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Geographic variation in human papillomavirus vaccination uptake among 13–17 year old adolescent girls in the United States

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Abstract

Geographic variation in provider-verified human papillomavirus (HPV) vaccine uptake among adolescent girls in the US has not been examined. To investigate this, we analyzed 2011 National Immunization Survey-Teen data. Among 13–17 year old girls ($n = 11,236$), weighted vaccine initiation (48.4%) and completion rates (30.6%) were the lowest in the South when compared to the Northeast (53.4% and 39.9%), Midwest (51.1% and 33.5%) and West (61.6% and 38.7%) ($P < .001$, both for initiation and completion). Multivariable log-binomial regression analysis indicated that 13–17 year old girls living in the South were less likely to initiate [adjusted prevalence ratio (aPR) = 0.86, 95% confidence interval (CI) 0.75–0.97] and complete (aPR = 0.83, 95% CI, 0.74–0.93) the HPV vaccine series compared to girls living in the Northeast. Similar differences were observed when the uptake rates in the South were compared to other regions in the US. Intervention programs to increase HPV vaccine uptake and reduce regional disparities are warranted.

Keywords

Geographic variation; Human papillomavirus; HPV vaccine; Cervical cancer; NIS-Teen

1. Introduction

About one-quarter of US men and women are infected with human papillomavirus (HPV) which is responsible for 99.8% of cervical cancer cases and 90% of genital warts as well as cancer of the anogenital and head and neck regions [1–6]. Two vaccines (bivalent and quadrivalent) are now available and protect against 70% of cervical cancer cases, while the quadrivalent vaccine also protects against 90% of genital warts cases [4,7]. However, vaccine initiation at a young age is critical as prevalence of HPV infection increases every

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Conflict of interest

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year between 14 and 24 years of age [1]. One objective of Healthy People 2020 is to increase 3-dose HPV vaccine coverage to 80% among 13–15 year old adolescent females [10]. Although HPV vaccine uptake (3 doses) among 13–17 year old adolescent girls increased to 34.8% in 2011 [8], it is still far below the 75–94% level that is usually needed for herd immunity [9].

Geographic location has been observed as a significant correlate of HPV vaccine uptake among 18–26 year old women [12,13], but not among 11–17 year old adolescent girls [11,14] in the US. In addition, another study also observed variation in HPV vaccine uptake among 13–17 year old girls by individual states based on data collected from 6 US states [15]. However, these estimates were based on self-reported vaccination status and not confirmed by health care providers. Studies are needed to examine whether similar regional disparities exist based on provider-confirmed vaccination information. The objective of this study was to examine the association between geographic region of the US and HPV vaccine initiation and completion rates among 13–17 year old adolescent girls using data from the National Immunization Survey–Teen (NIS-Teen) 2011.

2. Methods

2.1. Study population

The NIS-Teen study is a yearly cross-sectional survey conducted by the Centers for Disease Control and Prevention (CDC) using two phases of data collection to obtain vaccination information from parents or household members of 13–17 year old adolescents. The survey is based on a stratified national probability sample of households in the United States and uses: (1) a random-digit-dialed telephone survey with parents/guardians of 13–17 year old adolescents and (2) a mailed survey to adolescents' immunization providers identified by the parents/guardians during the telephone survey. Unlike data collected in earlier years, the 2011 NIS-Teen data included interviews collected both by landline telephones and cellphones in order to address the rapid rise of cellphone only households [16]. Details of NIS-Teen methodology have been reported elsewhere [17].

A total of approximately 4.9 million telephone numbers (4.3 million landline and 0.6 million cellphone) yielded household interviews for 39,839 teens (34,863 landline and 4976 cell-phone); of whom 24,049 (21,333 landline and 2716 cell-phone) had provider-verified HPV vaccination information. After excluding 485 observations originating from the US Virgin Islands, the number of adolescents became 23,564. We limited our study to 11,236 adolescent girls after excluding 12,328 adolescent boys. The response rate was 57.2% for households with a landline and 22.4% for households with a cellphone [8]. Data collection for the NIS-Teen was approved by the National Center for Health Statistics Research Ethics Review Board. This study was exempt from review by the *University of Texas Medical Branch* Institutional Review Board as we used a publicly available de-identified database.

2.2. Measures

We considered provider-verified HPV vaccine initiation (receipt of at least one dose of HPV vaccine) and completion (completed 3-dose HPV vaccine series) among adolescent girls as

the primary outcome variables. The main exposure of interest in this study was region of residence. Data from all states were categorized into four distinct regions: Northeast, Midwest, West and South after excluding observations from the US Virgin Islands [18]. Socio-demographic characteristics included information about the daughter, mother, and household. Respondents provided data on their age as well as their relationship to the adolescent (mother, father, other) and the adolescent's age, race/ethnicity, eligibility for the Vaccine For Children (VFC) program, influenza vaccination before age 13 years, health care coverage and HPV vaccine awareness. HPV vaccine awareness was assessed using the question "have you ever heard of the cervical cancer vaccine, HPV shot, or Gardasil?" The response options were "yes", "no", "don't know" and "refused". Those who responded "yes" were considered as having HPV vaccine awareness.

2.3. Statistical analysis

STATA 12 *svy* commands (STATA Corporation, College Station, TX) were used for data analysis by incorporating probability sampling weights in conjunction with strata and primary sampling units generated by NIS-Teen survey design. Final weight based on adolescents with adequate provider data was used to correct for the complex NIS-Teen survey design and bias. Pearson chi square tests were used to compare demographic characteristics among different geographic regions of the US. Log-binomial regression models were used to examine the association between region of residence and HPV vaccine initiation and completion after adjusting for socio-demographic characteristics. Adjusted prevalence ratios (aPR) and 95% confidence intervals (CIs) for HPV vaccine initiation and completion were reported for each geographic region. Any variables that were unevenly distributed by region were controlled for in the multivariable models. Variables associated with any of the dependent variables (vaccine initiation and completion) at $P \leq .20$ were included in the final multivariable models.

3. Results

Provider-verified HPV vaccination data were available for 11,236 adolescent girls. Overall, 53.0% (95% CI, 51.4%–54.7%) and 34.8% (95% CI, 33.2%–36.4%) of 13–17 year old girls (weighted values) reported initiating and completing the 3-dose series in 2011. Weighted HPV vaccine initiation and completion rates were lowest in the South; 48.4% and 30.6% in the South, 53.4% and 39.9% in the Northeast, 51.1% and 33.5% in the Midwest, and 61.6% and 38.7% in the West ($P < .001$, both for initiation and completion, Table 1), respectively. Respondents in the Northeast were older, more likely to be college graduates and had slightly higher HPV vaccine awareness. Respondents in the Northeast and Midwest were less likely to be eligible for VFC program, less likely to have moved from other state, and more likely to be white and have higher family income, healthcare coverage and history of seasonal influenza vaccination compared to their counterparts. On the other hand, respondents in the South were less likely to be married and more likely to be black. Age distribution of the teens and relationship of the respondents to the teen did not differ by region.

After adjusting for girl's age, race/ethnicity, healthcare coverage, eligibility for VFC program, provider-confirmed influenza vaccination, respondent's age, family income, history of moving from other state and HPV vaccine awareness, we observed that adolescent girls living in the South were less likely than adolescent girls in the Northeast to initiate (aPR 0.86, 95% CI 0.75–0.97) or complete (aPR 0.83, 95% CI, 0.74–0.93) the HPV vaccine series (Table 2). Adolescent girls living in the West were significantly more likely to initiate HPV vaccination compared to the Northeast and all other regions. No significant interactions were observed between race/ethnicity and region, and income and region on HPV vaccine uptake.

4. Discussion

We observed that adolescent girls residing in the South had the lowest HPV vaccine uptake rates in the US in 2011 based on provider-verified immunization records. This is similar to previously published data on young adult women using self-reported vaccination status [12]. Together, these studies demonstrate that HPV vaccine uptake both among adolescent girls and young adult women is lowest in the South which warrants further attention and interventions.

In contrast to our findings, two other studies based on National Health Interview Survey (NHIS) data did not observe any significant difference in HPV uptake by region among 11–17 year old adolescent girls. Several factors, such as larger sample size in our study, inclusion of 11–12 year old adolescents in the other two studies, and difference in survey methodology (provider-confirmed vs. self-reported) may explain these differences. Further, our study was based on 2011 data while the other two studies used data collected in 2008 [14] and 2010 [11].

As the incidence of cervical cancer is higher in the South as compared to the Midwest/West and Northeast [19], a consistently lower rate of HPV vaccine uptake in this region may contribute a higher cervical cancer burden in the future. Thus, it seems that HPV vaccine uptake is the lowest in the region where it is needed the most. In addition, the poverty level is higher in the South than the Northeast [15]. There is a need to design strategies to improve the HPV vaccine uptake in the South to lower the long-term burden of HPV-related diseases/cancers. As regional disparities existed even after adjusting for socio-demographic characteristics, it is plausible that state or regional policies may have contributed to these differences. One such policy, mandating school-entry administration of the HPV vaccine, however, was only passed in Washington D.C., among the 42 states (including D.C.) that attempted to pass this legislation [20]. It is also possible that the disparity in HPV vaccine uptake observed in this study is a general reflection of overall regional disparities in the US.

The strengths of this study include that it is nationally representative data from across the US, provider-verified vaccination information, and large sample size. This study also has several limitations. Our findings are based on only one year of data. We do not know whether vaccine completion was based on CDC recommended timeline or not. In spite of these limitations, this study provides important estimates of the regional variation in HPV vaccine uptake among adolescent girls based on a large representative sample.

Overall, we observed significant geographic variation in HPV vaccination rates between the South and the other regions in the US, with the lowest uptake among adolescent girls in the South. This demonstrates the need to develop and implement interventions programs to improve HPV vaccine uptake among adolescent girls in the South.

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Table 1
Characteristics of 13–17 year old adolescent girls by region of residence in the US (n = 11,236).

Characteristics	Region of residence				P Value
	Northeast	Midwest	South	West	
Age, year, <i>n</i> (%)					
13	422 (18.6)	490 (20.5)	849 (20.6)	478 (19.5)	.098
14	432 (19.1)	491 (20.5)	857 (20.8)	502 (20.5)	
15	480 (21.2)	467 (19.5)	835 (20.2)	547 (22.3)	
16	468 (20.7)	469 (19.6)	814 (19.7)	501 (20.4)	
17	462 (20.4)	474 (19.8)	771 (18.7)	427 (17.4)	
Respondent's age, year, <i>n</i> (%)					
34	125 (5.5)	157 (6.6)	380 (9.2)	180 (7.3)	<.001
35–44	775 (34.2)	1016 (42.6)	1738 (42.1)	1018 (41.5)	
45	1364 (60.3)	1218 (50.9)	2008 (48.7)	1257 (51.2)	
Race/ethnicity					
Non-Hispanic white	1669 (73.7)	1851 (77.4)	2461 (59.7)	1574 (64.1)	<.001
Non-Hispanic black	204 (9.0)	197 (8.2)	693 (16.8)	60 (2.4)	
Hispanic	235 (10.4)	184 (7.7)	698 (16.9)	470 (19.1)	
Non-Hispanic other ^a	156 (6.9)	159 (6.7)	274 (6.6)	351 (14.3)	
Marital Status of mother, <i>n</i> (%)					
Married	1678 (74.1)	1827 (76.4)	2977 (72.2)	1891 (77.0)	<.001
Never married/divorced, Widowed/separated/deceased	586 (25.9)	564 (23.6)	1149 (27.9)	564 (23.0)	
Education, <i>n</i> (%)					
<HS	150 (6.6)	173 (7.2)	501 (12.1)	270 (11.0)	<.001
HS graduate	407 (18.0)	427 (17.9)	856 (20.8)	455 (18.5)	
Some college hours	554 (24.5)	733 (30.7)	1050 (25.5)	746 (30.4)	
College graduate	1153 (50.9)	1058 (44.3)	1719 (41.7)	984 (40.1)	
Family income (% of the federal poverty line), <i>n</i> (%)					
<100%	250 (11.8)	298 (13.2)	764 (19.9)	328 (14.2)	<.001
100% to <200%	328 (15.5)	371 (16.4)	663 (17.2)	429 (18.6)	
200%	1537 (72.7)	1598 (70.5)	2421 (62.9)	1549 (67.2)	

Characteristics	Region of residence				P Value
	Northeast	Midwest	South	West	
Eligible for VFC program, <i>n</i> (%)	587 (26.0)	691 (29.1)	1404 (34.1)	799 (32.7)	<.001
Have healthcare coverage, <i>n</i> (%)	2157 (95.3)	2294 (95.9)	3830 (92.8)	2294 (93.4)	<.001
Relationship of respondent to the teen, <i>n</i> (%)					
Mother	1810 (80.0)	1918 (80.3)	3290 (79.8)	1907 (77.7)	.097
Father, grandparent, other	454 (20.1)	471 (19.7)	835 (20.2)	548 (22.3)	
Provider-confirmed seasonal influenza vaccination in past 3 years by age 13, <i>n</i> (%)	408 (18.0)	410 (17.2)	648 (15.7)	376 (15.3)	.031
Provider facility, <i>n</i> (%)					
Public	150 (7.1)	391 (17.6)	730 (19.1)	449 (19.8)	<.001
Private	1432 (67.6)	939 (42.3)	2022 (53.0)	988 (43.6)	
Hospital/mixed/clinics	535 (25.3)	891 (40.1)	1066 (27.9)	831 (36.6)	
Moved from different state, <i>n</i> (%)					
No	1812 (80.0)	2–18 (84.4)	3081 (74.7)	1831 (74.6)	<.001
Yes	452 (20.0)	373 (15.6)	1045 (25.3)	624 (25.4)	
HPV initiation, weighted % (95% CI)	53.4 (50.1–56.6)	51.1 (48.0–54.2)	48.4 (45.8–51.1)	61.6 (57.5–65.5)	<.001
HPV completion, weighted % (95% CI)	39.9 (36.7–43.1)	33.5 (30.6–36.6)	30.6 (28.1–33.2)	38.7 (34.6–43.0)	<.001
HPV vaccine awareness					.042
No	119 (5.3)	170 (7.2)	281 (6.8)	168 (6.9)	
Yes	2129 (94.7)	2204 (92.8)	3825 (93.2)	2260 (93.1)	

HS = High School; VFC = Vaccine for Children program.

^a Also included multiracial.

Table 2

Association of region of residence with HPV initiation and completion among 13–17 year old adolescent girls based on NIS-Teen 2011 data.

	HPV initiation Adjusted prevalence ratio (95% CI) ^a	P value	HPV completion Adjusted prevalence ratio (95% CI) ^a	P value
Region				
Northeast	Reference		Reference	
Midwest	0.93 (0.81–1.07)	.309	0.86 (0.76–0.97)	.013
South	0.86 (0.75–0.97)	.017	0.83 (0.74–0.93)	.002
West	1.22 (1.02–1.45)	.028	0.97 (0.83–1.12)	.658
Age, year, <i>n</i> (%)				
13	Reference		Reference	
14	1.17 (1.01–1.35)	.034	1.21 (1.06–1.39)	.004
15	1.96 (1.67–2.31)	<.001	1.77 (1.52–2.07)	<.001
16	2.31 (1.96–2.73)	<.001	1.96 (1.69–2.28)	<.001
17	2.68 (2.28–3.15)	<.001	2.30 (1.97–2.69)	<.001
Respondent's age, year, <i>n</i> (%)				
34	Reference		Reference	
35–44	0.72 (0.58–0.89)	.002	1.16 (0.97–1.40)	.104
45	0.69 (0.56–0.86)	.001	1.17 (0.97–1.41)	.106
Race/ethnicity				
Non-Hispanic white	Reference		Reference	
Non-Hispanic black	1.21 (1.02–1.44)	.026	1.01 (0.87–1.17)	.882
Hispanic	1.56 (1.32–1.86)	<.001	1.28 (1.10–1.49)	.002
Non-Hispanic other ^b	1.12 (0.91–1.37)	.287	1.06 (0.88–1.28)	.528
Family income (% of the federal poverty line), <i>n</i> (%)				
<100%	Reference		Reference	
100% to <200%	0.85 (0.70–1.02)	.080	0.82 (0.70–0.97)	.022
200%	0.88 (0.73–1.07)	.205	0.91 (0.78–1.08)	.288
Eligible for VFC program, <i>n</i> (%)				
No	Reference		Reference	
Yes	1.37 (1.18–1.60)	<.001	1.20 (1.04–1.37)	.010
Have healthcare coverage, <i>n</i> (%)				
No	Reference		Reference	
Yes	1.62 (1.32–1.98)	<.001	1.70 (1.40–2.06)	<.001
Moved from different state, <i>n</i> (%)				
No	Reference		Reference	
Yes	0.97 (0.86–1.10)	.666	0.88 (0.78–0.966)	.044
Provider-confirmed seasonal influenza vaccination in past 3 years by age 13, <i>n</i> (%)				
No	Reference		Reference	
Yes	1.94 (1.67–2.26)	<.001	1.83 (1.59–2.10)	<.001
Have HPV vaccine awareness				

	HPV initiation Adjusted prevalence ratio (95% CI)^a	<i>P</i> value	HPV completion Adjusted prevalence ratio (95% CI)^a	<i>P</i> value
No	Reference		Reference	
Yes	1.54 (1.27–1.88)	<.001	1.32 (1.07–1.62)	.009

CI = Confidence interval.

^a Adjusted for all covariates listed in this Table.

^b Also Included multiracial, Marital status, education of the respondent, relationship of the respondent to the teen and type of provider facility were excluded from final models as they had *p* value >.2 with both of the dependent variables.