinations. Vaccination coverage disparities among 17-year-olds by access and sociodemographic variables were assessed using data from NIS-Teen 2018. Associations between measures of health access and delayed or missed vaccination by age 17 were evaluated using multivariable logistic regression analysis.

Results: For adolescents age 17 years, missing the 11–12 years well-child check-up was the strongest predictor for delayed or missed vaccination for Tdap, ≥ 1 dose MenACWY, and HPV. Other measures of health care access, such as continuity of insurance and number of health provider visits in the past 12 months, were not significantly associated with delayed or missed vaccination for any of the vaccines.

Conclusions: For the small proportion of the adolescent population that does not have an 11–12-year-old check-up, the detrimental effect on vaccination follows them through adolescence with a higher likelihood of no recommended vaccinations by age 17. The findings support a need to improve efforts for catch-up vaccination throughout adolescence.

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Introduction

The Advisory Committee on Immunization Practices (ACIP) recommends that children aged 13–17 years receive four vaccinations: a tetanus booster (Tdap); a meningococcal vaccine (MenACWY); the human papillomavirus (HPV) vaccine; and the seasonal influenza vaccine (1). Tdap is a decennial immunization, recommended at 11–12 years, primarily intended to provide tetanus prophylaxis in the case of wound exposure (2). Tdap is generally recommended over other tetanus toxoid containing vaccines to ensure continued protection against diphtheria and pertussis as well (2). MenACWY is given at 11–12 years (first dose) and 16–17 years (a second dose) to prevent meningococcal disease, which has a high case fatality rate and is easily transmitted in conjugate living facilities (e.g., college dorms or military barracks) (3,4). Vaccination against HPV in adolescence prevents sexually-transmitted infection and associated cervical, penile, vulvar, vaginal, anal, and oropharyngeal cancers and is given in a 2–3 dose schedule over 6–12 months depending on the child’s age at initiation (5).

According to 2019 estimates, coverage with ≥ 1 dose of Tdap and ≥ 1 dose of the MenACWY remains high and stable among adolescents (1). The coverage for ≥ 1 dose of Tdap was estimated at 90.2%; for ≥ 1 dose of MenACWY, 88.9% (1). In contrast, only an estimated 53.7% of adolescents received their age 16–17 MenACWY booster (1). Vaccination coverage of the meningococcal booster has increased steadily since 2014; however, the increase from 2018–2019 was not statistically significant (1). While HPV coverage has increased steadily since it was first recommended by the ACIP in 2006, coverage remains lower than for other adolescent vaccines. Estimated coverage for ≥ 1 dose of HPV vaccine was 71.5% for all adolescents, with only 54.2% receiving enough doses to be considered up-to-date (UTD) for the multi-dose series (1,12). The fact that rates of ≥ 1 dose Tdap and ≥ 1 dose MenACWY coverage increased only

slightly over the last five years may indicate that coverage for those immunizations has reached a ceiling. Nonetheless, there is still much progress that can be made to achieve two doses of MenACWY by age 17 and higher rates of HPV vaccine initiation and completion.

Evidence indicates that Tdap, MenACWY, and HPV vaccination is often delayed to after the recommended ages of 11–12 years. Previous research examining vaccination rates among 17-year-old females in NIS-Teen-2013 indicated that large percentages of the cohort do not receive Tdap or at least one dose of MenACWY or HPV vaccine by age 13 (6). Tdap vaccination was delayed (i.e., received between ages 13–17 years) in 29% of the study population who reported receiving at least one dose (6). Forty percent of those who received at least one dose of MenACWY vaccine had their first dose after 11–12 years (6). HPV vaccination was the most frequently delayed vaccination: 47% of individuals 13–17-years-old who received at least one dose initiated the vaccine series after age 13 (6). NIS-Teen 2018 similarly shows that Tdap, MenACWY, and HPV vaccination is often delayed.

Existing literature demonstrates associations between measures of access to healthcare and adolescent vaccination completion. Previous research examining associations between health insurance status and vaccination coverage in NIS-Teen 2015 indicated that overall vaccination coverage for adolescents aged 13–17 years was lower for uninsured adolescents (7). The analysis also linked having an 11–12 well-child visit or at least two health care provider visits in the past year to an increased likelihood of receiving the recommended vaccinations (7). The study concluded that more contacts with health care providers meant more opportunities for providers to recommend and provide vaccinations. Those results were consistent with earlier data from NIS-Teen 2009, which found that adolescents who made at least one visit during which a vaccine was administered between ages 11–12 years were most likely to receive Td/Tdap on-time (8).

In order to evaluate the impact of health care access on timely vaccination, it is important to control for vaccine hesitancy, another important barrier to uptake. Sociodemographic characteristics can be markers of vaccine hesitancy. A study of the 2010 NIS-Teen dataset examined the association between sociodemographic characteristics and HPV initiation for adolescent females before and after age 13 years, and found differences among those who were vaccinated on-schedule, who delayed vaccination, or who refused (9). Girls in the group that delayed were more likely to be non-Hispanic white and be from more affluent sociodemographic households (9). Of the parents of girls who delayed vaccination, over 45% cited reasons related to vaccine effectiveness and safety (9). The sociodemographic characteristics of girls who refused HPV vaccination were more mixed, but those who delayed and then refused were more likely to be non-Hispanic white, come from the highest income households, and have older, highly-educated, married mothers (9). Additional evidence from an analysis of NIS-Teen 2011 supports that white adolescents are more likely to cite hesitancy and lack of intent to initiate HPV vaccination compared to racial/ethnic minorities (10). The 2010 group that ultimately refused HPV vaccination also had the highest percentage of parents citing doubt about vaccine effectiveness, long-term safety, and need for HPV vaccination (9). The 2010 data showed that access was a barrier to on-schedule, HPV initiation, but was less significant for HPV completion: parents of girls who delayed, but ultimately completed, vaccination were more likely to state inconvenience as a reason for not meeting recommendations than parents who refused the HPV vaccine (9).

These prior findings demonstrate that access to care is associated with vaccination coverage and that there are differences between adolescents who vaccinate on the recommended schedule or who delay. However, the access to care predictors of delayed vaccination have not

been fully examined (7,9). Also, while evidence supports delayed initiation of both Tdap and meningococcal vaccines as significant risk factors for delayed initiation of HPV vaccines in adolescent females, evidence is missing as to whether the same predictors drive delay of all three vaccines. This analysis addresses those limitations by identifying independent predictors of not being vaccinated on time at ages 11–12, and then assessing each significant predictor’s relation to health care access when adjusted for sociodemographic variables in a nationally representative sample of adolescents aged 17 years. Secondly, the analysis examined the consistency of each predictor across Tdap, MenACWY, and HPV immunizations.

Research Questions: Are health care access measures independently associated with delayed or no receipt of Tdap, MenACWY, and HPV vaccines, after controlling for sociodemographic factors as proxies for vaccine hesitancy? Is there consistency across different vaccines?

Methods

Part 1: Study Population/Data

This study utilized data from the 2018 National Immunization Survey-Teen. The National Immunization Survey-Teen (NIS-Teen) is an annual survey conducted by the Centers for Disease Control and Prevention to obtain and assess data on immunization coverage for adolescents age 13 to 17 years. The NIS-Teen survey is a representative stratified, national, probability sample conducted in two phases. The first phase is a cell-phone, random-digit-dial (RDD) household interview of parents/guardians of adolescents; 2018 was the first year the landline sample was excluded and the RDD sample design was limited to only cell-phones (11). The household interview includes questions on general health status, demographics, health insurance, vaccine history and any reasons for missed vaccinations. Parents/guardians also provide the names of the adolescent’s vaccination providers and oral consent to contact them. The response rate to the

household interview in 2018 was 71.9% (11). The second phase is an immunization history questionnaire mailed or faxed to each of the adolescent's vaccination providers to confirm vaccination status and dates. The overall proportion of adolescents with returned provider surveys containing adequate immunization histories was 48.3% (11).

In the 2018 survey, among the 18,700 adolescents with complete household interviews and adequate provider-reported vaccination histories, 3,480 (20%) of respondents were 17 years old at the time of the household interviews. Since the adolescent catch-up period includes immunization up to age 17, analysis was limited to only 17-year-olds to capture vaccine coverage when catch-up immunization should be complete. The final sample size was $n=3,480$.

Part 2: Defining Variables

The outcomes of interest were: completion of the recommended doses for each vaccine by the recommended age (13 years for Tdap, HPV and the first MenACWY dose), defined as 'on-time'; completion by age 17 years, 'delayed'; or no recorded doses by age 17 years, 'missed'. Since HPV vaccination requires a multiple dose schedule, it had an additional outcome for initiation by age 17. The second dose of MenACWY vaccine is recommended at age 16–17 years, so the outcomes for MenACWY vaccine completion were 1 dose, ≥ 2 doses, or no doses by age 17 years. Adolescents who received their first MenACWY dose at 16–17 years were counted with those who only received their 11–12-year-old dose, since both lack one of the recommended doses. Seasonal influenza vaccination is the fourth recommended adolescent immunization, but was excluded since it is given annually.

Table 1 summarizes what constitutes complete vaccination, the age to be considered on-time, and the age for being classified as delayed.

Table 1: Defining vaccination variables

<i>Vaccine</i>	What is considered up-to-date or complete?	Recommended age for on-time completion?	How is delayed completion defined for this vaccine?
<i>Tdap</i>	≥1 dose	10–12 (preferred 11–12)	≥1 dose by 17
<i>Meningococcal (≥1 dose)</i>	≥1 dose	11–12	≥1 dose by 17
<i>HPV</i>	- Prior to Oct. 2016: 3 doses, regardless of age of initiation - Current: 2 doses if initiated before their 15 th birthday. 3 doses if initiated on or after their 15 th birthday	11–12	Up-to-date by 17* [†]
<i>Meningococcal (2nd dose)</i>	Recommended booster at age 16, which can be counted as: 1 dose at 16–17 or 2 doses by 17	16–17	n/a within adolescence

*An HPV initiation variable by age 17 was included for adolescents who had received ≥1 dose by 17, but who had not finished the sequence (12).

[†]HPV catch-up can be completed as an adult by age 26 (12).

Part 3: Selection of Correlates:

The following variables were used for measures of access to health care: continuity of insurance coverage since age 11; having had an 11–12-year-old well-child check-up; and the number of doctor or other health care professional visits reported in the last 12 months. Access to care variables were those that directly relate to a missed opportunity to vaccinate, i.e., missed preventive health visits.

The following sociodemographic variables were used as proxies for measures of vaccine hesitancy: race/ethnicity of teen, sex of teen, poverty status, interview language, insurance status,

marital status of mother, educational level of mother, property rented/owned, number of children <18 years of age in the household, facility types for teen's providers, and census region.

Part 4: Statistical analysis

The unadjusted association between health care access, sociodemographic characteristics of adolescents, and vaccine completion or initiation by 13 or 17 years includes unweighted sample numbers and weighted percentages. Weighted percentages by each of the characteristic covariates were calculated using RDD and provider weights described in the NIS-Teen 2018 Data User's Guide (11). The weighting variables reflect the probability of the adolescents being included in the NIS-Teen sample and additional poststratification weights to better represent the national demographic characteristics of all adolescents 13–17 years (11). Likelihood ratio chi-square tests were used to find the unadjusted association between characteristic and on-time or delayed vaccine completion.

Multivariable logistic regression was conducted to assess the independent effects of each characteristic. The full, adjusted models included all characteristics to control for each covariate. To produce the reduced model of only significant predictors, backwards elimination was used to delete covariates that did not contribute to the regression based on the F statistic, with the significance level set at $\alpha < 0.05$. Adjusted odds ratios and 95% confidence intervals were reported for both the full and reduced models. An independent two-sided *t* test was used to assess associations, with the significance level set at $\alpha < 0.05$.

Results

In the 2018 National Immunization Survey-Teen, on-time (by 13 years of age) completion for HPV vaccination was only 15.3% among 17-year-olds (Table 2). Delayed completion of HPV vaccinations occurred at a much higher frequency than on-time vaccination:

41.0% of the cohort was up-to-date within the catch-up period (Table 2). An additional 12.8% of the sample initiated HPV vaccination, but did not complete all of their doses by age 17 (Table 2). HPV vaccination is the most frequently missed adolescent vaccination: 30.8% of 17-year-olds received no doses. By comparison, only 10.6% of 17-year-olds missed Tdap, and 14.1% missed MenACWY entirely (Table 2). On-time completion of Tdap and ≥ 1 dose of MenACWY vaccine was higher, 78.8% and 69.5%, respectively. However, this means that adolescents who delayed or missed vaccinations still made up 20% and 30%, respectively, of each group (Table 2). As shown in Table 3, approximately half (48.3%) of adolescents received ≥ 2 MenACWY doses by age 17.

Among the health care access measures, the frequency of responses that indicate lower access varied considerably between the different measures. In the 17-year-old cohort, 390 teens (11.2%) reported gaps in insurance coverage since they were 11 years-old. For well-child visits, only 132 adolescents (3.8%), reported that they did not have an 11–12 years well-child visit, and an additional 259 (7.4%) didn't know or didn't report whether or not they had the well-child visit. For visits within the past year, while two-thirds (2,133) of 17-year-olds in the survey reported two or more health care provider visits, of the remaining respondents, 892 (25.6%) reported only one provider visit in the past year and 421 (12.1%) reported zero visits.

Neither continuity of insurance nor number of health provider visits in the past 12 months were significant predictors of delayed vaccine uptake or no doses by age 17 years. In the unadjusted Chi-square associations, lack of continuity of insurance was significantly associated with a decrease in on-time completion for Tdap ($p < 0.001$) and the first dose of MenACWY ($p < 0.001$) (Tables 4 & 5). Continuous insurance was also significantly associated with an increase in overall completion of the MenACWY booster dose ($p = 0.044$) (Table 6). At least one

provider visit in the past year was significantly associated with an increase in on-time Tdap completion ($p=0.015$) (Table 4). In addition, at least one provider visit in the past year was also significantly associated with receipt the 2nd MenACWY dose in the unadjusted analysis ($p<0.001$) (Table 6). Continuity of health insurance and health care provider visits in the past 12 months were not associated with HPV vaccination (Table 7).

Tables 8-15 show the full and reduced models for each vaccine for comparison. After controlling for sociodemographic characteristics as markers of vaccine hesitancy, the 11–12-year-old well-visit exam was the only significantly associated access to care variable across all three vaccines in the full and reduced models (Tables 8-15). The odds of a teen without the 11–12 years well-visit receiving their Tdap vaccine after the recommended age was 4.26 times the odds of a teen who had the check-up (Table 9). Teens with no 11–12 years check-up were also 4.39 times more likely to receive no Tdap doses when compared to those who had their well-child visit (Table 9).

Teens who missed their 11–12 years check-up were 6.25 times more likely to receive their first MenACWY dose after the recommended age (Table 11). Missing the age 11–12 well-child visit was also the strongest predictor for missing all meningococcal vaccinations: teens who missed the check-up were 10.75 times more likely to have no MenACWY doses by age 17 (Table 11). The second dose of MenACWY was the only adolescent vaccine for which missing the 11–12-year-old well-child visit did not have a significant association when compared with adolescents who only received one dose (Table 13).

The well-visit exam was also a strong predictor for HPV vaccination completion. When compared to adolescents who had the visit, those who did not were 4.86 times more likely to complete their doses during the catch-up period, rather than on-time (Table 15). No 11–12 years

check-up also increased odds of initiating the HPV vaccination schedule by age 17, but failing to complete it, to 11.69 times the odds of adolescents who reported having the check-up (Table 15). Teens who missed the 11–12-year-old well-visit were 15.70 times more likely to have received no HPV doses by age 17 (Table 15).

Discussion

Overall, the proportion of adolescents who completed their Tdap, meningococcal, and HPV vaccinations by the recommended age varied greatly between the different vaccines. Among those who did not receive Tdap (21.2%) or the 1st MenACWY dose (30.5%) on-time, about half of the remainder caught-up by 17 and the other half remained unvaccinated. However, the fact that only 15.3% of adolescents completed the HPV vaccination series on-time, and nearly 85% did not, indicates that a lot of progress still needs to be made in providing HPV vaccines within the recommended time frame. With such large differences in on-time and delayed uptake of the adolescent vaccinations, we were interested in which health care access measures were predictors for delayed or missed vaccination for each vaccine and whether those measures were consistent drivers across all adolescent vaccinations.

Of the three health care access measures—continuity of insurance, number of provider visits in past year, and the 11–12-year-old well-child exam—only the well-child exam was significantly associated with delayed or missed vaccination for the three adolescent vaccinations. Unsurprisingly, the 11–12-year-old check-up was a highly consistent predictor for all vaccinations that are recommended to be given during those years. However, the proportion of 17-year-olds who missed their 11–12-year-old check-up is only about 3.8% among those with provider data and 4.5% of all 17-year-olds in NIS-Teen 2018 sample. Since 11–12 years well-

visit attendance is so high, clinicians should not miss the opportunity to vaccinate at this visit, but if they do, all subsequent visits should be viewed as opportunities for catch-up.

Since so few adolescents miss the 11–12-year-old well-child exam, even if all adolescents had the check-up, the overall impact on vaccination coverage would likely be very small. If coverage with ≥ 1 dose Tdap and 1st dose MenACWY has reached a ceiling effect, a push for universal 11–12-year-old well-child exams would offer only a slight increase compared to current coverage. The number of adolescents who reported attending the 11–12-year-old well-child visit has increased from 55% in 2009 to about 96% in 2018 (8). The large increase in well-visit attendance may explain why other access to care measures were not strong predictors of delayed or missed vaccination in 2018.

Among the sociodemographic measures that were proxies for hesitancy there were common predictors between the different vaccinations and common measures with no association. Adolescents living in the Midwest were significantly more likely to delay or not vaccinate for all three vaccinations compared to adolescents from the Northeast. In contrast, adolescents residing in the South and West were more likely to delay MenACWY and HPV vaccinations, but not Tdap. Adolescents whose household interviews were not conducted in English had an increased risk for delayed or missed vaccination for both Tdap and ≥ 1 dose of MenACWY. Household income and maternal education and marital status were not associated with on-time receipt of any of the vaccinations.

Racial and ethnic minorities were more likely than non-Hispanic white adolescents to receive meningococcal and HPV vaccinations. This is in line with previous evidence suggesting that the parents of white adolescents are less likely to vaccinate and more likely to cite concerns related to vaccine hesitancy (10). Interestingly, being a racial or ethnic minority was not a strong

predictor of increased likelihood of on-time vaccination when comparing delayed receipt of ≥ 1 dose of MenACWY to on-time vaccination, but it was not when comparing with those who received no doses. There was also a strong protective effect when comparing between those who received the 2nd MenACWY dose and those who only received one. Racial and ethnic associations with delayed or missed vaccination may imply that hesitancy has a greater effect with vaccinations that require doses to be given at multiple visits over time as opposed to one that can be completed in one visit, but there is not enough evidence to support this. Quadrivalent meningococcal and HPV vaccines were also licensed more recently (2005 and 2006), which may also contribute to increased hesitancy for both vaccines (5,12).

Limitations

One limitation in designing the outcomes of the vaccination variables was in defining the parameters for the 1st and 2nd dose of MenACWY. The first of two adolescent doses of MenACWY should be given between 11–12 years with a catch-up period through age 15 years (5). The booster dose should be administered at ages 16–18 years (5). Therefore, a second dose given prior to age 16, does not fall within the recommended booster timeframe and could be counted as receiving only the first dose. Also, individuals who received their first dose at or after age 16 years would have fulfilled the requirement for the booster dose, but not for the initial recommended adolescent dose. In order to compare across all the adolescent vaccinations, in this study, any individual who received one dose, regardless of the age at immunization, was considered to have met the requirements for the 1st dose of MenACWY. Similarly, any individual who received at least two doses, regardless of the age at immunization, was considered to have fulfilled both recommended MenACWY doses.

This analysis is also limited by the fact that only adolescents with verified provider data were included in the NIS-Teen dataset. Lu et al. reason that sample bias in selecting NIS-Teen respondents with provider data may underestimate measures of health care access since uninsured teens may not have a consistent provider who has their full vaccination history and therefore, they may be excluded due to inadequate provider data (7). Some adjustments are made in calculating the sampling weights to account for provider nonresponse, but a bias in the estimates might remain (11). In looking at the proportion of adolescents who missed their 11–12-year-old well-child exam, there is a difference between teens who had adequate provider data and teens who did not, but more work would need to be done to determine if there is a true difference and its magnitude.

The number of provider visits in the past 12 months has limited meaning when considering on-time completion of vaccinations recommended at ages 11–12 years. Adolescence is a period marked by relatively few health visits, so it stands to reason that the number of provider visits might differ at age 16–17 years compared to 11–13 years (13). Also, current health care access for a 17-year-old is not necessarily indicative of what the adolescent's health access looked like at age 12–13, so the number of visits in the past year might be more meaningful if analyzing vaccination coverage among 13-year-olds.

This analysis was not able to account for all of the barriers that may be caused by lack of health care access and proxy measures for vaccine hesitancy were imperfect. For simplicity, measures of health care access were variables that had a direct relation to a missed opportunity to vaccinate—in other words, a missed preventive health visit. With respect to vaccine hesitancy, while all of the sociodemographic variables that were used as measures of hesitancy are

frequently correlated with increased hesitancy—and were therefore assigned as proxies—all also have implications that may indirectly affect an individual's access to vaccination services.

One instance in which the selected sociodemographic variables may not have fully captured vaccine hesitancy is with respect to missed HPV vaccination. An assumption could be made that higher rates of missed HPV vaccination (30.8%) as compared to Tdap (10.6%) or MenACWY (14.1%) were due to higher rates of vaccine refusal (Table 2). Explicit parental reasoning for HPV refusal due to concerns about sexual activity has decreased over time; however, concerns relating to vaccine safety and the need for HPV vaccination are much higher than for Tdap or MenACWY (14). The reasons why parents refuse HPV vaccination for their children are multi-faceted, but hesitancy is given as a primary reason more frequently among parents who ultimately refuse the vaccine for their children (9,14)

Future Directions

A longitudinal analysis of NIS-Teen datasets would indicate if health care access measures are consistent drivers over time as well as between the different vaccines. Analyzing trends longitudinally could also provide insight into whether or not a ceiling has been reached in Tdap and 1st dose MenACWY vaccination. Consistent associations over time could reveal a characteristic of access or hesitancy that is a repeated barrier to adolescent vaccination coverage, which could be useful to know and account for in future vaccination campaigns.

Future analysis could also be stratified by the adolescent's residence in a Metropolitan Statistical Area (MSA) to examine regional variability. In this analysis, there was consistent association between census region and delayed or missed vaccination. However, since each census region is so large, the implications of census region being a predictor for delayed or missed vaccination is not particularly meaningful in terms of creating vaccination programs or

policies. Stratification by adolescents living in MSA/non-MSA areas, however, would provide more context on impact of health care access across the rural-urban divide. Previous research demonstrates that proximity to health care in rural areas has an effect on adolescent vaccination, so it would be interesting to see how the measures of access in this analysis compare across MSA status.

Conclusions

Adolescents who miss the 11-12-year-old well-child visit are more likely to have delayed completion of all the adolescent vaccinations. Additionally, this group has the highest odds of missed vaccination at age 17 years. Among the small proportion of adolescents who miss the 11–12-year-old well-child exam, there are lasting repercussions on the adolescent’s ability to catch-up on their adolescent vaccination. More evidence is needed to know why this group is less likely to catch-up on vaccinations at subsequent well-child exams during adolescence. Additional analyses would need to be done to determine characteristics that correlate with missing the 11–12-year-old well-visit and if these characteristics continue throughout adolescence.

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Appendix:**Table 2:** All NIS-Teen 2018 respondents age 17 years stratified by vaccination completion

	Completed by age 13 (on-time)	Completed by 17 (not by 13)	Initiation – no completion	No doses by 17
Tdap	2743 (78.8)	369 (10.6)	---	368 (10.6)
Meningococcal	2418 (69.5)	571 (16.4)	---	491 (14.1)
HPV	534 (15.3)	1426 (41.0)	447 (12.8)	1073 (30.8)

Table 3: Meningococcal 2nd dose completion by age 17, NIS-Teen 2018

	1 dose only	2 doses	No doses
Meningococcal	1308 (37.6)	1681 (48.3)	491 (14.1)

Table 4: Characteristics of adolescents age 17 years stratified by on-time (by 13), delayed (by 17), or no doses: Tdap vaccination, NIS-Teen 2018

Variable	Total N*	n (%) complete by 13 years	n (%) complete by 17 years	n (%) no doses by 17 years	p
Race/ethnicity					0.087
Non-Hispanic white	2123	1723 (83.9)	191 (7.5)	209 (8.6)	
Non-Hispanic black	290	227 (80.5)	34 (13.0)	29 (6.5)	
Hispanic	692	522 (78.8)	85 (11.6)	85 (9.6)	
Other + multiple race	375	271 (80.2)	59 (7.2)	45 (12.6)	
Poverty Status					<0.001
Above poverty (>\$75K)	1766	1449 (85.4)	145 (5.6)	172 (8.9)	
Above poverty (<=\$75K)	1038	795 (79.9)	123 (11.5)	120 (8.6)	
Below poverty	554	407 (73.3)	84 (16.1)	63 (10.5)	
Sex					0.461
Female	1589	1274 (83.4)	153 (8.5)	162 (8.2)	
Male	1891	1469 (80.6)	216 (9.7)	206 (9.7)	
Interview Language					<0.001
English	3120	2500 (84.0)	301 (7.5)	319 (8.5)	
Other	360	243 (66.5)	68 (20.9)	49 (12.6)	
Insurance status					<0.001
Private insurance only	2026	1659 (85.4)	170 (6.7)	197 (7.9)	
Any Medicaid	1016	775 (79.6)	129 (11.4)	112 (9.0)	
Other insurance**	287	215 (78.9)	35 (7.0)	37 (14.1)	
Uninsured	151	94 (58.9)	35 (27.4)	22 (13.7)	
Maternal marital status					0.856
Married	2449	1943 (81.5)	252 (9.4)	254 (9.1)	
Not married***	1031	800 (82.6)	117 (8.6)	114 (8.8)	
Maternal education					0.001
College grad	1663	1366 (85.2)	143 (6.2)	154 (8.6)	
More than 12 years, non-college grad	906	714 (84.8)	99 (7.9)	93 (7.4)	
12 years	521	377 (75.7)	74 (13.9)	70 (10.5)	
Less than 12 years	390	286 (74.0)	53 (14.6)	51 (11.3)	
Property rented/owned					<0.001
Owned/being bought	2548	2090 (85.2)	218 (6.9)	240 (7.9)	
Rented/other	921	645 (74.2)	148 (14.1)	128 (11.6)	
# of children <18					0.936
1	1699	1333 (82.5)	180 (8.4)	186 (9.1)	
2-3	1492	1189 (81.3)	151 (9.7)	152 (9.0)	
4+	289	221 (82.0)	38 (9.8)	30 (8.2)	
Facility type					<0.001
All private	1492	1243 (86.1)	116 (6.2)	133 (7.7)	
Public/hospital/STD/school/teen clinics	931	683 (72.3)	137 (15.1)	111 (12.6)	
Mixed	620	508 (87.3)	67 (7.4)	45 (5.2)	
Census region					0.006
Northeast	681	600 (89.9)	43 (5.3)	38 (4.8)	
Midwest	779	601 (75.9)	95 (12.0)	83 (12.1)	

South	1291	996 (80.1)	138 (10.6)	157 (9.3)	
West	729	546 (84.9)	93 (6.7)	90 (8.3)	
<hr/>					
Consistency of health insurance					<0.001
Current & no gaps	3079	2471 (83.6)	298 (7.9)	310 (8.5)	
Intermittent/no insurance	390	265 (68.7)	69 (18.7)	56 (12.6)	
11–12 well-child?					<0.001
Yes	3089	2508 (84.6)	281 (7.7)	300 (7.7)	
No	132	67 (50.1)	34 (25.9)	31 (24.0)	
# of visits in last 12 months					0.015
0	421	310 (72.5)	57 (15.5)	54 (12.0)	
1	892	697 (82.0)	92 (9.1)	103 (8.9)	
2+	2133	1713 (83.8)	217 (7.9)	203 (8.3)	
<hr/>					

* Numbers may not sum to total due to missing data

** Other insurance: CHIP, IHS, Military, or other alone or in combination w/ private insurance

***Never married/widowed/divorced/separated/deceased/living with partner

Table 5 Characteristics of adolescents age 17 years stratified by on-time (by 13), delayed (by 17), or no doses: MenACWY (≥ 1 dose) vaccination, NIS-Teen 2018

Variable	Total N*	n (%) ≥ 1 dose by 13 years	n (%) ≥ 1 dose by 17 years	n (%) no doses by 17 years	p
Race/ethnicity					0.046
Non-Hispanic white	2123	1470 (72.2)	332 (14.4)	321 (13.4)	
Non-Hispanic black	290	213 (77.5)	41 (14.0)	36 (8.5)	
Hispanic	692	498 (73.6)	124 (19.4)	70 (7.0)	
Other + multiple race	375	237 (70.4)	74 (16.0)	64 (13.6)	
Poverty Status					0.017
Above poverty (>\$75K)	1766	1279 (76.3)	244 (12.6)	243 (11.2)	
Above poverty (<=\$75K)	1038	677 (71.3)	189 (17.1)	172 (11.6)	
Below poverty	554	381 (65.9)	109 (21.7)	64 (12.3)	
Sex					0.128
Female	1589	1128 (75.1)	260 (15.3)	201 (9.5)	
Male	1891	1290 (71.2)	311 (15.9)	290 (12.9)	
Interview Language					<0.001
English	3120	2179 (74.3)	481 (13.9)	460 (11.9)	
Other	360	239 (63.9)	90 (28.4)	31 (7.7)	
Insurance status					<0.001
Private insurance only	2026	1454 (76.6)	300 (13.5)	272 (9.9)	
Any Medicaid	1016	697 (70.7)	178 (17.7)	141 (11.6)	
Other insurance**	287	187 (68.1)	53 (12.0)	47 (19.8)	
Uninsured	151	80 (52.6)	40 (33.7)	31 (13.8)	
Maternal marital status					0.884
Married	2449	1706 (73.2)	399 (15.0)	344 (11.7)	
Not married***	1031	712 (72.6)	172 (16.7)	147 (10.6)	
Maternal education					0.159
College grad	1663	1208 (76.2)	249 (13.8)	206 (10.0)	
More than 12 years, non-college grad	906	604 (73.6)	149 (14.9)	153 (11.5)	
12 years	521	340 (70.0)	101 (17.1)	80 (12.9)	
Less than 12 years	390	266 (65.1)	72 (21.5)	52 (13.4)	
Property rented/owned					<0.001
Owned/being bought	2548	1832 (76.1)	365 (13.1)	351 (10.8)	
Rented/other	921	578 (65.9)	203 (21.3)	140 (12.8)	
# of children <18					0.100
1	1699	1170 (72.6)	262 (13.7)	267 (13.7)	
2–3	1492	1057 (73.3)	252 (17.3)	183 (9.4)	
4+	289	191 (73.5)	57 (15.4)	41 (11.1)	
Facility type					<0.001
All private	1492	1149 (78.0)	202 (14.2)	141 (7.8)	
Public/hospital/ STD/school/teen clinics	931	568 (62.8)	199 (21.0)	164 (16.1)	
Mixed	620	440 (75.6)	99 (12.6)	81 (11.7)	
Census region					<0.001
Northeast	681	569 (83.7)	80 (11.5)	32 (4.7)	
Midwest	779	507 (66.8)	156 (19.7)	116 (13.5)	
South	1291	900 (68.5)	200 (18.5)	191 (13.1)	

West	729	442 (78.9)	135 (9.9)	152 (11.2)	
Consistency of health insurance					<0.001
Current w/ no gaps	3079	2188 (74.7)	476 (14.2)	415 (11.1)	
Intermittent/not insured	390	224 (60.4)	91 (26.3)	75 (13.4)	
11–12 well-child?					<0.001
Yes	3089	2245 (76.6)	470 (14.3)	374 (9.1)	
No	132	41 (23.7)	43 (36.1)	48 (40.2)	
# of visits in last 12 months					0.643
0	421	273 (68.1)	70 (17.7)	78 (14.3)	
1	892	608 (73.8)	148 (15.5)	136 (10.7)	
2+	2133	1512 (73.5)	348 (15.4)	273 (11.1)	

* Numbers may not sum to total due to missing data

** Other insurance: CHIP, IHS, Military, or other alone or in combination w/ private insurance

***Never married/widowed/divorced/separated/deceased/living with partner

Table 6: Characteristics of adolescents age 17 years stratified by receipt of 1st, 2nd or no doses: MenACWY, NIS-Teen 2018

Variable	Total N*	n (%) 1 dose by 17 years	n (%) 2+ doses by 17 years	n (%) no doses by 17 years	p
Race/ethnicity					0.037
Non-Hispanic white	2123	809 (36.9)	993 (49.7)	321 (13.4)	
Non-Hispanic black	290	103 (30.5)	151 (61.0)	36 (8.5)	
Hispanic	692	268 (39.0)	354 (54.0)	70 (7.0)	
Other + multiple race	375	128 (39.1)	183 (47.3)	64 (13.6)	
Poverty Status					0.911
Above poverty (>\$75K)	1766	638 (36.1)	885 (52.8)	243 (11.2)	
Above poverty (<=\$75K)	1038	409 (35.5)	457 (52.9)	172 (11.6)	
Below poverty	554	205 (38.6)	285 (49.1)	64 (12.3)	
Sex					0.035
Female	1589	589 (34.9)	799 (55.6)	201 (9.5)	
Male	1891	719 (38.3)	882 (48.8)	290 (12.9)	
Interview Language					0.302
English	3120	1174 (36.5)	1486 (51.6)	460 (11.9)	
Other	360	134 (37.8)	195 (54.5)	31 (7.7)	
Insurance status					0.004
Private insurance only	2026	736 (35.9)	1018 (54.2)	272 (9.9)	
Any Medicaid	1016	376 (35.2)	499 (53.3)	141 (11.6)	
Other insurance**	287	125 (39.6)	115 (40.6)	47 (19.8)	
Uninsured	151	71 (52.1)	49 (34.1)	31 (13.8)	
Maternal marital status					0.303
Married	2449	916 (35.1)	1189 (53.1)	344 (11.7)	
Not married***	1031	392 (39.7)	492 (49.7)	147 (10.6)	
Maternal education					0.337
College grad	1663	573 (34.5)	884 (55.4)	206 (10.0)	
More than 12 years, non-college grad	906	374 (40.7)	379 (47.9)	153 (11.5)	
12 years	521	217 (35.3)	224 (51.8)	80 (12.9)	
Less than 12 years	390	144 (39.0)	194 (47.6)	52 (13.4)	
Property rented/owned					0.291
Owned/being bought	2548	930 (35.8)	1267 (53.4)	351 (10.8)	
Rented/other	921	373 (38.7)	408 (48.5)	140 (12.8)	
# of children <18					0.114
1	1699	623 (37.9)	809 (48.4)	267 (13.7)	
2-3	1492	570 (35.3)	739 (55.3)	183 (9.4)	
4+	289	115 (38.3)	133 (50.6)	41 (11.1)	
Facility type					0.003
All private	1492	540 (36.9)	811 (55.3)	141 (7.8)	
Public/hospital/STD/school/teen clinics	931	373 (38.7)	394 (45.2)	164 (16.1)	
Mixed	620	236 (36.4)	303 (51.9)	81 (11.7)	
Census region					<0.001
Northeast	681	170 (21.9)	479 (73.3)	32 (4.7)	
Midwest	779	289 (37.6)	374 (48.9)	116 (13.5)	
South	1291	533 (43.7)	567 (43.2)	191 (13.1)	

West	729	316 (34.8)	261 (54.1)	152 (11.2)	
Consistency of health insurance					0.044
Current w/ no gaps	3079	1127 (35.6)	1537 (53.3)	415 (11.1)	
Intermittent/not insured	390	174 (43.8)	141 (42.8)	75 (13.4)	
11-12 well-child?					<0.001
Yes	3089	1161 (37.0)	1554 (54.0)	374 (9.1)	
No	132	46 (34.1)	38 (25.7)	48 (40.2)	
# of visits in last 12 months					<0.001
0	421	216 (53.2)	127 (32.5)	78 (14.3)	
1	892	344 (36.2)	412 (53.1)	136 (10.7)	
2+	2133	739 (33.8)	1121 (55.1)	273 (11.1)	

* Numbers may not sum to total due to missing data

** Other insurance: CHIP, IHS, Military, or other alone or in combination w/ private insurance

***Never married/widowed/divorced/separated/deceased/living with partner

Table 7: Characteristics of adolescents age 17 years stratified by up-to-date (UTD) by 13 years, UTD by 17 years, initiation by 17 years, or no doses: HPV, NIS-Teen 2018

Variable	Total N*	n (%) complete by age 13 years	n (%) complete by age 17 years	n (%) initiated by age 17 years	n (%) no doses by age 17 years	p
Race/ethnicity						<0.001
Non-Hispanic white	2123	280 (12.6)	839 (38.7)	268 (11.8)	736 (36.9)	
Non-Hispanic black	290	46 (18.4)	142 (53.7)	39 (11.9)	63 (15.9)	
Hispanic	692	152 (22.8)	279 (44.4)	89 (11.7)	172 (21.1)	
Other + multiple race	375	56 (11.3)	166 (47.2)	51 (9.8)	102 (31.7)	
Poverty Status						0.132
Above poverty (>\$75K)	1766	244 (12.8)	747 (41.7)	221 (11.8)	554 (33.7)	
Above poverty (<=\$75K)	1038	155 (18.4)	399 (43.7)	128 (10.7)	356 (27.2)	
Below poverty	554	116 (17.9)	226 (43.3)	81 (12.2)	131 (26.6)	
Sex						<0.001
Female	1589	326 (21.6)	674 (45.2)	205 (9.4)	384 (23.7)	
Male	1891	208 (10.1)	752 (41.2)	242 (13.5)	689 (35.3)	
Interview Language						<0.001
English	3120	434 (14.0)	1278 (42.7)	399 (11.7)	1009 (31.6)	
Other	360	100 (26.0)	148 (46.0)	48 (10.8)	64 (17.1)	
Insurance status						0.002
Private insurance only	2026	276 (12.8)	861 (45.2)	243 (10.7)	646 (31.3)	
Any Medicaid	1016	199 (21.2)	410 (41.3)	130 (12.4)	277 (25.1)	
Other insurance**	287	38 (15.9)	101 (33.6)	43 (10.8)	105 (39.7)	
Uninsured	151	21 (8.7)	54 (44.0)	31 (18.0)	45 (29.2)	
Maternal marital status						0.007
Married	2449	344 (14.4)	1000 (41.8)	299 (10.6)	806 (33.2)	
Not married***	1031	190 (17.5)	426 (45.5)	148 (13.5)	267 (23.5)	
Maternal education						0.224
College grad	1663	231 (13.2)	753 (45.6)	193 (10.1)	486 (31.0)	
More than 12 years, non-college grad	906	120 (15.1)	339 (40.4)	125 (14.3)	322 (30.2)	
12 years	521	83 (17.6)	187 (40.3)	75 (10.9)	176 (31.2)	
Less than 12 years	390	100 (21.0)	147 (44.4)	54 (12.6)	89 (22.0)	
Property rented/owned						0.486
Owned/being bought	2548	377 (15.7)	1050 (42.1)	307 (11.1)	814 (31.2)	
Rented/other	921	154 (14.7)	373 (45.4)	137 (12.7)	257 (27.2)	
# of children <18						0.010
1	1699	261 (16.3)	679 (39.1)	227 (14.5)	532 (30.0)	
2–3	1492	229 (15.1)	637 (47.7)	186 (9.5)	440 (27.7)	
4+	289	44 (13.6)	110 (37.3)	34 (9.4)	101 (39.8)	

Facility type						0.459
All private	1492	239 (15.0)	661 (45.0)	189 (11.3)	403 (28.7)	
Public/hospital/ STD/school/teen clinics	931	146 (17.5)	335 (38.1)	132 (11.5)	318 (32.9)	
Mixed	620	96 (15.7)	267 (47.5)	85 (11.0)	172 (25.7)	
Census region						0.169
Northeast	681	105 (14.1)	371 (52.7)	67 (7.2)	138 (26.0)	
Midwest	779	117 (13.5)	305 (40.5)	99 (12.2)	258 (33.8)	
South	1291	210 (16.2)	479 (41.5)	174 (41.5)	428 (30.7)	
West	729	102 (17.1)	271 (41.1)	107 (14.2)	249 (27.6)	
Consistency of health insurance						0.303
Current & no gaps	3079	484 (16.1)	1279 (42.9)	379 (11.3)	937 (29.7)	
Intermittent/not insured	390	49 (10.7)	144 (45.5)	68 (13.9)	129 (30.0)	
11–12 well-child?						<0.001
Yes	3089	504 (16.7)	1308 (44.5)	377 (11.3)	900 (27.6)	
No	132	5 (2.6)	35 (29.8)	31 (16.0)	61 (51.6)	
# of visits in last 12 months						0.744
0	421	56 (18.1)	138 (37.5)	53 (11.4)	174 (32.9)	
1	892	113 (13.7)	361 (43.7)	119 (12.9)	299 (29.7)	
2+	2133	354 (15.4)	919 (44.0)	269 (11.0)	591 (29.5)	

* Numbers may not sum to total due to missing data

** Other insurance: CHIP, IHS, Military, or other alone or in combination w/ private insurance

***Never married/widowed/divorced/separated/deceased/living with partner

Table 8: Multivariate logistic regression between study characteristics and Tdap vaccination (*Full model*), NIS-Teen 2018

Characteristic	Adjusted OR (95% CI) - delayed	p - delayed	Adjusted OR (95% CI) – no doses	p – no doses
Race/ethnicity				
Non-Hispanic white	1.00	---	1.00	---
Non-Hispanic black	0.90 (0.43, 1.88)	0.782	0.64 (0.31, 1.32)	0.227
Hispanic	0.50 (0.22, 1.15)	0.102	1.07 (0.62, 1.85)	0.805
Other + multiple race	0.93 (0.50, 1.73)	0.816	2.13 (1.11, 4.10)	0.024
Poverty Status				
Above poverty (>\$75K)	1.00	---	1.00	---
Above poverty (<=\$75K)	1.54 (0.86, 2.78)	0.150	0.81 (0.49, 1.34)	0.409
Below poverty	1.46 (0.60, 3.59)	0.405	0.66 (0.31, 1.40)	0.279
Sex				
Female	1.00	---	1.00	---
Male	1.17 (0.76, 1.81)	0.465	1.10 (0.74, 1.65)	0.639
Interview Language				
English	1.00	---	1.00	---
Other	4.89 (1.85, 12.94)	0.001	1.78 (0.77, 4.18)	0.174
Insurance status				
Private insurance only	1.00	---	1.00	---
Any Medicaid	0.50 (0.23, 1.08)	0.077	1.30 (0.72, 2.36)	0.381
Other insurance**	0.53 (0.18, 1.63)	0.270	2.45 (1.20, 5.03)	0.014
Uninsured	0.80 (0.25, 2.63)	0.716	1.18 (0.31, 4.56)	0.811
Maternal marital status				
Married	1.00	---	1.00	---
Not married***	0.64 (0.38, 1.06)	0.082	0.97 (0.56, 1.71)	0.928
Maternal education				
College grad	1.00	---	1.00	---
More than 12 years, non- college grad	1.54 (0.87, 2.74)	0.137	0.93 (0.55, 1.58)	0.794
12 years	1.74 (0.94, 3.22)	0.077	1.02 (0.56, 1.85)	0.948
Less than 12 years	1.34 (0.60, 3.01)	0.479	0.80 (0.31, 2.06)	0.637
Property rented/owned				
Owned/being bought	1.00	---	1.00	---
Rented/other	2.28 (1.35, 3.84)	0.002	1.35 (0.78, 2.33)	0.282
# of children <18				
1	1.00	---	1.00	---
2–3	1.01 (0.66, 1.54)	0.979	1.10 (0.70, 1.70)	0.688
4+	1.09 (0.45, 2.65)	0.845	0.82 (0.35, 1.91)	0.639
Facility type				
All private	1.00	---	1.00	---
Public/hospital/ STD/school/teen clinics	2.23 (1.38, 3.60)	0.001	1.51 (0.93, 2.45)	0.094
Mixed	0.87 (0.49, 1.53)	0.626	0.63 (0.35, 1.14)	0.126
Census region				
Northeast	1.00	---	1.00	---
Midwest	2.12 (1.09, 4.10)	0.027	2.48 (1.16, 5.30)	0.019
South	1.61 (0.84, 3.09)	0.151	1.88 (0.92, 3.84)	0.083
West	0.63 (0.30, 1.32)	0.218	1.67 (0.76, 3.66)	0.198

Consistency of health insurance				
Current & no gaps	1.00	---	1.00	---
Intermittent/never insured	1.37 (0.59, 3.15)	0.465	1.71 (0.81, 3.62)	0.158
11-12 well-child?				
Yes	1.00	---	1.00	---
No	4.35 (2.07, 9.16)	<0.001	3.68 (1.52, 8.90)	0.004
# of visits in last 12 months				
1	1.00	---	1.00	---
0	0.74 (0.33, 1.65)	0.465	0.68 (0.33, 1.41)	0.302
2+	0.77 (0.47, 1.25)	0.288	0.68 (0.43, 1.08)	0.101

** Other insurance: CHIP, IHS, Military, or other alone or in combination w/ private insurance

***Never married/widowed/divorced/separated/deceased/living with partner

Table 9: Multivariate logistic regression between study characteristics and Tdap vaccination (*Reduced model*), NIS-Teen 2018

Characteristic	Adjusted OR (95% CI) - delayed	p - delayed	Adjusted OR (95% CI) – no doses	p – no doses
Interview Language				
English	1.00	---	1.00	---
Other	3.11 (1.70, 5.68)	<0.001	1.88 (1.03, 3.45)	0.041
Property rented/owned				
Owned/being bought	1.00	---	1.00	---
Rented/other	1.98 (1.26, 3.12)	0.003	1.33 (0.86, 2.07)	0.205
Facility type				
All private	1.00	---	1.00	---
Public/hospital/ STD/school/teen clinics	1.99 (1.22, 3.26)	0.006	1.45 (0.92, 2.30)	0.113
Mixed	0.91 (0.52, 1.59)	0.730	0.63 (0.35, 1.12)	0.116
Census region				
Northeast	1.00	---	1.00	---
Midwest	2.57 (1.32, 5.00)	0.006	2.60 (1.13, 6.00)	0.025
South	1.90 (1.00, 3.58)	0.049	1.97 (0.92, 4.23)	0.083
West	0.68 (0.33, 1.39)	0.287	1.74 (0.76, 3.97)	0.189
11–12 well-child?				
Yes	1.00	---	1.00	---
No	4.26 (2.09, 8.65)	<0.001	4.39 (2.07, 9.31)	<0.001

Table 10: Multivariate logistic regression between study characteristics and ≥ 1 dose MenACWY (*Full model*), NIS-Teen 2018

Characteristic	Adjusted OR (95% CI) - delayed	p - delayed	Adjusted OR (95% CI) – no doses	p – no doses
Race/ethnicity				
Non-Hispanic white	1.00	---	1.00	---
Non-Hispanic black	0.55 (0.28, 1.09)	0.087	0.30 (0.14, 0.62)	0.001
Hispanic	0.61 (0.30, 1.23)	0.167	0.41 (0.22, 0.73)	0.003
Other + multiple race	1.06 (0.56, 1.99)	0.869	0.74 (0.40, 1.35)	0.323
Poverty Status				
Above poverty (>\$75K)	1.00	---	1.00	---
Above poverty (<=\$75K)	1.40 (0.86, 2.27)	0.179	1.05 (0.61, 1.82)	0.857
Below poverty	1.03 (0.49, 2.19)	0.933	0.76 (0.29, 1.98)	0.571
Sex				
Female	1.00	---	1.00	---
Male	1.11 (0.77, 1.61)	0.571	1.17 (0.79, 1.71)	0.432
Interview Language				
English	1.00	---	1.00	---
Other	3.22 (1.48, 7.01)	0.003	0.76 (0.30, 1.71)	0.572
Insurance status				
Private insurance only	1.00	---	1.00	---
Any Medicaid	0.77 (0.42, 1.42)	0.401	1.46 (0.84, 2.55)	0.182
Other insurance**	0.46 (0.21, 0.99)	0.048	2.69 (1.40, 5.16)	0.003
Uninsured	1.00 (0.33, 3.01)	0.998	2.30 (0.74, 7.14)	0.149
Maternal marital status				
Married	1.00	---	1.00	---
Not married***	1.04 (0.68, 1.60)	0.853	1.01 (0.62, 1.64)	0.979
Maternal education				
College grad	1.00	---	1.00	---
More than 12 years, non- college grad	1.26 (0.79, 2.03)	0.333	1.02 (0.61, 1.71)	0.943
12 years	1.14 (0.66, 1.97)	0.640	1.02 (0.53, 1.96)	0.950
Less than 12 years	0.72 (0.30, 1.74)	0.467	1.71 (0.72, 4.10)	0.227
Property rented/owned				
Owned/being bought	1.00	---	1.00	---
Rented/other	1.75 (1.06, 2.90)	0.086	1.40 (0.82, 2.39)	0.223
# of children <18				
1	1.00	---	1.00	---
2–3	1.52 (1.03, 2.24)	0.036	0.70 (0.46, 1.05)	0.086
4+	1.23 (0.65, 2.32)	0.526	0.75 (0.35, 1.60)	0.455
Facility type				
All private	1.00	---	1.00	---
Public/hospital/ STD/school/teen clinics	1.58 (1.06, 2.35)	0.024	2.23 (1.39, 3.57)	0.001
Mixed	0.96 (0.60, 1.56)	0.878	1.63 (0.96, 2.77)	0.071
Census region				
Northeast	1.00	---	1.00	---
Midwest	2.26 (1.25, 4.08)	0.007	5.27 (1.88, 14.77)	0.002
South	2.36 (1.33, 4.20)	0.004	7.01 (2.60, 18.92)	<0.001
West	0.81 (0.42, 1.54)	0.512	5.63 (1.97, 16.10)	0.001

Consistency of health insurance				
Current & no gaps	1.00	---	1.00	---
Intermittent/never insured	1.56 (0.78, 3.14)	0.211	1.08 (0.50, 2.37)	0.842
11–12 well-child?				
Yes	1.00	---	1.00	---
No	5.58 (2.64, 11.77)	<0.001	7.46 (3.20, 17.43)	<0.001
# of visits in last 12 months				
1	1.00	---	1.00	---
0	0.64 (0.33, 1.23)	0.180	1.01 (0.54, 1.88)	0.980
2+	1.11 (0.73, 1.68)	0.638	1.06 (0.70, 1.61)	0.784

Table 11: Multivariate logistic regression between study characteristics and ≥ 1 dose MenACWY (Reduced model), NIS-Teen 2018

Characteristic	Adjusted OR (95% CI) - delayed	p - delayed	Adjusted OR (95% CI) – no doses	p – no doses
Race/ethnicity				
Non-Hispanic white	1.00	---	1.00	---
Non-Hispanic black	0.73 (0.39, 1.36)	0.320	0.38 (0.19, 0.76)	0.007
Hispanic	0.64 (0.30, 1.35)	0.239	0.45 (0.25, 0.80)	0.007
Other + multiple race	1.04 (0.59, 1.84)	0.897	0.99 (0.51, 1.90)	0.965
Interview Language				
English	1.00	---	1.00	---
Other	2.58 (1.19, 5.59)	0.016	0.61 (0.26, 1.42)	0.249
Insurance status				
Private insurance only	1.00	---	1.00	---
Any Medicaid	1.10 (0.68, 1.79)	0.702	1.52 (0.92, 2.51)	0.102
Other insurance**	0.67 (0.36, 1.25)	0.204	2.59 (1.36, 4.91)	0.004
Uninsured	1.92 (0.83, 4.43)	0.125	2.64 (1.11, 6.28)	0.029
Facility type				
All private	1.00	---	1.00	---
Public/hospital/ STD/school/teen clinics	1.53 (1.04, 2.24)	0.030	2.12 (1.36, 3.32)	0.001
Mixed	0.92 (0.56, 1.51)	0.747	1.36 (0.81, 2.28)	0.246
Census region				
Northeast	1.00	---	1.00	---
Midwest	2.39 (1.35, 4.23)	0.003	3.53 (1.49, 8.37)	0.004
South	2.39 (1.36, 4.20)	0.002	4.71 (2.01, 11.00)	<0.001
West	0.83 (0.45, 1.53)	0.548	3.41 (1.36, 8.53)	0.009
11–12 well-child?				
Yes	1.00	---	1.00	---
No	6.25 (3.08, 12.68)	<0.001	10.75 (4.61, 25.06)	<0.001

Table 12: Multivariate logistic regression between study characteristics and 2+ dose MenACWY (*Full model*), NIS-Teen 2018

Characteristic	Adjusted OR (95% CI) – 1 dose only	p – 1 dose only	Adjusted OR (95% CI) – no doses	p – no doses
Race/ethnicity				
Non-Hispanic white	1.00	---	1.00	---
Non-Hispanic black	0.54 (0.32, 0.90)	0.018	0.25 (0.11, 0.54)	0.001
Hispanic	0.85 (0.52, 1.40)	0.527	0.42 (0.22, 0.79)	0.008
Other + multiple race	1.51 (0.87, 2.63)	0.147	0.89 (0.47, 1.68)	0.711
Poverty Status				
Above poverty (>\$75K)	1.00	---	1.00	---
Above poverty (<=\$75K)	0.84 (0.56, 1.26)	0.401	0.91 (0.52, 1.61)	0.755
Below poverty	0.81 (0.45, 1.46)	0.477	0.68 (0.25, 1.84)	0.452
Sex				
Female	1.00	---	1.00	---
Male	1.31 (0.96, 1.78)	0.085	1.32 (0.87, 1.99)	0.187
Interview Language				
English	1.00	---	1.00	---
Other	0.63 (0.30, 1.31)	0.215	0.41 (0.15, 1.14)	0.087
Insurance status				
Private insurance only	1.00	---	1.00	---
Any Medicaid	1.04 (0.62, 1.74)	0.885	1.58 (0.88, 2.83)	0.125
Other insurance**	1.33 (0.78, 2.24)	0.294	3.56 (1.80, 7.04)	<0.001
Uninsured	1.85 (0.67, 5.10)	0.237	3.01 (0.78, 10.94)	0.094
Maternal marital status				
Married	1.00	---	1.00	---
Not married***	1.15 (0.80, 1.65)	0.468	1.07 (0.64, 1.78)	0.809
Maternal education				
College grad	1.00	---	1.00	---
More than 12 years, non-college grad	1.62 (1.14, 2.30)	0.007	1.23 (0.72, 2.11)	0.444
12 years	1.30 (0.81, 2.09)	0.274	1.14 (0.58, 2.26)	0.708
Less than 12 years	1.55 (0.78, 3.09)	0.211	2.30 (0.91, 5.78)	0.078
Property rented/owned				
Owned/being bought	1.00	---	1.00	---
Rented/other	1.27 (0.83, 1.92)	0.269	1.40 (0.80, 2.45)	0.244
# of children <18				
1	1.00	---	1.00	---
2–3	0.82 (0.59, 1.13)	0.216	0.58 (0.37, 0.90)	0.015
4+	1.04 (0.59, 1.83)	0.905	0.74 (0.34, 1.60)	0.440
Facility type				
All private	1.00	---	1.00	---
Public/hospital/ STD/school/teen clinics	1.05 (0.74, 1.47)	0.800	2.06 (1.25, 3.40)	0.005
Mixed	0.81 (0.55, 1.21)	0.312	1.49 (0.85, 2.60)	0.162
Census region				
Northeast	1.00	---	1.00	---
Midwest	2.59 (1.67, 4.01)	<0.001	6.63 (2.33, 18.92)	<0.001
South	3.24 (2.12, 4.94)	<0.001	9.83 (3.56, 27.14)	<0.001
West	2.24 (1.27, 3.97)	0.006	7.77 (2.64, 22.86)	<0.001

Consistency of health insurance				
Current & no gaps	1.00	---	1.00	---
Intermittent/never insured	1.01 (0.55, 1.84)	0.975	0.96 (0.41, 2.23)	0.921
11-12 well-child?				
Yes	1.00	---	1.00	---
No	1.50 (0.65, 3.45)	0.339	5.11 (2.10, 12.44)	<0.001
# of visits in last 12 months				
1	1.00	---	1.00	---
0	1.87 (1.13, 3.11)	0.015	1.62 (0.82, 3.20)	0.167
2+	0.99 (0.69, 1.41)	0.954	1.03 (0.66, 1.63)	0.890

Table 13: Multivariate logistic regression between study characteristics and 2+ dose MenACWY (Reduced model), NIS-Teen 2018

Characteristic	Adjusted OR (95% CI) – 1 dose only	p – 1 dose only	Adjusted OR (95% CI) – no doses	p – no doses
Race/ethnicity				
Non-Hispanic white	1.00	---	1.00	---
Non-Hispanic black	0.57 (0.35, 0.94)	0.027	0.31 (0.15, 0.66)	0.002
Hispanic	0.74 (0.50, 1.10)	0.131	0.30 (0.16, 0.54)	<0.001
Other + multiple race	1.03 (0.57, 1.87)	0.919	0.95 (0.47, 1.92)	0.885
Insurance status				
Private insurance only	1.00	---	1.00	---
Any Medicaid	1.17 (0.82, 1.67)	0.399	1.58 (0.93, 2.62)	0.093
Other insurance**	1.55 (0.98, 2.44)	0.060	3.44 (1.79, 6.62)	<0.001
Uninsured	1.74 (0.82, 3.72)	0.150	2.27 (0.82, 6.26)	0.114
Facility type				
All private	1.00	---	1.00	---
Public/hospital/	1.17 (0.84, 1.63)	0.350	2.05 (1.28, 3.27)	0.003
STD/school/teen clinics				
Mixed	0.90 (0.61, 1.34)	0.612	1.32 (0.77, 2.25)	0.310
Census region				
Northeast	1.00	---	1.00	---
Midwest	2.58 (1.72, 3.88)	<0.001	4.34 (1.80, 10.45)	0.001
South	3.39 (2.29, 5.03)	<0.001	6.58 (2.75, 15.74)	<0.001
West	2.41 (1.39, 4.15)	0.002	4.84 (1.88, 12.46)	0.001
11–12 well-child?				
Yes	1.00	---	1.00	---
No	1.78 (0.79, 3.99)	0.220	6.93 (2.83, 16.99)	<0.001

Table 14: Multivariate logistic regression between study characteristics and HPV vaccination (*Full model*), NIS-Teen 2018

Characteristic	Adjusted OR (95% CI) – age 17 completion	p – age 17 completion	Adjusted OR (95% CI) – initiated	p – initiated	Adjusted OR (95% CI) – no doses	p – no doses
Race/ethnicity						
Non-Hispanic white	1.00	---	1.00	---	1.00	---
Non-Hispanic black	1.03 (0.55, 1.94)	0.916	0.82 (0.37, 1.82)	0.632	0.31 (0.15, 0.64)	0.002
Hispanic	0.62 (0.33, 1.16)	0.136	0.43 (0.18, 1.01)	0.053	0.41 (0.21, 0.80)	0.009
Other + multiple race	1.40 (0.73, 2.69)	0.309	1.11 (0.50, 2.50)	0.796	1.17 (0.56, 2.42)	0.678
Poverty Status						
Above poverty (>\$75K)	1.00	---	1.00	---	1.00	---
Above poverty (<=\$75K)	1.11 (0.66, 1.86)	0.697	0.75 (0.40, 1.38)	0.351	1.10 (0.65, 1.85)	0.727
Below poverty	1.26 (0.59, 2.70)	0.556	0.79 (0.28, 2.27)	0.666	1.20 (0.56, 2.59)	0.640
Sex						
Female	1.00	---	1.00	---	1.00	---
Male	1.72 (1.15, 2.56)	0.008	2.70 (1.70, 4.30)	<0.001	3.34 (2.18, 5.13)	<0.001
Interview Language						
English	1.00	---	1.00	---	1.00	---
Other	0.61 (0.27, 1.42)	0.254	0.62 (0.17, 2.30)	0.471	0.32 (0.13, 0.79)	0.013
Insurance status						
Private insurance only	1.00	---	1.00	---	1.00	---
Any Medicaid	0.54 (0.31, 0.97)	0.039	0.69 (0.34, 1.38)	0.297	0.54 (0.30, 0.97)	0.039
Other insurance**	0.53 (0.25, 1.13)	0.097	0.97 (0.39, 2.40)	0.963	1.08 (0.50, 2.34)	0.839
Uninsured	1.29 (0.40, 4.14)	0.668	2.57 (0.59, 11.18)	0.208	2.13 (0.62, 7.35)	0.233
Maternal marital status						
Married	1.00	---	1.00	---	1.00	---
Not married***	0.99 (0.63, 1.53)	0.950	1.16 (0.67, 2.03)	0.595	0.77 (0.48, 1.24)	0.284
Maternal education						
College grad	1.00	---	1.00	---	1.00	---
More than 12 years, non-college grad	0.80 (0.49, 1.30)	0.367	1.26 (0.71, 2.22)	0.429	1.06 (0.65, 1.74)	0.817

12 years	0.97 (0.51, 1.86)	0.922	1.28 (0.59, 2.75)	0.530	1.33 (0.67, 2.61)	0.415
Less than 12 years	0.96 (0.48, 1.94)	0.918	1.71 (0.65, 4.49)	0.280	0.99 (0.40, 2.47)	0.979
Property rented/owned						
Owned/being bought	1.00	---	1.00	---	1.00	---
Rented/other	1.40 (0.83, 2.36)	0.209	1.33 (0.70, 2.54)	0.389	1.39 (0.75, 2.56)	0.298
# of children <18						
1	1.00	---	1.00	---	1.00	---
2–3	1.57 (1.03, 2.39)	0.036	0.79 (0.48, 1.28)	0.332	1.25 (0.80, 1.95)	0.324
4+	1.30 (0.66, 2.56)	0.444	0.98 (0.43, 2.24)	0.959	2.96 (1.48, 5.94)	0.002
Facility type						
All private	1.00	---	1.00	---	1.00	---
Public/hospital/STD/school/teen clinics	0.74 (0.45, 1.22)	0.232	0.72 (0.40, 1.31)	0.281	1.06 (0.63, 1.78)	0.826
Mixed	0.91 (0.55, 1.51)	0.724	0.63 (0.35, 1.15)	0.131	0.76 (0.44, 1.29)	0.305
Census region						
Northeast	1.00	---	1.00	---	1.00	---
Midwest	0.76 (0.42, 1.37)	0.359	1.76 (0.83, 3.76)	0.143	1.38 (0.70, 2.72)	0.352
South	0.77 (0.45, 1.33)	0.345	1.29 (0.64, 2.60)	0.471	1.27 (0.68, 2.40)	0.454
West	0.79 (0.39, 1.59)	0.508	1.62 (0.69, 3.78)	0.270	1.08 (0.51, 2.28)	0.852
Consistency of health insurance						
Current & no gaps	1.00	---	1.00	---	1.00	---
Intermittent/never insured	1.41 (0.69, 2.85)	0.343	1.41 (0.55, 3.60)	0.471	1.07 (0.52, 2.22)	0.852
11–12 well-child?						
Yes	1.00	---	1.00	---	1.00	---
No	5.84 (1.31, 26.11)	0.021	9.02 (1.86, 43.87)	0.006	18.00 (3.88, 83.46)	<0.001
# of visits in last 12 months						
1	1.00	---	1.00	---	1.00	---
0	0.67 (0.32, 1.41)	0.294	0.67 (0.29, 1.54)	0.342	0.47 (0.23, 0.99)	0.046
2+	1.12 (0.71, 1.77)	0.638	1.14 (0.65, 2.03)	0.646	0.96 (0.60, 1.55)	0.877

Table 15: Multivariate logistic regression between study characteristics and HPV vaccination (*Reduced model*), NIS-Teen 2018

Characteristic	Adjusted OR (95% CI) – age 17 completion	p – age 17 completion	Adjusted OR (95% CI) – initiated	p – initiated	Adjusted OR (95% CI) – no doses	p – no doses
Race/ethnicity						
Non-Hispanic white	1.00	---	1.00	---	1.00	---
Non-Hispanic black	0.91 (0.47, 1.76)	0.786	0.73 (0.35, 1.53)	0.404	0.29 (0.15, 0.56)	0.003
Hispanic	0.57 (0.37, 0.88)	0.011	0.51 (0.27, 0.95)	0.035	0.26 (0.16, 0.43)	<0.001
Other + multiple race	1.28 (0.70, 2.32)	0.426	0.88 (0.42, 1.83)	0.726	0.97 (0.50, 1.90)	0.931
Sex						
Female	1.00	---	1.00	---	1.00	---
Male	2.02 (1.38, 2.96)	<0.001	3.36 (2.12, 5.34)	<0.001	3.76 (2.52, 5.60)	<0.001
# of children <18						
1	1.00	---	1.00	---	1.00	---
2–3	1.43 (0.96, 2.12)	0.077	0.69 (0.42, 1.13)	0.136	1.16 (0.77, 1.75)	0.474
4+	1.22 (1.68, 2.20)	0.506	0.82 (0.38, 1.77)	0.612	2.14 (1.18, 3.89)	0.013
11–12 well-child?						
Yes	1.00	---	1.00	---	1.00	---
No	4.86 (1.35, 17.48)	0.015	11.69 (3.27, 41.75)	<0.001	15.70 (4.63, 53.21)	<0.001