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# Parental vaccine hesitancy and its association with adolescent HPV vaccination

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## 1. Introduction

Despite the Advisory Committee on Immunization Practices' (ACIP) recommendations for routine vaccination of adolescents, vaccination coverage remains low for many adolescent vaccines, particularly the human papillomavirus (HPV) vaccine [1]. In 2018, 68.1% of adolescents aged 13–17 years had received ≥ 1 dose of HPV vaccine, and only 51.1% were up to date with the HPV vaccine series, well below the *Healthy People 2020* target of 80% [2,3]. More efforts are needed to understand barriers to vaccination and improve coverage for all recommended vaccines in this population.

Low vaccine uptake can be attributed to various factors, including access issues such as vaccine availability, convenience, cost, and motivation [4]. Motivation refers to overlapping constructs of intention, willingness, acceptability, and hesitancy toward vaccines (e.g., perceived risk of disease, confidence in vaccine effectiveness, safety concerns associated with vaccines and vaccine administration) and the social environment (e.g., strength of provider recommendation, social norms surrounding vaccines, vaccine myths, and misinformation) [4]. Vaccine hesitancy can be defined as a delay in acceptance or the refusal of vaccination despite availability of vaccination services [5,6]. For adolescents, vaccine hesitancy by parents is a significant barrier and has been a factor in outbreaks of vaccine-preventable diseases such as measles and pertussis [7]. Previous studies found that over a third of parents expressed concern about HPV vaccine effectiveness and side effects, and many did not think the HPV vaccine was necessary for their adolescent children [8,9] UTD.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

This study examines the association of parental vaccine hesitancy with receipt of HPV vaccination (≥1 and up-to-date (UTD) doses) among adolescents. Identifying characteristics of parents of adolescents with vaccine hesitant beliefs is an important step to understanding how such beliefs translate to vaccine uptake and developing strategies to improve communication with parents and adolescents.

## 2. Methods

### 2.1. Survey design

The National Immunization Surveys (NIS) are a group of phone surveys used to monitor vaccination coverage by age among children 19–35 months (NIS-Child), teens 13–17 years (NIS-Teen), and influenza vaccinations for children 6 months-17 years (NIS-Flu). This study uses data from the NIS-Teen, which is an annual random-digit-dialed cellular telephone survey that monitors vaccines received by adolescents in the 50 states, the District of Columbia, and U.S. territories [2]. The respondent is a person in the household who is most knowledgeable about the adolescent's vaccinations, usually the mother (64.2%), father (29.1%), or other relative or guardian (6.8%) (hereafter referred to as "parents"). Parents of eligible adolescents were asked questions on sociodemographic characteristics of the adolescent and household, and consent to contact the adolescent's vaccination providers. Vaccination providers identified during the interview were mailed a questionnaire requesting the vaccination history from the adolescent's medical record, and vaccination coverage estimates were based on provider-reported vaccination histories. Although the NIS-Teen is an annual survey that is administered throughout the year, questions on vaccine hesitancy were only asked from April to June in 2018 and 2019. For the 2018 NIS-Teen, 8,662 parents of adolescents were interviewed, and adequate provider data were collected from 48% (n = 4,199). For the 2019 NIS-Teen, 10,368 adolescents were interviewed from April to June and 47% (n = 4,903) had adequate provider data. The overall Council of American Survey Research Organizations (CASRO) response rate for the 2018 and 2019 NIS-Teen was 23.3% and 19.7%, respectively [10-11]. The Centers for Disease Control and Prevention determined that the NIS-Teen is public health surveillance and not human subjects research, so Institutional Review Board approval was not required.

### 2.2. Sociodemographic characteristics

Interviewers asked parents about their adolescent's sex and race/ethnicity, the relationship of the respondent to the adolescent, adolescent's mother's educational level, annual household income, if they received a provider recommendation for HPV vaccination, and city and zip code of the adolescent's residence. Mother's educational level was assessed because studies have identified mothers as the primary decision makers regarding childhood vaccinations, and was used in weighting based on birth certificate data [12]. Metropolitan Statistical Area (MSA) status (MSA principal city, MSA non-principal city, and non-MSA) was determined based on the city and county of the household's residence [13]. Non-MSA areas include urban populations not located within a MSA as well as rural areas. Census regions were categorized as Northwest, Midwest, South, and West. Annual household income was categorized as at or above the federal poverty level or below federal poverty level [14].

Parents were also asked if a doctor or other health care professional ever recommended that the adolescent receive the HPV vaccine.

### 2.3. Vaccine hesitancy variables

Interviewers asked parents six questions on vaccine hesitancy. The development of the six vaccine hesitancy questions have been published previously [15]) Briefly, researchers at the Centers for Disease Control and Prevention (CDC), including staff from the NCHS Questionnaire Design Research Laboratory, developed and tested survey questions to measure vaccine hesitancy. The findings of focus groups resulted in these six questions on vaccine hesitancy that were validated as individual data-producing questions and not designed to be scaled up to a single metric [15,16]. These questions asked parents to think about all vaccines recommended for children and adolescents, and asks them about the following: adherence to the standard vaccination schedule:1) *Is the child administered vaccines following a standard schedule, or some other schedule, such as the Sears Schedule?* The standard schedule is the vaccination schedule recommended by the CDC and by the American Academy of Pediatrics (AAP) [1]. "Some other schedule" refers to an alternative schedule which deviates from the CDC- and AAP-recommended schedule; overall vaccine hesitancy: 2) *Overall, how hesitant about childhood shots would you consider yourself to be?*; and perceptions toward vaccines: 3) *Did concerns about the number of vaccines the child gets at one time impact your decision to get the child vaccinated?*; 4) *Did concerns about serious, long-term side effects impact your decision to get the child vaccinated?*; 5) *Do you personally know anyone who has had a serious, long-term side effect from a vaccine?*; and, 6) *Is the child's doctor or health provider your most trusted source of information about childhood vaccines?* These questions were tested by the National Center for Health Statistics and found to validly describe components of vaccine hesitancy and were used in a previous study using the National Immunization Survey examining their association of each of the vaccine hesitancy variables with childhood influenza vaccination [15]. Response options were yes or no for all questions except those on vaccine schedule and vaccine hesitancy. For vaccine schedule, response options were "standard schedule" or "some other schedule." For vaccine hesitancy, response options were "not at all hesitant," "not that hesitant," "somewhat hesitant," and "very hesitant." Due to the low number of responses in some categories, responses for "very hesitant" (3.8%) and "somewhat hesitant" (13.8%) were combined and recoded as "hesitant" and responses for "not that hesitant" (15.7%) and "not at all hesitant" (66.7%) were recoded as "not hesitant".

### 2.4. Vaccination coverage

Initiation and completion rates for HPV vaccine (≥1 and UTD doses, not distinguishing between 9-, 4-, or 2-valent HPV vaccines) were assessed for adolescents overall and by sex. UTD HPV vaccination coverage is defined as having ≥ 3 doses, and 2 doses when the first HPV vaccine dose was initiated before age 15 years and there was at least 5 months minus 4 days between the first and second dose. Valid doses of vaccines administered for vaccination coverage analysis were determined based on confirmed provider-reported dates of vaccine administration.

### 2.5. Analytic methods

Data from April to June interviews in the 2018 and 2019 NIS-Teen were analyzed for this study. Weighted proportions of responses to vaccine hesitancy variables were assessed overall and by sociodemographic characteristics. T-tests were used to identify differences in vaccination coverage by each parental vaccine hesitancy variable and by sociodemographic differences. T-tests were then used to test for differences in the adjusted prevalence estimates output from multivariable logistic to determine the differences in HPV vaccination (≥1 dose and UTD doses), overall and by sex, for different levels of each vaccine hesitancy measure; prevalence estimates were adjusted for adolescent's race/ethnicity, relationship of the respondent to the adolescent, adolescent's mother's educational level, MSA status, Census region, poverty level, and provider HPV vaccination recommendation.

The adjusted population attributable risk (PAR) for HPV vaccination was calculated to assess the potential contribution of vaccine hesitancy to the observed non-vaccination level. PAR was calculated using the formula: p (rr-1) / rr, where p is the proportion of hesitant individuals among the not-vaccinated group of individuals and rr denotes the relative risk comparing the proportion of those who are not vaccinated among the hesitant group with the proportion of those who are not vaccinated among the non-hesitant group [17,18]. The rr is obtained using a log-link regression model with not vaccinated as the outcome measure and vaccine hesitancy as one of the covariates in the model, adjusted for sex, race/ethnicity, relationship of the respondent to the adolescent, mother's educational level, MSA status, Census region, poverty level, and provider HPV vaccination recommendation.

Analyses were weighted to population totals and adjusted for households having multiple telephone lines, unit non-response, non-coverage of non-cellular-telephone households, and to reduce bias due to children not having adequate provider data [10,11]. Estimates, along with 95% confidence intervals (CIs), were calculated using SAS-callable SUDAAN (Research Triangle Institute, Research Triangle Park, NC, version 11.0.1) to account for the complex survey design. All differences were tested using two-tailed t-tests with a significance level set at $\alpha = 0.05$.

## 3. Results

### 3.1. Parents' vaccine hesitancy and perceptions

In 2018 and 2019, 17.6% of parents reported being hesitant toward adolescent vaccines (Fig. 1). Over 4% reported following an alternative vaccine schedule; 15.6% were concerned about the number of vaccines the adolescent receives at one time; 21.6% were concerned about serious, long-term side effects from vaccines; 12.2% personally knew someone with a serious, long-term side effect from a vaccine; and 12.8% did not believe that their adolescent's doctor was the most trusted source of information about vaccines. Parents who had concerns about the number of vaccines received at one time or concerns about serious, long-term side effects from vaccines, personally knew someone with a serious, long-term side effect from a vaccine, or did not believe that their adolescent's doctor is the most trusted source of information about vaccines were more likely to be vaccine hesitant or followed a

non-standard vaccination schedule than their respective reference groups (Supplemental Table).

### 3.2. Correlates of parents' vaccine hesitancy and perceptions

Hesitancy toward vaccines was significantly associated with the relationship of the respondent to the adolescent, mother's educational level, poverty level, and provider recommendation for HPV vaccination (Table 1). A higher proportion of mothers were hesitant toward vaccinations than fathers or other guardians. Vaccine hesitancy was also higher among mothers who reported a lower educational level, households with lower income levels, and parents who did not receive an HPV vaccine recommendation for their adolescent. Concerns about the number of vaccines received and serious, long-term side effects of a vaccine also significantly differed by race/ethnicity, with non-Hispanic white and non-Hispanic black populations having higher levels of concerns than Hispanics. Parents who received an HPV vaccine recommendation from their adolescent's health care provider were less likely to be hesitant than parents who did not receive a recommendation (Table 1).

Adolescent HPV vaccination coverage was significantly lower among parents who were hesitant than among parents who were not hesitant (Table 2). For example, ≥1 dose and UTD HPV vaccination coverage was 18.4 and 22.9 percentage points lower, respectively, for adolescents whose parents were hesitant compared with parents who were not hesitant. Male adolescents had significantly lower coverage for ≥ 1 dose and UTD HPV vaccination than female adolescents among parents who were hesitant (Table 2). HPV (≥1 dose and UTD) vaccination coverage was also significantly lower for parents who followed a non-standard vaccine schedule, had concerns about the number of vaccines received at one time or concerns about serious, long-term side effects from a vaccine, personally knew someone with a serious, long-term side effect from a vaccine, or did not believe their child's doctor was the most trust source of information about vaccines. Differences ranged from 13.0% to 20.4% among females and 11.1% to 28.0% among males for ≥ 1 dose HPV, and from 15.3% to 20.1% among females and 10.9% to 33.7% among males for UTD HPV.

### 3.3. Population attributable risk of hesitancy on non-vaccination

The PAR of parental hesitancy on HPV vaccination was 10.7% and 8.3% for ≥ 1 dose and UTD HPV vaccine, respectively (Table 3). Across all sociodemographic characteristics, the percentage of adolescents who were not vaccinated was higher among hesitant parents than among non-hesitant parents. PAR for ≥ 1 dose and UTD HPV vaccine was highest for Non-Hispanic Black populations, mothers with higher educational level, and households living in rural or sub-urban areas.

## 4. Discussion

Vaccine hesitancy contributes to lower vaccination coverage and could reduce coverage below the necessary threshold to achieve herd immunity, which places individuals and communities at increased risk for vaccine-preventable diseases [19]. One in five parents of adolescents in this study were hesitant about adolescent vaccinations, and parental vaccine hesitancy was associated with significantly lower coverage for HPV vaccination among

adolescents, ranging from 18% to 24% lower coverage for ≥ 1 dose and UTD HPV vaccine, respectively, among adolescents with hesitant parents compared with adolescents with non-hesitant parents. Male adolescents were significantly less likely to receive an HPV vaccination than female adolescents among parents who were hesitant. Vaccine hesitancy was higher among mothers with lower educational levels and households with lower income. Concerns about the number of vaccines received at one time and serious, long-term side effects from a vaccine were highest among non-Hispanic black and white populations. About 12% of respondents indicated they know someone who has had a serious, long-term side effect from a vaccine. This is much higher than published literature of adverse side effects from vaccines, and suggest that these beliefs are based on perceptions of risk (e.g., temporal associations between vaccination and subsequent adverse health event) rather than true events [20]. These results suggest that more efforts are needed to understand root causes of vaccine hesitancy in these populations to increase vaccination coverage among adolescents.

Only 1 in 2 adolescents were vaccinated for ≥ 1 dose and only 1 in 3 adolescents were up-to-date with HPV vaccines among hesitant parents. HPV vaccine coverage (≥1 dose and UTD) was lower for adolescent males compared to females. While vaccinating female adolescents against HPV can prevent up to 90% of cervical cancers, HPV vaccination can prevent 63% of oropharyngeal cancers that affect males and females, and 60% penile cancers among males, emphasizing the importance of vaccination among females and males [20,22].

In this study, we found that approximately 10% of non-vaccination could be attributed to vaccine hesitancy, indicating that parental hesitancy plays some role in adolescent vaccination but that there are other barriers to vaccination coverage. PAR for ≥ 1 dose and UTD HPV vaccine was highest among non-Hispanic Black populations, mothers with higher education, and households in rural and sub-urban areas, suggesting that hesitancy plays a larger role in adolescent HPV vaccination in some populations than others. HPV vaccination coverage was higher for the non-Hispanic Black population compared the non-Hispanic White population, and the higher PAR among the non-Hispanic Black population may at least partially reflect a larger role of hesitancy as other barriers to vaccination are reduced. Other barriers to vaccination services may include limited access and missed opportunities at health provider visits [22,24]. While non- or under-vaccination among adolescents may be due to some of these barriers, understanding the role of hesitancy in vaccination coverage is important for targeting messages and interventions to address coverage gaps.

Vaccinate with Confidence, CDC’s strategic framework to strengthen vaccine confidence, aims to identify under-vaccinated communities, empower families in their decision to vaccinate by strengthening provider-parent vaccine conversations, and address vaccine myths and misinformation [25]. Once communities with low vaccination coverage rates are identified, key community immunization stakeholders can improve coverage by building partnerships with local health care providers, public health authorities, and other stakeholders to identify pockets with low vaccination coverage and vaccinate those who need to be vaccinated, including adolescents; use immunization information system data and small-area analyses to identify areas of low vaccination coverage and develop strategies to

overcome barriers to vaccination in those areas; and build program capacity to effectively promote routine use of vaccines.

To ensure parents are confident in their decision to vaccinate their adolescent children, health care providers should have access to appropriate resources to have effective conversations with them regarding vaccine safety and effectiveness. This study found that parents who received HPV vaccination recommendation from their providers were less hesitant than parents who did not receive a recommendation and receiving HPV vaccination recommendation is associated with increased HPV vaccination uptake. The power of provider recommendation is also illustrated by a recent study that found that influenza vaccination coverage among children for whom a provider recommendation was received was 72.2%, compared with 32.1% among children who did not receive a provider recommendation [26]. As the most trusted source of information on vaccination, health care providers should be aware of and use tools that are available to them, to make a strong vaccine recommendation and provide important information to help patients make informed decisions about vaccinations. Numerous studies have found that presumptive recommendations by providers are associated with increased vaccine update, parental acceptance, and positive visit experiences [26-29].

Overcoming myths and misinformation on vaccines requires educating parents and adolescents about vaccines on an ongoing basis and providing trusted messengers with updated, accurate, and reliable information. At the systems level, this effort involves vaccination community stakeholders—including professional health, education, and advocacy organizations, policy makers, and the public—working with social media outlets and the mass media. Together, efforts are needed to disseminate accurate vaccine safety and effectiveness information and current vaccination recommendations, debunking myths and correcting misinformation; and advancing coordinated local responses and community-based initiatives to address vaccine misinformation and hesitancy.

The findings in this report are subject to several limitations. First, the overall CASRO response rate for the survey was 23.3% and 19.7% in 2018 and 2019, respectively. Therefore, bias in estimates might remain even after weighting for household and provider nonresponse and noncoverage rates [10,11]. In addition, there were approximately 50% of respondents with completed interviews that did not have adequate provider data, so they were removed from the analyses. There are differences in characteristics for children with adequate provider data and children without adequate provider data but for which the household questionnaire was completed. A separate weighting step was implemented to mitigate possible bias from this stage of nonresponse [10,11]. The total survey error distribution, which is the sum of the errors that arise at every step of a survey, including both sampling error and nonsampling errors such as coverage, nonresponse, and measurement errors, for HPV is estimated to be −2.7 (95%CI: −6.3, 0.9) percentage points overall, which signifies that the statistical evidence is not inconsistent with the hypothesis that the mean total survey error is near zero [11]. Third, the vaccine hesitancy questions were only asked in the NIS-Teen for three months out of the year, which limited the number of participants and our ability to analyze the data by state and specific sociodemographic characteristics. Fourth, the survey asked about hesitancy toward vaccines in general and not specifically about HPV

vaccination. It is possible that the results might have been different had the survey asked about vaccine-specific hesitancy. Fifth, vaccine hesitancy was self-reported by parents and may be underestimated due to social desirability bias. Finally, data are from a cross-sectional survey and the PAR estimates are only an approximation to the unknown association between hesitancy and vaccination [17,18].

## 5. Conclusion

During the COVID-19 pandemic, studies have found declines in routine pediatric vaccine ordering and doses administered, which could be due to parents' concerns about potential exposure to COVID-19 during child well office visits [30]. These barriers, in addition to concerns about the COVID-19 vaccine, could further gaps and disparities in childhood vaccination, placing children and communities at increased risk for vaccine-preventable diseases [30,32]. Increasing vaccine confidence through provider recommendations is important to protect the health of adolescents and their families and communities. Further efforts to strengthen public trust include finding and protecting communities at risk, expanding resources for working with local communities, building and normalizing a culture of immunization in health care practices, continually improving communication strategies, and collaborating with government and health care partners. Increasing adolescent vaccination coverage not only protects the health of children and families and leads to stronger and safer communities, but also protects the entire nation from outbreaks of vaccine-preventable diseases.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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## Disclaimer:

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

## Abbreviations:

| | |
|---|---|
| **AAP** | American Academy of Pediatrics |
| **ACIP** | Advisory Committee on Immunization Practices |
| **aPD** | adjusted prevalence difference |

| | |
|---|---|
| **CASRO** | Council of American Survey Research Organizations |
| **CDC** | Centers for Disease Control and Prevention |
| **CI** | 95% confidence interval |
| **HPV** | human papillomavirus |
| **MSA** | metropolitan statistical area |
| **NIS-Teen** | National Immunization Survey-Teen |
| **PAR** | population attributable risk |

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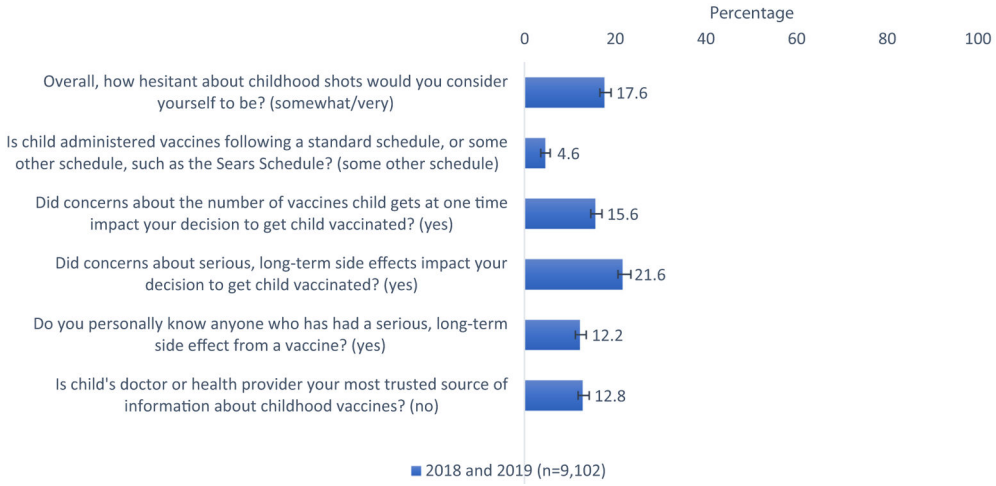


**Fig. 1.**

Prevalence of vaccine hesitancy, adherence to standard vaccination schedule, and perceptions in the United States among parents of adolescents age 13–17 years, United States, National Immunization Survey-Teen, April–June 2018 and 2019.

**Table 1**

Prevalence estimates of vaccine hesitancy, adherence to standard vaccination schedule, and perceptions among parents of adolescents aged 13–17 years, by sociodemographic characteristics, United States, National Immunization Survey-Teen, April–June 2018 and 2019.

| | Hesitant about childhood vaccinations | Follow some other schedule | Concerned about the number of vaccines received at one time | Concerned about serious, long-term side effects | Personally know someone with serious, long-term side effect from a vaccine | Doctor is not the most trusted source of information about childhood vaccines |
|---|---|---|---|---|---|---|
| | % (95% CI) | % (95% CI) | % (95% CI) | % (95% CI) | % (95% CI) | % (95% CI) |
| Adolescent's sex | | | | | | |
| Female (ref) | 18.1 (15.9–20.4) | 4.0 (3.1–5.2) | 16.2 (14.0–18.6) | 22.9 (20.2–25.8) | 11.6 (9.9–13.6) | 14.4 (12.1–17.1) |
| Male | 17.1 (15.2–19.1) | 5.1 (3.5–7.2) | 15.2 (13.5–17.0) | 20.4 (18.2–22.8) | 12.8 (10.9–15.0) | 11.3 (9.9–12.9)* |
| Adolescent's race/ ethnicity | | | | | | |
| Hispanic (ref) | 17.0 (13.8–20.9) | 6.7 (3.9–11.4) | 11.6 (9.4–14.3) | 19.2 (15.0–24.3) | 10.6 (7.8–14.2) | 11.0 (7.4–11.6) |
| Non-Hispanic White | 16.3 (14.5–18.1) | 3.6 (2.8–4.7) | 16.6 (14.7–18.7)* | 20.4 (18.4–22.5)* | 13.2 (11.7–14.7) | 13.7 (12.3–15.4) |
| Non-Hispanic Black | 20.5 (16.6–25.1) | 4.2 (2.7–6.6) | 16.6 (12.9–21.0)* | 27.2 (21.8–33.4)* | 9.6 (5.7–15.7) | 11.3 (8.4–15.1) |
| Non-Hispanic other/multiple races | 21.6 (17.0–27.0) | 5.4 (2.8–10.2) | 19.4 (14.8–24.9)* | 26.1 (21.2–31.7) | 15.0 (10.6–20.8) | 14.5 (10.5–19.6) |
| Relationship of respondent to adolescent | | | | | | |
| Mother (ref) | 19.0 (17.2–20.8) | 4.7 (3.8–5.7) | 17.2 (15.4–19.1) | 23.0 (20.9–25.3) | 14.0 (12.3–15.9) | 12.0 (10.7–13.5) |
| Father | 15.5 (12.9–18.5)* | 3.5 (2.3–5.3) | 13.5 (11.2–16.2)* | 19.2 (16.4–22.4) | 10.0 (7.9–12.9)* | 14.3 (11.5–17.6) |
| Other | 12.7 (7.9–19.8)* | 9.0 (2.3–29.3) | 10.2 (6.6–15.4)* | 18.8 (10.3–31.8) | 4.6 (2.3–8.7)* | 13.7 (6.1–27.7) |
| Mother's educational level | | | | | | |
| High school graduate or less (ref) | 22.7 (18.2–27.8) | 5.5 (3.7–8.0) | 13.8 (11.6–16.3) | 20.9 (17.7–24.6) | 7.9 (6.1–10.2) | 10.2 (7.7–13.3) |
| Some college | 19.3 (16.5–22.4) | 4.5 (3.3–6.1) | 17.0 (14.5–19.9) | 23.4 (20.0–27.2) | 14.6 (11.6–18.1)* | 12.4 (10.3–14.9) |
| College graduate | 14.8 (12.8–17.1)* | 5.1 (3.4–7.8) | 16.3 (14.1–18.8) | 21.2 (18.6–23.9) | 14.2 (12.2–16.5)* | 15.1 (12.9–17.5)* |
| MSA Status† | | | | | | |
| MSA, principal city (ref) | 18.1 (15.8–20.6) | 5.2 (4.0–6.8) | 15.7 (13.4–18.2) | 22.5 (19.8–25.5) | 12.2 (10.3–14.3) | 12.2 (10.4–14.3) |
| MSA, non-principal city | 16.3 (14.3–18.5) | 4.2 (2.8–6.5) | 15.0 (13.1–17.1) | 20.5 (17.9–23.3) | 12.4 (10.3–14.8) | 13.2 (10.9–15.8) |
| Non-MSA | 21.9 (18.5–25.6) | 3.6 (2.5–4.3) | 18.9 (15.8–22.5) | 23.8 (20.5–27.5) | 11.6 (9.4–14.3) | 13.4 (11.2–16.1) |
| **Census region** | | | | | | |
| Northeast (ref) | 15.9 (13.0–19.3) | 4.4 (2.9–6.5) | 16.2 (13.3–19.6) | 16.8 (14.0–19.9) | 10.5 (8.2–13.2) | 11.1 (8.7–13.9) |

| | Hesitant about childhood vaccinations | Follow some other schedule | Concerned about the number of vaccines received at one time | Concerned about serious, long-term side effects | Personally know someone with serious, long-term side effect from a vaccine | Doctor is not the most trusted source of information about childhood vaccines |
|---|---|---|---|---|---|---|
| | % (95% CI) | % (95% CI) | % (95% CI) | % (95% CI) | % (95% CI) | % (95% CI) |
| Midwest | 18.2 (15.8–20.9) | 5.0 (3.8–6.7) | 14.9 (12.8–17.4) | 24.0 (21.2–27.0) * | 12.1 (10.2–14.4) | 11.6 (9.7–13.7) |
| South | 19.8 (17.5–22.4) | 4.1 (2.9–5.7) | 16.9 (14.7–19.1) | 23.3 (20.9–25.9) * | 12.8 (11.0–15.0) | 12.9 (11.0–15.0) |
| West | 15.0 (11.9–18.6) | 5.0 (2.6–9.4) | 14.3 (11.0–18.3) | 20.6 (15.9–26.2) | 12.6 (9.2–17.0) | 14.8 (11.1–19.5) |
| Poverty Level‡ | | | | | | |
| At or above federal poverty status | 16.6 (15.1–18.3) * | 4.4 (3.2–5.9) | 16.1 (14.5–17.9) | 21.6(19.7–23.6) | 12.9 (11.4–14.6) | 13.5 (12.0–15.1) |
| Below federal poverty level (ref) | 22.0 (18.3–26.2) | 5.7 (4.0–7.8) | 14.3 (11.5–17.7) | 21.7 (17.2–27.0) | 10.7 (7.8–14.5) | 11.6 (7.9–16.7) |
| Provider HPV recommendation | | | | | | |
| Yes (ref) | 16.4 (14.7–18.2) | 4.3 (3.1–5.9) | 14.4 (12.9–16.1) | 21.4 (19.4–23.6) | 12.5 (10.9–14.3) | 13.0 (11.3–15.0) |
| No | 22.1 (18.5–26.1) * | 4.6 (3.3–6.4) | 20.0 (16.2–24.5) * | 24.3 (20.1–28.9) | 13.3 (10.5–16.6) | 13.5 (10.9–16.6) |

**Abbreviations:** CI = confidence interval; MSA = metropolitan statistical area.

*Denotes statistically significant result ($P < 0.05$) using *t*-test comparing each response level to the reference group.

†MSA was based on respondent-reported city, state, county, and ZIP code of residence using the (https://www.census.gov/programs-surveys/metro-micro.html) MSA definitions file.

‡Poverty level was defined based on the reported number of people living in the household and annual household income, according the U.S. Census poverty thresholds (https://www.census.gov/data/tables/time-series/demo/income-poverty/historical-poverty-thresholds.html).

**Table 2**

Association of parental vaccine hesitancy, adherence to standard vaccination schedule, and perceptions among parents of adolescents aged 13–17 years and adolescent HPV vaccination coverage*, United States, National Immunization Survey-Teen, April–June 2018 and 2019.

| | HPV vaccine ≥ 1 dose† | | | | | | HPV UTD‡ | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Overall | | Females | | Males | | Overall | | Females | | Males | |
| | % (95% CI) | aPD% (95% CI) | % (95% CI) | aPD% (95% CI) | % (95% CI) | aPD% (95% CI) | % (95% CI) | aPD% (95% CI) | % (95% CI) | aPD% (95% CI) | % (95% CI) | aPD% (95% CI) |
| **Level of hesitancy** | | | | | | | | | | | | |
| Hesitant | 53.5 (48.9,58.1) | −18.4 (−23.5,−13.3) § | 59.7 (53.1,66.2) | −13.0 (−20.3,−5.6) § | 47.7 (41.7,53.7) | −23.5 (−30.0,−17.1) § | 32.7 (28.6,36.8) | −22.9 (−27.7,−18.1) § | 38.9 (32.4,45.3) | −18.2 (−25.5,−10.8) § | 26.8 (21.9,31.7) | −27.3 (−32.9,−21.7) § |
| Not Hesitant | 72.0 (69.8,74.1) | Reference | 72.6 (69.3,76.0) | Reference | 71.2 (68.5,74.0) | Reference | 55.6 (53.2,58.0) | Reference | 57.0 (53.5,60.6) | Reference | 54.1 (50.8,57.4) | Reference |
| **Follow other (non-standard) vaccine schedule** | | | | | | | | | | | | |
| Yes | 45.8 (34.8,56.8) | −24.0 (−35.1,−12.8) § | 50.9 (38.7,63.0) | −19.4 (−32.0,−6.8) § | 41.3 (26.9,55.8) | −28.0 (−42.3,−13.6) § | 25.3 (17.5,33.1) | −27.9 (−36.1,−19.7) § | 34.7 (23.5,45.8) | −20.1 (−31.8,−8.5) § | 17.9 (8.7,27.2) | −33.7 (−43.4,−24.0) § |
| No | 69.8 (67.7,71.8) | Reference | 70.3 (67.1,73.4) | Reference | 69.3 (66.7,71.9) | Reference | 53.2 (50.9,55.4) | Reference | 54.8 (51.5,58.1) | Reference | 51.6 (48.5,54.7) | Reference |
| **Concerned about the number of vaccines received at one time** | | | | | | | | | | | | |
| Yes | 51.2 (46.1,56.3) | −20.9 (−26.4,−15.5) § | 54.4 (46.6,62.1) | −19.1 (−27.3,−10.9) § | 48.9 (42.7,55.1) | −21.9 (−28.4,−15.4) § | 33.4 (29.1,37.8) | −21.7 (−26.5,−16.9) § | 37.0 (30.5,43.6) | −20.1 (−27.3,−12.9) § | 30.5 (25.0,36.1) | −22.5 (−28.6,−16.4) § |
| No | 72.1 (70.1,74.2) | Reference | 73.4 (70.4,76.5) | Reference | 70.8 (68.0,73.5) | Reference | 55.1 (52.8,57.5) | Reference | 57.1 (53.8,60.5) | Reference | 53.1 (49.8,56.3) | Reference |
| **Concerned about serious, long–term side effect** | | | | | | | | | | | | |

| | HPV vaccine ≥ 1 dose[†] | | | | | | HPV UTD[‡] | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Overall | | Females | | Males | | Overall | | Females | | Males | |
| | % (95% CI) | aPD% (95% CI) | % (95% CI) | aPD% (95% CI) | % (95% CI) | aPD% (95% CI) | % (95% CI) | aPD% (95% CI) | % (95% CI) | aPD% (95% CI) | % (95% CI) | aPD% (95% CI) |
| **from a vaccine** | | | | | | | | | | | | |
| Yes | 54.8 (49.7,59.8) | −17.9 (−23.4,−12.4) [§] | 55.9 (48.4,63.4) | −18.6 (−26.6,−10.6) [§] | 53.9 (48.3,59.5) | −17.0 (−23.2,−10.8) [§] | 36.8 (32.1,41.6) | −18.9 (−24.2,−13.6) [§] | 41.8 (34.9,48.7) | −15.6 (−23.2,−7.9) [§] | 32.4 (26.5,38.3) | −21.7 (−28.3,−15.2) [§] |
| No | 72.7 (70.6,74.7) | Reference | 74.5 (71.6,77.4) | Reference | 70.9 (68.0,73.8) | Reference | 55.8 (53.4,58.2) | Reference | 57.3 (53.9,60.7) | Reference | 54.1 (50.7,57.5) | Reference |
| **Personal knowledge of someone who has had a serious, long-term side effect from a vaccine** | | | | | | | | | | | | |
| Yes | 53.5 (47.6,59.4) | −17.6 (−23.8,−11.4) [§] | 52.4 (44.3,60.4) | −20.4 (−28.8,−12.0) [§] | 54.2 (46.9,61.5) | −15.2 (−22.8,−7.7) [§] | 39.3 (32.8,45.8) | −14.1 (−21.0,−7.2) [§] | 37.5 (29.7,45.2) | −18.5 (−26.8,−10.2) [§] | 40.2 (31.3,49.0) | −10.9 (−20.1,−1.6) [§] |
| No | 71.1 (69.0,73.2) | Reference | 72.8 (69.6,75.9) | Reference | 69.5 (66.7,72.2) | Reference | 53.4 (51.0,55.7) | Reference | 56.0 (52.6,59.3) | Reference | 51.0 (47.7,54.3) | Reference |
| **Doctor is not the most trusted source of information about childhood vaccines** | | | | | | | | | | | | |
| Yes | 57.2 (50.5,63.8) | −13.5 (−20.5,−6.5) [§] | 58.5 (48.5,68.5) | −14.0 (−24.5,−3.5) [§] | 57.6 (50.9,64.4) | −11.1 (−18.2,−3.9) [§] | 39.1 (33.0,45.1) | −14.5 (−21.1,−8.0) [§] | 40.9 (31.6,50.2) | −15.3 (−25.2,−5.3) [§] | 38.4 (32.0,44.8) | −12.6 (−19.5,−5.6) [§] |
| No | 70.6 (68.6,72.7) | Reference | 72.5 (69.5,75.5) | Reference | 68.7 (65.9,71.5) | Reference | 53.6 (51.2,55.9) | Reference | 56.2 (52.9,59.5) | Reference | 51.0 (47.7,54.3) | Reference |

**Abbreviations:** aPD = adjusted prevalence difference; CI = confidence interval; HPV = human papillomavirus

Note: Negative numbers indicate direction of association (decrease in coverage).

[*] Independent multivariable logistic regression models adjusting for adolescent's race/ethnicity, relationship of respondent to adolescent, mother's educational level, metropolitan statistical area (MSA) status, Census region, poverty status, and provider HPV recommendation.

[†] HPV vaccine, nine-valent (9vHPV), quadrivalent (4vHPV), or bivalent (2vHPV).

[‡] HPV UTD includes those with ≥ 3 doses, and those with 2 doses when the first HPV vaccine dose was initiated before age 15 years and there was at least 5 months minus 4 days between the first and second dose. This update to the HPV recommendation occurred in December of 2016.

[§] Statistically significant difference (<0.05) using *t*-test comparing each response level to the reference group.



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**Table 3**

Adjusted population attributable risk (PAR)* of parental hesitancy on HPV vaccination coverage by select sociodemographic characteristics, United States, National Immunization Survey-Teen, April-June 2018 and 2019.

| | HPV vaccine ≥ 1 dose – All Adolescents[†] | | | | HPV UTD[‡] – All Adolescents | | | |
|---|---|---|---|---|---|---|---|---|
| | % Hesitant among Non-Vaccinated (95%CI) | % Not Vaccinated Among Hesitant (95%CI) | % Not Vaccinated Among Non-Hesitant (95%CI) | PAR[§] (95%CI) | % Hesitant among Non-Vaccinated (95%CI) | % Not Vaccinated Among Hesitant (95%CI) | % Not Vaccinated Among Non-Hesitant (95%CI) | PAR[§] (95%CI) |
| **Overall** | 26.4 (23.5–29.6) | 46.7 (42.3–51.2) | 27.7 (25.6–29.8) | 10.7 (8.0–14.0) | 24.3 (21.9–26.8) | 67.1 (62.9–71.1) | 44.6 (42.2–47.1) | 8.3 (6.5–10.4) |
| Adolescent's sex | | | | | | | | |
| Female | 24.9 (20.5–29.8) | 40.7 (34.4–47.3) | 27.1 (24.0–30.5) | 8.7 (5.0–14.5) | 24.2 (20.7–28.2) | 61.5 (55.0–67.7) | 42.4 (39.0–46.0) | 7.2 (4.6–11.1) |
| Male | 27.8 (24.0–31.9) | 52.7 (46.7–58.5) | 28.2 (25.5–31.0) | 12.2 (9.0–16.4) | 24.3 (21.2–27.6) | 72.6 (67.4–77.3) | 46.6 (43.2–50.1) | 9.1 (6.9–11.9) |
| Adolescent's race/ ethnicity | | | | | | | | |
| Non-Hispanic White | 25.6 (22.2–29.3) | 55.2 (49.1–61.1) | 31.1 (28.6–33.7) | 10.9 (7.9–14.7) | 23.4 (20.6–26.4) | 74.7 (69.6–79.2) | 47.6 (44.9–50.3) | 8.2 (6.3–10.6) |
| Non-Hispanic Black | 31.9 (22.5–43.0) | 43.2 (33.2–53.9) | 23.9 (17.6–31.5) | 15.0 (7.0–29.4) | 28.6 (21.8–36.5) | 61.9 (51.7–71.2) | 40.1 (32.8–47.8) | 9.3 (4.4–18.7) |
| Hispanic | 25.0 (18.0–33.7) | 34.4 (25.2–44.8) | 21.1 (16.8–26.2) | 9.1 (3.6–21.3) | 22.6 (17.1–29.2) | 59.7 (49.0–69.5) | 41.9 (35.4–48.6) | 6.8 (3.8–11.9) |
| Non-Hispanic other/ multiple races | 27.0 (18.0–38.4) | 40.5 (28.0–54.4) | 30.1 (24.5–36.4) | †† | 27.7 (20.2–36.8) | 57.4 (44.4–69.5) | 41.2 (35.0–47.7) | †† |
| Relationship of respondent to adolescent | | | | | | | | |
| Mother | 29.3 (25.6–33.2) | 48.4 (43.4–53.5) | 27.4 (24.9–30.1) | 12.0 (8.7–16.4) | 26.3 (23.4–29.5) | 67.7 (63.0–72.0) | 44.3 (41.4–47.3) | 9.2 (7.0–12.0) |
| Father | 22.9 (17.9–28.9) | 47.1 (37.6–56.8) | 29.0 (25.5–32.8) | 6.8 (2.9–15.2) | 22.1 (18.0–26.8) | 67.9 (57.9–76.5) | 43.9 (39.6–48.3) | 8.1 (5.9–10.9) |
| Other | 11.4 (5.3–22.7) | 21.4 (10.6–38.5) | 24.3 (14.7–37.5) | †† | 14.0 (6.6–27.3) | 56.1 (34.1–75.9) | 50.3 (38.6–61.9) | †† |
| Mother's educational level | | | | | | | | |
| High school degree or less | 25.4 (20.0–31.8) | 36.4 (29.7–43.7) | 26.5 (22.3–31.1) | 6.2 (2.3–15.8) | 24.9 (20.6–29.9) | 58.7 (51.5–65.5) | 43.9 (39.2–48.7) | 6.2 (3.2–11.6) |
| Some college | 28.4 (23.5–33.9) | 48.8 (41.1–56.5) | 29.4 (25.4–33.7) | 11.0 (6.9–17.3) | 27.0 (22.6–31.9) | 70.0 (62.3–76.7) | 45.3 (40.3–50.5) | 9.8 (6.7–14.3) |
| College degree | 25.9 (21.6–30.8) | 55.7 (47.7–63.3) | 27.6 (24.9–30.5) | 13.2 (9.5–18.0) | 22.2 (18.8–26.1) | 73.5 (66.2–79.7) | 44.8 (41.5–48.1) | 8.3 (6.0–11.5) |
| MSA Status[¶] | | | | | | | | |
| MSA, principal city | 23.8 (19.2–29.2) | 37.0(30.4–44.1) | 26.1 (22.9–29.7) | 6.8 (3.2–13.9) | 24.3 (20.4–28.6) | 60.0 (52.8–66.7) | 41.3 (37.7–45.0) | 7.7 (4.9–12.1) |
| MSA, non-principal city | 27.1 (22.9–31.8) | 52.3 (45.6–59.0) | 27.4 (24.4–30.6) | 12.7 (9.0–17.7) | 23.3 (20.0–27.0) | 71.6 (65.7–76.9) | 45.8 (42.1–49.6) | 8.5 (6.1–11.6) |

| | HPV vaccine ≥ 1 dose – All Adolescents[†] | | | | HPV UTD[‡] – All Adolescents | | | |
|---|---|---|---|---|---|---|---|---|
| | % Hesitant among Non-Vaccinated (95%CI) | % Not Vaccinated Among Hesitant (95%CI) | % Not Vaccinated Among Non-Hesitant (95%CI) | PAR[§] (95%CI) | % Hesitant among Non-Vaccinated (95%CI) | % Not Vaccinated Among Hesitant (95%CI) | % Not Vaccinated Among Non-Hesitant (95%CI) | PAR[§] (95%CI) |
| Non-MSA | 31.3 (25.4–37.9) | 58.3 (49.0–67.1) | 35.8 (31.3–40.5) | 12.6(7.9–19.5) | 28.3 (23.6–33.6) | 74.3 (64.9–81.8) | 52.5 (47.9–57.1) | 8.3 (5.3–13.0) |
| **Census region** | | | | | | | | |
| Northeast | 24.8 (18.0–33.1) | 42.3 (31.8–53.4) | 24.2 (20.4–28.4) | 10.4 (5.3–19.6) | 23.3 (17.8–29.8) | 59.4 (48.7–69.3) | 37.1 (32.9–41.5) | 9.2 (5.2–15.8) |
| Midwest | 26.7 (22.0–32.0) | 45.3 (37.7–53.0) | 27.6 (24.7–30.8) | 11.7 (7.6–17.5) | 24.8 (21.0–29.0) | 64.7 (56.8–71.9) | 43.7 (40.4–47.1) | 7.7 (4.9–11.9) |
| South | 27.6 (23.4–32.3) | 50.1 (43.1–57.1) | 32.6 (29.8–35.3) | 10.0 (6.5–15.1) | 26.3 (22.8–30.1) | 70.5 (63.7–76.6) | 48.9 (45.9–51.9) | 8.2 (5.8–11.4) |
| West | 25.1 (18.1–33.8) | 44.9 (34.5–55.8) | 23.6 (18.2–29.9) | 11.1 (5.4–21.3) | 21.3 (16.0–27.7) | 68.4 (58.4–76.9) | 44.6 (37.6–51.8) | 7.6 (4.2–13.2) |
| Poverty Level[**] | | | | | | | | |
| At or above federal poverty level | 24.3 (20.3–28.6) | 56.4 (48.5–63.9) | 28.9 (26.2–31.7) | 12.3 (9.5–15.8) | 24.0 (21.5–26.8) | 53.4 (44.4–62.2) | 41.9 (35.1–49.1) | 8.9 (7.0–11.1) |
| Below federal poverty level | 22.8 (15.7–31.9) | 26.1 (19.2–34.5) | 25.0 (18.9–32.2) | †† | 26.4 (20.1–33.9) | 71.5 (66.6–76.0) | 45.1 (42.6–47.7) | †† |
| Provider HPV recommendation | | | | | | | | |
| Yes | 26.2 (22.3–30.5) | 38.8 (33.6–44.2) | 21.4 (19.1–23.8) | 11.7 (8.1–16.6) | 23.7 (20.8–27.0) | 61.1 (55.7–66.3) | 38.5 (35.7–41.2) | 9.0 (5.5–14.3) |
| No | 26.9 (21.9–32.6) | 65.5 (56.5–73.5) | 50.4 (44.2–56.5) | †† | 23.7 (20.8–27.0) | 80.1 (72.5–86.0) | 67.7 (61.5–73.3) | †† |

**Abbreviations:** aPD = adjusted prevalence difference; CI = confidence interval; HPV = human papillomavirus

[*] PAR = p* (rr-1/rr), where p is the proportion of hesitant individuals among the not vaccinated group of individuals and rr denotes the relative risk comparing the proportion of those who are not vaccinated among the hesitant group with the proportion of those who are not vaccinated among the non-hesitant group.

[†] HPV vaccine, nine-valent (9vHPV), quadrivalent (4vHPV), or bivalent (2vHPV).

[‡] HPV UTD includes those with ≥ 3 doses, and those with 2 doses when the first HPV vaccine dose was initiated before age 15 years and there was at least 5 months minus 4 days between the first and second dose. This update to the HPV recommendation occurred in December of 2016.

[§] Model adjusted for adolescent's sex, race/ethnicity, relationship of respondent to adolescent, mother's educational level, MSA status, Census region, poverty level, and provider HPV recommendation.

[¶] MSA was based on respondent-reported city, state, county, and ZIP code of residence using the (https://www.census.gov/programs-surveys/metro-micro.html) MSA definitions file.

[**] Poverty level was defined based on the reported number of people living in the household and annual household income, according the U.S. Census poverty thresholds (https://www.census.gov/data/tables/time-series/demo/income-poverty/historical-poverty-thresholds.html).

[††] Estimates are suppressed if RSE > 30%.