

Human Papillomavirus Vaccination Before 13 and 15 Years of Age: Analysis of National Immunization Survey Teen Data

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Human papillomavirus (HPV) vaccination is suboptimally used in the United States. Vaccination before the 13th birthday is recommended by the Advisory Committee on Immunization Practices and vaccination before the 15th birthday requires only 2 doses. We estimated the proportion of adolescents up to date for HPV vaccine using provider-verified vaccination data from the 2016 National Immunization Survey-Teen. Only 16% of US adolescents completed HPV vaccination before turning 13, and 35% completed HPV vaccination before turning 15. With sexual activity initiation increasing throughout adolescence and higher immunogenicity for younger vaccinees, vaccination before the 13th birthday can provide better protection against HPV-related cancers.

Keywords. HPV; human papillomavirus; vaccination; immunization.

Human papillomavirus (HPV) vaccine coverage levels in the United States remain suboptimal. In 2016, approximately 60% of 13 to 17-year-old adolescents had initiated the HPV vaccine series and 43% were fully up to date [1]. Assessing HPV vaccination at 13–17 years of age does not fully account for key time points related to the Advisory Committee on Immunization Practices (ACIP) recommendations.

First, ACIP recommends vaccination at 11–12 years of age, which is best assessed by complete vaccination by age 13. Second, a recent update to HPV vaccine recommendations indicates only 2 vaccine doses are required for vaccination started before the 15th birthday, providing an opportunity to assess vaccination by age 15 [2]. These time points are important, as

the Youth Risk Behavior Surveillance System estimates that 2% of female and 5% of male adolescents had sexual debut before turning 13 [3], and the National Survey of Family Growth estimates that 11% of females and 16% of males had sexual debut by the time they turn 15 years of age [4].

Little is known about the prevalence of HPV vaccination series completion before adolescents turn 13 and 15 years of age. Prior research assessing age-level vaccination coverage has focused on HPV vaccine series initiation and on younger ages (ie, 11–12 years) [5, 6] without considering the impact of the recommendation for 2 doses if vaccinated prior to turning 15 years [7]. To address these gaps in our understanding of HPV vaccine coverage, we analyzed data from the 2016 National Immunization Survey-Teen (NIS-Teen) to understand HPV vaccine series completion before both the 13th and 15th birthday.

METHODS

We conducted a secondary analysis of HPV vaccination from the 2016 NIS-Teen using SAS (version 9.4, The SAS Institute, Cary, NC) procedures appropriate for complex survey data analysis, weighted according to NIS-Teen Data User's Guide specifications [8]. NIS-Teen methods have been described previously [8]. Briefly, NIS-Teen is a random digit dial telephone survey of parents of 13–17 year olds in the United States, using both landline and cell phone numbers. Parents completing the household survey are asked for permission for the survey team to contact their adolescent's health care provider(s) for vaccination history verification. This analysis was restricted to provider-verified immunization history data. At the time of this analysis, the 2016 NIS-Teen public use file was the latest available for inclusion. Given the recency of the 2-dose HPV vaccine recommendation when vaccinating before 15 years of age (first recommended in 2016 [2]) we did not include older NIS-Teen data in this analysis.

Using age-specific vaccination receipt data, we classified adolescents with regard to HPV vaccine series initiation and completion by 2 time points—before the adolescent turns 13 and 15 years of age. Adolescents were classified as: not having initiated HPV vaccination; initiated HPV vaccination, but not until after the reference time point (ie, 13 or 15 years of age); initiated HPV vaccination before the reference time point without completing the vaccine series; initiated HPV vaccination before the reference time point, with series completion after the reference time point; and initiated and completed HPV vaccination before the reference time point. We conducted a secondary subset analysis, restricted to adolescents who already reached their

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15th birthday, to compare vaccination by age 15 only among adolescents who reached that age.

After classifying adolescents by their HPV vaccination status, we compared these classifications by key sociodemographic factors (ie, sex, age, race/ethnicity, household poverty status, number of health care providers, and state of residence), using proportions and 95% confidence intervals.

We also conducted analysis of HPV vaccination status by state of residence. State-level vaccine up-to-date vaccine coverage by the 13th and 15th birthdays was categorized into tertiles specific to each outcome and mapped using SAS v9.4.

This secondary analysis of previously collected, publicly available, deidentified data does not meet the definition of human subjects research requiring Institutional Review Board review.

RESULTS

In 2016, the NIS-Teen surveyed parents of 43 071 13–17 year olds, of which 20 880 (48.5%) gave permission for provider verification of immunization records. Of these 20 880, 20 475 (98.1%) lived in the 50 states or District of Columbia, and had weight data available. This analysis was restricted to these 20 475 respondents.

In 2016, only 15.7% of 13–17 year olds in the United States had initiated and completed the HPV vaccine series prior to age 13, whereas 34.8% of 13–17 year olds were fully up to date by the 15th birthday. While 23.6% of adolescents initiated HPV vaccination after turning 13, only 7% initiated after turning 15 (Tables 1 and 2).

For both age points, female adolescents were more likely than male adolescents to be up to date by the specified cutoff ages (20.1% versus 11.6%, respectively, for completion before 13 years of age; 41.6% versus 28.3%, respectively, for completion before 15 years of age; Tables 1 and 2).

Previously identified patterns in HPV vaccination for 13–17 year olds (eg, higher vaccination among Hispanic adolescents compared to adolescents of other races and ethnicities, and among adolescents living below the poverty line compared to adolescents living at or above the poverty line) remained consistent across our detailed vaccine uptake classification (Tables 1 and 2). Adolescents with more than 1 health care provider were more likely to have not initiated HPV vaccination and less likely to have completed HPV vaccination before ages 13 or 15 years (Tables 1 and 2).

Table 1. Provider-Verified Human Papillomavirus Vaccination Status Before 13 Years of Age Among 13–17 Year Olds in the United States, 2016 National Immunization Survey-Teen

	Demographic Distribution		Never Initiated HPV Vaccination		Initiated at 13 y or Older		Initiated Prior to 13 y, Not Up to Date		Initiated Prior to 13 y, Up to Date at 13 y or Older		Initiated and Up to Date Prior to 13 y	
	N ^a	%	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI
Overall	20 475	100.0	39.6	38.4–40.8	23.6	22.5–24.7	6.4	5.7–7.1	14.7	13.7–15.7	15.8	14.8–16.7
Sex												
Male	10 814	51.1	44.0	42.3–45.7	26.1	24.5–27.6	5.9	5.1–6.8	12.3	11.1–13.6	11.6	10.5–12.7
Female	9 661	48.9	35.0	33.2–36.7	21.1	19.5–22.6	6.9	5.7–8.0	17.1	15.5–18.7	20.1	18.6–21.5
Age												
13	4 209	19.5	46.5	43.7–49.2	7.0	5.6–8.3	13.2	11.4–15.0	9.9	8.1–11.7	23.5	21.1–25.9
14	4 256	20.0	40.8	37.9–43.6	15.3	13.3–17.2	7.0	5.3–8.7	19.4	16.5–22.3	17.6	15.5–19.6
15	4 113	21.0	38.0	35.2–40.8	24.8	22.3–27.3	5.2	3.2–7.2	17.0	14.8–19.2	15.0	13.0–16.9
16	4 190	20.4	38.1	35.6–40.6	28.5	26.2–30.7	3.8	2.6–4.9	15.8	13.7–17.8	13.9	12.0–15.9
17	3 707	19.1	34.6	31.9–37.4	42.9	39.9–46.0	2.9	1.6–4.2	10.8	8.9–12.7	8.8	7.0–10.6
Race/ ethnicity												
Hispanic	3 223	23.2	30.2	27.2–33.3	24.1	21.0–27.2	8.2	5.9–10.4	18.7	15.7–21.7	18.9	16.3–21.4
Non-Hispanic White	12 883	52.7	45.3	43.9–46.8	23.8	22.6–25.1	4.9	4.2–5.6	11.9	10.9–12.8	14.1	13.0–15.1
Non-Hispanic Black	1 990	13.8	34.1	30.8–37.4	21.7	18.8–24.6	9.3	7.1–11.4	18.3	15.6–21.1	16.6	14.2–19.0
Other	2 379	10.3	38.5	34.1–42.4	24.0	21.0–27.0	6.2	4.2–8.3	15.2	12.0–18.3	16.1	13.5–18.8
Poverty												
Below poverty	3 461	22.6	29.8	27.2–32.5	22.7	20.1–25.4	8.8	7.1–10.5	19.0	16.4–21.6	19.6	17.4–21.9
At/above poverty	16 290	77.3	42.7	41.3–44.1	23.8	22.6–25.0	5.4	4.7–6.1	13.4	12.3–14.5	14.7	13.6–15.7
Number of providers												
0	76	0.2	100.0	100.0–10.00	NA	NA	NA	NA	NA	NA	NA	NA
1	11 760	59.1	36.9	35.3–38.4	24.4	23.1–25.8	5.9	5.0–6.9	16.4	15.0–17.8	16.4	15.2–17.6
2	5 578	26.1	42.5	40.2–44.8	23.2	21.2–25.3	6.9	5.5–8.2	12.1	10.5–13.7	15.3	13.5–17.1
3 or more	3 061	14.6	44.7	41.2–48.3	21.3	17.9–24.7	7.5	5.5–9.6	12.3	9.8–14.7	14.2	11.8–16.6

Abbreviation: NA, not applicable.

^aDemographic category N are unweighted; all proportions presented in the table are weighted.

Table 2. Provider-Verified Human Papillomavirus Vaccination Status by 15 Years of Age Among 13–17 Year Olds in the United States, 2016 National Immunization Survey-Teen

	Demographic Distribution		Never Initiated HPV Vaccination		Initiated at 15 y or Older		Initiated Prior to 15 y, Not Up to Date		Initiated Prior to 15 y, Up to Date at 15 y or Older		Initiated and Up to Date Prior to 15 y	
	N ^a	%	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI
Overall	20 475	100.0	39.6	38.4–40.8	7.0	6.26–7.6	12.3	11.4–13.2	6.4	5.8–7.0	34.8	33.5–36.0
Sex												
Male	10 814	51.1	44.0	42.3–45.7	8.2	7.15–9.2	12.6	11.3–13.8	7.0	6.1–7.8	28.3	26.7–29.8
Female	9 661	48.9	35.0	33.2–36.7	5.7	4.8–6.6	12.0	10.6–13.4	5.8	5.0–6.7	41.6	39.7–43.5
Age												
13	4 209	19.5	46.5	43.7–49.2	NA	NA	19.8	17.6–22.0	NA	NA	33.7	31.1–36.4
14	4 256	20.0	40.8	37.9–43.6	NA	NA	16.7	14.5–18.9	0.2	0.0–0.4	42.4	39.3–45.4
15	4 113	21.0	38.0	35.2–40.8	4.2	3.2–5.3	12.5	10.1–15.0	6.3	4.9–7.6	38.9	36.1–41.8
16	4 190	20.4	38.1	35.6–40.6	10.5	9.0–12.1	6.7	5.2–8.2	11.0	9.5–12.6	33.7	31.1–36.2
17	3 707	19.1	34.6	31.9–37.4	20.5	17.8–23.1	5.7	4.0–7.364	14.6	12.6–16.7	24.6	21.9–27.2
Race/ ethnicity												
Hispanic	3 223	23.2	30.2	27.2–33.3	8.2	6.1–10.3	14.1	11.4–16.8	6.1	4.5–7.8	41.3	37.8–44.8
Non-Hispanic White	12 883	52.7	45.3	43.9–46.8	6.7	5.97–7.4	10.7	9.7–11.7	6.2	5.6–6.9	31.1	29.7–32.4
Non-Hispanic Black	1 990	13.8	34.1	30.8–37.4	5.9	4.3–7.5	15.2	12.7–17.7	7.8	6.1–9.6	36.9	33.6–40.3
Other	2 379	10.3	38.5	34.6–42.4	6.9	5.0–8.8	12.5	10.0–14.9	6.0	4.6–7.5	36.2	32.4–39.9
Poverty												
Below poverty	3 461	22.6	29.8	27.2–32.5	7.0	5.5–8.6	15.0	12.8–17.1	6.1	4.7–7.5	42.1	39.1–45.1
At/above poverty	16 290	77.3	42.7	41.3–44.1	6.7	6.0–7.5	11.2	10.2–12.2	6.6	5.9–7.2	32.8	31.5–34.2
Number of providers												
0	76	0.2	100.0	100.0–100.0	NA	NA	NA	NA	NA	NA	NA	NA
1	11 760	59.1	36.9	35.3–38.4	7.5	6.6–8.3	11.7	10.5–12.9	6.4	5.6–7.1	37.6	36.0–39.3
2	5 578	26.1	42.5	40.2–44.8	6.5	5.2–7.8	12.9	11.2–14.6	7.4	6.1–8.7	30.7	28.5–32.9
3 or more	3 061	14.6	44.7	41.2–48.3	5.8	3.8–7.8	13.6	11.0–16.3	4.9	3.3–6.5	31.0	27.6–34.5

Abbreviation: NA, not applicable.

^aDemographic category N are unweighted; all proportions presented in the table are weighted.

Patterns in vaccine uptake by 15 years of age, restricted to those who reached 15 years of age, were similar to patterns seen for vaccine uptake by 15 years of age for all 13 to 17-year-old adolescents, though absolute vaccine uptake levels were higher in this subset given the exclusion of 13 and 14 year olds (Supplemental Table 1).

State-level HPV vaccine series completion before turning 13 years of age for all adolescents ranged from 7.5% to 25.9%, and from 22.8% to 56.7% for series completion before turning 15 years of age. Six states (South Carolina, Arkansas, Wyoming, Mississippi, Texas, and Indiana) were in the lowest tertile for all HPV vaccine series completion measures, whereas 5 states (New Mexico, Hawaii, Louisiana, Delaware, and Rhode Island) and the District of Columbia were in the highest tertile for all HPV vaccine series completion measures (Supplementary Figure 1).

DISCUSSION

We have documented very low HPV vaccine coverage before adolescents reach 2 key ages—13 years, when the ACIP recommendation indicates vaccination should ideally be completed,

and 15 years, after which 3 doses are recommended instead of 2. Compared to overall reported up-to-date coverage among 13–17 year olds (43%), our estimates of up to date by the 13th birthday (15.8%) and before the 15th birthday (34.8%) are concerning. HPV vaccination provides optimal protection when given prior to the onset of sexual activity, and thus the potential for transmission of HPV. With 11% of females and 16% of males reporting sexual intercourse by age 15 [4], there is the potential for HPV infection prior to vaccination when vaccine administration is delayed.

Unlike other sexually transmitted infections, HPV can be spread through skin-to-skin contact, and does not require penetrative sexual intercourse for transmission [9]. With many adolescents considering digital-genital contact or oral sex activities as marking a loss of virginity or abstinence, unvaccinated adolescents may not recognize the risk of HPV transmission from these nonpenetrative sexual activities, potential exposing them to HPV even if they do not consider themselves sexually active [10–12].

Vaccinating against HPV at the recommended ages (11–12 years) has 3 additional benefits. First, the immune response

to HPV vaccine is stronger when vaccination is given at younger ages (before the 15th birthday) than at later ages [2]. Second, vaccination prior to the 15th birthday requires only 2 doses to be up to date, reducing logistical barriers in vaccine series completion. Third, HPV vaccination is 1 of 3 vaccines recommended at 11–12 years of age, along with tetanus, diphtheria, and acellular pertussis vaccine and quadrivalent meningococcal conjugate vaccine [13]. Concomitant administration of these 3 vaccines can reduce missed opportunities and increase overall adolescent vaccine coverage.

Sociodemographic differences typically seen for HPV vaccination [1] were likewise borne out in this detailed analysis of initiation and completion. Notably, lower timely HPV vaccination among adolescents with more health care providers may indicate lack of a medical home leading to inconsistent vaccination tracking and uptake. This highlights the need for targeted outreach to specific populations to increase HPV vaccine acceptability and uptake. Our analysis provides a means to assess states that may be achieving higher vaccination overall compared to states with lingering disparities by sex.

This study has some limitations. First, we were unable to measure sexual activity among adolescents in the NIS-Teen sample, limiting our ability to assess the potential for HPV transmission among the unvaccinated. Second, even with a large total sample size for the NIS-Teen, state-level strata are typically small, approximately 300–400 per state, preventing detailed analysis of predictors within each state. Third, the NIS-Teen has a low response rate, potentially limiting the generalizability of the findings [14]. Fourth, only approximately half of parents gave permission for provider verification of vaccination status, which can bias the results toward higher vaccine coverage with the potential of additional parental engagement in health care among those giving this permission. Strengths of this study include a nationally weighted sample with provider-verified immunization history data, minimizing misclassification of our outcome.

These findings highlight gaps in HPV vaccine recommendations for young adolescents through documented low vaccine coverage by the time they reach 13 or 15 years of age. Future research is needed to improve HPV vaccine uptake in accordance with ACIP recommendations, including continued monitoring of completion relative to the 2-dose vaccine series for younger adolescents in future analyses of NIS-Teen data.

Supplementary Data

Supplementary materials are available at *The Journal of Infectious Diseases* online. Consisting of data provided by the authors to benefit the reader, the posted materials are not copyedited and are the sole responsibility of the authors, so questions or comments should be addressed to the corresponding author.

Notes

Disclaimer. All analyses, interpretations, or conclusions reached are attributed to the author and not to the National Center for Immunization and Respiratory Diseases, which is responsible only for the initial data. The findings and conclusions in this article are those of the authors and do not necessarily represent the official position of the US Department of Health and Human Services.

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