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Comparing Human Papillomavirus Vaccine Initiation in Georgia to Regional and National Estimates: Results from the National Immunization Survey – Teen, 2014 - 2016

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2013

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Abstract

Comparing Human Papillomavirus Vaccine Initiation in Georgia to Regional and National Estimates: Results from the National Immunization Survey – Teen, 2014 - 2016

By Cymone Gates

Objective: To assess the coverage of HPV vaccine series initiation among adolescents living in Georgia and to investigate the extent of Georgia-specific predictors of HPV vaccine initiation relative to the regional and national estimates.

Methods: Data were merged and analyzed from the NIS-Teen from 2014 through 2016. Study participants, aged 13 to 17 years, with adequate provider-verified immunization data from all 50 states and Washington, D.C. (N=64,151) were included in the analysis. Subsets of the data were created for HHS Region 4 states (N=8,446) and the state of Georgia (N=1,114) for geographical comparisons. The outcome of interest was HPV vaccine initiation status (≥1 doses versus 0 doses of HPV vaccine). Poisson regression was used to evaluate significant predictors of the outcome of interest within the three populations: Georgia, HHS Region 4 and the United States.

Results: Approximately half of adolescents in all compared geographies initiated HPV vaccination (Georgia: 56%, CI: 54.0-61.5; National: 56%, CI: 55.0 – 56.5; HHS Region 4: 52%, CI 50.0 – 53.1). Female adolescents in Georgia were more likely to be vaccinated (66%) compared to male adolescents (50%) (PR: 1.19, CI: 1.02 - 1.41) and provider recommendation was strongest for males (Georgia Males: aPR=2.49, CI=1.74, 3.56; Georgia Females: aPR=1.60, CI=1.23, 2.07).

Conclusions: Provider recommendation for HPV vaccine initiation was the strongest predictor for both male and female adolescents across the three study populations. Although Georgia generally followed patterns of initiation seen in HHS Region 4 and in the U.S., deviations did occur in certain demographic groups. These findings support the need for further investigations into state-level predictors of low HPV vaccine uptake, and preliminarily suggest a need for Georgia-based HPV vaccine interventions targeted towards specific subgroups.

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Introduction

Human Papillomavirus (HPV) is the most common sexually transmitted infection in the United States, with most sexually active individuals contracting the virus during their lifetime.[1] Although most HPV infections are asymptomatic, the virus can lead to genital warts and several types of cancers including cervical, anal, oropharyngeal and reproductive organ cancer in both men and women.[2] Three vaccines, recommended for all children starting at age 11 or 12, are currently available to protect against HPV.[3,4]

The U.S. Department of Health and Human Services (HHS) set a national goal to increase the vaccination coverage of 3 doses of HPV vaccine for males and females to 80% by the year 2020.[5] Unfortunately, due to several complex factors, uptake of the vaccine in the United States has consistently failed to meet public health goals.[6-8] In 2016, the Centers for Disease Control and Prevention (CDC) reported national HPV vaccine coverage estimates for 13-17-year-olds of 60.4% and 43.4% for HPV vaccine series initiation and completion status, respectively.[8] However, state-specific HPV vaccine initiation estimates were as high as 88.9% in Rhode Island and as low as 44.2% in South Carolina.[8]

Numerous research studies exist that describe factors that have attributed to low HPV vaccine uptake in the United States. These include parental attitudes and beliefs about the vaccine, provider hesitancy to recommend the vaccine for younger children, child and adolescent access to healthcare, socioeconomic status, and both parental and physician associations of the vaccine with early sexual activity. [9-14] To date however, there are far less studies investigating predictors of suboptimal HPV vaccine coverage on regional and state levels, and the studies that do exist have varied from region to region. Bodson et al. for example reported differences in predictors of low HPV immunization between the East, Central and West sub-regions of the Intermountain West region of the United States.[15] In contrast, a statewide study conducted by Jacobson et al. showed no difference in predictors between national HPV vaccine coverage when compared to Minnesota's estimates.[16] These divergent and limited findings do, however, underscore an emergent aim for states and regions to investigate their unique characteristics and how they can best address barriers to vaccine coverage in their own geographic areas.

Georgia in particular was ranked as having one of the highest rates at which people were diagnosed with an HPV-associated cancer from 2009 to 2013.[17] This is particularly important because the national incidence of HPV-associated cancers has been consistently highest among black and Hispanic men and women.[18] Notably, while African-Americans make up 13.3% of the US population, they account for nearly one-third of the population of Georgia.[19,20] The state of Georgia has conducted three annual Georgia Adolescent Immunization Studies from 2015 to 2017 that estimates vaccine coverage among seventh graders residing in the state.[21-23] Although the study has detailed data on vaccine coverage by state district level, data on potential predictors of vaccine uptake such as socioeconomic status (SES), parental knowledge of HPV, and race are not collected. Consequently, a state report of this format is usually unable to be directly compared to national-level data due to differences in study design and the type of data collected. In this study, we utilize the National Immunization Study—Teen data to evaluate Georgia's HPV vaccine initiation coverage in comparison to national and regional estimates to assess any predictors of low HPV vaccine uptake significant to the state of Georgia.

Methods

We analyzed data from the NIS-Teen data from 2014 through 2016. The NIS-Teen is implemented annually by the National Center for Immunization and Respiratory Diseases (NCIRD) and the National Center for Health Statistics (NCHS) of the CDC. The target population of NIS-Teen is non-institutionalized adolescents aged 13-17 year living in U.S. households at the time of the interview. Additional information on the NIS-Teen methodology have been published elsewhere.[24-26] We merged the 2014, 2015 and 2016 NIS-teen datasets and excluded variables not of interest for the analysis. To estimate multi-year estimates, new weight and teen ID variables were created following the guidance of the 2016 NIS-Teen Public-Use Data File.[26] Weighted population estimates were based only on participants with provider-verified HPV vaccination data.

The primary outcome of this study was HPV vaccine series initiation defined as at least one HPV vaccine shot at the time the survey was conducted, excluding any vaccinations after the interview date. Vaccine initiation was coded as a binary variable with the values of Yes or No. HPV vaccine series completion was not selected as the primary outcome due to the 2016 change in recommendation from a 3-dose to a 2-dose series for adolescents 14 years of age and younger. Significant differences in HPV vaccination between males and females are well published in the literature [8,9,15] and as such we present regression results stratified by sex.

The primary purpose of this analysis was to compare HPV vaccine uptake and predictors of HPV vaccine initiation between the national-level (N=63,177), HHS Region 4 level (Alabama, Florida, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee and Georgia; N=8,446) and state of Georgia level (N=1,114).

To compare demographic percentages by HPV vaccine initiation between regions, confidence interval parameters were used. Poisson regression models with robust error variance were then created and stratified by sex to examine differences in HPV vaccine initiation between the U.S., HHS Region 4

(Region 4) and Georgia. Additionally, Poisson models were created and stratified by provider recommendation for the national study population to examine the strength of provider recommendation on other variables. Populations were treated as independent, acknowledging that Georgia is included in both Region 4 and in the U.S., and that Region 4 is a subset of the national study population. All regression results presented are fully adjusted for all other listed variables, unless otherwise stated.

All analyses were conducted in SAS version 9.4 for Windows (SAS Institute, Cary, NC) using SAS survey procedures for bivariate analyses and PROC GENMOD with appropriate weighting and the REPEATED SUBJECT option for regression analyses[27], at an alpha level of .05. Emory University's Institutional Review Board determined that this analysis did not meet the definition of human subjects research as it was designated as a secondary analysis of de-identified data, and thus not subject to IRB review.

Results

Participant characteristics

The race and ethnicity distributions among adolescents in the national study population were as follows: 54% non-Hispanic White, 23% Hispanic, 14% non-Hispanic Black, and 10% non-Hispanic other. Adolescents in the Region 4 and Georgia subsets had notably higher proportions of non-Hispanic Black adolescents (Region 4: 26%; Georgia: 33%) and lower proportions of Hispanic adolescents (Region 4 and Georgia: 13%). The majority of adolescents were reported as having an 11-12 year old well-child exam or check-up (92%) and most adolescents received an HPV vaccination recommendation from their provider (63%), similar to national and regional proportions. Additional results for participant characteristics can be found in Table 1.

Race & Ethnicity Variation in HPV vaccine initiation – Stratified by Sex

Approximately half of adolescents in our study populations initiated HPV vaccination (Georgia: 56%, CI: 54.0-61.5; National: 56%, CI: 55.0 – 56.5; Region 4: 52%, CI 50.0 – 53.1) Female adolescents in Georgia were more likely to be vaccinated (66%) compared to male adolescents (50%) (PR: 1.19, CI: 1.02 - 1.41). Non-Hispanic black male adolescents in Georgia were 22% less likely to initiate HPV vaccine compared to non-Hispanic white male adolescents in Georgia (aPR: 0.78, CI: 0.59, 1.02). However, no related difference was seen for female adolescents in Georgia. This also contrasts with national and Region 4 estimates where HPV vaccine initiation was higher among non-Hispanic black male adolescents (Table 2).

Provider Recommendation Variation in HPV vaccine initiation – Stratified by Sex

Males and females across all three study geographies were more likely to have at least 1 HPV vaccine dose when a provider recommendation was present (e.g. Region 4 Males: aPR=2.61, CI=2.24, 3.05; Region 4 Females: PR=1.78, CI=1.56, 2.05). In Georgia when a provider recommendation was present, the likelihood of HPV vaccine initiation for males and females were 2.49 and 1.60 times greater than

adolescents that did not receive a provider recommendation, respectively (Tables 2 and 3). The association between provider recommendation and HPV immunization was also seen in the Region 4 and national populations, but the associations were not as strong as in Georgia (Tables 2 and 3).

Stratification by Provider Recommendation Only

Among those who reported receipt of a provider recommendation, male adolescents and adolescents of mothers who completed high school and owned their home were more likely to have initiated vaccination. Among those who did not report receipt of a provider recommendation, all remaining demographic characteristics became stronger predictors of HPV vaccine initiation (Table 4).

Discussion

The 3-year prevalence of HPV initiation among adolescents in Georgia has remained relatively consistent with Region 4 and national estimates, withstanding demographic differences between the three populations. HPV vaccine initiation improved in Georgia from 2014 to 2016, however barriers to complete coverage remain. In 2016, females in Georgia were more likely to initiate than males in the Region 4 and national study populations. This increase in female uptake of the HPV vaccine in Georgia was so substantial that the CDC recognized the Georgia Department of Public Health (GDPH) in 2014 for increasing the rate of coverage for the HPV vaccine among adolescent girls.[28] According to the GDPH, the increase was due to several initiatives undertaken by the state through their work with health providers, local health departments, and mass media campaigns.[28]

Prior studies have reported higher rates of HPV vaccination among Hispanic and Black adolescents, potentially due to increased feelings of perceived susceptibility and need among parents of these adolescents.[29-31] Interestingly, in our study non-Hispanic Black adolescents in Georgia and adolescents of married mothers were not more likely to have initiated than non-Hispanic Whites and adolescents of single mothers. This contrasts with Region 4 and national estimate results seen in our study. This difference suggests a Georgia-specific deviation in higher risk groups for suboptimal HPV series initiation, possibly explained by increased proportions of single mothers and minorities in Georgia compared to national proportions. Another explanation addressed in prior studies suggests an association between decreased access to healthcare and HPV vaccination among black adolescents[32]. Adolescents in our Georgia study population reported histories of insurance lapses more frequently than the national proportion (Table 1) which could explain the absence of a stronger likelihood of HPV vaccine initiation among black adolescents. Future research needs to be conducted to investigate this claim.

As documented in prior studies[9-13,33], receipt of a provider recommendation was the strongest predictor of HPV vaccine initiation in adolescents. The clear majority of adolescents in Georgia reported having an 11-12 year old well child exam but the HPV initiation prevalence among these adolescents was not as

high. This suggests that adolescents are visiting healthcare providers at the recommended ages, but a significant portion are not receiving an HPV vaccine dose during this visit. Significant missed opportunities in improving HPV vaccine coverage in Georgia appear to be associated with a lack of provider recommendation. This phenomenon has been so well recognized that in 2014, the National Foundation for Infectious Diseases (NFID) and the Council of State and Territorial Epidemiologists (CSTE) put forth an HPV Call to Action where they urged health care providers that have contact with adolescents to take stronger leadership roles in helping to reduce HPV-related cancers through adolescent vaccination.[34] The association of provider recommendation with vaccine initiation in this study was stronger in males than in females (Table 2 and Table 4), which may be due a variety of factors. One such factor could be due to fewer parents of male adolescents recognizing the need to vaccinate, thus making the provider's recommendation more impactful.[35,36] Another factor could be the provider's own hesitancy to recommend the HPV vaccine for boys due to a perceived lower health risk for boys or due to personal beliefs that parents would be less comfortable vaccinating their sons.[37,38]

This study had several limitations. The overall household response rate was only about 30% for each year included in the study and only about half of those participants had provider verified data.[6-8] As a result of merging three years of data, the results of our analysis represent an average over the years. The composition of the three study populations may have changed over time and it is possible that a teen could have been included more than once over the years. We did however make efforts to only use NIS-Teen data from 2014 and later due to the change in the definition of adequate provider data in 2014. Finally, the sample size for the Georgia subset had a smaller number of participants. As a result, bivariate and regression analysis results for Georgia were imprecise, as seen in the wide confidence intervals. Withstanding these limitations however, HPV initiation prevalence ratios in Georgia followed national and regional trends in many areas and did show statistical significance in stronger predictors. The strengths of the study include the large number of participants in the NIS-Teen Survey, and our exclusive

use of provider-verified data to increase certainty in the accuracy of the data being reported and used for the analysis.

Conclusions & Public Health Implications

Georgia's HPV vaccine initiation estimates are slightly above estimates for the nation and higher than those for the Region 4. Estimates have been increasing each year across the U.S. and show increased promise in Georgia, particularly among girls. In Georgia, we must continue to encourage providers to strongly recommend vaccines for adolescents, especially for male, non-Hispanic black adolescents. Lower HPV vaccine initiation among non-Hispanic black adolescents in Georgia is particularly important because of the higher burden of cervical cancer among black minorities, and the lack of healthcare access among minority groups in the state of Georgia. The state's public health efforts show promise, as recognized by the CDC, but our results suggest that additional interventions should be developed that further target increasing immunization rates among male adolescents and particularly among non-Hispanic Black adolescents.

Mandating HPV immunization for entry into public secondary schools has been piloted in Rhode Island, Virginia and Washington D.C. and has shown great effects in Rhode Island.[8] Further research is needed to assess whether this type of mandate is a viable option for increasing HPV vaccination coverage in other states and what the best methods are for implementation of this type of mandate. Future research investigating state-specific analyses need to be conducted as well. These types of analyses provide data that state public health professionals can use to help inform effective and targeted public health interventions for HPV immunization. Tailoring HPV vaccine interventions to state-specific predictors of low uptake may serve male and female adolescents best in increasing HPV vaccine coverage and preventing HPV infections and cancers in the future.

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Table 1
Demographic characteristics of adolescent residents of Georgia, HHS Region 4 and the United States that have provider-verified records of HPV vaccine initiation—NIS Teen, 2014-2016

Characteristics	Georgia			HHS Region 4			United States		
	N[a]	%[b]	% UTD[c] (95% CI)	N[a]	%[b]	% UTD[c] (95% CI)	N[a]	%[b]	% UTD[c] (95% CI)
Age									
13	233	20.4	57.0 (48.7, 65.3)	1718	20.4	48.0 (44.5, 51.5)	12,977	20.6	50.2 (48.6, 51.9)
14	236	20.7	60.2 (52.0, 68.4)	1753	20.7	51.6 (48.1, 55.1)	13,152	20.4	54.1 (52.4, 55.7)
15	266	25.2	57.1 (49.4, 64.9)	1752	20.4	52.8 (49.4, 56.3)	12,701	20.2	57.5 (55.8, 59.1)
16	213	18.6	59.5 (51.2, 67.7)	1733	19.5	52.7 (49.3, 56.1)	12,808	20.2	56.9 (55.3, 58.5)
17	166	15.2	54.0 (44.5, 63.5)	1490	19.0	52.3 (48.4, 56.3)	11,539	18.7	60.1 (58.4, 61.7)
Race/Ethnicity									
Hispanic	111	12.5	63.0 (51.2, 74.1)	753	13.4	61.7 (56.5, 66.8)	11,091	23.3	64.6 (62.6, 66.5)
Non-Hispanic White	638	48.2	56.0 (51.1, 60.9)	5326	54.0	45.9 (44.0, 47.8)	39,163	53.6	50.6 (49.7, 51.4)
Non-Hispanic Black	286	33.2	58.2 (51.1, 65.4)	1740	25.7	56.7 (53.3, 60.1)	6,200	13.5	60.2 (58.2, 62.1)
Non-Hispanic Other	79	6.1	57.8 (43.8, 71.8)	627	6.9	55.2 (49.8, 60.6)	6,723	9.5	57.1 (54.7, 59.5)
Poverty Status									
Above Poverty	839	65.6	54.6 (50.2, 58.0)	6219	67.4	48.0 (46.1, 49.8)	49,258	70.9	52.9 (52.1, 53.7)
Below Poverty	225	29.1	64.7 (56.9, 72.4)	1925	29.0	60.0 (56.7, 63.2)	11,714	25.3	64.9 (63.2, 66.5)
Unknown/Missing	50	5.2	62.6 (47.2, 78.0)	302	3.6	56.4 (48.6, 64.2)	2,205	3.8	55.6 (51.9, 59.2)
Mother's Age									
≤ 34	98	11.1	63.9 (52.2, 75.6)	831	10.8	58.6 (53.6, 63.6)	5,139	9.1	62.9 (60.5, 65.3)
35 - 44	508	48.4	60.2 (54.7, 65.6)	3,888	48.1	52.0 (49.7, 54.4)	25,971	43.9	55.3 (54.2, 56.5)
≥ 45	508	40.6	53.2 (47.6, 58.8)	3,727	41.1	49.1 (46.7, 51.5)	32,067	47.1	54.7 (53.7, 55.8)
Mother's Education									
< 12 tears	114	13.3	69.9 (59.6, 80.2)	1,009	12.5	62.3 (57.6, 66.9)	7,435	15.1	67.5 (65.4, 69.7)
12 years	201	25.2	58.3 (49.8, 66.9)	1,573	24.4	53.2 (49.6, 56.8)	10,481	22.5	56.0 (54.4, 57.7)
>12 years, Non-college grad	315	25.6	53.4 (46.3, 60.4)	2,435	27.4	48.1 (45.2, 51.0)	16,800	25.2	51.8 (50.3, 53.2)
College graduate	484	35.8	56.5 (50.8, 62.2)	3,429	35.7	49.7 (47.2, 52.2)	28,461	37.3	54.0 (52.9, 55.1)
Mother's relationship status									
Never Married/Not Married	368	45.1	67.3 (61.4, 73.2)	2,860	42.0	57.6 (55.0, 60.2)	18,308	36.7	60.6 (59.3, 61.9)
Married	746	54.9	50.2 (45.5, 54.9)	5,586	58.0	47.3 (45.3, 49.3)	44,869	63.3	53.0 (52.1, 53.9)
Home Ownership Status									
Renter	304	36.0	61.1 (54.3, 67.9)	2,083	33.3	56.0 (52.9, 59.1)	15,151	33.1	62.2 (60.7, 63.6)
Owner	776	60.9	55.8 (51.3, 60.2)	6,101	63.1	49.5 (47.7 (51.3)	46,380	64.3	52.4 (51.6, 53.2)
Other	30	3.1	60.8 (39.2, 82.4)	233	3.6	45.8 (36.5, 55.1)	1,480	2.7	54.3 (49.0, 59.5)
11-12 year old Well-Child Exam									
Yes	870	92.4	61.4 (57.2, 65.6)	6,558	92.3	55.5 (53.7, 57.3)	49,678	91.9	59.1 (58.3, 59.9)
No	52	5.5	48.6 (31.0, 66.1)	374	4.7	39.7 (32.6, 46.8)	2,780	4.9	47.0 (43.1, 50.9)
Don't Know/Missing	23	2.1	47.4 (22.0, 72.8)	229	3.0	41.4 (31.3, 51.5)	1,799	3.2	52.8 (48.3, 57.3)
Ever been uninsured since 11?									
Yes	129	14.3	58.7 (48.0, 69.3)	719	10.7	49.7 (44.3, 55.1)	4,829	9.2	52.2 (49.6, 54.9)
No	921	85.7	58.4 (54.2, 62.5)	7,328	89.3	51.9 (50.2, 53.7)	55,525	90.8	56.5 (55.7, 57.2)

Provider Recommendation									
Yes	708	64.0	71.0 (66.7, 75.4)	4,866	60.5	65.7 (63.7, 67.7)	40,439	63.4	69.1 (68.3, 70.0)
No	308	28.0	31.5 (25.0, 38.0)	2,773	32.4	28.2 (25.5, 30.8)	17,226	29.0	30.5 (29.1, 32.9)
Don't Know/Missing	80	8.1	45.9 (31.4, 60.3)	645	7.1	40.4 (34.6, 46.2)	4,424	7.6	46.4 (43.5, 49.2)
Survey Year									
2014	373	36.1	53.0 (46.4, 59.7)	2,896	35.5	47.3 (44.4, 50.1)	20,827	35.9	50.6 (49.3, 52.0)
2015	374	30.2	52.6 (46.3, 59.0)	2,793	32.1	51.4 (48.6, 54.1)	21,875	32.3	56.1 (54.9, 57.4)
2016	367	33.7	67.3 (61.2, 73.5)	2,757	32.4	55.8 (53.1, 58.5)	20,475	31.8	60.4 (59.2, 61.6)

a: Unweighted N
b: Weighted percent
c: Percent up-to-date defined as ≥1 HPV vaccine shot and 95% confidence interval

Table 2
HPV vaccine coverage and multivariable Poisson regression analysis results for male adolescent residents of Georgia, HHS Region 4 and the United States that have provider-verified records of HPV vaccine initiation, NIS-Teen, 2014-2016

Characteristics	Georgia		HHS Region 4		United States	
	PR (95% CI)[a]	aPR (95% CI)[b]	PR (95% CI)[a]	aPR (95% CI)[b]	PR (95% CI)[a]	aPR (95% CI)[b]
Age (years)	0.99 (0.94,1.05)	0.93 (0.79,1.10)	1.03 (1.01,1.06)	0.92 (0.84,99)	1.06 (1.05,1.07)	0.91 (0.87,0.94)
Race/Ethnicity						
Non-Hispanic White			**Ref.**			
Non-Hispanic Black	1.03 (0.86,1.24)	0.78 (0.59,1.02)	1.23 (1.12,1.34)	1.06 (0.93,1.20)	1.16 (1.11,1.21)	1.08 (1.01,1.15)
Non-Hispanic Other	1.19 (0.93,1.51)	1.13 (0.76,1.70)	1.19 (1.06,1.35)	1.08 (0.87,1.36)	1.07 (1.01.1.13)	1.15 (1.07,1.24)
Hispanic	0.97 (0.75,1.26)	0.80 (0.52,1.23)	1.22 (1.08,1.37)	1.15 (0.97,1.35)	1.18 (1.13,1.23)	1.19 (1.12,1.27)
Poverty Status						
Above Poverty			**Ref.**			
Below Poverty	1.12 (0.94,1.33)	1.13 (0.82,1.56)	1.17 (1.08,1.27)	1.09 (0.95,1.26)	1.17 (1.13,1.22)	1.13 (1.06,1.21)
11-12 year old Well-Child Exam						
No			**Ref.**			
Yes	1.03 (.73,1.44)	2.85 (0.91,8.92)	1.32 (1.07,1.63)	1.28 (0.88,1.87)	1.23 (1.15,1.41)	1.06 (0.93,1.21)
Ever been uninsured since 11?						
Yes			**Ref.**			
No	0.89 (0.74,1.06)	1.03 (0.71,1.51)	1.05 (0.91,1.20)	0.96 (0.78,1.12)	1.12 (1.04,1.19)	1.04 (0.96,1.13)
Provider Recommendation						
No			**Ref.**			
Yes	1.86 (1.41,2.47)	2.49 (1.74,3.56)	1.85 (1.62,2.12)	2.61 (2.24,3.05)	1.84 (1.73,1.97)	2.49 (2.32,2.68)
Mother's Age						
<= 34 years old			**Ref.**			
Between 35 – 44 years old	0.88 (0.72,1.07)	1.07 (0.70,1.65)	0.90 (0.80,1.01)	0.84 (0.72,0.99)	0.89 (0.85,0.94)	0.88 (0.81,0.96)
>= 45 years old	0.74 (0.60,0.91)	0.88 (0.56,1.40)	0.89 (0.79,1.00)	0.78 (0.66,0.92)	0.89 (0.85,0.94)	0.89 (0.82,0.97)
Mothers educational level						
< 12 years			**Ref.**			
12 years of school	0.83 (0.65,1.08)	0.83 (0.57,1.22)	0.86 (0.76,0.98)	0.94 (0.77, 1.15)	0.89 (0.84,0.94)	0.82 (0.76,0.89)
>12 years, Non-college grad	0.85 (0.67,1.08)	0.67 (0.45,0.98)	0.78 (0.69,0.88)	0.80 (0.65, 0.98)	0.82 (0.77.0.86)	0.77 (0.72,0.83)
College graduate	0.88 (0.71,1.09)	0.94 (0.64,1.36)	0.84 (0.75,0.94)	0.85 (0.69, 1.04)	0.84 (0.80,0.89)	0.86 (0.80,0.92)
Home ownership status						
Renter			**Ref.**			
Owner	0.95 (0.81,1.12)	0.74 (0.64,1.36)	0.88 (0.82,0.96)	0.78 (0.56,1.10)	0.86 (0.83,0.89)	0.87 (0.75,1.02)
Mother's relationship status						
Never Married			**Ref.**			
Married	0.82 (0.70,0.96)	0.70 (0.55,0.89)	0.86 (0.80,0.93)	0.86 (0.75,0.94)	0.87 (0.84,0.89)	0.97 (0.92,1.02)

a: Unadjusted prevalence ratio and 95% confidence interval

b: Prevalence ratio adjusted for other predictors in model and 95% confidence interval

Table 3
HPV vaccine coverage and multivariable Poisson regression analysis results for female adolescent residents of Georgia, HHS Region 4 and the United States that have provider-verified records of HPV vaccine initiation, NIS-Teen, 2014-2016

Characteristics	Georgia		HHS Region 4		United States	
	PR (95% CI)[a]	aPR (95% CI)[b]	PR (95% CI)[a]	aPR (95% CI)[b]	PR (95% CI)[a]	aPR (95% CI)[b]
Age (years)	0.99 (0.92, 1.07)	0.99 (0.87, 1.12)	1.00 (0.97, 1.04)	0.96 (0.90, 1.02)	1.02 (1.00, 1.03)	0.96 (0.93, 0.99)
Race/Ethnicity						
Non-Hispanic White			**Ref.**			
Non-Hispanic Black	1.02 (0.80, 1.31)	1.00 (0.84, 1.20)	1.25 (1.11, 1.40)	1.16 (1.05, 1.29)	1.21 (1.14, 1.29)	1.07 (1.02, 1.13)
Non-Hispanic Other	0.85 (0.54, 1.33)	1.22 (0.91, 1.62)	1.22 (1.01, 1.46)	1.12 (0.98, 1.29)	1.20 (1.11, 1.29)	1.06 (1.00, 1.12)
Hispanic	1.30 (0.96, 1.75)	1.08 (0.85, 1.38)	1.47 (1.27, 1.71)	1.09 (0.96, 1.25)	1.40 (1.33, 1.47)	1.09 (1.03, 1.14)
Poverty Status						
Above Poverty			**Ref.**			
Below Poverty	1.23 (0.96, 1.56)	0.95 (0.75, 1.20)	1.34 (1.21, 1.49)	1.05 (0.94, 1.16)	1.29 (1.23, 1.35)	1.07 (1.02, 1.12)
11-12 year old Well-Child Exam						
No			**Ref.**			
Yes	1.84 (0.84, 4.00)	1.03 (0.65, 1.63)	1.65 (1.18, 2.29)	1.27 (0.97, 1.65)	1.25 (1.09, 1.44)	1.21 (1.08, 1.36)
Ever been uninsured since 11?						
Yes			**Ref.**			
No	1.23 (0.83, 1.80)	1.03 (0.83, 1.27)	1.08 (0.89, 1.31)	1.06 (0.92, 1.21)	1.06 (0.98, 1.15)	1.12 (1.05, 1.20)
Provider Recommendation						
No			**Ref.**			
Yes	2.63 (1.90, 3.64)	1.60 (1.23, 2.07)	2.71 (2.35, 3.12)	1.78 (1.56, 2.05)	2.58 (2.42, 2.76)	1.77 (1.66, 1.90)
Mother's Age						
<= 34 years old			**Ref.**			
Between 35 – 44 years old	1.13 (0.75, 1.70)	0.77 (0.63, 0.94)	0.88 (0.75, 1.03)	0.99 (0.87, 1.13)	0.87 (0.81, 0.93)	0.93 (0.88, 0.98)
>= 45 years old	1.03 (0.68, 1.56)	0.68 (0.54, 0.86)	0.77 (0.65, 0.90)	1.02 (0.88, 1.17)	0.84 (0.78, 0.90)	0.97 (0.91, 1.02)
Mothers educational level						
< 12 years			**Ref.**			
12 years of school	0.82 (0.59, 1.13)	0.79 (0.57, 1.10)	0.86 (0.73, 1.01)	0.81 (0.70, 0.94)	0.76 (0.71, 0.82)	0.86 (0.80, 0.91)
>12 years, Non-college grad	0.66 (0.48, 0.91)	0.92 (0.68, 1.24)	0.77 (0.66, 0.89)	0.76 (0.66, 0.88)	0.70 (0.66, 0.75)	0.81 (0.76, 0.86)
College graduate	0.73 (0.55, 0.96)	1.03 (0.74, 1.44)	0.76 (0.65, 0.88)	0.83 (0.72, 0.95)	0.75 (0.71, 0.80)	0.84 (0.79, 0.90)
Home ownership status						
Renter			**Ref.**			
Owner	1.01 (0.59, 1.73)	0.72 (0.31, 1.68)	0.85 (0.63, 1.15)	0.83 (0.61, 1.13)	0.88 (0.76, 1.00)	0.88 (0.77, 1.00)
Mother's relationship status						
Never Married			**Ref.**			
Married	0.67 (0.55, 0.83)	0.95 (0.80, 1.13)	0.78 (0.70, 0.86)	0.95 (0.87, 1.05)	0.89 (0.85, 0.93)	0.93 (0.90, 0.97)

a: Unadjusted prevalence ratio and 95% confidence interval

b: Prevalence ratio adjusted for other predictors in model and 95% confidence interval

Table 4
HPV vaccine coverage and multivariable Poisson regression analysis results for adolescent residents of the United States stratified by provider recommendation, NIS-Teen, 2014-2016

Characteristics	Unstratified	No Recommendation	Recommendation
	aPR (95% CI)[a]	aPR (95% CI)[a]	aPR (95% CI)[a]
Age (years)			
13		Ref.	
14	1.00 (0.95, 1.06)	1.07 (0.90, 1.29)	0.98 (0.93, 1.04)
15	1.01 (0.95 1.08)	1.06 (0.85, 1.31)	0.99 (0.93, 1.06)
16	1.02 (0.95, 1.09)	1.02 (0.82, 1.27)	1.01 (0.95, 1.08)
17	1.08 (1.01, 1.15)	1.28 (1.02, 1.60)	1.04 (0.98, 1.11)
Sex			
Female		Ref.	
Male	0.89 (0.86, 0.91)	0.70 (0.64, 0.77)	0.93 (0.91, 0.96)
Race/Ethnicity			
Non-Hispanic White		Ref.	
Non-Hispanic Black	1.08 (1.04, 1.13)	1.34 (1.18, 1.53)	1.04 (1.00, 1.09)
Non-Hispanic Other	1.11 (1.06, 1.16)	1.43 (1.23, 1.66)	1.06 (1.02, 1.11)
Hispanic	1.14 (1.09, 1.19)	1.40 (1.23, 1.59)	1.11 (1.06, 1.15)
Poverty Status			
Above Poverty		Ref.	
Below Poverty	1.10 (1.06, 1.14)	1.31 (1.17, 1.47)	1.05 (1.01, 1.09)
11-12 year old Well-Child Exam			
No		Ref.	
Yes	1.14 (1.05, 1.24)	1.27 (1.04, 1.54)	1.12 (1.03, 1.22)
Ever been uninsured since 11?			
Yes		Ref.	
No	1.10 (1.04, 1.16)	1.15 (0.98, 1.34)	1.08 (1.02, 1.14)
Mother's Age			
<= 34 years old		Ref.	
Between 35 – 44 years old	0.90 (0.86, 0.94)	0.90 (0.77, 1.04)	0.90 (0.86, 0.94)
>= 45 years old	0.93 (0.88, 0.97)	0.83 (0.70, 0.97)	0.94 (0.90, 0.99)
Mothers educational level			
< 12 years		Ref.	
12 years of school	0.84 (0.80, 0.89)	0.73 (0.64, 0.82)	0.92 (0.88, 0.96)
>12 years, Non-college grad	0.79 (0.76, 0.83)	0.65 (0.56, 0.76)	0.93 (0.89, 0.98)
College graduate	0.85 (0.81, 0.90)	0.59 (0.51, 0.68)	0.88 (0.84, 0.93)
Home ownership status			
Renter		Ref.	
Owner	0.88 (0.80, 0.97)	0.72 (0.50, 1.03)	0.92 (0.80, 1.01)
Mother's relationship status			
Never Married		Ref.	
Married	0.95 (0.92, 0.98)	0.97 (0.88, 1.07)	0.94 (0.91, 0.96)

Provider Recommendation			
No		**Ref.**	
Yes	2.18 (2.08, 2.30)	N/A	N/A

a: Prevalence ratio adjusted for other predictors in model and 95% confidence interval