



Cancer-related Disparities among Residents of Appalachia Ohio

## Journal of Health Disparities Research and Practice

Volume 2 | Issue 2

Article 4

© Center for Health Disparities Research, School of Public Health, University of Nevada, Las Vegas

2008

### Cancer-related Disparities among Residents of Appalachia Ohio

James L. Fisher , *Comprehensive Cancer Center, Ohio State University*

Holly L. Engelhardt , *Ohio Department of Health*

Julie A. Stephens , *Center for Biostatistics, Ohio State University*

*See next page for additional authors*

Follow this and additional works at: <https://digitalscholarship.unlv.edu/jhdrp>



Part of the [Community-Based Research Commons](#), [Demography, Population, and Ecology Commons](#), [Oncology Commons](#), and the [Public Health Education and Promotion Commons](#)

#### Recommended Citation

Fisher, James L.; Engelhardt, Holly L.; Stephens, Julie A.; Smith, Bette R.; Haydu, Georgette G.; Indian, Robert W.; and Paskett, Electra D. (2008) "Cancer-related Disparities among Residents of Appalachia Ohio," *Journal of Health Disparities Research and Practice*: Vol. 2: Iss. 2, Article 4.

Available at: <https://digitalscholarship.unlv.edu/jhdrp/vol2/iss2/4>

This Article is protected by copyright and/or related rights. It has been brought to you by Digital Scholarship@UNLV with permission from the rights-holder(s). You are free to use this Article in any way that is permitted by the copyright and related rights legislation that applies to your use. For other uses you need to obtain permission from the rights-holder(s) directly, unless additional rights are indicated by a Creative Commons license in the record and/or on the work itself.

This Article has been accepted for inclusion in *Journal of Health Disparities Research and Practice* by an authorized administrator of Digital Scholarship@UNLV. For more information, please contact [digitalscholarship@unlv.edu](mailto:digitalscholarship@unlv.edu).

---

## Cancer-related Disparities among Residents of Appalachia Ohio

### Abstract

The authors sought to identify cancer-related disparities in Appalachia Ohio and better understand reasons for the disparities. Data from the Ohio Cancer Incidence Surveillance System, among other sources, were used to examine potential cancer disparities among residents of Appalachia Ohio. Using Ohio census data, the authors examined contributions of household income, educational attainment and population density to disparities in cancer incidence. Results suggest the following disparities in Appalachia Ohio (compared to non-Appalachia Ohio): greater cancer incidence and mortality rates for cancers of the cervix, colon and rectum, lung and bronchus and melanoma of the skin; a later stage at diagnosis of melanoma of the skin; lower prevalence of cancer screening behaviors of mammography, Pap smears, and sigmoidoscopy/colonoscopy; and less favorable cancer-related behaviors of obesity, physical activity, diet and especially tobacco smoking. Disparities in Appalachia Ohio may be associated with differences in household income, educational attainment and population density.

### Keywords

Appalachia Region; Cancer – Diagnosis; Cancer – Statistics; Cancer Screening; Health surveys; Ohio; Social status – Health aspects; Socioeconomic Differences

### Authors

James L. Fisher, Holly L. Engelhardt, Julie A. Stephens, Bette R. Smith, Georgette G. Haydu, Robert W. Indian, and Electra D. Paskett



## **Cancer-related Disparities among Residents of Appalachia Ohio**

James L. Fisher, Comprehensive Cancer Center, Ohio State University

Holly L. Engelhardt, Ohio Department of Health

Julie A. Stephens, Center for Biostatistics, Ohio State University

Bette R. Smith, Ohio Department of Health

Georgette G. Haydu, Ohio Department of Health

Robert W. Indian, Ohio Department of Health

Electra D. Paskett, College of Public Health, Ohio State University

### **Abstract**

The authors sought to identify cancer-related disparities in Appalachia Ohio and better understand reasons for the disparities. Data from the Ohio Cancer Incidence Surveillance System, among other sources, were used to examine potential cancer disparities among residents of Appalachia Ohio. Using Ohio census data, the authors examined contributions of household income, educational attainment and population density to disparities in cancer incidence. Results suggest the following disparities in Appalachia Ohio (compared to non-Appalachia Ohio): greater cancer incidence and mortality rates for cancers of the cervix, colon and rectum, lung and bronchus and melanoma of the skin; a later stage at diagnosis of melanoma of the skin; lower prevalence of cancer screening behaviors of mammography, Pap smears, and sigmoidoscopy/colonoscopy; and less favorable cancer-related behaviors of obesity, physical activity, diet and especially tobacco smoking. Disparities in Appalachia Ohio may be associated with differences in household income, educational attainment and population density.

**Key Words:** Appalachia, Cancer, Socioeconomic Differences, Cancer Screening,

## Introduction

The Appalachian region of the U.S. contains 410 counties in 13 states from New York to Mississippi, and approximately 22.9 million people reside in Appalachia. Characteristics of Appalachia include lower income, higher prevalence of unemployment, less urbanization, lower level of educational attainment and numerous health disparities<sup>1-4</sup>. In Ohio, approximately 13 percent of the population (or 1.5 million people) reside in the 29 Appalachian counties along the eastern and southern border.

With the exception of cancer mortality rates, there have only been a few reports/investigations concerning cancer disparities in Appalachia and the potential reasons for these disparities<sup>1-12</sup>. Ohio is an ideal state to study such differences because a sizable portion of the population resides in the Appalachian region, and the populations of both Appalachia and non-Appalachia Ohio are large enough to identify differences. Potential cancer disparities between residents of Appalachia Ohio and non-Appalachia Ohio were examined. Specifically, the authors compared cancer incidence and mortality and stage at diagnosis of cancer for the leading (female breast, colon and rectum, lung and bronchus and prostate) and selected screenable (cervix, melanoma of the skin and oral cavity and pharynx) anatomic sites/types of cancer. Potential differences in cancer-related screening and health behaviors, type of reporting source and primary type of insurance were also examined. In addition, because socioeconomic status (SES) is associated with cancer incidence<sup>13-20</sup> and because residents of Appalachia have, on average, lower household income and lower educational attainment, the authors sought to determine whether income and education contribute to potential differences in cancer incidence rates between Appalachia and non-Appalachia Ohio. Moreover, results from several studies suggest that population density is associated with cancer incidence<sup>21-23</sup> and imposes barriers in accessing health care, such as cancer screening and treatment<sup>1,9,10,24</sup>. Therefore, because Appalachia is characterized by lower population density, the authors evaluated the potential contribution of this factor to cancer incidence. The goal of this effort was to identify cancer-related disparities in Appalachia Ohio and to better understand reasons for the disparities.

## Methods

### Sources of Data

Data from the Ohio Cancer Incidence Surveillance System (OCISS), the central cancer registry for the State of Ohio, were used to examine cancer incidence in Appalachia and non-Appalachia Ohio. Primary

cancers diagnosed among Ohio residents were coded to the International Classification of Diseases (ICD) - Oncology - 3<sup>25</sup>, and were grouped by anatomic sites/types using Surveillance, Epidemiology, and End Results (SEER) Program site recode classifications. OCISS was also the source of data for examination of potential differences in SEER summary stage at diagnosis, type of reporting source, and primary type of insurance. To examine cancer mortality, data from the Vital Statistics Program at the Ohio Department of Health were used. Ohio residents with an underlying cause of death of cancer were included in the mortality file and cancers were coded to the ICD-9<sup>26</sup> for deaths occurring from 1996 to 1998, and to the ICD-10<sup>27</sup> for deaths occurring from 1999 to 2003. Data from the Ohio Behavioral Risk Factor Surveillance System (OBRFSS) were used to characterize differences in cancer screening and cancer-related health behaviors. The most recent years of the OBRFSS corresponding to the years examined for cancer incidence and mortality (1999 through 2003) were used. Household income, educational attainment and population density were estimated using census tract-level Ohio data from the 2000 U.S. Census of Population<sup>28</sup>.

## Statistics

Average annual (1996 to 2003) age-adjusted rates (using the 2000 U.S. standard population) and percent differences were used to examine potential disparities in incidence and mortality between Appalachia and non-Appalachia Ohio. Potential differences in stage at diagnosis were characterized by examining the proportions diagnosed at both later stages (regional and distant stages combined) and unstaged/unknown stages. Incidence rates and proportions of later stage at diagnosis were calculated using SEER\*Stat software<sup>29</sup> and SAS. Proportions and percent differences were also used to examine potential disparities in cancer screening and cancer-related health behaviors, type of reporting source and primary type of insurance.

To examine the potential contribution of household income, educational attainment and population density to cancer disparities, cancer incidence rates in Appalachia Ohio were compared to rates in areas of low income, education and population density in non-Appalachia Ohio. To determine "low" areas for each variable, census tracts were ranked by household income, proportion of persons with at least a high school education and population density. These rankings were then divided into quartiles, and cases were placed in a quartile based on residence within a census tract. Quartile cutpoints were generated for educational attainment using all of Ohio; whereas, cutpoints for household income and population density were generated based on Appalachia Ohio due to large differences in these measures in Appalachia compared to non-Appalachia. Non-Appalachia Ohio

census tracts in the lowest quartiles of household income (Q1-HI), educational attainment (Q1-EA), and population density (Q1-PD) were grouped, cancer incidence rates were calculated and these rates were then compared to the rates of Appalachia Ohio and non-Appalachia Ohio as a whole. If an incidence rate in Q1-HI, Q1-EA or Q1-PD of non-Appalachia Ohio was greater than those of Appalachia Ohio and non-Appalachia Ohio as a whole, then this factor contributed, at least in part, to the cancer incidence disparity between Appalachia and non-Appalachia Ohio; if an incidence rate in Q1-HI, Q1-EA or Q1-PD of non-Appalachia Ohio was between those of Appalachia and non-Appalachia Ohio, then this factor may have contributed to the cancer incidence disparity; and if an incidence rate in Q1-HI, Q1-EA or Q1-PD of non-Appalachia Ohio was lower than those of Appalachia and non-Appalachia Ohio, then this factor was not likely to have contributed to the cancer incidence disparity.

## Results

Based on a method of ascertaining completeness of reporting using expected cancer incidence rates and observed cancer mortality, the completeness of reporting incident cancer cases from 1996 to 2003 in Appalachia Ohio (91 percent) was found to be similar to that of non-Appalachia Ohio (92 percent). Average annual age-adjusted incidence and mortality rates for selected anatomic sites/types of cancer are shown in Table 1 according to region of residence in Ohio. Both incidence and mortality were greater in Appalachia Ohio for cancers of the cervix, colon and rectum, lung and bronchus and melanoma of the skin, while both incidence and mortality rates of cancers of the female breast and prostate were lower in Appalachia Ohio. The greatest disparity was observed for cervical cancer, for which the incidence rate was 38.6 percent greater and the mortality rate was 44.4 percent greater in Appalachia Ohio compared to non-Appalachia Ohio. The incidence rate of oral cavity and pharynx cancer in Appalachia Ohio was similar to that of non-Appalachia Ohio; however, the mortality rate was lower in the Appalachian region. Although the incidence rate of melanoma of the skin was only slightly greater (3.5 percent) in Appalachia Ohio, the mortality rate was 23.1 percent greater in Appalachia Ohio.

Examination of stage at diagnosis of the selected anatomic sites/types in Appalachia and non-Appalachia Ohio revealed no striking differences. These examinations were interpreted in light of the proportions of unstaged/unknown stage at diagnosis, which did vary slightly according to region of residence. There were greater proportions of unstaged/unknown stage at diagnosis in Appalachia Ohio for cancers of the female breast and colon and rectum; while, for melanoma of the skin, there was a slightly greater

proportion of unstaged/unknown stage at diagnosis in non-Appalachia Ohio. Of the anatomic sites/types of cancers examined, only melanoma of the skin had a greater proportion (more than 20 percent) of later stages in Appalachia Ohio. For the remaining anatomic sites/types, there were either similar proportions of later stage cancers in Appalachia and non-Appalachia Ohio (female breast, colon and rectum, lung and bronchus, and oral cavity and pharynx), or a slightly lower proportion of later stage cancers in Appalachia (cervix and prostate).

**Table 1. Average Annual Age-adjusted Cancer Incidence and Mortality Rates for Selected Anatomic Sites/Types in Appalachia and Non-Appalachia Ohio, 1996-2003<sup>1</sup>**

Anatomic Site/Type	Incidence <sup>2</sup>			Mortality <sup>3</sup>		
	Rate <sup>1</sup>		% Diff.	Rate <sup>1</sup>		% Diff.
	Appalachia Ohio	Non-Appalachia Ohio		Appalachia Ohio	Non-Appalachia Ohio	
Breast (Female)	120.8	128.5	-6.0	28.7	29.5	-2.7
Cervix	11.5	8.3	38.6	3.9	2.7	44.4
Colon and Rectum	62.3	55.2	12.9	25.7	22.6	13.7
Lung and Bronchus	82.3	74.3	10.8	66.7	61.5	8.5
Melanoma of the Skin	14.8	14.3	3.5	3.2	2.6	23.1
Oral Cavity & Pharynx	9.5	9.4	1.1	2.5	2.7	-7.4
Prostate	135.5	149.8	-9.5	28.3	32.5	-12.9

1. Average annual rates are per 100,000 and age-adjusted to the U.S. 2000 standard population. 2. Ohio Cancer Incidence Surveillance System (OCISS), 1996-2003 (April 2006). 3. Vital Statistics Program, Ohio Department of Health, 1996-2003 (March 2006).

Table 2 shows cancer-related screening and health behaviors in Appalachia and non-Appalachia Ohio for the years 1999 to 2003. A lower proportion of Appalachia Ohio adult residents reported the following cancer screening behaviors: history of having ever had a mammogram (82.8 percent in Appalachia, 89.8 percent in non-Appalachia), having had a mammogram within the past two years (69.3 percent in Appalachia, 77.6 percent in non-Appalachia), having had a Pap smear within the past three years (79.0 percent in Appalachia, 86.9 percent in non-Appalachia), and having had a sigmoidoscopy or colonoscopy within the past five years (31.9

percent in Appalachia, 38.6 percent in non-Appalachia). However, more men in Appalachia reported having had prostate-specific antigen (PSA) measured within the past year (58.6 percent in Appalachia, 56.3 percent in non-Appalachia) and having had a digital rectal examination (DRE) within the past year (54.6 percent in Appalachia, 51.3 percent in non-Appalachia).

As expected from previous reports, disparities in cancer-related health behaviors were found. Table 2 shows that a greater proportion of Appalachia Ohio residents reported current tobacco smoking (31.5 percent in Appalachia, 26.1 percent in non-Appalachia), obesity (23.4 percent in Appalachia, 22.3 percent in non-Appalachia), no leisure time physical activity (29.4 percent in Appalachia, 28.6 percent in non-Appalachia), and consuming fewer than five fruits and vegetables per day (78.9 percent in Appalachia, 77.1 percent in non-Appalachia). The proportion of Ohio residents who reported current tobacco smoking was more than 20 percent greater in the Appalachian region.

**Table 2. Cancer Screening and Health Behaviors among Adult Residents of Appalachia and Non-Appalachia Ohio, 1999-2003<sup>1</sup>**

	Appalachia Ohio	Non-Appalachia Ohio	% Difference
<b>Cancer Screening Behaviors</b>	%	%	
Ever Had a Mammogram (Ages 40+)	82.8	89.8	-7.8
Mammogram Past 2 Years (Ages 40+)	69.3	77.6	-10.7
Pap Smear Past 3 Years <sup>2</sup>	79.0	86.9	-9.1
Prostate-specific Antigen Past Year (Ages 50+)	58.6	56.3	4.1
Digital Rectal Exam Past Year (Ages 50+)	54.6	51.3	6.4
Sigmoidoscopy/Colonoscopy Past 5 Years (Ages 50+)	31.9	38.6	-17.4
<b>Cancer Health Behaviors</b>			
Current Smoker	31.5	26.1	20.7
Obese (Body mass index 30+)	23.4	22.3	4.9
No Leisure Time Physical Activity	29.4	28.6	2.8
< 5 Servings of Fruits and Vegetables	78.9	77.1	2.3

1. Ohio Behavioral Risk Factor Surveillance System, 1993-2003.

2. Among women ages 18 years and older with an intact cervix.



There was very little difference in type of reporting source between Appalachia and non-Appalachia Ohio. The majority of invasive cases in both regions were reported by a hospital or clinic (91.1 percent in both regions). The proportion reported by death certificate only or autopsy was similar (2.8 percent in Appalachia, 2.6 percent in non-Appalachia), and the proportion reported by a physician's office, private practitioner, nursing home, convalescent facility or hospice was identical (5.4 percent in both regions). A slightly lower proportion of cases residing in Appalachia were reported by a laboratory only (0.6 percent in Appalachia, 0.9 percent in non-Appalachia).

The proportion of invasive cancer cases that were uninsured at diagnosis was greater among those residing in Appalachia (4.9 percent in Appalachia, 4.0 percent in non-Appalachia). A lower proportion of cases residing in Appalachia had a primary type of insurance of managed care, HMO or PPO (7.8 percent in Appalachia, 14.6 percent in non-Appalachia), and Medicare (36.8 percent in Appalachia, 39.7 percent in non-Appalachia). A greater proportion of cases residing in Appalachia had Medicaid (3.4 percent in Appalachia, 2.4 percent in non-Appalachia), an 'other' or 'not otherwise specified' primary type of insurance (15.1 percent in Appalachia, 14.8 percent in non-Appalachia), or an unknown or unreported primary type of insurance (31.0 percent in Appalachia, 24.5 percent in non-Appalachia).

Table 3 shows average annual age-adjusted cancer incidence rates in Appalachia Ohio, non-Appalachia Ohio as a whole, as well as Q1-HI, Q1-EA and Q1-PD of non-Appalachia Ohio. The purpose of this table is to determine whether features associated with Appalachia (lower income, lower level of education and lower population density) contributed to disparities in cancer incidence rates among residents of Appalachia; therefore, only anatomic sites/types of cancer for which a disparity in cancer incidence was found are shown in Table 3. For cancer of the cervix, the incidence rates in Q1-HI and Q1-EA in non-Appalachia Ohio were greater than the rate in Appalachia Ohio. This suggests that lower household income and lower educational attainment, or factors associated with income and education, contributed to the difference in cervical cancer incidence rates between Appalachia and non-Appalachia Ohio. The cervical cancer incidence rate for Q1-PD in non-Appalachia Ohio was greater than that of non-Appalachia Ohio, but lower than that of Appalachia Ohio, suggesting that lower population density may have contributed to the difference in cervical cancer incidence between Appalachia and non-Appalachia Ohio. For cancer of the colon and rectum, because each of the incidence rates in Q1-HI, Q1-EA and Q1-PD in non-Appalachia Ohio were between those of Appalachia and non-Appalachia Ohio, each of these factors may have contributed to the difference in incidence between the regions.

**Table 3. Average Annual Age-adjusted Cancer Incidence Rates<sup>1,2</sup> for Selected Anatomic Sites/Types in Appalachia Ohio, Non-Appalachia Ohio and Non-Appalachia Census Tracts in the Lowest Quartiles<sup>3</sup> of Household Income, Educational Attainment and Population Density, 1996-2003**

Anatomic Site/ Type	Appalachia Ohio	Non- Appalachia Ohio	Q1-HI <sup>4</sup>	Q1- EA <sup>5</sup>	Q1-PD <sup>6</sup>
Cervix	11.5	8.3	13.7	13.4	11.0
Colon and Rectum	62.3	55.2	61.0	60.7	57.3
Lung and Bronchus	82.3	74.3	104.6	104.8	60.9
Melanoma of the Skin	14.8	14.3	7.2	7.7	16.6

1. Average annual rates are per 100,000 and age-adjusted to the U.S. 2000 standard population. 2. Ohio Cancer Incidence Surveillance System (OCISS), 1996-2003 (April 2006). 3. The selection of cutpoints for quartiles of educational attainment was based on census information for the entire State of Ohio; however, because the distributions of household income and population density in Appalachia Ohio differed greatly from those of non-Appalachia Ohio, cutpoints were generated using only the region of Appalachia Ohio. 4. Non-Appalachia Ohio Census Tracts in Lowest Quartile of Household Income ( $\leq \$28,641$ ). 5. Non-Appalachia Ohio Census Tracts in Lowest Quartile of Educational Attainment of High School or Higher ( $\leq 75.2\%$ ). 6. Non-Appalachia Ohio Census Tracts in Lowest Quartile of Population Density ( $\leq 65.1$  persons per square mile)

For cancer of the lung and bronchus, the incidence rates in Q1-HI and Q1-EA in non-Appalachia Ohio were similar to one another and were much greater than the rate in Appalachia Ohio, while the incidence rate in Q1-PD of non-Appalachia Ohio was considerably lower than the rates in Appalachia and non-Appalachia Ohio. Therefore, lower household income and lower educational attainment, or factors associated with income and education, contributed to the difference in lung and bronchus cancer incidence rates between Appalachia and non-Appalachia Ohio, and population density was not likely to have contributed to the disparity in Appalachia Ohio. Conversely, for melanoma of the skin, population density contributed to the difference in incidence between Appalachia and non-Appalachia Ohio, but household income and educational attainment were not likely to have contributed to the disparity in incidence. In general, results shown in Table 3 suggest the following: lower household income and lower educational attainment contributed to the disparities in cancer incidence for cervical and lung and bronchus cancer and may have contributed to the disparity in colon and

rectum cancer; whereas, lower population density contributed to the disparity in incidence of melanoma of the skin and may have contributed to the disparities in cervical and colon and rectum cancer. It should be noted that associations between cancer incidence rates and lower household income, lower educational attainment and lower population density may have reflected the contributions of SES and population density to cancer-related health care and behaviors, such as tobacco smoking and obesity.

## Discussion

These results suggest disparities in Appalachia Ohio for the following: incidence and mortality for cancers of the cervix, colon and rectum, lung and bronchus and melanoma of the skin; later stage at diagnosis for melanoma of the skin; cancer screening behaviors of mammography, Pap smears, and sigmoidoscopy/colonoscopy; and cancer-related behaviors of obesity, physical activity, diet and especially tobacco smoking. Residents of Appalachia Ohio were also less likely to have a primary type of insurance of managed care, HMO, PPO or Medicare, perhaps reflecting lower SES among residents of Appalachia Ohio. Although not definitive evidence, results suggest that cancer incidence differences between Appalachia and non-Appalachia regions of Ohio may result, at least in part, from lower household income, educational attainment and population density, or from factors associated with SES and population density.

The most striking differences in incidence and mortality rates between Appalachia and non-Appalachia Ohio were observed for cervical cancer. Because the strongest known risk factor for cervical cancer is infection with the Human Papillomavirus (HPV), this disparity may have resulted from differences in sexual behavior. Evidence from the Youth Risk Behavior Surveillance System suggests that the proportions of girls reporting having had sexual intercourse, early sexual intercourse and intercourse with four or more people were, generally, greater in states containing Appalachian regions, and these proportions were, generally, greater in states with larger populations residing in Appalachian Counties<sup>30,31</sup>. Disparities observed for lung and bronchus cancer are likely explained by differences between the two regions in the prevalence of tobacco smoking<sup>8,31,32</sup>, and disparities for colon and rectum cancer may have resulted from differences in cancer health behaviors related to diet and obesity and to differences in colon and rectum screening behaviors<sup>32</sup>. The authors speculate that the greater mortality rate of melanoma of the skin in Appalachia Ohio may have resulted from the greater proportion of residents with a later stage at diagnosis, perhaps reflecting a lower prevalence of skin cancer screening in the Appalachian region.

Previous reports of higher cancer incidence rates in Appalachia for cancers of the cervix<sup>9,12</sup>, colon and rectum<sup>9</sup> and lung and bronchus<sup>8,9</sup> were supported by these results. In addition, Ohio data support previous findings of higher mortality rates in Appalachia for cancers of the cervix<sup>3,6,12,24</sup>, colon and rectum<sup>3,5</sup> and lung and bronchus<sup>2,3,8</sup>. During the years 1994 to 1998, the disparities in Appalachia were more apparent in rural areas for cervical and lung and bronchus cancers<sup>9</sup>.

Although there were only slight differences in proportions of later stage at diagnosis and unknown/unstaged cancers, results were not stratified by urban/rural status or population density. Lengerich and colleagues<sup>9</sup> reported that rates of unstaged cancer in Appalachia were elevated in rural Appalachia, suggesting lack of access to cancer health care among residents of rural Appalachian areas. Disparities reported here concerning cancer screening and health-related behaviors among residents of Appalachia Ohio were similar to those reported for the U.S. Appalachian region<sup>33</sup>. Although there was little difference in stage at diagnosis, results did support the notion that residents of Appalachia Ohio had fewer screenings for female breast, cervical and colon and rectum cancers. The majority of research attention concerning cancer in Appalachia has focused on disparities in cancer screening behaviors.

According to Katz and colleagues<sup>34</sup>, who interviewed knowledgeable residents of Appalachia Ohio about barriers to cervical cancer screening, the lower prevalence of screening among residents of Appalachia may result from cost, lack of insurance, transportation problems, fear, embarrassment, and privacy issues. Aspects of Appalachian culture, SES and the notion that 'cancer is always fatal' may also contribute to poor screening<sup>10</sup>. Breast and cervical cancer screenings among Appalachian women were less common among women who were older, had lower educational attainment, did not visit a doctor in the past year<sup>3</sup>, were obese and smoked tobacco<sup>35</sup>. Further, results from a focus group intended to reveal physician-related barriers to cancer screening in Appalachia suggest that primary care physicians (PCP) in Appalachia may not be conducting recommended cancer screenings due to time constraints, conflicting guidelines, and perceptions that patients do not value prevention<sup>10</sup>. Barriers to cancer screening and especially cervical cancer screening may be greater among patients and PCP in rural areas of Appalachia<sup>10,24</sup>. Lower levels of income and educational attainment, lack of transportation and more sparsely distributed PCP and screening facilities may also contribute to the lower prevalence of cancer screening behaviors in Appalachia Ohio.

Findings pertaining to household income and educational attainment suggest that SES may at least partially explain the differences between Appalachia Ohio and non-Appalachia Ohio in the incidence of cancers of

the cervix, colon and rectum and lung and bronchus. Singh and colleagues<sup>16</sup> demonstrated the importance of SES by showing that patterns of U.S. male cancer mortality changed according to SES between 1950 and 1998. “Throughout the 1950s and 1960s, there was a positive socioeconomic gradient, with higher cancer mortality rates in high area socioeconomic groups than in low area socioeconomic groups. The positive gradient narrowed in the 1970s, and by the late 1980s, socioeconomic differences in cancer mortality began to reverse and widen<sup>16</sup>.” Cervical cancer incidence may be strongly related to census-level indicators of SES, as cervical cancer incidence in the U.S. has been greater in impoverished areas and in areas of lower educational attainment<sup>15</sup>. Women residing in areas of lower household income and lower educational attainment had much higher cervical cancer incidence rates. It is likely that the higher incidence and mortality rates of cancers of the cervix, colon and rectum and lung and bronchus witnessed in Appalachia Ohio could be accounted for by the fact that Appalachia Ohio contains a greater proportion of people with lower household incomes and lower educational attainments. Importantly, deleterious health behaviors such as tobacco smoking and inadequate consumption of fruits and vegetables have been associated with lower income and lower educational attainment; these associations likely explain the variation in cancer incidence and mortality rates according to SES. Hopenhayn and colleagues<sup>20</sup> examined cervical cancer incidence rates in three states containing Appalachian regions and found that, after control for confounding by other demographic factors, the effect of residence in the Appalachian region only weakly explained incidence rates, while residing in a rural region and having a lower educational attainment were strong, independent and statistically significant predictors.

These efforts to describe cancer-related disparities in Appalachia Ohio were restricted by at least three limitations. First, reliance on census information as a proxy for individual-level data concerning SES and population density reduced the ability to describe rates among groups not inherently defined by geography. Further, this is especially problematic for census tracts with wide ranges of income and educational attainment; for example, high-income individuals residing in census tracts with low median incomes would be incorrectly classified in these analyses. Second, the authors did not determine whether household income, educational attainment and population density function independently in explaining disparities in cancer incidence. It is possible that, after controlling for confounding by other variables, only one or two of these factors remain salient in explaining the disparity in cancer incidence, especially given that household income and educational attainment are strongly associated with one another. Third, because the OCISS is not a follow-up registry, potential disparities in survival

probability could not be described. In the U.S., survival probabilities are usually obtained using data from the SEER program; however, none of the original nine SEER registries contained a geographic region in Appalachia. The Kentucky State cancer registry was added to the SEER program in 2001 for expanded coverage, and this addition will be important in the future for examining potential survival disparities among Appalachian residents.

In summary, cancer-related disparities in the Appalachian region of the U.S. are poorly understood and should be evaluated thoroughly through national efforts, such as that of the Appalachia Community Cancer Network<sup>4</sup>, a “network of academic and community organizations that seek to conduct surveillance, intervention, and dissemination research to reduce this excess cancer burden in Appalachia”.

## References

1. Friedell, G.H., et al. Community cancer control in a rural, underserved population: the Appalachian Leadership Initiative on Cancer Project. *Journal of Health Care for the Poor and Underserved* 12, 5-19 (2001).
2. Friedrich, M.J. Lung cancer death rates in Appalachia, 1994-1998 Program aims to reduce cancer burden in Appalachia. *Journal of the National Cancer Institute* 94, 1190 (2002).
3. Hall, H.I., Uhler, R.J., Coughlin, S.S. & Miller, D.S. Cancer death rates--Appalachia, 1994-1998 Breast and cervical cancer screening among Appalachian women. *MMWR. Morbidity and Mortality Weekly Report* 51, 527-529 (2002).
4. Lengerich, E.J., et al. The Appalachia Cancer Network: cancer control research among a rural, medically underserved population. *The Journal of Rural Health : Official Journal of the American Rural Health Association and the National Rural Health Care Association* 20, 181-187 (2004).
5. Armstrong, L.R., et al. Colorectal carcinoma mortality among Appalachian men and women, 1969-1999. *Cancer* 101, 2851-2858 (2004).
6. Hall, H.I., Rogers, J.D., Weir, H.K., Miller, D.S. & Uhler, R.J. Breast and cervical carcinoma mortality among women in the Appalachian region of the U.S., 1976-1996. *Cancer* 89, 1593-1602 (2000).
7. Hampton, J.W. & Friedell, G.H. Cancer surveillance. A problem for Native Americans and Appalachian populations. *Cancer* 91, 242-246 (2001).
8. Hopenhayn, C., Jenkins, T.M. & Petrik, J. The burden of lung cancer in Kentucky. *The Journal of the Kentucky Medical Association* 101, 15-20 (2003).
9. Lengerich, E.J., et al. Cancer incidence in Kentucky, Pennsylvania, and West Virginia: disparities in Appalachia. *The Journal of Rural Health : Official Journal of the American Rural Health Association and the National Rural Health Care Association* 21, 39-47 (2005).
10. Shell, R. & Tudiver, F. Barriers to cancer screening by rural Appalachian primary care providers. *The Journal of Rural Health : Official Journal of the American Rural Health Assn. and the National Rural Health Care Association* 20, 368-373 (2004).

11. Spitler, H.D., Mayo, R.M. & Parker, V.G. Patterns of breast, cervical, colorectal, and prostate cancer in the Appalachian region of South Carolina. *Ethnicity & Disease* 11, 51-59 (2001).
12. Wyatt, S.W., Huang, B., Tucker, T.C., Redmond, J. & Hopenhayn, C. Geographic trends in cervical cancer incidence and mortality in Kentucky, 1995-2000. *The Journal of the Kentucky Medical Association* 102, 11-14 (2004).
13. Krieger, N., et al. Race/ethnicity and changing US socioeconomic gradients in breast cancer incidence: California and Massachusetts, 1978-2002 (United States). *Cancer Causes & Control : CCC* 17, 217-226 (2006).
14. Shipp, M.P.L., et al. Population-based study of the geographic variation in colon cancer incidence in Alabama: relationship to socioeconomic status indicators and physician density. *Southern Medical Journal* 98, 1076-1082 (2005).
15. Singh, G.K., Miller, B.A., Hankey, B.F. & Edwards, B.K. Persistent area socioeconomic disparities in U.S. incidence of cervical cancer, mortality, stage, and survival, 1975-2000. *Cancer* 101, 1051-1057 (2004).
16. Singh, G.K., Miller, B.A., Hankey, B.F., Feuer, E.J. & Pickle, L.W. Changing area socioeconomic patterns in U.S. cancer mortality, 1950-1998: Part I--All cancers among men. *Journal of the National Cancer Institute* 94, 904-915 (2002).
17. Yost, K., Perkins, C., Cohen, R., Morris, C. & Wright, W. Socioeconomic status and breast cancer incidence in California for different race/ethnic groups. *Cancer Causes & Control : CCC* 12, 703-711 (2001).
18. Marcella, S. & Miller, J.E. Racial differences in colorectal cancer mortality. The importance of stage and socioeconomic status. *Journal of Clinical Epidemiology* 54, 359-366 (2001).
19. Goel, V. Socioeconomic status and cancer incidence and survival. *Cancer Prevention & Control : CPC = Prevention & Controle En Cancerologie : PCC* 2, 211-212 (1998).
20. Hopenhayn, C., Bush, H., Christian, A. & Shelton, B.J. Comparative analysis of invasive cervical cancer incidence rates in three Appalachian states. *Preventive Medicine* 41, 859-864 (2005).
21. Coughlin, S.S., et al. Rural/nonrural differences in colorectal cancer incidence in the United States, 1998-2001. *Cancer* 107, 1181-1188 (2006).
22. Kinney, A.Y., Harrell, J., Slattery, M., Martin, C. & Sandler, R.S. Rural-urban differences in colon cancer risk in blacks and whites: the North Carolina Colon Cancer Study. *The Journal of Rural Health : Official Journal of the American Rural Health Association and the National Rural Health Care Association* 22, 124-130 (2006).
23. Shi, L., et al. Primary care, social inequalities and all-cause, heart disease and cancer mortality in US counties: a comparison between urban and non-urban areas. *Public Health* 119, 699-710 (2005).
24. Yabroff, K.R., et al. Geographic disparities in cervical cancer mortality: what are the roles of risk factor prevalence, screening, and use of recommended treatment? *The Journal of Rural Health : Official Journal of the American Rural Health Association and the National Rural Health Care Association* 21, 149-157 (2005).

25. International Classification of Diseases for Oncology, Third Edition. World Health Organization. (2000).
26. International Classification of Diseases, Ninth Revision. World Health Organization. (1975).
27. International Classification of Diseases and Related Health Problems, Tenth Revision. World Health Organization. (1992).
28. U.S. Census of Population Summary File 3. (2000).
29. NCI. Surveillance Research Program National Cancer Institute SEER\*Stat software version 6.2.3 (2006).
30. Fisher, J.L., et al. Cervical Cancer in Appalachia. in progress (2007).
31. Grunbaum, J.A., et al. Youth risk behavior surveillance--United States, 2003. MMWR. Surveillance Summaries : Morbidity and Mortality Weekly Report. Surveillance Summaries / CDC 53, 1-96 (2004).
32. Wewers, M.E., Katz, M., Fickle, D. & Paskett, E.D. Risky behaviors among Ohio Appalachian adults. Preventing Chronic Disease 3, A127 (2006).
33. Halverson, J. An Analysis of Disparities in Health Status and Access to Health Care in the Appalachian Region. Appalachian Regional Commission: <http://www.arc.gov/index.do?nodeId=2467> (2004).
34. Katz, M.L., Wewers, M.E., Single, N. & Paskett, E.D. Key informants' perspectives prior to beginning a cervical cancer study in Ohio Appalachia. Qualitative Health Research 17, 131-141 (2007).
35. Amonkar, M.M. & Madhavan, S. Compliance rates and predictors of cancer screening recommendations among Appalachian women. Journal of Health Care for the Poor and Underserved 13, 443-460 (2002).

**James L. Fisher, PhD**, James Cancer Hospital and Solove Research Institute, Columbus, Ohio; Comprehensive Cancer Center at The Ohio State University, Columbus, Ohio

**Holly L. Engelhardt**, The Ohio Department of Health, Columbus, Ohio

**Julie A. Stephens**, The Center for Biostatistics at The Ohio State University, Columbus, Ohio

**Bette R. Smith**, The Ohio Department of Health, Columbus, Ohio

**Georgette G. Haydu**, The Ohio Department of Health, Columbus, Ohio

**Robert W. Indian**, The Ohio Department of Health, Columbus, Ohio

**Electra D. Paskett**, Comprehensive Cancer Center at The Ohio State University, Columbus, Ohio; College of Public Health, The Ohio State University, Columbus, Ohio