Published in final edited form as:

Vaccine. 2013 November 12; 31(47): 5495–5499. doi:10.1016/j.vaccine.2013.09.022.

Geographic variation in human papillomavirus vaccination uptake among young adult women in the United States during 2008–2010

Mahbubur Rahman, MBBS, PhD, MPH, Tabassum H. Laz, MBBS, PhD, and Abbey B. Berenson, MD, PhD

Department of Obstetrics and Gynecology and the Center for Interdisciplinary Research in Women's Health

Abstract

Very little is known about geographic variation in human papillomavirus (HPV) vaccine uptake among young adult women in the US. To investigate this, we analyzed data from 12 US states collected through the Behavioral Risk Factor Surveillance System between 2008 and 2010. Among 2,632 young adult women (18–26 years old) who responded to HPV vaccine uptake questions, weighted vaccine initiation and completion rates were: 28.0% and 17.0% overall, 14.0% and 6.6% in the South, 28.7% and 19.3% in the Midwest/West, and 37.2% and 23.1% in the Northeast ($P<.001$), respectively. Log-binomial regression analysis showed that women living in the South were less likely to initiate (adjusted prevalence ratio (aPR) 0.71, 95% confidence interval (CI) 0.60–0.83) or complete (aPR 0.61, 95% CI, 0.53–0.71) the HPV vaccine series compared to women living in the Northeast. Interventions programs to improve HPV vaccine uptake in the Southern states are warranted.

1. Introduction

In 2006, the United States Food and Drug administration (FDA) approved a quadrivalent vaccine which offers protection against human papillomavirus (HPV) types 6, 11, 16, and 18 [1]. In 2009, a bivalent HPV vaccine was approved against HPV types 16 and 18 [2]. Both vaccines have demonstrated reasonably high efficacy (90%–100%) in preventing infections and precancerous lesions caused by vaccine type-HPV among sexually active adolescents and young women who have not been infected with those strains [3, 4]. As a result, the Advisory Committee on Immunization Practices (ACIP) now recommends routine vaccination for all US girls 11–12 year age and “catch-up” vaccination for those 13–26 years old not previously vaccinated [1, 2].

© 2013 Elsevier Ltd. All rights reserved.

Correspondence Author: Mahbubur Rahman, MBBS, PhD, MPH, Center for Interdisciplinary Research in Women's Health, Department of Obstetrics & Gynecology, University of Texas, Medical Branch, John Sealy Annex, Room No. 3.108.D, Galveston TX 77555-0587, Phone: 409-772-2978, Fax: 409-747-5129, marahman@utmb.edu.

Conflict of interest: None

MR: Conception and design of the study, drafting the manuscript and approval of the final version. **THL:** Conception and design of the study, revising the manuscript and approval of the final version. **ABB:** Conception and design of the study, revising the manuscript and approval of the final version.

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

In spite of its proven efficacy, 2010 National Health Interview Survey (NHIS) data demonstrated that HPV vaccination rates have been very low in the US. Only 23% of women 18–26 years of age have initiated the vaccine and 13% completed the three dose series [5], which is lower than that observed among 11–17 year old adolescent girls (29% and 14%, respectively) [6]. Wei et al. [7] observed in their analysis of this database that geographic location was a correlate of HPV vaccine uptake among 18–26 old women in the US, but not among those 11–17 years old [6]. As compared to the Northeast, HPV vaccine initiation was significantly higher in the West/Midwest and North Central regions and lower in the South, although this difference did not achieve statistical significance. The NIS-Teen data showed a similar pattern among 13–17 year old adolescent girls [8]. However, those studies are all based on a single year of data and describe vaccine initiation only. Thus, further studies which include both initiation and completion rates, and assess multiple years are needed. The objective of this study was to examine the association between geographic region of the US and HPV vaccine initiation and completion rates among 18–26 year old women using the Behavioral Risk Factor Surveillance System (BRFSS) data collected between 2008–2010.

2. Methods

2.1 Study population

The BRFSS is a continuous cross-sectional monthly telephone health survey among adults 18 years of age conducted by the Centers for Disease Control (CDC) and Prevention since 1984. Adults from all 50 U.S. states, the District of Columbia, and U.S. territories are queried on their health-related risk behaviors and events, chronic health conditions, and use of preventive services. This survey is the largest ongoing health survey in the world with more than 400,000 interviews conducted each year during 2008–2010. Details of the survey methods used have been published elsewhere [9]. This study was limited to 2008–2010 BRFSS data as the adult HPV module was introduced in 2008. In total, 12 U.S. states (Connecticut, Delaware, Kansas, Massachusetts, Minnesota, Nebraska, Oklahoma, Pennsylvania, Rhode Island, Texas, West Virginia, and Wyoming) conducted the adult HPV module survey during 2008–2010 in different combinations with the response rate ranging from 43.4% to 66.9% in different years. For this study, we restricted our sample to women aged 18–26 years as ACIP recommends “catch-up” vaccination for those 13–26 years old not previously vaccinated. This study was exempt from review by the UTMB Institutional Review Board as we used a publicly available de-identified database.

2.2 Data collection

This study focused on survey questions related to HPV vaccination status, region of residence, and other socio-demographic variables of interest. The main outcomes of interests were HPV initiation and completion. HPV initiation was based on the question: “A vaccine to prevent the human papilloma virus or HPV infection is available and is called the cervical cancer or genital warts vaccine, HPV shot, (GARDASIL or CERVARIX). Have you ever had the HPV vaccination?” The response options were “yes” or “no. Those who responded “yes” to the question were considered as HPV vaccine initiators. A follow-up question was asked among those who had responded “yes” to the first question: “How many HPV shots did you receive?” Those who responded “all shots” were considered as HPV vaccine completers. The main exposure of interest in this study was region of residence. We categorized data from 12 states into four distinct regions: Northeast (Connecticut, Massachusetts, Pennsylvania, Rhode Island), Midwest (Kansas, Minnesota, Nebraska), West (Wyoming) and South (Delaware, Oklahoma, Texas, West Virginia) [10]. We combined Midwest and West together to balance the sample size for each region.

Socio-demographic characteristics were also assessed. Age (18–21 vs. 22–26), race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, and others), education (high school, some college hours, and college degree), marital status (never married vs. ever married), annual household income (<50,000\$, 50,000–75,000\$ and >75,000\$), length of time since last routine medical check-up (within the past year vs. 2 years or more), influenza vaccination in the past season (yes vs. no), and health care coverage (yes vs. no) were categorized for the purpose of analysis.

2.3 Statistical analysis

We used STATA 12 *svy* commands (STATA Corporation, College Station, TX) for data analysis by incorporating probability sampling weights in conjunction with strata and primary sampling units (psu) generated by BRFSS complex survey design. Poststratification weight was used to correct for the complex BRFSS study design, and bias originated from nonresponse and non-telephone coverage. We also considered interview year as a stratum and generated a new weight variable that is consistent across years. We used chi square tests to compare demographic characteristics among different geographic regions of the US. We also estimated weighted rates of HPV vaccine initiation and completion and their 95% confidence intervals (CIs) by region. We used log-binomial regression models to examine the association between region of residence and the HPV vaccine initiation and completion of the vaccine series after adjusting for socio-demographic characteristics and year of study. These models were used as the vaccine uptake rates were relatively common. Adjusted prevalence ratios (aPR) and 95% CIs for HPV vaccine initiation and completion were reported for each of the geographic regions. In addition, aPR (95%) was also reported for all other demographic variables. The interaction terms between region and race/ethnicity, and region and income were also included in the model to examine the effects of race/ethnicity and income on HPV vaccine uptake by region.

3. Results

A total of 97.5% (2632/2700) of 18–26 year old women from 12 states responded to the questions on HPV vaccination during 2008–2010. Overall, 28.0% and 17.0% of women (weighted values) reported initiating and completing the 3-dose series (Table 1). Weighted HPV vaccine initiation and completion rates were 14.0% and 6.6% in the South (S), 28.7% and 19.3% in the Midwest/West (MWW) and 37.2% and 23.1% in the Northeast (NE) ($P < .001$), respectively. Women living in the Midwest/West were more likely to be younger, white and have history of influenza vaccination in the past season while women in the South were more likely to be married and have annual household income <\$50,000, and less likely to have college degree compared to their counterparts. Women residing in the Northeast had the highest health coverage and routine medical check-up during the past year. HPV vaccine initiation rate in the South was the lowest consistently over time.

After adjusting for age, race/ethnicity, marital status, education, income, health coverage, routine medical check-up in the past year, influenza vaccination in the past season and year of vaccination, we observed that women living in the South were still less likely than women in the Northeast to initiate (aPR 0.71, 95% confidence interval (CI) 0.60–0.83) or complete (aPR 0.61, 95% CI, 0.53–0.71) the HPV vaccination (Table 2). Women residing in the Midwest/West region were also less likely to initiate the HPV vaccination (aPR 0.81, 95% CI, 0.69–0.95). Several other characteristics were associated with the HPV initiation and completion after adjusting for confounders. Women who were younger (18–21 year old), never married, graduated college, and had an annual household income >\$75,000, healthcare coverage, routine medical check-up during the past 12 months, influenza vaccination in the past season and HPV injections in later years were more likely to initiate the HPV vaccination. Almost similar correlates were also observed for vaccine completion.

In addition, white women were more likely to complete the 3-dose series than other race/ethnicities. A separate analysis based on the Midwest/West region as the reference category showed that, women living in the South were also less likely to complete (aPR 0.70, 95% CI 0.59–0.83, $P < .001$) the HPV vaccine while women in the Northeast were more likely to initiate (aPR 1.24 95% CI 1.05–1.45; $P = .009$) it (data not shown). No significant interaction effects were observed between race/ethnicity and region, and between income and region on HPV vaccine uptake.

4. Discussion

We observed that young adult women residing in the South had the lowest HPV vaccine uptake rates in the US between 2008 and 2010. This is similar to data published on 13–17 year old girls showing that the HPV vaccination uptake rates are lower in the southeastern U.S. compared with those living in other regions in that age category [8]. In contrast, Wei et al [7] did not observe any significant difference between the Northeast and Southern regions of the US in their analysis of NHIS 2010 data. Several factors could be responsible for the discrepancies between the Wei et al report and our study. Less representation from the South ($n=695$) and Northeast ($n=242$) regions in the Wei et al study compared to our study (South, $n=1028$; Northeast, $n=1040$) may have impacted their results. Further, our study was based on 2008–2010 data while the other study was based on 2010 data only. Despite these differences, our finding that HPV vaccination uptake was consistently lower in the South compared to the Northeast over the years 2008–2010 warrants further attention.

As the incidence of cervical cancer is higher in the South than in the Midwest/West and Northeast [11], a lower rate of HPV vaccine uptake in this region, if continued consistently, may contribute to the burden of cervical cancer in the long run. Thus, it would not be an overstatement that the HPV vaccine uptake is the lowest in the US where it is needed the most. In addition, the poverty level in the South, by and large, is higher than that in the Northeast [12]. Thus, there is a need to design strategies to improve the HPV vaccine uptake in the South to lower the burden of HPV-related diseases and cancers in the long run. Moreover, it needs to be examined whether regional or state level policies contribute to this regional variation.

Several correlates of HPV initiation and completion such as age, marital status, education, income, routine medical check-up during the past year, influenza vaccination in the past season and health care coverage identified in this study are consistent with other published studies [5, 7, 13, 14]. We observed that women with lower incomes were less likely to initiate the HPV vaccine, which has been reported as a common trend [15]. The same was true for women without healthcare coverage. In fact, lack of insurance was labeled as a major barrier to HPV vaccination among young adult women due to the high cost of the vaccine series [13, 16, 18, 19]. However, several studies have observed that the Vaccine for Children (VFC) program eliminates socioeconomic disparities in vaccine initiation [8, 20–22]. Thus, similar assistance for low-income adults could eliminate disparities in HPV uptake among this population which could decrease regional disparities in HPV vaccine uptake.

The strength of this study includes data from a number of different states based on three years. This study also has several limitations. First, not all states of different regions of the US conducted the HPV vaccination uptake survey among young adult women. Second, different states participated in different years during 2008–2010. Third, the sample size was low from some regions during certain years. Finally, similar to NHIS survey data reported in Wei et al. study [7], the BRFSS survey data may be subjected to recall bias as they are self-reported. In spite of these limitations, this study provides important estimates of the regional

variation in HPV vaccine uptake among young adult women based on a representative sample.

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

Acknowledgments

Federal support for this study was provided by the Eunice Kennedy Shriver National Institute of Child Health & Human Development (NICHD) (K24 HD04365, Berenson). The content is solely the responsibility of the authors and does not necessarily represent the official views of the NICHD or the National Institutes of Health.

References

1. Markowitz LE, Dunne EF, Saraiya M, Lawson HW, Chesson H, Unger ER. Quadrivalent human papillomavirus vaccine: Recommendations of the Advisory Committee on Immunization Practices (ACIP). *MMWR Recomm Rep*. 2007; 56:1–24. [PubMed: 17380109]
2. Centers for Disease Control and Prevention. FDA licensure of bivalent human papillomavirus vaccine (HPV2, Cervarix) for use in females and updated HPV vaccination recommendation from the Advisory Committee on Immunization Practices (ACIP). *MMWR*. 2010; 59:626–629. [PubMed: 20508593]
3. Garland SM, Hernandez-Avila M, Wheeler CM, Perez G, Harper DM, Leodolter S, et al. Quadrivalent vaccine against human papillomavirus to prevent anogenital diseases. *N Eng J Med*. 2007; 356:1928–1943.
4. Paavonen J, Naud P, Salmeron J, Wheeler CM, Chow SN, Apter D, et al. Efficacy of human papillomavirus (HPV)-16/18 ASO4-adjuvanted vaccine against cervical infection and precancer caused by oncogenic HPV types (PATRICIA): final analysis of a double-blind, randomised study in young women. *Lancet*. 2009; 374:301–314. [PubMed: 19586656]
5. Laz TH, Rahman M, Berenson AB. Human papillomavirus vaccine uptake among 18- to 26-year-old women in the United States: National Health Interview Survey, 2010. *Cancer*. 2013; 119:1386–92. [PubMed: 23508594]
6. Laz TH, Rahman M, Berenson AB. An update on human papillomavirus vaccine uptake among 11–17 year old girls in the United States: National Health Interview Survey, 2010. *Vaccine*. 2012; 30:3534–3540. [PubMed: 22480927]
7. Wei F, Moore PC, Green AL. Geographic variability in human papillomavirus vaccination among U.S. young women. *Am J Prev Med*. 2013; 44:154–7. [PubMed: 23332332]
8. Centers for Disease Control and Prevention. National and state vaccination coverage among adolescents aged 13 through 17 years- United States, 2010. *MMWR*. 2011; 60:1117–2011. [PubMed: 21866084]
9. Mokdad AH. The Behavioral Risk Factors Surveillance System: past, present, and future. *Annu Rev Public Health*. 2009; 30:43–54. [PubMed: 19705555]
10. Census Bureau Regions and Divisions with State FIPS Codes. US Census Bureau; http://www.census.gov/geo/www/us_regdiv.pdf [Accessed on Feb 24, 2013]
11. Watson M, Saraiya M, Ahmed F, Cardinez CJ, Reichman ME, Weir HK, Richards TB. Using population-based cancer registry data to assess the burden of human papillomavirus-associated cancers in the United States: overview of methods. *Cancer*. 2008; 113(10 Suppl):2841–54. [PubMed: 18980203]
12. Pruitt SL, Schootman M. Geographic disparity, area poverty, and human papillomavirus vaccination. *Am J Prev Med*. 2010; 38:525–33.10.1016/j.amepre.2010.01.018 [PubMed: 20409501]
13. Price RA, Tiro JA, Saraiya M, Meissner H, Breen N. Use of Human papillomavirus vaccines among young adult women in the United States: An analysis of the 2008 National Health Interview Survey. *Cancer*. 2011; 117:5560–5568. [PubMed: 21732336]

14. Chao C, Velicer C, Slezak JM, Jacobsen SJ. Correlates for human papillomavirus vaccination of adolescent girls and young women in a managed care organization. *Am J Epidemiol.* 2010; 171:357–67. [PubMed: 20047978]
15. Renwick, T. Geographic Adjustments of supplemental poverty measure thresholds: using the American community survey five-year data on housing costs. U.S. Census Bureau; SEHSD Working Paper Number 2011–21 available at https://www.census.gov/hhes/povmeas/methodology/supplemental/research/Renwick_GeographicAdjustmentsJuly2011_WEA.pdf
16. Conroy K, Rosenthal SL, Zimet GD, et al. Human papillomavirus vaccine uptake, predictors of vaccination, and self-reported barriers to vaccination. *J Womens Health.* 2009; 18:1679–1686.
17. Jain N, Euler GL, Shefer A, Lu P, Yankey D, Markowitz L. Human papillomavirus (HPV) awareness and vaccination initiation among women in the United States, National Immunization Survey-Adult 2007. *Prev Med.* 2009; 48:426–431. [PubMed: 19100762]
18. Tylor LD, Harriri S, Sternberg M, Dunne EF, Markowitz LE. Human papillomavirus vaccine coverage in the United States, National Health and Nutrition Examination Survey, 2007–2008. *Prev Med.* 2011; 52:398–400. [PubMed: 21108962]
19. Schluterman NH, Terplan M, Lydecker AD, Tracy JK. Human papillomavirus (HPV) vaccine uptake and completion at an urban hospital. *Vaccine.* 2011; 29:3767–3772. [PubMed: 21440038]
20. Centers for Disease Control and Prevention. National, state, and local area vaccination coverage among adolescents aged 13–17 years- United States, 2008. *MMWR.* 2009; 58:997–1001. [PubMed: 19763075]
21. Centers for Disease Control and Prevention. National, state, and local area vaccination coverage among adolescents aged 13–17 years- United States, 2009. *MMWR.* 2010; 59:1018–23. [PubMed: 20724968]
22. Niccolai LM, Mehta NR, Hadler JL. Racial/ethnic and poverty disparities in human papillomavirus vaccination completion. *Am J Pev Med.* 2011; 41:428–33.

Highlights

Data from 2,632 young adult women from 12 US states collected during 2008–2010 were analyzed.

Weighted vaccine initiation and completion rates were the lowest in the South compared to other regions in the US.

Interventions programs to improve HPV vaccine uptake in the South are warranted.

Table 1

Characteristics of women by region of residence in the US (n=2632)

Characteristics	Region of Residence			P Value
	Northeast	Midwest/West	South	
Age, year, n (%)				.001
18–21	322 (31.0)	227 (40.3)	337 (32.8)	
22–26	718 (69.0)	337 (59.8)	691 (67.2)	
Race/ethnicity				<.001
White	656 (63.1)	456 (81.0)	599 (58.3)	
Black	104 (10.0)	37 (6.6)	115 (11.2)	
Hispanic	200 (19.2)	41 (7.3)	223 (21.7)	
Other	80 (7.7)	29 (5.2)	91 (8.9)	
Marital Status, n (%)				<.001
Single, never married	694 (66.7)	329 (58.3)	506 (49.2)	
Married, divorced, widowed, separated	346 (33.3)	235 (41.7)	522 (50.8)	
Education, n (%)				<.001
HS	387 (37.4)	237 (42.1)	542 (52.8)	
Some college hours	349 (33.7)	196 (34.8)	310 (30.2)	
College graduate	300 (29.0)	130 (23.1)	174 (17.0)	
Annual Household Income, US\$, n (%)				<.001
<50,000	432 (41.5)	217 (38.5)	497 (48.4)	
50,000–75,000	238 (22.9)	141 (25.0)	239 (23.3)	
>75,000	151 (14.5)	84 (14.9)	100 (9.7)	
Missing	219 (21.1)	122 (21.6)	192 (18.7)	
Have healthcare coverage, n (%)				<.001
No	127 (12.2)	117 (20.7)	342 (33.3)	
Yes	913 (87.8)	447 (79.3)	686 (66.7)	
Length of time since last routine medical check-up				<.001
One year or less	777 (74.7)	360 (63.8)	610 (59.3)	
2 year or more	263 (25.3)	204 (36.2)	418 (40.7)	
Influenza vaccination in the past season				<.001
No	729 (70.1)	379 (67.2)	797 (77.5)	
Yes	311 (29.9)	185 (32.8)	231 (22.5)	
HPV initiation, weighted % (95% CI)				
Overall	37.2 (33.9–40.5)	28.7 (24.7–33.2)	14.0 (11.7–16.7)	<.001
2008	20.8 (15.3–27.8)	36.4 (27.1–46.8)	13.1 (10.7–16.0)	<.001
2009	34.8 (29.3–40.8)	26.6 (21.5–32.4)	14.7 (9.4–22.2)	<.001
2010	44.1 (39.6–48.8)	29.2 (21.3–38.7)	22.5 (14.2–33.7)	<.001
HPV completion, [†] weighted % (95% CI)				
Overall	23.1 (20.3–26.0)	19.3 (15.9–23.3)	6.6 (5.1–8.5)	<.001

HS= High School

[†] HPV completion by year of study was not reported due to small number of events from the Northeast in 2008 and South in 2010

Table 2

Association of region of residence with HPV initiation and completion among 18–26 year old women based on BRFSS 2008–10 data

	HPV initiation	P value	HPV completion	P value
	Adjusted prevalence ratio (95% CI)		Adjusted prevalence ratio (95% CI)	
Region				
Northeast	Reference		Reference	
Midwest/West	0.81 (0.69–0.95)	.009	0.87 (0.75–1.02)	.079
South	0.71 (0.60–0.83)	<.001	0.61 (0.53–0.71)	<.001
Age, y				
18–21	Reference		Reference	
22–26	0.58 (0.50–0.68)	<.001	0.65 (0.56–0.76)	<.001
Race/ethnicity				
White	Reference		Reference	
Black	0.97 (0.79–1.20)	.801	0.72 (0.58–0.91)	.005
Hispanic	0.93 (0.78–1.10)	.400	0.82 (0.69–0.98)	.033
Other	0.80 (0.63–1.01)	.060	0.71 (0.56–0.90)	.005
Marital Status, n (%)				
Single, never married	Reference		Reference	
Married, divorced, widowed, separated	0.73 (0.64–0.84)	<.001	0.77 (0.67–0.88)	<.001
Education, n (%)				
HS	Reference		Reference	
Some college hours	1.07 (0.93–1.24)	.343	1.20 (1.04–1.39)	.013
College graduate	1.28 (1.07–1.53)	.007	1.56 (1.30–1.87)	<.001
Annual Household Income, US\$, n (%)				
<50,000	Reference		Reference	
50,000–75,000	1.06 (0.90–1.24)	.343	1.05 (0.89–1.25)	.540
>75,000	1.28 (1.07–1.53)	.007	1.40 (1.15–1.70)	.001
Missing data	1.10 (0.94–1.30)	.207	1.18 (0.995–1.39)	.057
Have healthcare coverage, n (%)				
No	Reference		Reference	
Yes	1.27 (1.08–1.49)	.004	1.12 (0.94–1.33)	.197
Length of time since last routine medical check-up				
One year or less	1.41 (1.23–1.61)	<.001	1.41 (1.22–1.63)	<.001
2 year or more	Reference		Reference	
Influenza vaccination in the past season				
No	Reference		Reference	
Yes	1.30 (1.14–1.49)	<.001	1.24 (1.08–1.42)	.002
Year of study				
2008	Reference			
2009	1.24 (1.05–1.46)	.010	.. [†]	

	HPV initiation	<i>P</i> value	HPV completion	<i>P</i> value
	Adjusted prevalence ratio (95% CI)		Adjusted prevalence ratio (95% CI)	
2010	1.48 (1.25–1.77)	<.001		

CI=Confidence interval; HS=High School

[†]Year of study was not included in the model with HPV completion as a dependent variable due to small number of events from the Northeast in 2008 and South in 2010.