

## THE RELATIONSHIP BETWEEN EDUCATIONAL ATTAINMENT AND LUNG CANCER MORTALITY IN KENTUCKY: IMPLICATIONS FOR NURSES

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### ABSTRACT

**Context:** The professional literature indicates health has a positive correlation with socioeconomic status. More specifically, prior research documents heightened rates of lung cancer incidence and mortality in Appalachia, a region plagued by persistent poverty and below-average educational attainment. This study analyzed predictors of lung cancer mortality within Kentucky, a predominantly rural state in central Appalachia.

**Purpose:** To determine whether county-level lung cancer mortality is related to counties' high school graduation rates, per capita personal income levels and adult smoking rates. Also, to test whether significant differences exist among these variables between Kentucky's Appalachian and non-Appalachian counties.

**Methods:** Data from the Kentucky Institute of Medicine's 2007 report *The Health of Kentucky: A County Assessment* were analyzed using independent samples *t* tests, bivariate correlations and regression analyses.

**Results:** On a statewide basis, inverse associations were found between county-level lung cancer mortality and counties' graduation rates ( $p < .001$ ) and per capita personal income ( $p < .01$ ). Statistically significant differences were detected between Kentucky's Appalachian and non-Appalachian regions for each variable except adult smoking rates.

**Conclusions:** In the context of similar adult smoking rates between the state's Appalachian and non-Appalachian counties, high school graduation rates showed the strongest statistical association with lung cancer mortality. This indicates that continued improvements in Kentucky's rate of diploma attainment may contribute to future reductions in lung cancer mortality statewide. These findings suggest practice and policy implications for nurses in Kentucky and, potentially, other states with low educational attainment and high lung cancer mortality.

### INTRODUCTION

Lung cancer was responsible for an estimated 159,390 deaths during 2009, making it the leading cause of cancer-related death in the United States (Lung Cancer Alliance, 2009). The disease is particularly problematic in Kentucky, where a rate of 80 lung cancer-related deaths per 100,000 population is much higher than the national rate of 55 deaths (Kentucky Institute of Medicine [KIOM], 2007). In fact, each of Kentucky's 120 counties has a lung cancer mortality rate that exceeds the national average.

An obvious research question, then, is what aspects of life in Kentucky increase the risk of dying from lung cancer? An additional consideration is the role the state's nurses can play in mitigating this health disparity.

The purpose of this study was to determine whether Kentucky's county-level lung cancer mortality is related to two socioeconomic predictors (high school graduation rates and per capita

personal income levels). Lung cancer mortality's association with a personal behavior, adult smoking rates, also was evaluated. Finally, the study was designed to detect the influence of Appalachian versus non-Appalachian residence (that is, whether significant differences exist among the variables between these two distinct regions of Kentucky).

Tobacco smoking is the primary risk factor for lung cancer and accounts for approximately 87% of lung cancer-related deaths (Mannino, Aguayo, Petty, & Redd, 2003; The Washington Post, 2008). Kentucky's heritage as a tobacco-growing state and continued high level of tobacco production have fostered, to a large degree, a cultural acceptance of smoking among its residents. Consequently, Kentucky had the nation's highest rate of adult smokers each year from 2000 to 2007, and again in 2009 (Behavioral Risk Factor Surveillance System [BRFSS], 2010).

The state's first local law to limit indoor smoking in public facilities was not enacted until 2004, and as recently as 2005 Kentucky's cigarette excise tax of 3 cents per pack was the lowest in the nation. Since that time, 26 other Kentucky communities have adopted smoke-free laws or regulations, and the cigarette excise tax has been raised to 60 cents per pack, which ranks 39<sup>th</sup> among the states (Kentucky Center for Smoke-Free Policy, 2010; National Conference of State Legislatures, 2009). These developments are credited with helping to reduce Kentucky's adult smoking rate from a high of 32.6% in 2002 to its current level of 25.6% (BRFSS, 2010).

Hahn (a University of Kentucky College of Nursing professor) and other researchers have analyzed smoke-free legislation's positive effect on smoking cessation behaviors in Lexington, Ky., and its association with reduced asthma-related emergency department visits (Hahn et al., 2008; Hahn, Rayens, Langley, Darville, & Dignan, 2009; Rayens et al., 2008). Yet, exposure to secondhand smoke remains a concern in most Kentucky localities.

This study analyzed lung cancer mortality in Kentucky's 54 Appalachian counties (primarily those in the eastern and southern portions of the state, with 94.4% classified rural) (Economic Research Service, 2003) compared to the rates in its 66 non-Appalachian counties (those located in the central, northern and western regions, which include the state's three urban centers). Like much of Appalachia, Kentucky's mountain counties have long been associated with cultural isolation, limited educational opportunities and heavy reliance on extractive industries such as coal mining.

Prior research documents heightened rates of lung cancer incidence and mortality in Appalachia, with increasing concentrations over time in Kentucky and other states in central Appalachia (Grauman, Tarone, Devesa, & Fraumeni, 2000; Lengerich et al., 2005; Lengerich et al., 2004). More recent studies suggest lung cancer may be amplified within coal-mining areas of Appalachia because of exposure to environmental contaminants (Hendryx & Ahern, 2008; Hendryx, O'Donnell, & Horn, 2008). Lung cancer also has been associated with occupational exposures (Engholm, Palmgren, & Lynge, 1996; The Washington Post, 2008).

Most of Kentucky's Appalachian counties (38 out of 54, or 70.4%) are labeled as economically "distressed" by the Appalachian Regional Commission (2008) based on their multi-year rates of low per capita income and elevated rates of poverty and unemployment. The area's pervasive poverty is evidenced by the fact that Kentucky accounts for nearly half of the 81 distressed counties within the entire 13-state Appalachian region.

## BACKGROUND

As a whole, Kentucky's high school graduation rate trails the US average by 8 percentage points, while its per capita personal income level is \$6,000 below the national rate (KIOM, 2007). A review of previous studies indicates that, regardless of age, socioeconomic status is an important determinant of individuals' overall health. Deaton, for instance, noted that "proportional increases in income are associated with equal proportional decreases in mortality throughout the income distribution" (2002, p. 13). Of particular relevance to this project is that smoking rates generally are higher among the poor and less educated.

Hemminki and Lee (2003) documented the association between an individual's level of education and his/her risk of developing lung cancer. In their study, 760,000 invasive cancer cases from the Swedish Family-Cancer Database were analyzed. Subjects were identified according to educational attainment and cancers were tracked from 1971 to 1998. While overall cancer risks showed only minimal differences based on education, some site-specific cancers varied significantly depending upon educational group. Lung cancer was much less common in those who were university educated (standardized incidence ratio of 0.47) than those with less than nine years of education (standardized incidence ratio of 1.00).

Previously, Gorey and Vena (1995) had reported on a cancer incidence study described as the first to examine lung and other site-specific cancers among the poor and what was a new socioeconomic status measure: the *near poor*, or persons living below 200% of the federal poverty level. By tracking New York State Cancer Registry data for nearly 42,000 cases from 1979 to 1986, the authors found that near poverty status in and of itself was a cancer risk factor. For instance, the lung cancer rate for women living in high-poverty areas (those with census tracts in which more than half of residents were below 200% of the federal poverty level) was approximately twice that observed among women living in areas with lower poverty rates.

Gorey and Vena did not explicitly discuss *why* living in impoverished areas increased residents' susceptibility to lung or other types of cancer, only referencing the "attendant health risks" (1995, p. 363) found within such locations. The authors likely were alluding to the premise that, in general, a high socioeconomic status allows one to make healthier choices, while low education forces geographic and work choices that place one at greater risk of environmental and occupational exposures. Indeed, it has been suggested that health may be influenced by multiple "place effects" (Macintyre, Ellaway, & Cummins, 2002, p. 125) (e.g., air and water quality, the availability of non-hazardous employment, access to education, socio-cultural features, and an area's reputation).

## HYPOTHESES

Based on this review of the literature, it was expected that negative relationships would be detected between county-level lung cancer mortality and the independent variables high school graduation rates and per capita personal income levels. Therefore, stated hypotheses were that the lower a county's high school graduation rate and/or per capita personal income level, the higher its lung cancer mortality rate would be.

## METHODS

The primary data source for this study was KIOM's 2007 report *The Health of Kentucky: A County Assessment*. This document analyzed Kentucky counties' health status based on 25 different health-related measures, which were used to produce a 1 (best) to 120 (worst) ranking of counties' relative health status. Because of variation in the number of county-level deaths each year, data were combined for multiple years (1997-2004) to produce more stable rates for some measures.

This study's dependent variable was county-level lung cancer deaths per 100,000 population, with original data derived from the Kentucky Cancer Registry Inquiry System. Independent variables were: counties' per capita personal income levels, or the mean income computed for every man, woman and child in a particular group, from the Bureau of Economic Analysis, U.S. Department of Commerce; high school graduation (percentage of adults 25 years or older in each county who had graduated from high school), from the U.S. Census Bureau and Kentucky State Data Center; and prevalence of smoking (percentage of adult population within each county), from the Kentucky Behavioral Risk Factor Surveillance Survey.

Appalachian counties in Kentucky were designated by the Appalachian Regional Commission, a federal-state partnership charged with facilitating community and economic development. This designation is based on geography, certain economic criteria and political considerations. The use of county-level variables is especially appropriate in Kentucky, which ranks third among the states for number of counties (National Association of Counties, 2009). County borders influence personal attributes and behaviors in a number of ways related to this study, including school systems' dropout rates, employment opportunities and whether indoor smoking bans are in effect. As such, data were not weighted by population in order to more fully reflect the collective, shared experiences of residents within each county.

Independent samples *t* tests were conducted to compare the variables' means within Kentucky's Appalachian and non-Appalachian counties. Correlation coefficients were calculated to determine whether statistical relationships exist between county-level lung cancer mortality and counties' high school graduation rates, per capita personal income levels and adult smoking rates. Finally, regression analyses were carried out to predict lung cancer mortality as a function of each independent variable.

These analyses were conducted using SPSS Statistics 16.0. Alpha was set at .05 for all tests.

## RESULTS

Exploration of the data revealed practical differences between Kentucky's Appalachian and non-Appalachian regions with regard to most of this study's variables. For example, high school graduation rates ranged from 49% to 80% in Appalachian counties, compared to 61% to 87% in non-Appalachian counties. Yet adult smoking rates had the same range within the two regions (from 20% to 36%). Table 1 shows the results of independent samples *t* tests analyzing the variables' regional differences.

Statistically significant differences were detected between the regions' means for lung cancer deaths, per capita personal income and high school graduation rate. In other words, it is

Table 1. Differences Between Kentucky Counties for Various Health Indicators

Health indicator	County designation		<i>p</i> value
	Appalachian	Non-Appalachian	
Lung cancer deaths (per 100,000)	86.4	76.8	< .001
Per capita personal income	\$19,693	\$25,339	< .001
High school graduation rate	60.1%	74.0%	< .001
Adult smoking rate	28.9%	27.5%	.078
	( <i>n</i> = 54)	( <i>n</i> = 66)	

unlikely these samples “could have been drawn from the same population” (Meier, Brudney, & Bohte, 2009, p. 218). The adult smoking rate difference, however, was not significant at the designated .05 level. Of note is that Appalachian counties had a less favorable rating for each variable. This suggests Kentucky’s lung cancer mortality and socioeconomic disparities are more acutely felt in rural areas.

The regional and statewide associations between lung cancer mortality rates and each independent variable are presented in Table 2. This analysis required the calculation of Pearson’s *r* correlation coefficients with two-tailed tests. Within the respective regions, most variables were not significantly related with lung cancer mortality rates. On a statewide basis, however, significant negative associations were found between lung cancer mortality and counties’ high school graduation rates and per capita personal income levels, while adult smoking rates had a significant positive association with lung cancer mortality. These findings are not unexpected, as associations typically become more stable as sample size (in this case, the number of counties) increases.

Regression analyses were carried out to predict statewide lung cancer mortality as a function of the independent variables. In a multivariate linear regression containing each independent variable and a dummy variable representing counties’ designation as either Appalachian or non-Appalachian, the variables accounted for 21.4% of explainable variation in statewide lung cancer mortality (Table 3). In this model, only one variable (high school

Table 2. Correlation Results for Predictors of Lung Cancer Mortality in Kentucky

Independent variable	Correlation with lung cancer mortality rates		
	Appalachian counties	Non-Appalachian counties	Statewide
Per capita personal income	-.185	-.077	-.302**
High school graduation rate	-.393**	-.187	-.470***
Adult smoking rate	.103	.245*	.210*

\**p* < .05; \*\**p* < .01; \*\*\**p* < .001

Table 3. Summary of Ordinary Least Squares Regression Analysis for Variables Predicting Lung Cancer Mortality in Kentucky Counties

Variable	B Coefficient	Std. Beta Coefficient	<i>t</i> score	<i>p</i> value
Constant	113.241		9.029	< .001
B1 Per capita personal income	.000	.157	1.227	.222
B2 High school graduation rate	-.685	-.509	-3.231	.002
B3 Adult smoking rate	.286	.096	1.137	.258
B4 County designation	-1.898	-.075	-.621	.536

Adjusted R Square = .214; F = 9.080 (< .001)

graduation rate) remained significantly associated with lung cancer mortality rates. Counties' graduation rates and per capita personal income levels were highly correlated ( $r = .772$ ), but tests for multicollinearity among the variables were negative (i.e, each had an acceptable variance inflation factor – 3.753 and 2.480, respectively).

Table 3 can be further interpreted to project that, over time, each 1 percentage point increase in high school graduation rates would produce .685 fewer lung cancer-related deaths per 100,000 population. The somewhat linear association between county-level lung cancer mortality in Kentucky and counties' high school graduation rates is displayed as a scatter plot in Figure 1.

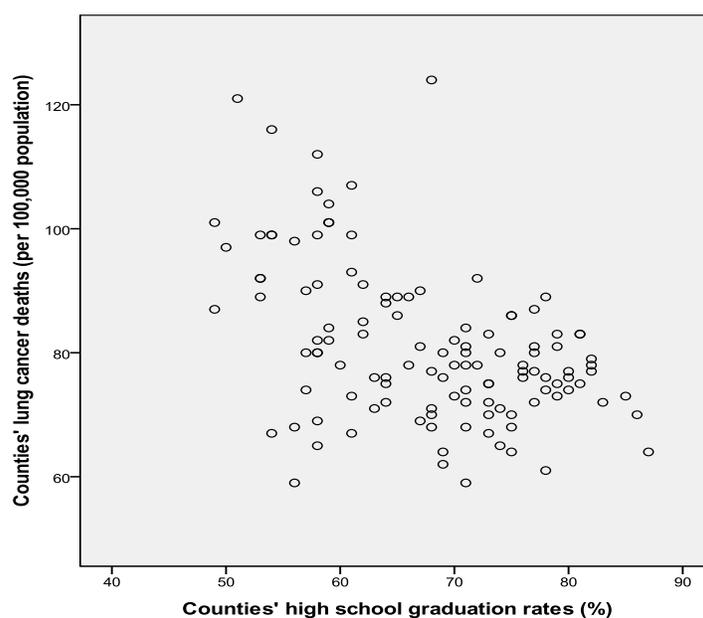


Figure 1. Kentucky's County-Level Lung Cancer Mortality as a Function of High School Graduation Rates

## DISCUSSION AND CONCLUSIONS

Limitations of this study include its focus on a single behavioral predictor of lung cancer mortality. This focus on adult smoking rates neglects the possibility of such other causes as occupational and community exposures to additional toxins. These exposures are known to increase health risks. For example, the combination of coal mining and smoking has been shown to increase individuals' likelihood of developing lung cancer (Miyazaki & Une, 2001). Another possible synergy is the acceptance of high levels of secondhand smoke in areas with elevated smoking rates. This study also did not include counties' demographic features.

The absence of these and other potential variables might have contributed to this study's underspecified regression model. Further evidence that variables beyond the scope of this study affect lung cancer mortality rates can be observed in Figure 1, which illustrates the presence of an outlier within the data. Gallatin County, located in northern Kentucky, had an average high school graduation rate (68%), as well as an average per capita personal income level and a slightly above average adult smoking rate, but had the state's highest rate of lung cancer mortality (124 deaths per 100,000 population). It should be noted that with a population of barely more than 8,000 (Kentucky State Data Center, 2009), Gallatin's mortality rate would be sensitive to even modest increases in lung cancer-related deaths. Still, one-sample *t* tests found Gallatin's lung cancer mortality to be significantly higher than the means for other non-Appalachian counties and Kentucky as a whole ( $p < .001$  for both measures).

Although some researchers support the removal of outliers to avoid inflated error rates and statistical distortions, in this case including Gallatin County in the data was the more conservative approach. Future research should more closely analyze relationships between lung cancer mortality and its potential causes in this and other counties with significantly high lung cancer death rates.

Despite its limitations, this study found statewide associations in the hypothesized direction for lung cancer mortality with high school graduation rates and per capita personal income levels, as well as statistically significant differences between Kentucky's Appalachian and non-Appalachian counties for each variable except adult smoking rates.

Adult smoking rates were similar in Appalachian and non-Appalachian counties in Kentucky and were not significantly associated with counties' lung cancer mortality rates in a multivariate linear regression model that included high school graduation rates, per capita personal income and county designation. In the context of similar adult smoking rates, lower high school graduation rates were significantly associated with increased lung cancer mortality.

Appalachian counties had significantly lower high school graduation rates, and graduation rates showed the strongest statistical association with lung cancer death rates, which might explain higher lung cancer mortality in Appalachian counties. In that regard, this study provides support for prior research suggesting that education may be the best socioeconomic predictor of individuals' disease risk factors and overall health (Robert Wood Johnson Foundation, 2009; Wamani, Tylleskär, Åström, Tumwine, & Peterson, 2004; Karlson et al., 1995; Ross & Wu, 1995; Winkleby, Jatulis, Frank & Fortmann, 1992).

Indeed, level of educational attainment can influence personal and collective social milieu in a number of ways. These include: occupation (e.g., one's likelihood of working as a coal miner); place of residence (e.g., proximity to coal-mining sites); amount of disposable income; adherence to healthy behaviors (e.g., one's likelihood of not smoking); and one's likelihood of participating in health promotion programs.

These findings suggest that Kentucky's emphasis on improving high school graduation rates, which resulted in a 6.2 percentage point gain during a recent five-year period (Jester, 2008), may contribute to future reductions in statewide lung cancer mortality. It also has the potential to address other health disparities between Kentucky's Appalachian and non-Appalachian counties, provided that graduation rates in Appalachian counties catch up with the rest of the state.

### *Implications for Nurses*

Relevant to this study is that nurses have demonstrated effectiveness as smoking cessation interventionists (Rice, 1999; Rice & Stead, 2006), despite a reported lack of education in treating tobacco dependence (Wewers, Kidd, Armbruster, & Sarna, 2004). Previous studies, however, indicate that more than one-third of current smokers have not been asked about their smoking status by nurses or other clinicians (Fiore et al., 2000). This might be partially attributable to smoking rates among nurses, which are estimated at 18% nationally and up to 25% in Kentucky (Bialous, Sarna, Wewers, Froelicher, & Danao, 2004; Adams, 2010). Scholars have expressed concern that "nurses who smoke may be less apt to support tobacco-control programs or encourage their patients to quit" (Medical News Today, 2008, p. 1).

These confounders, in combination with this study's findings, suggest that relying on clinic- or hospital-based smoking cessation counseling will not adequately reduce the risk of lung cancer mortality among patients. Rather, an approach that encompasses the social determinants of health might be required. Stanton (2009) has outlined several rural nurse competencies that would be applicable to such an approach. For instance, she noted that rural nurses should be "acutely aware of disparities;" "have broad clinical skills that ... span all levels of care including health promotion and disease prevention;" and "need to be proficient ... with accessing educational opportunities for themselves and their colleagues" (Stanton, p. 8).

Perhaps an additional rural nurse competency should be proficiency in accessing educational opportunities for patients. Whereas Dunkin and Dunn (2009) suggested that every patient receive a spiritual assessment, this study indicates that a more in-depth evaluation of patients' educational attainment is warranted. While it is not uncommon at initial check-in for patients to be queried on this topic, the line of questioning often begins and ends with, "What is the highest level of education you have completed?" For adults whose response is "less than high school," nurses or other clinicians should seek additional information (e.g., the patients' willingness to pursue a high school diploma or GED, perceived barriers to doing so, interest in receiving further assistance).

State-level data suggest it is entirely appropriate for nurses to advocate that such patients advance their education. Among the 20 states (plus the District of Columbia) that experienced at least a 5 percentage point decline in adult smoking rates between 1999 and 2009, nearly one-quarter had a corresponding reduction in the proportion of residents who had not completed high school (BRFSS, 2010).

This study also highlights the ideal position of school nurses to address education-related issues among their patients. School nurses should act as educational encouragers. Moreover, advocates have posited that "school nurses promote student success because healthy students are better learners" (Kentucky School Nurse Association, n.d., p. 1). The association between school nurse practice and students' educational outcomes has been identified as a research priority for school nursing (Edwards, 2002).

Yet, the impact of individual interventions on lung cancer mortality rates and other health disparities is modest. To get at the core of such issues, nurses must be willing to embrace the role of community activist. Prior research indicates that nurses generally have had limited public policy involvement (Whitehead, 2003; Peters, 2002; Oden, Price, Alteneider, Boardley, & Ubokudom, 2000). More recently, however, Gangeness (2009) suggested that community-focused nurses have the capacity “to inform the development of health care policy” (p. 62).

The most immediate benefit seemingly could be produced by rural nurses who become involved at the local level. With regard to lung cancer mortality rates, that likely would include advocating for laws or regulations to limit indoor smoking in public facilities. Based on this study’s findings, nurses also should urge local school districts to adopt policies that increase student achievement and reduce dropout rates.

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