High school females and those with other vaccinations most likely to complete the Human Papillomavirus vaccine

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Abstract

Objective. Adolescent females’ HPV vaccine completion in the U.S. is low. More recent research is needed to investigate factors that relate to HPV vaccine completion among female adolescents in the United States.

Methods. Provider-validated data from the 2012 National Immunization Survey-Teen for females ages 13–17 years (N = 9058) were analyzed from February–May 2014 using survey sample weighted statistics. A multivariable Poisson regression estimated prevalence ratios (PR) for factors influencing HPV vaccine completion: mother’s education, poverty status, adolescent’s grade, facility type, and receipt of other adolescent vaccinations.

Results. In multivariable models, 9–12th grade daughters were more likely to complete HPV vaccination than 6–8th grade daughters (PR = 1.81, 95% CI = 1.58–2.06). Those seen in hospital facilities completed HPV vaccination 1.3 times more (PR = 1.29, 95% CI = 1.02–1.62) and those seen in private facilities were 1.2 times more likely to complete (PR = 1.22, 95% CI = 1.01–1.48), than those seen in public facilities, respectively. Compared to those without recommended adolescent vaccinations, receipt of seasonal influenza vaccination related to HPV vaccine completion (PR = 1.71, 95% CI = 1.54–1.89), as did receipt of TDAP vaccination (PR = 1.17, 95% CI = 1.03–1.33) and Meningitis vaccination (PR = 2.74, 95% CI = 2.20–3.42).

Conclusions. Adolescent females in high school, seen in private/hospital facilities, and up to date on other recommended adolescent vaccinations are most likely to complete the HPV vaccine.

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Background

The Healthy People 2020 HPV vaccination goal among females is 80% (Healthy People, 2020 Topics & Objectives: U.S. Department of Health and Human Services, 2014). In 2012, 33.4% of eligible adolescents have completed HPV vaccination in the United States (U.S.), with variation among states (Mississippi = 12.1% to Rhode Island = 57.7%) (2012 NIS-Teen Vaccination Coverage Table Data: Centers for Disease Control and Prevention, 2014).

In 2010, minority race adolescents were more likely to initiate the HPV vaccine, (Laz et al., 2012) but less likely to complete the series (Niccolai et al., 2011; Reiter et al., 2014). In 2009, older adolescents were less likely to complete HPV vaccination than younger patients (Hirth et al., 2012). Those living below poverty level are less likely to complete HPV vaccination (Niccolai et al., 2011). Research is needed to provide updated data on factors influencing HPV vaccine completion.

This is one of the first studies of 2012 National Immunization Survey-Teen (NIS-Teen) data to investigate HPV vaccine completion factors among female adolescents in the U.S. Those individuals whose mother had lower education, living below poverty level, of racial or ethnic minority, younger adolescents, and receiving the vaccine at private facilities, or from a Vaccine for Children provider were hypothesized to have lower completion of the HPV vaccine. Individuals with other adolescent vaccinations were expected to be more likely to complete the HPV vaccine than those without other vaccines.

Methods

This secondary data analysis occurred from February–May 2014 and utilized the 2012 NIS-Teen survey, a publicly available, nationally
representative survey with a complex sampling design described elsewhere (Jain et al., 2009). Annually, the NIS-Teen uses random digit dialing to sample parents and adolescent health care providers through a telephone and mailed survey, respectively. These data assess adolescent vaccination coverage among 13–17 year olds in the U.S. The 2012 NIS-Teen had a cellular-household response rate of 23.6%, and a landline-household response rate of 55.1% (National State Vaccination Coverage Among Adolescents Aged 13–17 Years — United States, 2012, 2014). Analysis of publicly available data is considered exempt research by the University of Utah Institutional Review Board.

The Andersen healthcare utilization model guided the selection of factors examined in this study. Health services use is determined by three components: predisposing factors, enabling factors, and need. Predisposing factors include patient and caregiver/parent demographics (e.g., age, education, marital status, race, and income). Enabling factors include access to insurance, provider access to vaccinations, and access to other adolescent immunizations. Need includes perceived need for healthcare services which may relate to parent prioritization of other recommended adolescent vaccinations (Anderson, 1995).

Table 1
Bivariate analysis of female respondent characteristics: full sample and those with HPV completionb. Bold indicates statistically significant p-values that are less than p=0.05.

| Factor | Total (N = 9058) | % (95% CI) | HPV completion (N = 3246) | % (95% CI) | p-Value |
|--------|-----------------|------------|---------------------------|------------|---------|
| Age (mother) | | | | | |
| ≤34 years | 671 | 10.0 (8.8, 11.4) | 217 | 10.4 (8.1, 13.2) | 0.738 |
| 35–44 years | 3709 | 45.3 (43.5, 47.2) | 1304 | 44.2 (41.4, 47.4) | |
| ≥45 years | 4678 | 44.6 (42.8, 46.5) | 1725 | 45.4 (42.3, 48.5) | |
| Education (mother) | | | | | 0.007 |
| <12 years | 905 | 14.3 (12.8, 15.9) | 352 | 16.7 (14.0, 19.7) | |
| 12 years | 1723 | 24.0 (22.4, 25.8) | 615 | 23.7 (21.1, 26.5) | |
| >12 years (some college) | 2547 | 27.8 (26.1, 29.5) | 836 | 24.1 (21.6, 26.8) | |
| College graduate | 3883 | 33.9 (32.3, 35.6) | 1443 | 35.5 (32.7, 38.5) | |
| Poverty status | | | | | 0.048 |
| Above poverty (> $75 k) | 3943 | 33.4 (31.8, 35.1) | 1472 | 34.4 (31.6, 37.3) | |
| Above poverty (≤ $75 k) | 3335 | 39.2 (37.3, 41.0) | 1101 | 35.9 (32.9, 39.1) | |
| Below poverty | 1515 | 27.4 (25.6, 29.4) | 587 | 28.7 (26.5, 30.0) | |
| Marital status (mother) | | | | | 0.944 |
| Married | 6691 | 64.0 (62.1, 65.9) | 2354 | 64.1 (60.9, 67.1) | |
| Other | 2367 | 36.0 (34.1, 37.9) | 892 | 35.9 (32.9, 39.1) | |
| Adolescent’s race/ethnicity | | | | | 0.262 |
| Non-Hispanic White only | 6058 | 54.2 (52.4, 56.1) | 2151 | 54.7 (51.5, 57.8) | |
| Non-Hispanic Black only | 899 | 14.2 (12.9, 15.7) | 306 | 12.3 (10.4, 14.6) | |
| Other | 870 | 9.7 (8.6, 11.0) | 334 | 9.8 (8.0, 11.9) | |
| Adolescent’s current grade | | | | | 0.001 |
| 6th to 8th grade | 2511 | 27.1 (25.5, 28.7) | 590 | 18.0 (15.8, 20.5) | |
| 9th to 12th grade | 6441 | 71.5 (69.8, 73.1) | 2615 | 80.9 (78.5, 83.2) | |
| HS graduate/GED | 106 | 1.4 (1.0, 2.1) | 41 | 1.0 (0.6, 1.7) | |
| Adolescent’s health insurance | | | | | 0.475 |
| Employment/union | 5928 | 56.6 (54.7, 58.5) | 2102 | 55.6 (52.4, 58.8) | |
| Other | 3054 | 43.4 (41.5, 45.3) | 1118 | 44.4 (42.1, 47.6) | |
| Facility type for adolescent’s providers | | | | | 0.001 |
| All public facilities | 1270 | 15.5 (14.1, 17.0) | 367 | 12.1 (10.0, 14.5) | |
| All hospital facilities | 791 | 7.4 (6.5, 8.3) | 337 | 8.1 (6.6, 9.8) | |
| All private facilities | 4213 | 50.8 (49.0, 52.7) | 1567 | 55.4 (52.2, 58.6) | |
| Mixed/other | 2427 | 26.3 (24.7, 28.0) | 861 | 24.5 (21.9, 27.3) | |
| Do adolescent’s providers order vaccinations from state/local health department | | | | | 0.052 |
| All providers | 5988 | 64.5 (62.6, 66.3) | 2232 | 67.3 (64.2, 70.2) | |
| Some but possibly not all | 1309 | 14.0 (12.8, 15.4) | 466 | 13.9 (11.8, 16.4) | |
| No providers | 1008 | 11.7 (10.6, 12.9) | 316 | 11.0 (9.3, 12.9) | |
| Don’t know | 728 | 9.8 (8.6, 11.2) | 232 | 7.9 (6.3, 9.7) | |
| Influenza vaccinationf | | | | | 0.001 |
| Yes | 3850 | 38.9 (37.2, 40.7) | 1887 | 56.0 (52.8, 59.1) | |
| No | 5208 | 61.1 (59.3, 62.8) | 1359 | 44.0 (40.9, 47.2) | |
| TDAP vaccinationg | | | | | 0.001 |
| Yes | 6085 | 65.0 (63.2, 66.8) | 2465 | 72.4 (69.2, 75.4) | |
| No | 2973 | 35.0 (33.2, 36.9) | 781 | 27.6 (24.7, 30.7) | |
| Meningitis vaccinationa | | | | | 0.001 |
| Yes | 6657 | 73.5 (71.7, 75.1) | 2916 | 90.7 (88.5, 92.4) | |
| No | 2401 | 26.5 (24.9, 28.3) | 330 | 9.3 (7.6, 11.5) | |

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a Respondents from the Virgin Islands were excluded.
b Female adolescents in the U.S. with adequately complete provider-reported immunization records in the 2012 NIS-Teen survey were included in the analysis.
c Weighted percentages from Dual-Frame Sampling Weights.
d HPV completion includes those who had received at least 3 doses of the HPV vaccine.
e Survey weighted Pearson chi-square test compared those with HPV vaccine completion to those who did not receive 3 doses.
f Adolescent has taken at least one dose of seasonal influenza vaccination in the past three years.
g Adolescent has taken at least one dose of TDAP only vaccination since age 10 years old and before 13 years old.
h Adolescent has taken at least one dose of Meningitis vaccination.
Participants

Parents consented to have their adolescent’s provider contacted to verify vaccine receipt (About the National Immunization Survey: Centers for Disease Control and Prevention, 2014). Female adolescents with provider-verified immunization records were included in the analysis (N = 9058).

Outcome measures

The outcome of interest was completion of the 3-dose HPV vaccine series. After phone interviews were conducted with parents or guardians, providers were mailed a questionnaire to acquire provider-confirmed immunization information for receipt of 3 doses of the vaccine (Centers for Disease Control and Prevention. National, Regional, State, and Selected Local Area Vaccination Coverage Among Adolescents Aged 13–17 Years — United States, 2013). Participants with provider verified receipt of three doses were considered to have completed the vaccine. Variable weights selected adjust for respondents with missing provider data.

Statistical analysis

Provider-phase sampling weight for both landline and cell-phone samples in the U.S. proper was used to produce Dual-Frame point estimates and 95% confidence intervals (CI). Missing values of each variable were excluded. Frequency counts, percents, and 95% CI, each properly weighted by survey sampling weights, were reported for the total sample and HPV vaccine completion subgroup. For categorical variables, a survey weighted Pearson chi-square test was used to compare distributions between those with HPV vaccine completion to those with less than 3 doses. A survey weighted multivariable Poisson regression was fitted to assess the impact of selected predictors and reported as an adjusted prevalence ratio (PR) with 95% CI. All tests were two-sided comparisons in STATA version 13.1 (College Station, Texas).

Results

There were 9058 respondents with provider-verified vaccination records and daughters ages 13–17 years. Of these, 3246 had completed the HPV vaccine series. In Table 1, mothers were mostly aged ≥ 35, college graduates, and married. Adolescents were primarily living above poverty level, Non-Hispanic White, 9th–12th grade, and on private health insurance. In bivariate analyses of female adolescent characteristics, comparing those who had completed the HPV vaccine to those who had not, demographic factors related to HPV vaccine completion included: mother’s education, poverty status, and adolescent’s current grade, all p < 0.05. Healthcare factors associated with HPV vaccine completion included facility type for adolescent’s providers and completion of other recommended adolescent vaccinations (i.e., influenza, TDAP, Meningitis), all p < 0.05.

Multivariable analysis of factors predicting HPV vaccine completion among female adolescents

In Table 2, respondents whose mothers had some college, but no college degree, were less likely to complete the HPV vaccine than those whose mothers had less than 12 years of education (PR = 0.81, 95% CI = 0.67–0.99, p = 0.036). Daughters in 9–12th grade were 1.8 times more likely to have completed HPV vaccination than those in 6–8th grade (PR = 1.81, 95% CI = 1.58–2.07, p < 0.001). Female adolescents who were seen in hospital facilities were 1.3 times more likely to complete (PR = 1.28, 95% CI = 1.01–1.61, p = 0.037) and those seen in private facilities were 1.2 times more likely to complete (PR = 1.21, 95% CI = 1.00–1.45, p = 0.050), compared to those seen in public facilities.

| Variable | Adjusted Vaccination Coverage (%) (95% CI) | Prevalence Ratio (95% CI) |
|----------|-------------------------------------------|--------------------------|
| Age (mother) | | |
| ≤ 34 years | 37.8 (30.0, 45.6) | Reference |
| 35–44 years | 33.4 (30.7, 36.1) | 0.88 (0.71, 1.10) |
| ≥ 45 years | 32.9 (30.4, 35.3) | 0.87 (0.70, 1.09) |
| Education (mother) | | |
| < 12 years | 38.0 (32.0, 44.1) | Reference |
| 12 years | 34.3 (30.4, 38.1) | 0.90 (0.75, 1.09) |
| < 12 years (some college) | 30.9 (27.7, 34.0) | 0.81 (0.67, 0.99) |
| College graduate | 33.4 (30.3, 36.6) | 0.88 (0.72, 1.07) |
| Poverty status | | |
| Above poverty (> $75 k) | 32.9 (29.6, 36.1) | Reference |
| Above poverty (<= $75 k) | 32.9 (30.1, 35.7) | 1.00 (0.88, 1.13) |
| Below poverty | 35.4 (31.0, 39.9) | 1.08 (0.90, 1.29) |
| Marital status (mother) | | |
| Married | 32.9 (30.6, 35.2) | Reference |
| Other | 34.8 (31.4, 38.2) | 1.06 (0.93, 1.20) |
| Adolescent’s race/ethnicity | | |
| Hispanic | 33.0 (28.4, 37.6) | Reference |
| Non-Hispanic White only | 35.8 (33.4, 38.1) | 1.08 (0.93, 1.27) |
| Non-Hispanic Black only | 28.1 (23.4, 32.8) | 0.85 (0.69, 1.06) |
| Other | 31.8 (26.7, 36.8) | 0.96 (0.78, 1.19) |
| Adolescent’s current grade | | |
| 6th to 8th grade | 21.3 (18.7, 24.0) | Reference |
| 9th to 12th grade | 38.6 (36.3, 40.9) | 1.81 (1.58, 2.07) |
| HS graduate/GED | 32.7 (30.5, 34.9) | 1.53 (1.20, 1.96) |
| Adolescent’s health insurance | | |
| Employment/union | 32.8 (30.2, 35.4) | Reference |
| Other | 34.6 (31.6, 37.7) | 1.06 (0.93, 1.20) |
| Facility type for adolescent’s providers | | |
| All public facilities | 28.8 (23.9, 33.7) | Reference |
| All hospital facilities | 36.8 (31.0, 42.6) | 1.28 (1.01, 1.61) |
| All private facilities | 34.7 (32.1, 37.4) | 1.21 (1.00, 1.45) |
| Other | 32.9 (29.2, 36.5) | 1.14 (0.93, 1.40) |
| Do adolescent’s providers order vaccinations from state/local health department | | |
| All providers | 34.6 (32.5, 36.8) | Reference |
| Some but possibly not all | 29.9 (24.9, 34.9) | 0.86 (0.72, 1.04) |
| No providers | 35.0 (30.1, 40.0) | 1.01 (0.87, 1.18) |
| Don’t know | 28.6 (22.5, 34.6) | 0.82 (0.66, 1.03) |
| Influenza vaccination | | |
| Yes | 44.1 (41.3, 46.9) | 1.71 (1.54, 1.90) |
| No | 25.8 (23.6, 28.1) | Reference |
| TDAP vaccination | | |
| Yes | 35.3 (31.1, 37.4) | 1.18 (1.04, 1.35) |
| No | 29.8 (26.4, 33.3) | Reference |
| Meningitis vaccination | | |
| Yes | 39.1 (36.9, 41.3) | 2.75 (2.20, 3.42) |
| No | 14.2 (11.2, 17.2) | Reference |

Table 2

Multivariable analysis of factors predicting HPV vaccine completion among female adolescents, NIS-Teen 2012.

- Respondents from the Virgin Islands were excluded as were those with missing values (N = 3388). Female adolescents in the U.S. with adequately complete provider-reported immunization records in the 2012 NIS-Teen survey were included in the analysis.
- Multivariable Poisson regression.
- Predictive marginal prevalence.
- Adolescent has taken at least one dose of seasonal influenza vaccination in the past three years.
- Adolescent has taken at least one dose of TDAP only vaccination since age 10 years old and before 13 years old.
- Adolescent has taken at least one dose of Meningitis vaccination.

Similar to the bivariate analyses, receipt of other adolescent vaccinations increased the likelihood of HPV vaccine completion. Those with at least one dose of seasonal influenza vaccination in the past three years were 1.7 times more likely to complete HPV vaccination (PR = 1.71, 95% CI = 1.54–1.90, p < 0.001) than those without influenza vaccination. Adolescents with at least one dose of TDAP vaccination ages 10–13 years were 1.2 times more likely to complete HPV vaccination (PR = 1.18, 95% CI = 1.04–1.35, p = 0.012) than those who had not received TDAP. Adolescents with at least one Meningitis vaccination were 2.7 times more likely to complete HPV vaccination than those without a Meningitis vaccination (PR = 2.75, 95% CI = 2.20–3.42, p < 0.001).
In sensitivity analyses, a multivariable model was used to investigate factors related to females who received three doses of the HPV vaccine among those who had a minimum of 24 weeks between the receipt of the first dose of the HPV vaccine and the date of the interview (n = 4548). Females in higher grades were more likely to complete the 3-dose HPV vaccine series than females in 6th–8th grades (p < .001). Females attending private facilities compared to public facilities (p < .01), and females with the flu and TDAP vaccines (both p < .05) were also more likely to complete the 3-dose series within the recommended time frame (data not shown).

**Discussion**

Prevalence of HPV types 6, 11, 16 and 18 have declined over 50% following HPV vaccine introduction among girls ages 14–19 in the U.S., yet national immunization rates are far below the Healthy People 2020 goal of 80% completion among adolescent females (Healthy People, 2020 Topics & Objectives: U.S. Department of Health and Human Services, 2014; Accelerating HPV Vaccine Uptake: Urgency for Action to Prevent Cancer. A Report to the President of the United States from the President’s Cancer Panel. Bethesda MD: National Cancer Institute, 2014). To our knowledge, this is the first study to examine factors related to HPV vaccine completion using the 2012 NIS–Teen survey.

The ACIP has recommended that females ages 11–12 are to receive three doses of the HPV vaccine since 2006 (Centers for Disease Control and Prevention (CDC), MMWR 2007). These results indicate that adolescent females are not receiving the HPV vaccine at recommended ages. Despite parental concerns about vaccine safety and efficacy, (Markowitz et al., 2007; Oldach and Katz, 2012) clinical trial data and safety monitoring by the CDC, FDA and vaccine manufacturers indicate that the vaccine is highly safe and risk for serious reaction to the HPV vaccine is extremely rare (Centers for Disease Control and Prevention. National, Regional, State, and Selected Local Area Vaccination Coverage Among Adolescents Aged 13–17 Years – United States, 2013; Kepka et al., 2014; Gee et al., 2011; Chao et al., 2012; Klein et al., 2012). HPV vaccine administration is optimal during this age, when adolescents have the best immune response to the vaccination (Accelerating HPV Vaccine Uptake: Urgency for Action to Prevent Cancer. A Report to the President of the United States from the President’s Cancer Panel.). Providers and parents need to recognize the full-panel of recommended adolescent vaccinations and improve primary care by adhering to recommended vaccine schedules.

Future studies are needed to investigate the importance of pairing HPV vaccination with other recommended adolescent immunizations, encouraging providers to make strong recommendations for the receipt of HPV vaccination, and clinic-based parent and patient reminder systems for 3-dose series completion.

**Limitations**

This study is limited by non-response among the NIS–Teen sample, with adequate provider-verified vaccination data available among only 56.4% of cellular and 62% of landline respondents. After weighting adjustments, bias may persist (National State Vaccination Coverage Among Adolescents Aged 13–17 Years — United States, 2012, 2014). Lastly, only one multivariable regression model was included in our analyses.

**Conclusions**

Future development of multifaceted, comprehensive strategies to improve clinical recommendation and administration of the HPV vaccine series is needed, including: strong and consistent provider recommendations, use of electronic health records and information systems to incorporate reminder systems for adolescents who are due for HPV vaccination, and policies that ensure adequate provider reimbursement for administration of the HPV vaccine series (Accelerating HPV Vaccine Uptake: Urgency for Action to Prevent Cancer. A Report to the President of the United States from the President’s Cancer Panel). Moreover, community outreach and education promoting HPV vaccination as a cancer prevention method, and addressing adolescents’ and caregivers’ concerns about vaccine safety and efficacy, may also improve the uptake of the HPV vaccine.

**Conflict of interest/financial disclosure statement**

No conflicts of interest or financial disclosures were reported by the authors of this paper.

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