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Geographic Disparity, Area Poverty and Human Papillomavirus (HPV) Vaccination

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Abstract

Background—The purpose of this study is to examine geographic disparity in the prevalence of human papillomavirus (HPV) vaccination and to examine individual-, county-, and state--level correlates of vaccination.

Methods—Three-level random intercept multilevel logistic regression models were fitted to data from girls aged 13–17 living in 6 U.S. states using 2008 Behavioral Risk Factor Surveillance System and 2000 U.S. Census data.

Results—Data from 1,709 girls nested within 274 counties and 6 states were included. Girls were predominantly white (70.6%) and insured (74.5%). Overall, 34.4% of girls were vaccinated. Significant geographical disparity across states (Variance: 0.134 standard error [SE]: 0.065) and counties (Variance: 0.146 SE: 0.063) was present, which was partially explained by state- and county-level poverty rates. Independent of individual-level factors, poverty had differing effects at the state- and county-level: girls in higher poverty states were less likely while girls in higher poverty counties were more likely to be vaccinated. Household income demonstrated a similar pattern to that of county-level poverty: compared to girls in the highest income families, girls in the lowest income families were more likely to be vaccinated.

Conclusions—The results of this study suggest geographic disparity in HPV vaccination and area-level effects of poverty that have not previously been reported. Overall vaccination rates continue to be sub-optimal however, and future research is needed to examine the impact of state- and local-area policies and to increase vaccination among eligible girls.

Introduction

In 2009, an estimated 11,270 incident cases of cervical cancer will be diagnosed and 4,070 women will die from cervical cancer in the U.S.¹ Widespread acceptance the Papanicolaou (Pap) test and treatment for precancerous and cancerous lesions have resulted in impressive declines of over 70% in both incidence and death over recent decades in the U.S.² However, persistent disparities in cervical cancer incidence, stage, and mortality has been demonstrated across race/ethnicity and socioeconomically disadvantaged individuals and areas.^{3–7} Moreover, geographic disparity in Pap testing has been demonstrated and the very populations at highest risk of cervical cancer (women who are poor, minority, less educated, and those living in areas of greater socioeconomic deprivation, higher percent African

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American or Hispanic, and fewer health care providers) are often the least likely to obtain Pap testing.^{8–13}

In 2006, the U.S. Food and Drug Administration (FDA) approved GARDASIL, a vaccine that prevents infection by two strains of the sexually transmitted human papillomavirus (HPV) found in approximately 70% of all cases of cervical cancer and two strains of HPV that cause approximately 90% of genital warts.¹⁴ In 2007, the Advisory Committee on Immunization Practices (ACIP) and the American Cancer Society (ACS) issued guidelines recommending vaccination.^{15,16} While approved by the FDA for girls as young as 9, the guidelines recommend vaccination for girls aged 11–12 and, for the purposes of “catch up vaccination,” for adolescents and young women as old as 26. In 2007, approximately one-fourth and in 2008, 37.2% of adolescent females aged 13–17 had at least initiated the 3-shot vaccination series.^{17–19}

With universal uptake of HPV vaccination, recommended screening, and treatment for precancerous lesions, incidence of invasive cervical cancer could be dramatically reduced. However, vaccination may be adopted unequally and may simply serve to widen existing cervical cancer disparities across socioeconomic status, race, and geography. At up to \$140 per dose for the 3-shot series plus office and administration fees, the vaccine is costly, and few states mandate insurance coverage. Because geographic and socioeconomic disparities exist for uptake of the cheaper Pap test, typically covered by insurance, it is likely that disparities will be seen in the uptake of the costlier HPV vaccination. On the other hand, ACIP-approved vaccines are eligible for funding through a variety of public programs, including the federal program Vaccines for Children (VFC), potentially lessening the potential for disparity.²⁰ However, wide gaps in public financing for childhood vaccinations have been documented across U.S. states and are largest for the most expensive and newest vaccines.²¹ Furthermore, persistent socioeconomic, racial, and geographic disparities in other publicly-funded vaccinations have been documented in U.S. children,^{22–25} suggesting that disparity is likely to be evident in HPV vaccination.

To examine the uptake of HPV vaccination among girls aged 13–17, we assessed geographic disparity in vaccination across 6 states in the U.S. and the individual- and area-level socio-demographic and socioeconomic correlates that may account for this variation using the child HPV module of the 2008 Behavioral Risk Factor Surveillance System (BRFSS).

Methods

Data

All individual-level data were obtained from the public-use data files of the 2008 BRFSS,²⁶ a national random digit dial telephone survey of the civilian non-institutionalized adult population in the U.S. Random child selection and population-based weighting are used to obtain representative data on the health conditions and behavioral risks of U.S. children aged ≤17. For every household with ≥1 child, one random child is selected. All data on the selected child is provided by the adult proxy. This study analyzes data from the inaugural launch of the optional child HPV module, used by 6 states: Delaware, New York, Oklahoma, Pennsylvania, Texas, and West Virginia. Although all adult respondents self-report county of residence, county identifiers are not released for individuals living in counties with <50 respondents. Of those otherwise eligible for this study, few were missing county identifiers (n=33). More information on survey procedures is available elsewhere.²⁷ Similar to previous studies^{17–19}, to provide time for vaccination during the recommended ages (11–12), girls eligible for this study were those aged 13–17 with complete data on

county of residence and HPV vaccination status. This study was approved by the Washington University School of Medicine Institutional Review Board.

Measures

The dichotomous dependent variable is girls' receipt of the HPV vaccination assessed with the question: "A vaccine to prevent the human papilloma virus or HPV infection is available and is called cervical cancer vaccine, HPV shot, or GARDASIL®. Has this child EVER had the HPV vaccination?" Adults who responded that the child had received the vaccination were then asked, "How many HPV shots did she receive?" We were unable to assess vaccine dosage due to the large number of missing responses (59.3%) to this question.

Individual-level correlates were those associated with acceptance of or intention to vaccinate adolescent females in previous research.^{28–33} Covariates included child's age and race/ethnicity. While the majority of adult respondents (88.1%) reported being the child's parent; many adults indicated different relationships with the child (e.g. grandparent). To ensure accuracy and preserve sample size, the following household- and/or parent-specific variables answered by other adults were coded as missing and included in the models as a dummy variable. Sociodemographic, socioeconomic, and access to care correlates included household total annual income, highest level of completed schooling by the parent, parent marital status, presence of other children in the home, having a usual source of healthcare not including an emergency room, and having medical insurance. The parents' preventive health orientation was measured with: smoking status, seat belt use, timing of last medical check-up, and for maternal respondents, use of Pap test. Because few mothers (n=4) were in the recommended age range for vaccination (≤ 26 years), maternal HPV vaccination was not included.

Area-level measures, including poverty at the state- and county-level and the percent living in urban areas at the county-level, were obtained from the U.S. 2000 Census. Poverty was selected because it is a robust indicator of socioeconomic status across levels of geography and time, has been associated with various health outcomes, and has relevance for policymakers.^{34,35} We used quartiles of county-level variables to examine non-linear trends. Poverty at the state-level was included as a continuous variable and was centered at the grand mean to help reduce collinearity.

Statistical analysis

We used three-level random intercept logistic regression models in which individuals (Level 1) were nested within counties (Level 2) which were, in turn, nested within states (Level 3). All models were fit using second order penalized quasi-likelihood (PQL) estimation and the iterative generalized least squares (IGLS) algorithm in MLwiN 2.11.³⁶ No evidence of extra binomial variation was seen in an empty model. To calculate the variation found at the higher levels, the variation at Level 1 was set at $\pi^2/3$ (approximately 3.29).³⁷ Model assumptions regarding random effects at area-levels were evaluated by visual inspection of normal-probability plots of the residuals. We present 4 models: an empty model (Model 1); individual-level model (Model 2); individual- and county-level model (Model 3); and individual-, county-, and state-level model (Model 4).

All analyses used weighted estimation of model parameters. Individual-level weights were those calculated by the Centers for Disease Control and Prevention (CDC) to adjust for representativeness of the sample by gender, age, and race/ethnicity and inclusion probability, including correcting for the probability of selection between sample strata.³⁸ County-level weights were the ratio of the number of female individuals aged 13–17 to the

total population of the county calculated using the 2000 U.S. Census and state-level weights were the sum of those ratios for all included counties in the state.

The girl's age and race were included in all models as *a priori* correlates of vaccination. Other individual-level correlates were selected if they: (1) were associated with vaccination in bivariate analyses ($p < .05$) and (2) continued to be associated with vaccination or significantly contributed to the amount of variance explained in the individual-level covariate model and (3) were not highly correlated with each other ($r \geq 0.70$). All fixed and random parameters were tested with the Wald test ($p < .05$).

Associations between all variables and HPV vaccination were shown with odds ratios (ORs) and 95% confidence intervals (CIs). To demonstrate the variation in vaccination at both area-levels, we report the intra-cluster correlation (ICC), median odds ratio (MOR), and the 80% IOR. The ICC expresses the proportion of the total variance in vaccination resulting from the influence of the area level(s). The MOR quantifies the unexplained cluster heterogeneity and the 80% IOR incorporates random effects in the measurement of fixed effects.^{39,40} The value of the MOR is always ≥ 1 ; where 1 indicates no variation between the clusters and larger values indicate greater geographic variation. A narrow IOR interval indicates small residual variation and a large interval indicates large residual variation. If the IOR contains 1, the effect of the area-level variable is not considered to be very strong when compared to the residual area-level variation.^{39,40}

Results

Adult respondents provided data on a total of 1,709 adolescent females aged 13–17 nested within 274 counties, representing 8.7% of all U.S. counties. The counties were, in turn, nested within 6 states (i.e., Delaware, New York, Oklahoma, Pennsylvania, Texas, and West Virginia). The mean sample size was 6.2 (range: 1–74) per county and 284.8 (range: 128–284.8) per state. The percent living in poverty did not differ between included and not included counties and states; however, included counties were more urbanized (Table 1). The adolescents were predominantly white (70.6%) and the majority of their parents had health insurance (74.6%). Compared to adolescents not included due to residence in other states, missing county identifiers or missing data on HPV, adolescents in the study sample were more racially diverse, had lower parental education and income, and had a higher percent of parents without insurance (Table 2).

Overall, a survey-weighted 34.4% (95% CI: 30.7, 38.3, $n=615$) of all girls had received ≥ 1 vaccination shot. Vaccination rates ranged widely between the states, from 20.6% in Texas to 50.4% in New York (Table 3).

Significant variation at both the county- (Var: 0.146 SE: 0.063) and state- (Var: 0.134 SE: 0.065) levels was seen in the empty model (Table 4). In the individual-level model, girls aged 15–17 and whose parents had insurance were more likely to be vaccinated. Compared to girls living in homes earning $\geq \$50,000$, those living in homes earning $< \$25,000$ were more likely to be vaccinated. These associations persisted and the odds ratios remained unchanged after the inclusion of county- and state-level correlates. In Models 3 and 4, girls of other or unknown race were less likely than whites to be vaccinated. In Model 4, compared to girls with a college-educated parent, girls with parents with a $\leq$ high school education were less likely to be vaccinated.

The inclusion of county- and state-level poverty in the final model resulted in decreased variation at both area levels; this model explained 40% of the overall geographic disparity seen in the empty model. County- and state-level poverty both demonstrated significant fixed effects. Compared to those living in counties with the lowest percent of the population

living in poverty (highest SES counties), those living in the 2nd and 4th quartiles (lower SES and lowest SES counties) were more likely to be vaccinated. However, increasing state-level poverty was associated with lower odds of vaccination.

Discussion

We demonstrate geographic disparity in HPV vaccination among girls in 6 U.S. states using data from the first application of the BRFSS Child HPV Module. Overall, only 1 in 3 girls reported to have received ≥ 1 dose of the HPV vaccine. While both our study and the 2008 data from the National Immunization Survey¹⁹ indicate vaccination has increased since 2007,^{17,18} given that routine vaccinations are recommended,^{15,16} we consider this rate to be sub-optimal.

Notably, while higher state-level poverty was associated with decreased odds, higher county-level poverty was associated with increased odds of vaccination. While seemingly contradictory, this indicates that while girls in poorer states had overall lower odds, girls living in any state experienced higher odds of vaccination if they lived in higher poverty counties. The limited resources of poor states are likely part of the explanation: states differ in regard to requirements for private coverage, the eligibility criteria for publicly-funded vaccination programs, and the amount of funds available for the promotion and administration of these programs. Public programs are frequently administered and delivered via county-level systems, however, and all states, even the poorest, likely allocate a greater proportion of public funds to the most disadvantaged counties. For example, underinsured children can only be vaccinated through the VFC program in Federally Qualified Health Centers or Rural Health Clinics, both of which are limited to medically underserved communities.⁴¹ Although at this time it is not clear why, our finding of geographic disparity at both area levels indicates that some characteristics of both counties and states are related to HPV vaccination among girls. While the county-level poverty measure reflects our sample of relatively more urbanized counties, our measure of state poverty captures the entirety of a state's counties, including the more rural counties not included in our sample.

Our results at the state level are troubling, given that states with greater poverty may face both a higher burden of cervical cancer incidence and mortality³⁵ (Table 5) and as demonstrated here, lower rates of vaccination. If lower vaccination rates persist in poor states and in states with an existing disproportionate burden of cervical cancer, it may serve to widen existing geographic, racial/ethnic, and socioeconomic cervical cancer inequities. The long-term clinical and public health relevance of county- and state- poverty is not yet known and future research is needed to understand the impact of these findings over time and in other geographic regions.

The county-level association was mirrored at the individual-level, with the lowest income girls more likely to be vaccinated. Similarly, in the 2008 National Immunization Survey, girls living in poverty were significantly more likely to have received ≥ 1 dose of HPV vaccine than those at or above poverty.¹⁹ Conversely, in our study, girls in less educated households were *less* likely to be vaccinated. Although likely indicating different underlying constructs (i.e. purchasing power vs. cognitive resources), income and education are often used interchangeably and treated as equivalent markers of socioeconomic status. In our study, where low income may be a marker of eligibility for and access to publicly-funded programs, lower education may indicate less favorable attitudes and/or knowledge about vaccination. Both positive and negative associations between vaccine acceptability and income and education have been reported with slightly more studies reporting higher acceptability among parents with lower income and/or education.^{28,30,31,33}

The positive association between county-level poverty and vaccination contradicts a large body of research demonstrating predominantly negative or, less frequently, non-significant associations, between area- and individual-level SES and health and health behaviors.^{42–44} In this study, the positive association could indicate the success of publicly-funded vaccination efforts targeting the underserved, as eligibility for these programs is predominantly based on income. Alternatively, this association may indicate a bias against vaccination among wealthier respondents and those living in higher-income areas or a lack of knowledge or skepticism about vaccination among less educated parents. Studies of other childhood vaccines indicate that while poor and poorly educated families may be more likely to have under-vaccinated children, the parents of completely unvaccinated children are more likely to be college educated and have higher incomes.⁴⁵ Furthermore, as a vaccine for a sexually transmitted infection, the HPV vaccine may face unique biases and negative attitudes.²⁸ However, given the overall lack of knowledge about HPV in the general public⁴⁶ and the marketing campaign for the vaccine that downplayed sexual transmission; it seems unlikely that such biases played a role.⁴⁷

Notably, similar to the majority of previous acceptability studies,²⁸ we found no evidence of a racial-ethnic disparity; a promising finding in light of the importance of vaccinating African American and Hispanic girls given the higher burden of cervical cancer in these populations.^{6,7} Unlike an earlier surveillance report,¹⁷ we found that older age was associated with a greater odds of vaccination. Although previous studies suggested that insurance is not related to HPV acceptability or acceptance,^{30,48,49} parental insurance was strongly associated with receipt of HPV vaccination in our study.

At the time of data collection, none of the states using this BRFSS module had enacted mandatory vaccination for school enrollment or insurance coverage. While mandatory HPV vaccination proposals have met with some negative responses,^{50,51} mandatory school entrance requirements for other vaccines have been shown to be very effective methods for assuring population-wide coverage⁵² and have virtually eliminated racial-ethnic disparities in Hepatitis B vaccination.⁵³ There are wide gaps in public financing for vaccination of underinsured children and coverage rates vary widely by state in the U.S.²¹ It remains to be seen how these funding gaps will be addressed for the purpose of HPV vaccination and whether vaccine mandates will reduce or widen geographic disparity in vaccine uptake and overall cervical cancer burden.

This study has several limitations. There are no data yet on the validity of the BRFSS HPV measure, however, it is very similar to NIS and National Health Interview Survey items which have undergone extensive cognitive testing. (GL Euler, National Center for Immunization and Respiratory Diseases CCID/CDC/DHHS, personal communication 6-22-09.) Several of the adult proxy respondents were not the child's parent and may have provided less accurate recall. However, in sensitivity analyses, while non-parent responders were slightly more likely to report vaccination, similar geographic variation and effects of poverty at both levels were found when analyses were restricted to parent proxies (data not shown). Only 6 states used this module in 2008, many counties within these states were not included, and our results may not be generalizable to the entire population of U.S. adolescents aged 13–17. Funding sources, financial assistance, cost, and availability of the vaccine within health departments can vary widely across counties and states, even within a single geographic region,⁵⁴ suggesting that further testing of our findings in other geographic areas is needed. Despite these limitations, our study provides data from the first year of BRFSS HPV vaccination data and suggests geographic disparity and area-level effects of poverty that, to our knowledge, have not previously been reported.

Overall, we demonstrated geographic disparity and sub-optimal vaccination of girls aged 13–17. Cancer prevention and control efforts rarely face such an exceptional opportunity to prevent cancer. However, if lower vaccination rates persist in poor states, they may serve to widen existing geographic, racial/ethnic, and socioeconomic cervical cancer inequities. Such geographic disparity and effects of area-level poverty are potentially detrimental to important prevention efforts and should be addressed in future research, policy, and intervention.

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Table 1

Comparison of Counties and States Included and Not Included in the Analysis

	Counties included in analysis (n=274)	Counties not included (n=2945)		All counties in U.S. (n=3219)
	Median (minimum –maximum)	Median (minimum –maximum)	<i>p</i> value	Median (minimum –maximum)
Percent of individuals below federal poverty line	13.5 (4.4–37.7)	13.09 (0–68.0)	.15	13.12 (0–68.0)
Percent of individuals living in urban areas	53.9 (0–100)	39.27 (0–100)	<.001	40.74 (0–100)
	States included in analysis (n=6)	States not included (n=45)		All U.S. states and Puerto Rico U.S. (n=51)
	Median (minimum –maximum)	Median (minimum –maximum)	<i>p</i> value	Median (minimum –maximum)
Percent of individuals below federal poverty line	14.3 (9.9–19.1)	13.03 (6.9–52.9)	.99	13.03 (6.9–52.9)

Table 2

Descriptive Characteristics of Adolescent Females Age 13–17 and Adult Proxy Respondents in the Study Sample (n=1,709) and those Not in the Study Sample (n=10,312)

	Sample		U.S. Females Age 13–17 not in Sample	
	N	%		
Race/ethnicity				
White	1207	70.6	7403	71.8 p=.004
Black	157	9.2	788	7.6
Hispanic	223	13.1	1209	11.7
Other/unknown	116	6.8	862	8.4
Missing	6	0.3	50	0.5
Age				
13–14	621	36.3	3632	35.2 p=.354
15–17	1088	63.7	6680	64.8
Missing	0	-	0	-
Household Income				
≥\$0,000	788	46.1	4990	48.4 p=.002
25–49,999	308	18.0	1949	18.9
≤\$24,999	299	17.5	1443	14.0
Missing ^a	314	18.4	1930	18.7
Parent education				
College/technical grad	522	30.5	3426	33.2 P=.009
Some college/technical	414	24.2	2502	24.3
≤High school	550	32.2	2931	28.4
Missing ^a	223	13.1	1453	14.1
Insurance				
No	209	12.2	1048	10.16 p=.033
Yes	1275	74.6	7812	75.76
Missing ^a	225	13.2	1452	14.08
Adult Respondent				
Parent (biologic/step/adoptive)	1488	87.1	8866	86.0 p=.190

	Sample		U.S. Females Age 13–17 not in Sample	
	N	%		
Grandparent	83	4.9	465	4.5
Sibling (biologic/step/adoptive)	78	4.6	597	5.8
Foster parent/guardian	24	1.4	121	1.2
Other relative	21	1.2	134	1.3
Not related	15	0.9	101	1.0
Missing	0	-	28	0.25

^aTo ensure accuracy of responses, missing categories for these variables represent unanswered or refused questions as well as questions coded as missing if the adult proxy respondent was not the child's parent.

Table 3

Number and Survey-weighted Percent of Girls Age 13–17 Receiving ≥1 HPV Vaccination Shot in 2008, by State and County Poverty Quartile

State (n, % state living in poverty)	Poverty						Total	
	1 (low poverty)		2		3			
	%	(95% CI)	%	(95% CI)	%	(95% CI)	%	(95% CI)
Delaware (n=185, 9.2%)	39.0	(28.0–51.2)	63.5	(50.2–75.1)	<i>a</i>		43.4	(33.9, 53.5)
New York (n=269, 14.6%)	41.8	(30.3–54.3)	69.1	(55.8–79.8)	43.7	(25.4–63.8)	49.6	(31.4–68.0)
Oklahoma (n=266, 14.7%)	40.1	(17.5–67.9)	29.3	(19.1–42.3)	21.3	(13.4–32.2)	34.2	(20.6–50.9)
Pennsylvania (n=452, 11.0%)	33.0	(24.8–42.3)	47.8	(35.0–60.8)	36.1	(16.0–62.7)	30.3	(17.8–46.7)
Texas (n=409, 15.4)	16.0	(0.07–33.7)	19.3	(0.07–44.9)	20.7	(13.1–31.2)	25.0	(16.2–36.5)
West Virginia (n=128, 17.9%)	<i>b</i>		24.5	(0.08–55.2)	39.4	(20.8–61.5)	40.5	(27.3–55.3)
Total (n=1,709)	32.0	(26.1–38.6)	48.2	(39.9–56.6)	27.4	(20.5–35.6)	34.7	(26.9–43.3)
							34.4	(30.7, 38.3)

^aThere are only 3 counties in Delaware.

^bSample size inadequate (n=5).

HPV=Human papillomavirus

Table 4

Fixed and Random Effects from Multivariable 3-level Random Intercept Logistic Regression Models for Having Received ≥ 1 HPV Vaccination Dose among Girls aged 13–17 Living in 6 U.S. States, 2008 Behavioral Risk Factor Surveillance System and 2000 U.S. Census (n=1,709)

Fixed	Model 1: Empty Model		Model 2: Individual		Model 3: Individual + County		Model 4: Individual + County + State	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Individual								
Race/ethnicity								
White	-	1			1		1	
Black	-	0.85	0.58, 1.25	0.85		0.59, 1.22	0.84	0.57, 1.22
Hispanic	-	1.04	0.58, 1.88	1.02		0.58, 1.79	1.01	0.58, 1.75
Other/unknown	-	0.90	0.81, 1.01	0.83		0.74, 0.93	0.89	0.80, 0.99
Age								
13–14	-	1			1		1	
15–17	-	1.24	1.02, 1.50	1.24		1.03, 1.49	1.24	1.03, 1.49
Household income								
$\geq 50,000$	-	1			1		1	
25–49,999	-	0.89	0.65, 1.23	0.87		0.63, 1.20	0.87	0.63, 1.20
$\leq 24,999$	-	1.53	1.06, 2.21	1.48		1.18, 1.85	1.48	1.17, 1.86
Missing	-	1.06	0.76, 1.49	1.05		0.76, 1.44	1.04	0.78, 1.39
Parent education								
College/technical graduate	-	1			1		1	
Some college/technical	-	1.17	0.88, 1.56	1.18		0.89, 1.57	1.18	0.89, 1.57
$\leq$ High school	-	0.75	0.55, 1.00	0.74		0.55, 1.00	0.74	0.55, 0.99
Missing	-	2.53	0.53, 12.14	2.81		0.58, 13.68	2.53	0.39, 16.6
Parent insurance								
No	-	0.48	0.34, 0.69	0.45		0.34, 0.68	0.48	0.34, 0.68
Yes	-	1			1		1	
Missing	-	0.45	0.10, 2.01	0.40		0.09, 1.85	0.40	0.09, 1.85
County-level								
Poverty quartile								
1 (highest SES)	-	-			1		1	

	Model 1: Empty Model		Model 2: Individual		Model 3: Individual + County		Model 4: Individual + County + State	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Fixed								
2	-	-	1.60	1.33, 1.92	0.67, 3.82	1.62	1.36, 1.94	0.77, 3.40
3	-	-	1.11	0.85, 1.43	0.46, 2.64	1.15	0.88, 1.50	0.55, 2.40
4 (lowest SES)	-	-	1.57	1.14, 2.15	0.66, 3.73	1.64	1.13, 2.37	0.78, 3.44
State-level								
Percent living in poverty (per % increase in poverty)	-	-	-	-	-	0.91	0.84, 0.98	0.43, 1.90
Random								
State								
Var (SE)	0.134 (0.065)	0.126 (0.065)			0.141 (0.056)			0.081 (0.043)
ICC	0.039	0.037			0.041			0.024
MOR	1.42	1.40			1.62			1.31
County								
Var (SE)	0.146 (0.063)	0.133 (0.061)			0.089 (0.065)			0.086 (0.068)
ICC	0.042	0.039			0.026			0.025
MOR	1.44	1.42			1.43			1.32
Total								
Var (SE)	0.280 (0.128)	0.259 (0.126)			0.230 (0.121)			0.167 (0.111)
ICC	0.078	0.073			0.065			0.048
Proportion change in total variance relative to Model 1	-	-7.5			-17.9			-40.4

HPV=Human papillomavirus

Table 5

Age-adjusted Cervical Cancer Incidence (2005) and Mortality (1990–2005) Rates for Included States and the U.S.

State	Incidence Rate (per 100,000)		Mortality Rate (per 100,000)	
	Rate	(95% CI)	Rate	(95% CI)
Delaware	8.7	(6.1–11.9)	2.1	(1.8–2.3)
New York	8.9	(8.4–9.5)	1.7	(1.7–1.7)
Oklahoma	8.4	(7.1–9.9)	1.8	(1.7–1.9)
Pennsylvania	7.9	(7.2–8.6)	1.6	(1.5–1.6)
Texas	9.1	(8.3–10.0)	1.9	(1.9–2.0)
West Virginia	10.5	(8.6–12.8)	2.1	(2.0–2.3)
U.S.	8.0	(7.8–8.1)	1.6	(1.6–1.6)

Mortality rates are from the Surveillance, Epidemiology, and End Results (SEER) Program (www.seer.cancer.gov) SEER*Stat Database: Mortality - All COD, Aggregated With State, Total U.S. (1990–2006) <Katrina/Rita Population Adjustment>, National Cancer Institute, DCCPS, Surveillance Research Program, Cancer Statistics Branch, released May 2009. Underlying mortality data provided by NCHS (www.cdc.gov/nchs). Incidence rates from 2005 are from the State Cancer Registries and the CDC's National Program of Cancer Registries Cancer Surveillance System (NPCR-CSS) January 2008 data submissions and SEER November 2006 submission as published in the *United States Cancer Statistics 2005* and were obtained from State Cancer Profiles <http://statecancerprofiles.cancer.gov> on 10/05/2009.