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Concomitant Adolescent Vaccination in the U.S., 2007–2012

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Abstract

Introduction—Concomitant (same-day) delivery of two or more vaccines to adolescents is effective, safe, and efficient. Increasing concomitant vaccination could improve coverage for recommended adolescent vaccines, but little is known about who receives vaccines concomitantly.

Methods—Data came from healthcare provider–verified records on 70,144 adolescents (aged 13–17 years) in the 2008–2012 versions of the National Immunization Survey–Teen who had received at least one dose of tetanus, diphtheria, and acellular pertussis (Tdap) booster, meningococcal conjugate vaccine (MenACWY), or human papillomavirus (HPV) vaccine. Separately for each vaccine, multivariable logistic regression identified adolescent and household correlates of concomitant versus single vaccination, stratified by adolescent sex. Vaccination took place in 2007–2012, data collection in 2008–2012, and data analysis in 2015.

Results—Among vaccinated adolescents, 51%–65% of girls and 25%–53% of boys received two vaccines concomitantly. Concomitant uptake of each vaccine increased over survey years (e.g., 2012 vs 2008: girls' Tdap booster, OR=1.88, 95% CI=1.56, 2.26; boys' Tdap booster, OR=2.62, 95% CI=2.16, 3.16), with the exception of HPV vaccination among boys. Additionally, concomitant vaccination was less common as adolescents got older and in the Northeast (all $p<0.05$). For MenACWY and HPV vaccine, concomitant uptake was less common for girls whose mothers had higher versus lower education and for boys who lived in metropolitan versus non-metropolitan areas (all $p<0.05$).

Conclusions—Missed opportunities for concomitant adolescent vaccination persist, particularly for HPV vaccine. Future interventions targeting groups with low rates of concomitant vaccination could improve population-level coverage with recommended vaccines.

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Introduction

The Advisory Committee on Immunization Practices recommends that adolescents aged 11–12 years routinely receive three vaccines: tetanus, diphtheria, and acellular pertussis (Tdap) booster, quadrivalent meningococcal conjugate vaccine (MenACWY), and human papillomavirus (HPV) vaccine.[1] In 2014, national coverage for these vaccines among adolescents aged 13–17 years reached 88% for Tdap booster, 79% for MenACWY, and 60% and 42% for initiation of the three-dose HPV vaccine series among girls and boys, respectively.[2] These rates were lower than coverage observed for routine childhood vaccinations,[3] and coverage levels for MenACWY and HPV vaccine among adolescents aged 13–15 years were lower than national goals.[4, 5] Failing to improve vaccination coverage could result in considerable morbidity and mortality for young people now and as they age.[1, 6, 7]

Concomitant vaccination (also called simultaneous or same-day vaccination) refers to the receipt of two or more vaccines during a single healthcare encounter.[1, 8] Concomitant vaccination maintains each vaccine's immunogenicity[8–13] and safety profile,[8–14] and it also saves time by reducing the number of healthcare visits needed to complete the adolescent vaccination platform. Thus, concomitant vaccination is an efficient way to increase adolescent vaccination coverage by reducing missed opportunities,[10, 11] especially important because adolescents seek preventive health care less often than younger children.[15] A 2014 study from the Centers for Disease Control and Prevention (CDC) estimated that routine concomitant vaccination among female adolescents could almost double the rates of HPV vaccine initiation and thus substantially reduce risk of HPV-associated diseases.[16]

Despite these benefits, many parents remain reluctant to consent to concomitant vaccination for children and adolescents,[17–19] and providers may also hesitate to deliver vaccines concomitantly.[18–20] Missed opportunities for concomitant vaccination, particularly with HPV vaccine, are common.[16, 21, 22] Parents' hesitancies could arise from fears about side effects, such as pain or "overburdening" the immune system.[23–25] Some clinicians share these concerns[18, 19] or overestimate parents' concerns,[24] and thus may hesitate to recommend concomitant vaccination. Health communication campaigns that target groups who are least likely to concomitantly vaccinate could overcome these barriers.

Although some studies have examined the prevalence of having received all three adolescent vaccines,[26, 27] no studies have investigated the frequency or correlates of concomitant adolescent vaccination. The present study examined associations between adolescent and household characteristics and concomitant vaccination within a nationally representative sample. Findings from this study can inform future programs that intend to increase concomitant vaccination and, as a result, increase vaccination coverage.

Methods

Procedures and Sample

Each year, CDC conducts the National Immunization Survey (NIS)-Teen, a population-based telephone survey of caregivers (hereafter called "parents") of adolescents aged 13–17

years.[28] Data for the present study came from the 2008–2012 versions of NIS-Teen. Sampling frames for survey years 2008–2010 were U.S. landline phone numbers, and sampling frames for survey years 2011–2012 were U.S. landline and cell phone numbers. The NIS-Teen interview included questions assessing adolescents' sociodemographic and healthcare information (including adolescent vaccination). If parents provided consent, NIS-Teen staff verified vaccination through written questionnaires mailed to the clinics of the adolescents' healthcare providers.

For each of 5 survey years, >30,000 parents completed the NIS-Teen phone survey.[28] Of these, around 65% had provider verification of vaccination history (n=99,921 across survey years). Exclusion criteria included non-receipt of any of the three adolescent vaccines (n=21,574), as previous studies have already identified correlates of adolescent vaccination (single or concomitant) versus non-vaccination, and receipt of vaccines outside of the study period (n=8,203).[29–32] The study period was January 1, 2007, through December 31, 2012, as national guidelines[1] began recommending all three routine adolescent vaccines by early 2007 (for HPV vaccination, the initial recommendation was among girls only[33]). Although data collection for the 2012 NIS-Teen continued into the early months of 2013, vaccinations that took place after December 31, 2012 were excluded to allow analysis of time trends across whole years. The final analytic sample included 70,144 adolescents. Data analysis took place in 2015.

The National Center for Health Statistics Research Ethics Review Board approved data collection for NIS-Teen. Analysis of de-identified data from the survey is exempt from federal regulations for the protection of human research participants. Analysis of restricted data through the National Center for Health Statistics Research Data Center is also approved by the National Center for Health Statistics Research Ethics Review Board. The IRB at the University of North Carolina exempted this study from review.

Measures

Predictor variables included adolescent and household characteristics gathered during the phone interviews across the 5 survey years. Adolescent characteristics were sex (male or female), age (range, 13–17 years), race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, or other), private health insurance status (no or yes), and preventive checkup in the last year (no or yes). Household characteristics were mother's age (≤34 years, 35–44 years, or ≥45 years), mother's education level (high school or less, or at least some college), annual household income (below poverty level, above poverty level, or unknown), urbanicity (non-metropolitan or metropolitan); U.S. Census region of residence (South, Midwest, Northeast, or West), and number of children in the household (1 or ≥2). In NIS-Teen reports[2] and other studies,[29–32] these variables have correlated with adolescent vaccination.

Dichotomous indicator variables reflected whether adolescents received Tdap booster, MenACWY (one or more dose, though adolescents aged >16 years may receive a booster), and HPV vaccine (one or more dose of the three-dose series)[1] singly or concomitantly, according to provider records. Providers reported the date on which adolescents received their vaccines on the written survey. Adolescents were classified as singly vaccinated (coded as 0) if they received the target vaccine but no other adolescent vaccine on the same day

(e.g., only Tdap booster on a given day). They were classified as concomitantly vaccinated (coded as 1) if they received the target vaccine and another adolescent vaccine on the same day (e.g., Tdap booster on a given day, with MenACWY or HPV vaccine on the same day). Adolescents did not contribute to a model if they did not receive a particular vaccine, but they were retained in models of other vaccine(s) they received. MenACWY included meningococcal conjugate and unknown type of meningococcal vaccine, following NIS-Teen.[2] To be consistent with other studies,[29–32, 34–37] HPV vaccination referred to series initiation (receipt of the first dose).

Statistical Analysis

Analyses included multivariable logistic regressions to examine the relationships between concomitant vaccination and all of the adolescent and household characteristics described above, given their associations with vaccination behaviors in previous studies.[29–32] Analyses also included NIS-Teen study year. In the regression models, adolescent age was treated as a continuous variable.

Because the adolescents in this sample were aged 13–17 years, they were eligible to have already received Tdap booster, MenACWY, and HPV vaccine (assuming they had no medical contraindications[1]) when they were aged 11–12 years. The one caveat is for HPV vaccine among male adolescents: The Advisory Committee on Immunization Practices issued a recommendation for routine HPV vaccination among female adolescents in 2007,[33] but issued a permissive recommendation for HPV vaccination in male adolescents in 2009 and a recommendation for routine vaccination in 2011.[38] Therefore, regression analyses were stratified by adolescent sex.

Analyses were implemented in SAS, version 9.2, using a two-tailed *p*-value of 0.05. NIS-Teen sampling weights were applied to account for non-equal probability of selection into the survey. Results include unweighted frequencies and weighted proportions and effect estimates.

Results

Adolescents were fairly evenly distributed across survey year, sex, and age (Table 1). Most adolescents were non-Hispanic white (57%), had a preventive checkup in the last year (88%), and lived in households above the poverty level (74%). Over the study period (2008–2012), national vaccination coverage increased for Tdap booster (41% to 85%), MenACWY (42% to 74%), and HPV vaccine (37% to 54%, initiation among female adolescents).[39] From 2010 to 2012, HPV vaccine initiation among male adolescents increased from 1% to 21%.[39]

Among vaccinated female adolescents, about half received Tdap booster concomitantly with another adolescent vaccine, about two thirds received MenACWY concomitantly, and about half received HPV vaccine concomitantly (Table 2). For each vaccination outcome, concomitant uptake increased over survey years (Table 2, Figure 1A).

In addition, concomitant Tdap booster vaccination was less common among female adolescents who were older (OR=0.81, 95% CI=0.79, 0.84), lived in households with unknown income (compared with below poverty level: OR=0.71, 95% CI=0.55, 0.91), and lived in the Northeast region (compared with South: OR=0.77, 95% CI=0.68, 0.86) (Table 2). Concomitant Tdap booster vaccination was also negatively related to mothers' age, and positively related to Hispanic ethnicity and living in metropolitan areas.

Concomitant MenACWY vaccination was less common among female adolescents who were older (OR=0.82, 95% CI=0.80, 0.85), whose mothers had higher education (OR=0.80, 95% CI=0.71, 0.90), who lived in households with higher or unknown incomes (OR=0.81, 95% CI=0.68, 0.96 and OR=0.75, 95% CI=0.58, 0.96, respectively), and who lived in the Northeast region (compared with South: OR=0.66, 95% CI=0.59, 0.74) (Table 2). Concomitant MenACWY vaccination was also negatively related to having private health insurance, having a preventive checkup in the last year, and mother's age, and positively related to living in the West region.

Concomitant HPV vaccination was less common among female adolescents who were older (OR=0.87, 95% CI=0.83, 0.90), whose mothers had higher education (OR=0.85, 95% CI=0.75, 0.96), and who lived in the Northeast region (compared with South: OR=0.74, 95% CI=0.65, 0.84) (Table 2). Concomitant HPV vaccination was also negatively related to having private health insurance, and positively related to living in the West region.

Among vaccinated male adolescents, about half received Tdap booster concomitantly with another adolescent vaccine, about half received MenACWY concomitantly, and only one quarter received HPV vaccine concomitantly (Table 3). For Tdap booster and MenACWY, concomitant uptake increased over survey years (Table 3, Figure 1B).

In addition, concomitant Tdap booster vaccination was less common among male adolescents who were older (OR=0.74, 95% CI=0.72, 0.77) and who lived in the Northeast region (compared with South: OR=0.78, 95% CI=0.70, 0.87). Concomitant Tdap booster vaccination was also positively related to non-Hispanic black race/ethnicity, Hispanic ethnicity, and living in metropolitan areas.

Concomitant MenACWY vaccination was less common among male adolescents who were older (OR=0.65, 95% CI=0.62, 0.67), who lived in metropolitan areas (OR=0.85, 95% CI=0.75, 0.96), and who lived in the Northeast region (compared with South: OR=0.68, 95% CI=0.61, 0.77). Concomitant MenACWY vaccination was also positively related to non-Hispanic black race/ethnicity and living in the Midwest or West regions, and negatively related to having a preventive checkup in the last year.

Concomitant HPV vaccination was less common among male adolescents who were older (OR=0.71, 95% CI=0.62, 0.81), who lived in metropolitan areas (OR=0.49, 95% CI=0.33, 0.73), and who lived in the Northeast region (compared with South: OR=0.43, 95% CI=0.25, 0.76).

Discussion

Missed opportunities for concomitant vaccination were common, with two thirds or less of U.S. adolescents who had initiated vaccination receiving two doses during the same healthcare visit. However, the frequency of concomitant administration has increased for most vaccines since 2008. Clear differences in concomitant vaccination emerged among key demographic groups. Future public health promotion campaigns could encourage this behavior among targeted subgroups in order to safely, effectively, and efficiently increase adolescent vaccination coverage and protect against future disease.

Important temporal patterns to concomitant vaccination emerged, specifically around survey year and adolescent age. Almost all of the concomitant vaccination outcomes demonstrated clear increases over the survey years. It is possible that, in the years since the introduction of the national guidelines for routine vaccination, adolescents and their parents have become more accustomed to the doses in the adolescent vaccination platform, increasing their acceptability individually and in combination, or that providers have become more comfortable recommending concomitant vaccination. Concomitant HPV vaccination among boys may not have demonstrated the same pattern owing to the low rates of this behavior in general, which precluded the detection of stable trends. In addition, concomitant vaccination was less common among adolescents who were older at the time of their parents' participation in NIS-Teen. Again, this pattern could have emerged because of the relatively higher acceptability of vaccines in more recent years (when younger adolescents would have become eligible to receive their vaccines). Alternatively, providers may be more comfortable delivering multiple vaccines concomitantly when adolescents are aged 11–12 years, given that most of the safety and efficacy data have focused on younger adolescents. Future studies should monitor trends in concomitant (versus single) vaccination over time and how these contribute to trends in overall vaccination coverage.

Another consistent pattern was that, compared with adolescents living in the South, adolescents in the Northeast were less likely to receive every vaccine concomitantly. However, adolescents in the West were more likely to concomitantly receive MenACWY (girls and boys) or HPV vaccine (girls only). These findings provide a contrast to the NIS-Teen reports of overall vaccination coverage,[2] which indicate that, generally, states in the Northeast and West regions have the highest rates of coverage in the nation. Thus, high rates of vaccination coverage have emerged in the Northeast, despite the low rates of concomitant vaccination, and high rates of vaccination coverage have emerged in the West, potentially due (at least in part) to the high rates of concomitant vaccination. One potential explanation for this pattern is the high density of healthcare providers (both in terms of pediatricians[40] and in school-located health centers[41]) in the Northeast; adolescents in that region who did not receive their vaccines concomitantly had relatively easy access to healthcare facilities where they could return for multiple visits to receive vaccines individually. A recent study by Jeyarajah and colleagues[22] found a similar pattern, reporting that HPV vaccination by age 13 years among adolescent females was highest in the West, despite the overall higher levels of coverage in the Northeast; clearly, vaccination patterns, including concomitant and on-time uptake, vary meaningfully across the U.S.

Among adolescent girls, concomitant vaccination differed by SES and healthcare access. Girls living in households below the federal poverty level and whose mothers had the lowest education were more likely to concomitantly vaccinate, especially with MenACWY. Vaccine refusal or delay[42, 43] is less common lower-SES families than higher-SES families, and these patterns likely extend to concomitant vaccination. A related pattern was that girls who did not have private health insurance and did not have a recent preventive checkup were more likely to concomitantly vaccinate, especially with MenACWY. These families, who may not have easy or consistent access to healthcare providers,[44] may be especially motivated to concomitantly vaccinate because returning to the medical office to receive individual vaccines could be prohibitive. More research is needed to understand parents' motivations for concomitant vaccination.

Finally, there were no consistent patterns in concomitant vaccination by race/ethnicity. Though descriptively, non-Hispanic white adolescents had the lowest rates for most of the concomitant vaccination outcomes, these differences were not generally statistically significant in the multivariable models. These results reflect a pattern toward increased concomitant vaccination among minority adolescents, which stands in contrast to findings that minorities have less favorable attitudes toward vaccines.[45] However, it is possible that these racial/ethnic patterns in concomitant vaccination are confounded with measures of healthcare access (described above). Given that minorities are less likely to have access to high-quality preventive health care,[46] they may be more accepting of concomitant vaccination because of the challenge they may face in returning to the medical office for individual administration of vaccines. Future studies should monitor racial/ethnic differences in concomitant vaccination, especially as the Affordable Care Act makes preventive healthcare services more accessible.[47]

In terms of study strengths, data came from a large, nationally representative, multiyear sample.[28] In addition, NIS-Teen includes provider verification of vaccination, which was crucial to the operationalization of concomitant vaccination (i.e., determining if adolescents received more than one vaccination on the same day, according to medical records). Moreover, this study is the first investigation of correlates of concomitant vaccination, a behavior noted as crucial to increasing vaccination coverage by CDC, the American Academy of Pediatrics, the American Academy of Family Physicians, and the American Medical Association.[1, 16, 48]

Limitations

In terms of study limitations, the 2008–2010 NIS-Teen exclusively used landline phone numbers to contact participants, whereas in 2011–2012, they also contacted participants through cell phone numbers; this difference in data collection mode could introduce some systematic differences in samples across years. Each year's NIS-Teen sample is intended to be representative of a given calendar year[28] and combining across years creates an average and not a valid representation of vaccination behaviors at a given time. In addition, this preliminary investigation of the frequency and correlates of concomitant vaccination focused on demographic characteristics of adolescents and their households; other factors, including those related to adolescents' contraindications for vaccination, local attitudes and norms,

healthcare policies, and provider behaviors,[20] may also contribute to concomitant vaccination. Additional studies are needed to parse the relationships among these variables and concomitant vaccination, especially in subgroups with low rates of concomitant vaccination. Similarly, this investigation was limited to only Tdap booster, MenACWY (first dose), and HPV vaccine (first dose), excluding concomitant administration of other vaccines (e.g., seasonal influenza vaccine, catchup of childhood vaccines); thus, the prevalence of concomitant vaccination among adolescents may be underestimated. Finally, the Advisory Committee on Immunization Practices released their recommendation for routine HPV vaccination in girls in March 2007, which could have reduced concomitant HPV vaccination during 2007, potentially leading to artificially inflated estimates of time trends in concomitant vaccination in later survey years. However, given the consistency of the increases in concomitant vaccination each year (except for HPV vaccination among boys), this pattern does not appear to have unduly influenced the findings.

Conclusions

Missed opportunities for concomitant adolescent vaccination are common, though concomitant vaccination seems to be increasing over time. Subgroups with lower rates of concomitant vaccination include adolescents who are older, live in the Northeast, and have higher SES and better healthcare access. Future public health interventions could build upon these findings to target subgroups that are less prone to concomitant adolescent vaccination in order to promote this behavior. Increases in concomitant vaccination and vaccination coverage will confer more protection for adolescents from several infectious and chronic diseases, including multiple types of cancer, both now and as they get older.

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JLM conceived of the study, conducted data analyses, drafted the manuscript, and reviewed and approved of the final text. PLR provided conceptual guidance, reviewed data analyses, and reviewed and approved of the final text. NTB oversaw the study, provided conceptual guidance, reviewed data analyses, and reviewed and approved of the final text.

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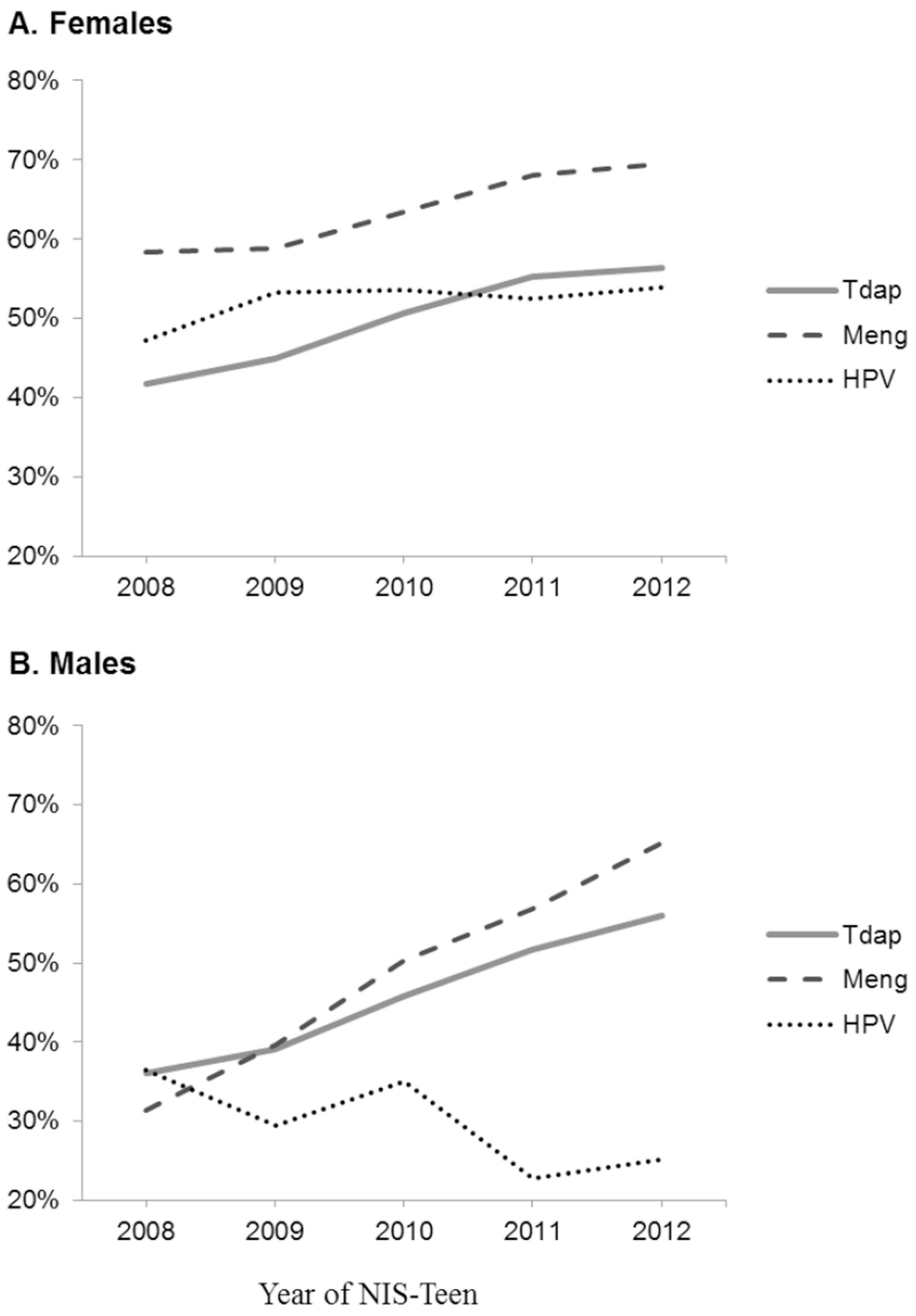

Figure 1.

Concomitant uptake of adolescent vaccines for (A) female and (B) male adolescents across years of participation in National Immunization Survey (NIS)-Teen.

Notes: Tdap, tetanus, diphtheria, and acellular pertussis booster; MenACWY, meningococcal conjugate and unknown types of meningococcal vaccine; HPV, human papillomavirus vaccine (first dose)

Errors bars represent SEs.

Table 1

Characteristics of Participants in National Immunization Survey (NIS)-Teen, 2008–2012

	Total sample		Female		Male	
Characteristic	**n**	**(%)**	**n**	**(%)**	**n**	**(%)**
Overall	70,144		35,774	52.1	34,370	47.9
Survey year						
2008	7,519	12.5	4,365	13.8	3,154	11.0
2009	12,118	17.4	6,516	18.2	5,602	16.4
2010	14,111	20.7	7,209	20.5	6,902	20.8
2011	19,481	23.9	9,584	23.1	9,897	24.9
2012	16,915	25.5	8,100	24.3	8,815	26.9
Adolescent characteristics						
Age at interview						
13	15,302	21.1	7,519	20.4	7,783	21.9
14	15,323	21.0	7,593	20.4	7,730	21.6
15	14,633	22.0	7,481	22.0	7,152	22.0
16	13,566	19.6	7,092	19.9	6,474	19.2
17	11,320	16.4	6,089	17.3	5,231	15.3
Race/ethnicity						
Non-Hispanic white	47,691	57.2	24,239	56.9	23,452	57.6
Non-Hispanic black	7,079	14.4	3,604	14.4	3,475	14.3
Hispanic	9,502	20.5	4,875	20.6	4,627	20.3
Other	5,872	8.0	3,056	8.1	2,816	7.8
Private health insurance						
No	21,925	39.3	11,114	39.0	10,811	39.7
Yes	47,846	60.7	24,474	61.0	23,372	60.3
Preventive check-up in last year						
No	8,156	12.5	4,082	12.0	4,074	13.0
Yes	61,988	87.5	31,692	88.0	30,926	87.0
Household characteristics						
Mother's age						

Characteristic	Total sample n	Total sample (%)	Female n	Female (%)	Male n	Male (%)
≤ 34 years	5,221	9.6	2,639	9.7	2,582	9.5
35–44 years	29,050	45.3	14,739	44.8	14,311	45.7
≥ 45 years	35,873	45.1	18,396	45.5	17,477	44.7
Mother's education level						
High school or less	19,725	39.0	10,020	38.6	9,705	39.4
At least some college	50,419	61.1	25,754	61.4	24,665	60.5
Annual income						
Below poverty level	9,902	20.7	5,101	21.0	4,801	20.3
Above poverty level	57,584	74.3	29,347	74.0	28,237	74.6
Unknown	2,658	5.1	1,326	5.0	1,332	5.1
Urbanicity						
Non-metropolitan	13,076	14.3	6,807	14.5	6,269	14.0
Metropolitan	50,373	85.7	25,727	85.5	24,646	86.0
Census region						
South	23,845	34.5	12,107	34.3	11,738	34.7
Midwest	15,524	21.5	8,001	21.4	7,523	21.6
Northeast	15,356	19.6	7,836	19.7	7,520	19.5
West	15,419	24.4	7,830	24.6	7,589	24.1
Number of children in household						
1	22,619	30.0	11,317	30.2	11,302	29.8
2 or more	38,659	70.0	19,049	69.8	19,610	70.2

Note. Frequencies are unweighted, and percentages are weighted.

Table 2

Frequency and Weighted Percentages, and Adjusted Correlates, of Concomitant Vaccination Among Female Adolescents (*N*=35,774)

Characteristic	Tetanus, diphtheria, and acellular pertussis (Tdap) booster				Meningococcal conjugate and unknown type meningococcal vaccine (MenACWY)				Human papillomavirus (HPV) vaccine[a]			
	n/N	%	OR	95% CI	n/N	%	OR	95% CI	n/N	%	OR	95% CI
Overall	15,340/30,366	51.4			17,600/28,106	64.6			10,942/22,635	52.4		
Survey year												
2008	1,103/2,806	41.8		(ref)	1,675/3,084	58.4		(ref)	1,304/3,083	47.3		(ref)
2009	2,187/4,999	44.9	1.18	(0.98–1.41)	2,777/4,867	58.9	1.03	(0.87–1.22)	2,063/4,332	53.3	**1.30**	**(1.07–1.58)***
2010	2,945/6,165	50.6	**1.49**	**(1.24–1.78)****	3,433/5,654	63.4	**1.23**	**(1.04–1.46)***	2,215/4,492	53.6	**1.28**	**(1.06–1.55)***
2011	4,732/8,746	55.3	**1.88**	**(1.52–2.16)****	5,094/7,801	68.1	**1.53**	**(1.30–1.80)****	2,908/5,831	52.5	**1.22**	**(1.00–1.48)***
2012	4,373/7,650	56.4	**1.88**	**(1.56–2.26)****	4,621/6,700	69.5	**1.60**	**(1.35–1.90)****	2,452/4,897	54.0	**1.27**	**(1.04–1.56)***
Adolescent characteristics												
Age at interview (continuous)			**0.81**	**(0.79–0.84)****			**0.82**	**(0.80–0.85)****			**0.87**	**(0.83–0.90)****
Race/ethnicity												
Non-Hispanic white	10,001/20,598	48.5		(ref)	11,270/18,523	61.6		(ref)	6,836/14,886	48.6		(ref)
Non-Hispanic black	1,642/2,998	49.6	1.05	(0.90–1.22)	1,999/3,060	66.3	1.07	(0.92–1.24)	1,232/2,334	54.1	1.15	(0.96–1.38)
Hispanic	2,410/4,189	59.4	**1.32**	**(1.14–1.54)****	2,818/4,060	71.1	1.08	(0.92–1.26)	1,867/3,387	58.8	1.10	(0.94–1.30)
Other	1,287/2,581	49.6	0.93	(0.79–1.10)	1,513/2,463	65.0	0.91	(0.77–1.09)	1,017/2,028	56.5	1.14	(0.94–1.39)
Private health insurance												
No	5,108/9,388	54.2		(ref)	5,876/8,623	70.5		(ref)	4,076/7,515	58.5		(ref)
Yes	10,149/20,819	49.6	0.98	(0.88–1.10)	11,629/19,329	61.0	**0.86**	**(0.76–0.97)***	6,807/15,004	47.9	**0.78**	**(0.68-0.89)****

Characteristic	Tetanus, diphtheria, and acellular pertussis (Tdap) booster				Meningococcal conjugate and unknown type meningococcal vaccine (MenACWY)				Human papillomavirus (HPV) vaccine[a]			
	n/N	%	OR	95% CI	n/N	%	OR	95% CI	n/N	%	OR	95% CI
Preventive check-up in last year												
No	1,656/3,146	51.4		(ref)	1,757/2,466	70.9		(ref)	1,064/1,870	58.7		(ref)
Yes	13,684/27,220	51.4	1.04	(0.89–1.23)	15,843/25,640	64.0	**0.77**	**(0.64–0.93)***	9,878/20,765	51.8	0.83	(0.65–1.06)
Household characteristics												
Mother's age												
≤ 34 years	1,379/2,304	61.3		(ref)	1,507/2,037	76.9		(ref)	1,062/1,828	61.0		(ref)
35–44 years	6,663/12,536	52.3	0.86	(0.71–1.04)	7,567/11,377	66.6	**0.78**	**(0.62–0.98)***	4,878/9,260	55.9	1.02	(0.82–1.26)
≥ 45 years	7,298/15,526	48.3	**0.82**	**(0.67–0.99)***	8,526/14,692	60.2	**0.69**	**(0.55–0.87)***	5,002/11,547	46.7	0.80	(0.64–1.01)
Mother's education level												
High school or less	4,495/8,358	53.9		(ref)	5,236/7,722	70.1		(ref)	3,723/6,844	58.4		(ref)
At least some college	10,845/22,008	49.9	0.92	(0.83–1.03)	12,364/20,384	61.3	**0.80**	**(0.71–0.90)****	7,219/15,791	48.1	**0.85**	**(0.75–0.96)***
Annual income												
Below poverty level	2,480/4,303	57.1		(ref)	2,887/4,062	73.8		(ref)	2,063/3,763	59.1		(ref)
Above poverty level	12,335/24,956	50.2	0.93	(0.80–1.09)	14,073/22,970	62.3	**0.81**	**(0.68–0.96)***	8,468/18,033	50.3	1.06	(0.89–1.26)
Unknown	525/1,107	45.5	**0.71**	**(0.55–0.91)***	640/1,074	60.5	**0.75**	**(0.58–0.96)***	411/839	49.7	0.95	(0.72–1.26)
Urbanicity												
Non-metropolitan	2,600/5,738	46.7		(ref)	2,808/4,451	65.9		(ref)	2,040/4,213	51.9		(ref)
Metropolitan	10,986/21,627	51.3	**1.24**	**(1.12–1.39)****	12,947/20,996	63.7	1.00	(0.89–1.13)	7,890/16,415	52.2	1.04	(0.92–1.18)
Census region												

Characteristic	Tetanus, diphtheria, and acellular pertussis (Tdap) booster				Meningococcal conjugate and unknown type meningococcal vaccine (MenACWY)				Human papillomavirus (HPV) vaccine[a]			
	n/N	%	OR	95% CI	n/N	%	OR	95% CI	n/N	%	OR	95% CI
South	5,576/ 10,102	53.1		(ref)	6,460/ 9,817	67.0		(ref)	3,809/ 7,540	51.9		(ref)
Midwest	3,515/ 6,815	50.5	1.00	(0.90–1.11)	3,894/ 6,061	63.9	0.97	(0.87–1.08)	2,283/ 4,863	50.5	0.97	(0.86–1.10)
Northeast	2,876/ 6,617	44.8	**0.77**	**(0.68–0.86)****	3,412/ 6,503	54.2	**0.66**	**(0.59–0.74)****	2,036/ 5,090	42.1	**0.74**	**(0.65–0.84)****
West	3,373/ 6,832	55.3	1.13	(0.98–1.30)	3,834/ 5,725	70.8	**1.24**	**(1.07–1.44)***	2,814/ 5,142	61.9	**1.48**	**(1.25–1.74)****
Number of children in household												
1	5,336/ 11,317	48.6		(ref)	6,262/ 10,537	60.4		(ref)	3,912/ 8,748	47.3		(ref)
2 or more	10,004/ 19,049	52.6	1.04	(0.94–1.14)	11,338/ 17,569	66.4	1.09	(0.99–1.21)	7,030/ 13,887	54.6	1.09	(0.97–1.21)

Notes: Results for each vaccine come from a single multivariable model, reflecting adjusted ORs. Frequencies are unweighted, and percentages (and ORs) are weighted. Overall *n* (35,774) represents female adolescents who received at least one vaccine under study, and column *n*s represent female adolescents who received the respective vaccine. In keeping with NIS-Teen norms, we include an "Unknown" group for Annual income but not for other variables.

Boldface indicates statistical significance (*p<0.05, **p<0.01).

[a]HPV vaccine initiation (receipt of first dose) only.

Table 3

Frequency and Weighted Percentages, and Adjusted Correlates, of Concomitant Vaccination Among Male Adolescents (*N*=34,370)

	Tetanus, diphtheria, and acellular pertussis (Tdap) booster				Meningococcal conjugate and unknown type meningococcal vaccine (MenACWY)				Human papillomavirus (HPV) vaccine[a]			
Characteristic	**n/N**	**%**	**OR**	**95% CI**	**n/N**	**%**	**OR**	**95% CI**	**n/N**	**%**	**OR**	**95% CI**
Overall	14,428/30,912	48.3			14,612/28,629	52.5			757/3,328	25.0		
Survey year												
2008	809/2,332	35.1		(ref)	809/2,548	31.4		(ref)	--[b]	36.5		(ref)
2009	1,685/4,643	39.2	1.20	(0.98–1.46)	1,684/4,555	39.6	**1.44**	**(1.18–1.76)****	--[b]	29.5	0.71	(0.07–6.77)
2010	2,651/6,202	45.8	**1.65**	**(1.37–1.99)****	2,667/5,686	50.3	**2.36**	**(1.96–2.84)****	55/176	35.0	0.98	(0.17–5.81)
2011	4,622/9,283	51.6	**2.13**	**(1.78–2.56)****	4,689/8,363	56.8	**3.15**	**(2.64–3.77)****	226/1,055	22.8	0.41	(0.08–2.18)
2012	4,661/8,452	56.1	**2.62**	**(2.16–3.16)****	4,763/7,477	65.2	**4.58**	**(3.78–5.55)****	465/2,063	25.1	0.56	(0.11–2.94)
Adolescent characteristic												
Age at interview (continuous)			**0.74**	**(0.72–0.77)****			**0.65**	**(0.62–0.67)****			**0.71**	**(0.62–0.81)****
Race/ethnicity												
Non-Hispanic white	9,493/21,207	45.5		(ref)	9,612/19,172	50.4		(ref)	390/1,815	24.9		(ref)
Non-Hispanic black	1,597/3,031	54.1	**1.35**	**(1.16–1.57)****	1,607/3,071	56.3	**1.31**	**(1.13–1.53)****	97/462	24.8	0.76	(0.46–1.26)
Hispanic	2,128/4,150	52.4	**1.16**	**(1.00–1.34)***	2,166/3,991	54.9	1.02	(0.87–1.19)	188/719	26.6	0.72	(0.40–1.30)
Other	1,210/2,524	47.8	0.97	(0.82–1.15)	1,227/2,395	50.6	0.83	(0.69–1.00)	82/332	19.8	0.73	(0.42–1.30)
Private health insurance												
No	4,799/9,678	51.6		(ref)	4,878/8,985	55.7		(ref)	391/1,429	28.5		(ref)

Characteristic	Tetanus, diphtheria, and acellular pertussis (Tdap) booster				Meningococcal conjugate and unknown type meningococcal vaccine (MenACWY)				Human papillomavirus (HPV) vaccine[a]			
	n/N	%	OR	95% CI	n/N	%	OR	95% CI	n/N	%	OR	95% CI
Yes	9,557/21,071	46.0	0.97	(0.86–1.08)	9,659/19,484	49.8	0.99	(0.88–1.12)	362/1,878	20.8	0.83	(0.54–1.29)
Preventive check-up in last year												
No	1,674/3,400	52.3		(ref)	1,686/2,698	64.2		(ref)	69/163	36.6		(ref)
Yes	12,754/27,512	47.7	0.87	(0.76–1.01)	12,926/26,931	50.8	**0.59**	**(0.50–0.70)** **	688/3,165	24.3	0.67	(0.33–1.37)
Household characteristic												
Mother's age												
≤ 34 years	1,306/2,341	57.2		(ref)	1,315/2,130	63.2		(ref)	119/338	38.2		(ref)
35–44 years	6,380/12,956	49.8	0.92	(0.77–1.10)	6,453/11,790	54.3	0.88	(0.73–1.08)	351/1,402	24.7	1.15	(0.66–2.01)
≥ 45 years	6,742/15,615	44.8	0.92	(0.76–1.10)	6,844/14,709	47.8	0.85	(0.40–1.04)	287/1,588	20.7	1.34	(0.73–2.46)
Mother's education level												
High school or less	4,267/8,662	50.0		(ref)	4,335/8,053	54.5		(ref)	314/1,148	28.6		(ref)
At least some college	10,161/22,250	47.1	0.92	(0.82–1.02)	10,277/20,576	50.7	0.89	(0.80–1.00)	443/2,180	21.7	0.79	(0.53–1.18)
Annual income												
Below poverty level	2,255/4,281	52.9		(ref)	2,298/4,098	56.8		(ref)	229/778	31.3		(ref)
Above poverty level	11,670/25,453	47.2	0.95	(0.81–1.11)	11,802/23,410	51.2	1.00	(0.85–1.18)	507/2,433	22.1	0.67	(0.71–1.08)
Unknown	503/1,178	45.4	0.97	(0.75–1.24)	512/1,121	49.0	1.01	(0.77–1.32)	21/117	14.1	0.59	(0.23–1.51)
Urbanicity												
Non-metropolitan	2,370/5,703	44.9		(ref)	2,417/4,552	55.7		(ref)	179/489	37.8		(ref)

Characteristic	Tetanus, diphtheria, and acellular pertussis (Tdap) booster				Meningococcal conjugate and unknown type meningococcal vaccine (MenACWY)				Human papillomavirus (HPV) vaccine[a]			
	n/N	%	OR	95% CI	n/N	%	OR	95% CI	n/N	%	OR	95% CI
Metropolitan	10,209/ 21,933	47.2	**1.16**	**(1.05–1.30)** *	**10,308/ 21,136**	**49.5**	**0.85**	**(0.75–0.96)** *	**388/ 2,107**	**20.1**	**0.49**	**(0.33–0.73)** **
Census region												
South	5,368/ 10,446	50.4		(ref)	5,422/ 10,095	54.8		(ref)	596/ 1,202	28.1		(ref)
Midwest	3,300/ 6,852	49.0	1.11	(0.99–1.23)	3,331/ 5,142	54.6	**1.13**	**(1.01–1.27)** *	158/ 594	28.5	1.15	(0.74–1.80)
Northeast	2,668/ 6,644	41.4	**0.78**	**(0.70–0.87)** **	2,700/ 6,620	41.4	**0.68**	**(0.61–0.77)** **	91/ 803	13.3	**0.43**	**(0.25–0.76)** *
West	3,092/ 6,970	49.9	1.10	(0.96–1.26)	3,159/ 5,772	55.6	**1.24**	**(1.0—1.44)** *	212/ 729	25.7	0.86	(0.54–1.38)
Number of children in household												
1	4,833/ 11,302	44.6		(ref)	4,902/ 10,528	48.3		(ref)	241/ 1,137	25.7		(ref)
2 or more	9,595/ 19,610	49.8	1.07	(0.97–1.17)	9,710/ 18,101	53.8	1.01	(0.91–1.11)	516/ 2,191	24.8	0.84	(0.58–1.23)

Notes: Results for each vaccine come from a single multivariable model, reflecting adjusted ORs. Frequencies are unweighted, and percentages (and ORs) are weighted. Overall *n* (34,370) represents male adolescents who received at least one vaccine under study, and column *n*s represent male adolescents who received the respective vaccine. In keeping with NIS-Teen norms, we include an "Unknown" group for Annual income but not for other variables.

Boldface indicates statistical significance (*p<0.05; **p<0.01).

[a] HPV vaccine initiation (receipt of first dose) only.

[b] Frequency suppressed due to small cell size (<10 observations).