Cervical Cancer Incidence in the United States by Area of Residence, 1998–2001

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OBJECTIVES: To examine differences in cervical cancer incidence rates among women in rural, suburban, and metropolitan areas of the United States.

METHODS: This study examined invasive cervical cancer incidence among women in United States counties classified as rural, suburban, and metropolitan for the period 1998–2001. We examined differences in incidence by age, race, Hispanic ethnicity, stage at diagnosis, and poverty level, using the Center for Disease Control and Prevention National Program of Cancer Registries, National Cancer Institute's Surveillance, Epidemiology, and End Results Program and 2000 U.S. Census data.

RESULTS: A total of 39,946 cases of cervical cancer were included. Overall, the rates increased among younger women, peaked at ages 40–44 years, remained relatively constant in middle age, and decreased after age 69 years. Incidence rates were lower among residents of metropolitan areas than residents of rural areas, both overall and across groups defined by race, ethnicity, (localized) stage, and poverty level.

CONCLUSION: Rural women in the United States have higher cervical cancer incidence rates. Among older women (aged 45–80 years) in whom half of cervical cancers occur, geographic differences largely disappear after controlling for poverty and race.

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Cervical cancer incidence rates have declined dramatically in the United States since the Papanicolaou (Pap) test was introduced.[1] Regular cervical cancer screening is associated with an earlier stage of invasive disease at diagnosis and decreased incidence through detection and treatment of preinvasive disease.[2] In 2005, almost 80% of surveyed U.S. women reported having had a recent Pap test.[3] Despite the nationwide gains in screening and declines in cervical cancer incidence and mortality, the improvements have not been uniform across groups defined by factors such as age, race or ethnicity, or geographic area of residence.

Geographic variation in cervical cancer incidence and mortality may be partly due to variation in cervical cancer screening.[4–8] Several factors suggest that access barriers or underuse might be greater in rural than in urban areas. Compared with urban residents, rural residents are more likely to lack health insurance[4] and may have to travel long distances to obtain care.[5] Rural residents are older and poorer on average,[6] and both age and poverty are associated with lack of screening and later stage disease.[7,8] A recent comprehensive review of variation in cervical cancer mortality did not find sufficient evidence to conclude that geographic screening differences led to higher mortality.[9] Previous studies have examined rural differences in cervical cancer incidence among selected groups of women.[10–14] This study provides a detailed examination of cervical cancer incidence with broad coverage by geographic location.

To further clarify these relationships, we therefore examined cervical cancer incidence among women in counties in the United States classified as rural, suburban, and metropolitan. We assessed incidence among rural, suburban, and metropolitan residents by age, race, Hispanic ethnicity, stage at diagnosis, and an area-based measure of poverty.

MATERIALS AND METHODS

For this analysis, we used data from the National Program of Cancer Registries reported to the Centers

for Disease Control and Prevention as of January 31, 2004, for registries that met the United States Cancer Statistics data quality publication standard for all cancer sites combined.[15] We included all National Program of Cancer Registries registries that met these standards, with the exceptions of Alaska, Illinois, and Minnesota, which were excluded because county-level data on rural or nonrural residence were not available.[16] We also used state registry data from the November 2003 submission to the National Cancer Institute's Surveillance, Epidemiology, and End Results (SEER) Program.[17] Surveillance, Epidemiology, and End Results data from Hawaii were excluded because county-level data were not available. The final analytic data set included incidence data for 35 states and the District of Columbia, representing approximately 80% of the U.S. population. We combined data for invasive cancer diagnoses between 1998 and 2001, inclusive, among adult women aged 20 years or older at the time of diagnosis.

We computed incidence rates and 95% confidence intervals (CIs) for the period 1998–2001. We compared the incidence of cervical cancer in metropolitan, suburban, and rural counties of the United States using the U.S. Department of Agriculture's urban–rural continuum codes, which are based on information from the 2000 United States Census.[18] Codes 0–3 correspond to metropolitan counties (including metropolitan areas with populations of about 250,000 to more than 1 million); codes 4–5 correspond to predominately suburban populations of 20,000 or more, but fewer than 250,000; and codes 6–9 correspond to rural populations and small towns with up to 19,999 residents. Based on their county of residence, persons were assigned a county-level rural–urban continuum code and categorized as residents of 1) metropolitan areas (codes 0–3), 2) suburban areas (codes 4–5), or 3) rural areas (codes 6–9).

We examined cervical cancer incidence rates in metropolitan, suburban, and rural areas by age categories, race, ethnicity, stage at cancer diagnosis, and an area-based indicator of poverty. We categorized patient age at diagnosis in 5-year intervals for ages 20–84 years, with a final category of 85 years or older. Among rural, suburban, and metropolitan residents, we examined cervical cancer incidence rates by residence for African-American, white, Asian or Pacific Islander, and Alaskan Native or American Indian women. We also examined differences in cervical cancer incidence by residence and Hispanic ethnicity, which is the only ethnic group available for this analysis.

Stage at diagnosis was categorized according to SEER summary stage (localized, regional, distant, or unstaged). Poverty was defined by the percentage of the total county population below the federal poverty level, as reported in the 2000 United States Census. We categorized counties as less than 20% or 20% or more of total county population below poverty level to be consistent with cutpoints used by similar studies for comparison.

All except age-specific rates were adjusted by the direct method to the 2000 United States standard population by 5-year age groups. Rates were compared only where there were at least 16 cases in each cell; 95% CIs were estimated based on the gamma distribution.[19]

We used negative binomial modeling techniques to examine the effects of age, race and ethnicity, year of diagnosis, and percentage of population below the federal poverty level and to adjust for these factors while examining metropolitan, suburban, and rural differences in the cervical cancer incidence rates.[20] Negative binomial models were used rather than Poisson models due to large amounts of overdispersion. Race and ethnicity could not be included in the same model because population data are not available for some race or ethnicity combinations. For example, race and Hispanic ethnicity were recorded separately. These variables were thus fitted to separate models. Statistical testing of all models was by the Wald χ^2 test. The Centers for Disease Control and Prevention Institutional Review Board approved this study.

RESULTS

A total of 39,946 newly diagnosed cases of cervical cancer were included in this analysis. Age-specific cervical cancer incidence rates by metropolitan, suburban, and rural residence for the period 1998–2001 are shown in Table 1. Overall, the rates increased among younger women, peaked at ages 40–44 years, remained relatively constant in middle age, and decreased after age 69 years. This pattern was similar for rural, metropolitan, and suburban residents. The cervical cancer incidence rates were highest among women aged younger than 50 years who resided in rural areas; at older ages, incidence rates were frequently highest among women in suburban areas.

Table 2 shows age-adjusted cervical cancer incidence rates for the period 1998–2001, by residence, race, ethnicity, stage, and percentage of population below poverty level. Overall, the cervical cancer rate was lowest in metropolitan areas (11.8, 95% CI 11.7–11.9). This relationship was also noted across all race

Table 1. Age-Specific Cervical Cancer Incidence Rates* by Metropolitan, Suburban, and Rural Resident Status, 1998–2001†

	Total			Metropolitan			Suburban			Rural		
Age(y)	Cases	Rate	95% CI	Cases	Rate	95% CI	Cases	Rate	95% CI	Cases	Rate	95% CI
20–24	474	1.6	(1.5–1.8)	376	1.5	(1.3–1.7)	48	2.3	(1.7–3.1)	47	2.1	(1.5–2.8)
25–29	2,078	6.8	(6.5–7.1)	1,701	6.4	(6.1–6.8)	154	8.3	(7.0–9.7)	217	9.8	(8.5–11.2)
30–34	3,892	11.9	(11.5–12.3)	3,244	11.5	(11.1–11.9)	276	13.8	(12.2–15.5)	362	14.9	(13.4–16.5)
35–39	5,017	13.9	(13.5–14.3)	4,104	13.3	(12.9–13.8)	394	16.8	(15.2–18.6)	513	17.5	(16.0–19.0)
40–44	5,561	15.5	(15.1–15.9)	4,605	15.2	(14.8–15.7)	408	16.8	(15.2–18.5)	545	17.7	(16.2–19.2)
45–49	4,757	14.7	(14.3–15.1)	3,930	14.5	(14.1–15.0)	321	14.2	(12.7–15.9)	498	17.2	(15.7–18.8)
50–54	3,941	14.0	(13.5–14.4)	3,262	13.9	(13.4–14.3)	304	15.2	(13.6–17.0)	371	14.3	(12.9–15.8)
55–59	3,137	14.2	(13.7–14.7)	2,573	14.2	(13.6–14.7)	248	15.1	(13.3–17.1)	314	14.2	(12.6–15.8)
60–64	2,657	14.6	(14.1–15.2)	2,127	14.4	(13.8–15.1)	213	15.0	(13.1–17.2)	311	15.9	(14.1–17.7)
65–69	2,394	14.4	(13.8–15.0)	1,901	14.1	(13.5–14.8)	219	16.6	(14.4–18.9)	273	15.1	(13.3–17.0)
70–74	2,086	12.9	(12.4–13.5)	1,673	12.8	(12.2–13.4)	168	13.2	(11.2–15.3)	242	14.2	(12.5–16.1)
75–79	1,752	12.4	(11.8–13.0)	1,408	12.2	(11.6–12.9)	139	12.5	(10.5–14.8)	203	13.8	(12.0–15.9)
80–84	1,238	12.2	(11.6–12.9)	991	12.1	(11.4–12.9)	96	12.0	(9.7–14.6)	147	13.3	(11.2–15.6)
85+	962	9.9	(9.3–10.5)	780	10.0	(9.3–10.7)	87	11.3	(9.0–13.9)	95	8.4	(6.8–10.2)

* Per 100,000 persons.

† Data are from selected statewide and metropolitan area cancer registries that met the following data quality criteria for publication in *United States Cancer Statistics: 2001 Incidence and Mortality*: case ascertainment is at least 90% complete; 97% or more of cases pass a standard set of computerized edits; 5% or fewer cases were ascertained by death certificate only; 3% or fewer cases are missing information on sex; 5% or fewer cases are missing information on race; 3% or fewer cases are missing information on age. The data represent approximately 80% of the United States population. Alaska, Hawaii, Illinois, and Minnesota were excluded due to missing county data.

Table 2. Age-Adjusted Cervical Cancer Incidence Rates* by Metropolitan, Suburban, and Rural Resident Status, 1998–2001†

	Total			Metropolitan			Suburban			Rural		
Characteristic	Cases	Rate	95% CI	Cases	Rate	95% CI	Cases	Rate	95% CI	Cases	Rate	95% CI
Overall	39,946	12.0	(11.9–12.2)	32,675	11.8	(11.7–11.9)	3,075	13.2	(12.7–13.7)	4,138	13.8	(13.4–14.2)
Race												
White	31,873	11.4	(11.3–11.5)	25,538	11.1	(11.0–11.3)	2,690	12.7	(12.2–13.2)	3,614	13.2	(12.7–13.6)
African American	5,839	17.1	(16.7–17.6)	5,197	16.8	(16.4–17.3)	268	19.4	(17.2–21.9)	372	21.1	(19.0–23.3)
Asian or Pacific Islander	1,162	9.9	(9.3–10.5)	1,113	9.8	(9.2–10.4)	27	15.8	(9.5–28.5)	20	20.3	(11.8–36.8)
American Indian or Alaska Native	200	7.2	(6.2–8.4)	100	5.3	(4.2–6.6)	37	9.6	(6.7–13.7)	62	12.3	(9.4–16.0)
Ethnicity												
Hispanic	5,431	16.6	(16.2–17.1)	5,021	16.5	(16.0–17.0)	193	19.3	(16.6–22.4)	212	18.6	(16.2–21.4)
Non–Hispanic	34,511	11.6	(11.5–11.7)	27,650	11.3	(11.2–11.4)	2,882	13.0	(12.5–13.5)	3,926	13.6	(13.2–14.1)
Stage												
Localized	18,862	6.7	(6.6–6.8)	15,069	6.6	(6.5–6.7)	1,607	7.3	(6.9–7.7)	2,160	7.6	(7.3–7.9)
Regional	10,736	3.7	(3.7–3.8)	8,630	3.7	(3.6–3.8)	860	3.7	(3.5–4.0)	1,243	4.0	(3.8–4.3)
Distant	3,128	1.1	(1.0–1.1)	2,522	1.1	(1.0–1.1)	262	1.1	(1.0–1.2)	341	1.1	(1.0–1.2)
Unstaged	3,063	1.1	(1.0–1.1)	2,427	1.0	(1.0–1.1)	257	1.1	(1.0–1.2)	353	1.2	(1.0–1.3)
Percentage below poverty level												
Less than 20	34,680	11.6	(11.5–11.7)	28,996	11.4	(11.2–11.5)	2,627	12.9	(12.4–13.4)	3,057	13.0	(12.6–13.5)
20 or more	5,208	16.7	(16.2–17.1)	3,679	17.0	(16.4–17.5)	448	15.4	(14.0–16.9)	1,081	16.5	(15.6–17.6)

* Per 100,000 persons.

† Data are from selected statewide and metropolitan area cancer registries that met the following data quality criteria for publication in *United States Cancer Statistics: 2001 Incidence and Mortality*: case ascertainment is at least 90% complete; 97% or more of cases pass a standard set of computerized edits; 5% or fewer cases were ascertained by death certificate only; 3% or fewer cases are missing information on sex; 5% or fewer cases are missing information on race; 3% or fewer cases are missing information on age. The data represent approximately 80% of the United States population. Alaska, Hawaii, Illinois, and Minnesota were excluded due to missing county data.

groups and Hispanic ethnicity, localized stage, and less than 20% population below poverty level.

In the multivariable analysis, both age and race had significant interactions with area of residence. To

simplify the interpretation, separate models were computed. Table 3 contains the race–area interaction (adjusted for age, diagnosis year, and poverty level) and Table 4 contains the age–area interaction (adjusted for race, diagnosis year, and poverty level). Among whites, rural areas had only slightly higher incidence than metropolitan areas (ratio 1.11, 95% CI 1.00–1.23). However, among Asian or Pacific Islander and Alaskan Native or American Indian women, this difference was much larger (Asian or Pacific Islander ratio 1.94, 95% CI 1.23–3.08; Alaskan Native or American Indian Alaskan Native or American Indian ratio 2.15, 95% CI 1.53–3.02). In the age interaction analysis, rural women in the younger than 35 year and 35- to 44-year age groups had higher incidence than these women in metropolitan areas (Table 4). However, incidence was higher in metropolitan women aged older than 85 years. No differences by area were seen in women aged 45–84 years.

DISCUSSION

The findings from this study add to the evidence that rural women in the United States have higher cervical cancer incidence rates by providing additional information on effect modification by age and race. With adjustment for age, the highest cervical cancer incidence rates were observed among rural women. This pattern was also seen among women aged younger than 45 years, controlling for both poverty and race. However, among older women (aged 45–80 years), in whom more than one half of cervical cancers occur, geographic differences largely disappear after controlling for these factors. Our results do not control for health insurance and usual source of care, which may play a significant role in whether women are screened and receive timely follow-up and treatment.[21,22] Women who live in rural areas tend to be poorer and may lack health insurance, which might account for the higher cervical cancer incidence noted in those aged younger than 45 years.[10] Our findings might also be explained by variation in screening rates by age. Although such factors as low income, lack of health insurance, and lack of physician availability are concentrated in rural areas, no studies have identified how these might affect cervical cancer incidence by age.

Of particular concern are cases diagnosed at a regional or distant stage, because cervical cancer is much more likely to be successfully treated if caught early. However, no differences were noted between rural and nonrural women in the percentages by stage (local, regional, or distant) of diagnosed cervical cancer cases (data not shown). Differences were seen, however, between racial and ethnic groups in the percentages of cases diagnosed as distant, including more distant cases in African-American, non-Hispanic women [data not shown]: 8.6% white, 10.5% African American, 7.6% Asian or Pacific Islander, and 10.1% American Indian or Alaska Native; 7.2% Hispanic and 9.0% non-Hispanic. These observed patterns in stage at diagnosis might be due to racial or ethnic disparities in access to routine screening and appropriate follow-up care or to differences in health insurance coverage or to socioeconomic status.[22]

One limitation of the present study is that metropolitan areas in the United States are diverse and

Table 3. Adjusted Relationship* of Area of Residence on Cervical Cancer Incidence by Race Among Women Aged 20 Years and Older, 1998–2001†

Area of Residence Comparison Within Race Groups	Incidence Rate Ratio	95% CI
White		
Rural compared with metropolitan	1.11	1.00–1.23
Rural compared with suburban	1.02	0.91–1.14
African American		
Rural compared with metropolitan	1.11	0.96–1.28
Rural compared with suburban	1.08	0.89–1.30
Asian or Pacific Islander		
Rural compared with metropolitan	1.94	1.23–3.08
Rural compared with suburban	1.32	0.73–2.38
American Indian or Alaska Native		
Rural compared with metropolitan	2.15	1.53–3.02
Rural compared with suburban	1.31	0.86–1.99

* Data are from selected statewide and metropolitan area cancer registries that met the following data quality criteria for publication in *United States Cancer Statistics: 2001 Incidence and Mortality*: case ascertainment is at least 90% complete; 97% or more of cases pass a standard set of computerized edits; 5% or fewer cases were ascertained by death certificate only; 3% or fewer cases are missing information on sex; 5% or fewer cases are missing information on race; 3% or fewer cases are missing information on age. The data represent approximately 80% of the United States population. Alaska, Hawaii, Illinois, and Minnesota were excluded due to missing county data.

† From negative binomial model predicting cervical cancer incidence. Adjusted for age, poverty, and diagnosis year.

Table 4. Adjusted Relationship* of Area of Residence on Cervical Cancer Incidence by Age Among Women Aged 20 Years and Older, 1998–2001†

Area of Residence Comparison Within Age Groups	Incidence Rate Ratio	95% CI
Younger than 35 y		
Rural compared with metropolitan	1.72	1.44–2.05
Rural compared with suburban	1.21	0.98–1.50
35–44 y		
Rural compared with metropolitan	1.31	1.11–1.55
Rural compared with suburban	1.04	0.86–1.27
45–54 y		
Rural compared with metropolitan	1.12	0.94–1.33
Rural compared with suburban	1.10	0.89–1.35
55–64 y		
Rural compared with metropolitan	1.06	0.88–1.28
Rural compared with suburban	0.98	0.78–1.23
65–74 y		
Rural compared with metropolitan	1.00	0.82–1.22
Rural compared with suburban	0.93	0.73–1.18
75–84 y		
Rural compared with metropolitan	0.96	0.78–1.19
Rural compared with suburban	1.18	0.90–1.55
85+ y		
Rural compared with metropolitan	0.73	0.55–0.99
Rural compared with suburban	0.73	0.50–1.05

* Data are from selected statewide and metropolitan area cancer registries that met the following data quality criteria for publication in *United States Cancer Statistics: 2001 Incidence and Mortality*: case ascertainment is at least 90% complete; 97% or more of cases pass a standard set of computerized edits; 5% or fewer cases were ascertained by death certificate only; 3% or fewer cases are missing information on sex; 5% or fewer cases are missing information on race; 3% or fewer cases are missing information on age. The data represent approximately 80% of the United States population. Alaska, Hawaii, Illinois, and Minnesota were excluded due to missing county data.

† From negative binomial model predicting cervical cancer incidence. Adjusted for race, poverty, and diagnosis year.

include socioeconomically distressed inner city areas and higher income and affluent areas. Although rural women were found to have higher incidence rates than metropolitan women, we cannot rule out the possibility that incidence rates are relatively high among some subgroups of metropolitan and suburban women. The use of urban–rural continuum codes is an accepted classification method, yet rural–nonrural residence, based on population sizes of geopolitical units, is defined inconsistently, and the geographic size of counties varies widely. Rural populations may exist within the boundaries of metropolitan areas, and urban areas can overlap geopolitical boundaries and extend into areas classified as rural or nonmetropolitan. Consequently, misclassifications may partly obscure any differences in cervical cancer incidence. A second limitation is that the results from this study may not be generalizable to selected rural populations, because not all rural populations are equivalent, and rural status does not always signify lower levels of health care access or use, similar to findings among women living in metropolitan areas.[23] Rural areas vary in population density and socioeconomic characteristics. Another possible concern is that both Alaska and Hawaii were excluded from the analysis, yet we discuss Pacific Islanders in our results. When making reference to Pacific Islanders in this study, this should be interpreted under the restriction of Alaska and Hawaii excluded.

However, a number of strengths should be highlighted in this study. This study covers approximately 80% of the U.S. population, unlike previous estimates that have used SEER data extrapolated to the general population. Poverty, a risk factor for cervical cancer and a confounder for residence, was controlled for in the analysis. By using a shorter age interval, the true incidence is exemplified by age and geography. Thus, the results of this study add to the literature on disparities in cervical cancer incidence by area of residence, including effect modification by age and race.

These results underscore the need for continued efforts to provide cervical cancer screening to women throughout the United States, including rural communities in specified age and race categories. The areas in which women live might be related to cervical cancer incidence through several mechanisms, including screening usage, access to health care, and other factors not measured in this study. This information could guide more focused interventions to

increase access to screening as well as vaccinations against human papillomavirus.

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