

Introduction

As of 2002, the Centers for Disease Control and Prevention estimated that 16.3% of deaths in the United States were related to smoking (CDC 2002), which equates to around 400,000 deaths per year. Although smoking is associated with mortality from a variety of causes, lung cancer mortality was the leading cause of these diseases causally related to smoking. And, lung cancer mortality rates are frequently used as an indicator of the burden of disease caused by smoking.

Lung cancer mortality rates differ substantially by both educational attainment and smoking patterns. In general, mortality rates are higher among the lower educated and smoking is more prevalent among the lower educated. Smoking pattern differences in lung cancer mortality rates also differ by sex (Preston and Wang 2006; Waldron 1993) and these sex differences exist on a cohort basis (Preston and Wang 2006). Lower rates of cigarette smoking followed by an increased adoption of smoking by females in the United States have narrowed the differences by sex that exist within lung cancer mortality rates (Pampel 2002a). Similarly, higher rates of cigarette smoking among males have been a major cause of men's higher lung cancer mortality (Waldron 1993).

The relationship between cigarette smoking patterns, education, and lung cancer mortality is important because of the role that smoking plays in educational differences in mortality. Education is a fundamental indicator of social stratification in the US. Information regarding smoking prior to the 1960's was limited and cigarette smoking was not generally viewed as harmful to one's health. As information regarding the risks associated with smoking became available, it was the higher educated persons that receive this information first. Furthermore, the higher educated members of society typically lead healthier lifestyles than the less educated. High mortality and low income are direct consequences of health problems (Preston and Elo 1995) which disproportionately affect the lower educated. Lastly, in the United States, it is the male population that first adopted cigarette smoking (Ravenholt 1990). Males in US society have long had a higher status than that of females. As females begin to gain equality in US society (primarily through education), the focus on the differences in smoking patterns shifted from sex differences to educational differences.

The relationship between smoking patterns, educational attainment and lung cancer mortality is a significant one in the United States. Persons with low educational attainment are more likely to have ever smoked, to be current smokers, and they are less likely to have quit smoking than higher educated persons. Moreover, smoking is linked with several diseases, in addition to lung cancer (Ravenholt 1990; Waldron 1993; Doll 1998; Malarcher et al. 2000). The elimination of smoking will increase life expectancies and increase the overall health of the US population. Thus, it is critical that researchers continue to document patterns and trends regarding lung cancer mortality.

Despite the enormous death toll associated with smoking, relatively few demographic studies have looked at the link between educational attainment and lung cancer mortality in the United States. Few studies have examined the specific demographic groups, smoking statuses, and specific causes of death associated with smoking (Hummer et al. 1998). Additionally, there are very limited studies which examine the relationship between educational attainment, smoking patterns and lung cancer mortality in the US.

Smoking has also become more tied to education in the United States than ever before (Escobedo et al. 1996; Zhu et al. 1996). As this relationship becomes stronger, it is important to gain a greater understanding of this relationship and its affects on society and lung cancer mortality. In this paper, we will examine the association between educational attainment and cigarette smoking patterns in the United States. Next, we will analyze lung cancer mortality rates and their varying patterns across age groups by smoking and by education. We will then do this separately by gender because of the very different patterns of education, smoking and mortality that have been found for men and women. Finally, we will examine the data to determine if education has a buffering effect against mortality for smokers and if low education exacerbates the effect of smoking on mortality.

Data and Methods

Dataset

We use the Sample Adult supplements of the National Health Interview Survey (NHIS) 1997 through 2000, linked to the National Death Index (NDI) via the Longitudinal Mortality Follow-Up (LMF) file, through the end of 2002 (NCHS 2004). These data supplements allow for consistency in the questionnaire design and in the questions asked of the respondents regarding their smoking habits. The NHIS-LMF 1997-2000 data are a cross-sectional random household sample drawn from the civilian, non-institutionalized US adult population.

The LMF mortality files exclude deaths outside of the US. The causes of death are coded using the International Classification of Diseases; the 9th revision for survey years 1997 through 1998 and the 10th revision for survey years 1999 through 2002. Respondents not eligible for matches are excluded from the analyses. We restrict the data to persons ages 45 years or older at the time of the survey. This leaves a sample of 63,147 individuals among whom 5,324 died during the follow up period.

Variables and Measures

Age is measured using two categories: age 45 to 64 years and ages 65 or more years. **Cigarette smoking status** is measured using six categories: never smoker, former short term smoker, former long term smoker, current light smoker, current medium smoker, and current heavy smoker. **Education** is measured using the number of years of completed schooling. It is then grouped into 0 to 8 years of school, 9 to 11 years of school, 12 years of school, 13 to 15 years of school, 16 years of school and 17 years or more of completed schooling. **Survival Status** is measured in six categories: survivor, or has an underlying cause of death of lung cancer, any other cancer, heart disease, respiratory illness, or any other underlying cause of death.

Methods

The four NHIS datasets (1997 through 2000 Sample Adult supplements) were combined into one dataset. This dataset was matched to the LMF file using the public identification variables. The data were analyzed using the SAS. Crosstabs were produced using the weighted data and tested using a chi-square test for significance. These cross-tabulation results were used to understand the relationships between cigarette smoking, educational attainment and lung cancer mortality by age group and gender.

We will in a progressive manner also use hazard models to further analyze the relationships in these data and test our hypotheses. We will build these models so that we can better understand the relationships between education, smoking and mortality, first for the overall population aged 45 and

above and then for specific age and sex groups. Finally, we will include education by smoking interactions in our models to determine if the effects of smoking are moderated by education (i.e. Pampel and Rogers 2004).

Analysis and Results

Descriptive Findings

Table 3 is an example of a descriptive table to be included in the completed analysis. It shows the survival status of US adults ages 45 years or higher by smoking status and educational attainment. For the least educated individuals (0 to 8 years of education), former smokers have the lowest survival rates. This is particularly true for the long term former smokers. Long term former smokers also experience a high proportion of their deaths to be due to heart disease and lung cancer. The highest survival rates within this education category are experienced by the nonsmokers, as well as the light and medium current smokers.

Within the educational category 9 to 11 years of education, the highest proportion of deaths among long term former smokers is attributable to lung cancer. This is also true for heavy current smokers within the same educational group. Heart disease appears to be the leading cause of death for short term former and light current smokers within this educational category.

Former smokers overall have the worst survival rates among those with 12 years of education. Heart disease is a leading cause of death within each smoking group for this educational category. Similarly, individuals with some college education (13 to 15 years of education) experience the worst survival rates among former smokers. As expected, nonsmokers experience the highest survival rates. Of the cause of death categories reviewed, lung cancer and respiratory diseases represent the smallest proportion of causes of death of nonsmokers with some college education.

Of the college educated respondents, long term former smokers again experience the worse survival rates. Surprisingly, short term former smokers experience the best survival rates. This result may be a result of the gestational period of smoking related diseases. Heavy current smokers experience very low survival rates within the highest educational attainment category (17 or more years) when compared to other smoking categories. This is interesting when compared to the least educated non smokers. The highest educated heavy smokers experience lower survival rates than the least educated non smokers.

Plans for the Continued Research

We have completed additional descriptive analysis of the data which have not been included in this abstract. We plan to include additional tables and analyses of the risk of death for smoking status groups, education groups, and smoking and education interactions using proportional hazards modeling. We will display the results of our models by age and sex.

Full reference list not included due to page limitation but is available upon request.

TABLE 3

Survival Status of US Adults Aged 45+:
by Smoking Status and Educational Attainment

Survival Status	Smoking Status					
	No	Long term Former	Short term Former	Light Current	Medium Current	Heavy Current
0-8 Yrs Ed						
Not Dead	85.5%	68.3%	78.1%	83.9%	85.7%	82.5%
Lung Cancer	0.3%	8.2%	2.4%	1.9%	1.8%	1.1%
Other Cancer	2.0%	1.6%	5.0%	3.8%	2.1%	5.7%
Heart Disease	5.9%	10.3%	5.5%	4.6%	4.4%	4.1%
Respiratory	1.0%	6.4%	8.5%	1.9%	3.5%	3.7%
Other Causes	5.4%	5.1%	0.5%	3.8%	2.5%	2.8%
Totals	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Survival Status	Smoking Status					
	No	Long term Former	Short term Former	Light Current	Medium Current	Heavy Current
9-11 Yrs Ed						
Not Dead	88.3%	88.9%	86.6%	86.3%	87.7%	86.3%
Lung Cancer	0.2%	3.3%	2.0%	2.0%	2.9%	3.9%
Other Cancer	2.2%	2.2%	1.2%	1.4%	2.2%	3.3%
Heart Disease	4.4%	1.7%	7.4%	4.6%	2.3%	2.2%
Respiratory	0.5%	1.0%	0.0%	1.9%	1.0%	1.6%
Other Causes	4.3%	2.8%	2.8%	3.9%	4.0%	2.7%
Totals	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Survival Status	Smoking Status					
	No	Long term Former	Short term Former	Light Current	Medium Current	Heavy Current
12 Yrs Ed						
Not Dead	92.5%	89.0%	90.4%	91.2%	92.3%	91.2%
Lung Cancer	0.2%	2.3%	1.3%	1.3%	1.8%	1.4%
Other Cancer	1.5%	1.6%	1.8%	1.3%	1.5%	1.2%
Heart Disease	2.9%	2.8%	2.0%	2.4%	2.2%	3.1%
Respiratory	0.4%	1.8%	2.0%	1.1%	0.7%	0.9%
Other Causes	2.6%	2.6%	2.5%	2.6%	1.6%	2.2%
Totals	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Survival Status	Smoking Status					
	No	Long term Former	Short term Former	Light Current	Medium Current	Heavy Current
13-15 Yrs of Ed						
Not Dead	94.3%	90.7%	90.4%	92.9%	92.7%	92.1%
Lung Cancer	0.2%	2.2%	3.9%	1.1%	1.4%	2.0%
Other Cancer	1.2%	2.3%	2.6%	1.4%	1.0%	0.8%
Heart Disease	1.9%	3.7%	2.0%	1.5%	1.4%	1.2%
Respiratory	0.2%	0.4%	1.1%	0.8%	1.0%	0.5%
Other Causes	2.2%	0.6%	0.0%	2.4%	2.6%	3.4%
Totals	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Survival Status	Smoking Status					
	No	Long term Former	Short term Former	Light Current	Medium Current	Heavy Current
16 Yrs of Ed						
Not Dead	95.8%	88.2%	97.0%	94.9%	96.0%	90.7%
Lung Cancer	0.2%	2.2%	0.0%	0.8%	0.8%	0.0%
Other Cancer	0.9%	4.4%	0.0%	1.0%	0.0%	0.0%
Heart Disease	1.4%	2.7%	1.7%	0.6%	1.2%	2.2%
Respiratory	0.3%	1.1%	0.0%	0.5%	0.8%	3.4%
Other Causes	1.5%	1.4%	1.4%	2.2%	1.1%	3.6%
Totals	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Survival Status	Smoking Status					
	No	Long term Former	Short term Former	Light Current	Medium Current	Heavy Current
17+ Yrs of Ed						
Not Dead	97.3%	94.3%	87.8%	95.8%	91.5%	77.7%
Lung Cancer	0.1%	0.0%	0.0%	0.8%	1.6%	1.8%
Other Cancer	0.7%	0.0%	9.5%	0.0%	2.6%	7.6%
Heart Disease	1.0%	5.7%	0.0%	1.4%	1.3%	2.6%
Respiratory	0.1%	0.0%	2.7%	0.0%	1.6%	2.8%
Other Causes	0.8%	0.0%	0.0%	2.0%	1.4%	7.5%
Totals	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: NHIS-LMF 1997-2002