Mortality from Lung Cancer in U.S. Coal Miners

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A study of 3726 Appalachian coal miners revealed a low standard mortality ratio for lung cancer. This result agrees with previously published British data but disagrees with recent American data. Our study looks at the lung cancer mortality of this sample and compares it with the death rate of United States males as a whole.

Introduction

Mortality figures from Britain have indicated that coal miners tend to have a lower than expected death rate from lung cancer than do nonminers.[1-4] However, two recent papers suggest that this may not be true of United States coal miners.[5,6] We have recently followed up a cohort of Appalachian coal miners who were included in the 1962–1963 U.S. Public Health Service prevalence study.[7] It is the purpose of this paper to look at the lung cancer mortality of this sample and to compare it with the death rate of United States males as a whole.

Methods

In 1962–1963, a cohort of 4134 Appalachian miners was randomly selected by the U.S. Public Health Service for inclusion in a prevalence study of coal miners' pneumoconiosis.[7] Of the sample, 3726 coal miners or 90.1 per cent agreed to participate. These men have been followed to the present time. Of the original cohort, 451 men were certified as having died on or before January 1, 1972. At this time there are about 230 men whose vital status remains undetermined.

Death certificates have been obtained from the appropriate State Departments of Vital Statistics for each of the 451 deceased miners. The death certificates were then coded for underlying cause of death by a nosologist utilizing the International Classification of Diseases, Adapted for Use in the United States, 8th revision.[8] All miners having been coded 162.1, neoplasm of bronchus and lung, were separated from the rest of the certificates. In addition, certificates were checked for cancers of the following nearby organs: esophagus, nasopharynx, mouth, and stomach (Table 1).

The death rate for lung cancer is expressed as a standardized mortality ratio (SMR), this being the ratio of observed deaths to expected death times 100. The standard population used for comparison was all males in the United States in 1968. Expected deaths were calculated by the following method: death rates based on midyear population for 5-year age intervals were calculated from Tables 1-22, 1-25, and 6.2 in Vital Statistics of the United States[9] for 1968. The logarithms of these rates were interpolated to give logarithms of single-year age interval death rates. The average of three interpolated points in successive 15-year intervals resulted in the logarithms of single-year death rates. Proportions dying (q_x) of men alive at the beginning

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of each year were calculated by the method described by Spiegelman in Introduction to Demography using age-specific death rates for lung cancer as calculated by the described interpolation method.[10] The expected number of deaths was computed for each 5-year age group of miners by a modified life table procedure, essentially by multiplying in each 5-year age group the number of men at risk of dying at the outset of each year of follow-up by the q_x value for the age groups.

Smoking history was taken from a questionnaire that was given to all of the original cohort at the time of their original examinations (January 15, 1963—January 14, 1965). Smoking was measured in terms of pack-years, a pack-year being equivalent to 20 cigarettes per day for 1 year.

Results

Table 1 gives a breakdown of the number of coal miners dying from selected types of cancer. As can be seen from the table, neoplasm of the bronchus and lung accounted for 24 of the 451 deaths, and neoplasms of tongue and mouth accounted for none. Of the 24 men dying from lung cancer, 22 were Caucasian and two were Negro.

The age distribution by 5-year intervals of those dying from lung cancer versus those dying from all causes is given in Table 2. The largest number of lung cancer deaths occurred in the 65—69 age year interval, while the 60—64 age year interval was largest for deaths of all causes.

TABLE 1—Distribution of Selected Underlying Causes of Death

ICDA Code	Underlying Cause	Number of Cases
162.1	Neoplasm of bronchus and lung	24
150	Neoplasm of esophagus	2
147	Neoplasm of nasopharynx	1
145.9	Neoplasm of mouth	0
141.9	Neoplasm of tongue	0
151.9	Neoplasm of stomach	3

TABLE 2—Age Distributions of Lung Cancer Deaths and All Deaths

Age Interval	Number of Lung Cancer Deaths	Number of All Deaths
25–29	0	3
30–34	0	4
35–39	1	10
40–44	0	23
45–49	0	40
50–54	2	55
55–59	5	98
60–64	5	204
65–69	9	14
70–74	1	0
75–79	1	0
Total	24	451

TABLE 3—Observed and Expected Deaths and Standard Mortality Ratio*

Age	Observed	Expected
25–29	0	–
30–34	0	1
35–39	1	–
40–44	0	1
45–49	0	3
50–54	2	6
55–59	5	8
60–64	5	16
65–69	9	1
70–74	1	0
75–79	1	0
Total	24	36

*SMR = (24/36) X 100 = 67.

TABLE 4—Distribution of Cigarette Smokers by Number Smoked and Pack-Years

Cigarettes/Day	Number	Pack-Years	Number
0–19	10	0–19	3
20–39	10	20–39	11
40+	1	40+	7

Table 3 gives by 5-year age interval the distribution of observed deaths versus expected deaths from lung cancer as calculated by the interpolation method. Observed numbers of death due to lung cancer were low in the 55—59 and 60—64 year age brackets and high in the 65—69 year age bracket as compared to the calculated expected values. The standard mortality ratio was found to be 67.

Twenty-one of the 24 miners dying from lung cancer were and/or had been cigarette smokers. Nineteen of the 22 were smokers at the time of the first examination, and three had a past record of smoking. One was a pipe smoker only. In terms of pack-years, the largest number of smokers were in the 20—39 pack-year group. Table 4 shows the distribution of cigarette smokers by number of cigarettes per day and by pack-years.

Discussion

Mortality caused by lung cancer has been studied in coal miners both in the United States and Britain. In 1936, Kennaway and Kennaway[1] obtained a standardized mortality ratio of 55 for lung cancer in coal miners in England and Wales for the years 1921—1932. An extension of this study for the years 1933—1938 showed that the SMR was 65.

Goldman[2] reports that the Registrar General's Decennial Supplement on Occupational Mortality (1958) stated

that the standardized mortality ratio for lung cancer of mine workers and quarrymen in England and Wales in the 20—65 age range was 71. This covered the period 1949—1953. The standard mortality ratio for coal miners aged 15—64 in Scotland was 80, according to the same report. Goldman indicates that data acquired in the Rhondda Fach area of South Wales during 1951—1956 indicated a SMR of 81 for coal miners for lung cancer, which was appreciably lower than the national rate for males.

Stocks[3] in 1952 observed that the comparative mortality rates from lung cancer in Merthyr Tydfil, Cardiff, and Swansea, Wales, were 77, 128, and 132. Merthyr Tydfil in those days was a coal mining town, while Cardiff and Swansea were and still are ports.

Liddell[4] states that "miners generally had high rates of deaths from accidents and pneumoconiosis, and low rates for lung cancer." In a study of deaths of British coal miners in 1961, he found that lung cancer had a SMR of 49 in face workers, a SMR of 53 in other underground workers, and a SMR of 82 for surface workers.

On the other hand, two recent papers concerning coal miners in the United States indicate that low mortality rates for lung cancer are not necessarily true in American miners. Enterline,[5] using occupational data from the National Office of Vital Statistics of the U.S. Public Health Service for 1950, calculated SMR's for several selected causes of death for coal miners aged 20—64 and 20—59. In the age group 20—64, there were 161 observed deaths caused by cancer of trachea, bronchus, and lung, with 84 expected deaths giving a SMR of 192. In the 20—59 age groups, the SMR was 164. In the same article, however, Enterline reports on a 28½ year follow-up on 553 working coal miners from the Beckley, West Virginia, area. He found that the SMR for "malignant neoplasms, respiratory system" was 110.9, this being slightly over one-half of the SMR for malignant neoplasms of the digestive system (210.0). In addition, an SMR of 80 for malignant neoplasms was obtained from a 1967 study by the Society of Actuaries.

As can be seen, there is a large disparity between the British findings and the findings Enterline reports from 1950 census computations and his studies of insured populations. In the 1950 census study, all men whose usual occupation was shown as coal miner on death certificates were included in the counts of deaths of coal miners. However, the populations on which expected deaths were based came from 1950 census estimates. The 1950 census asked for last occupation preceding the date the census was taken, i.e., men who had once mined coal but shifted to other occupations would not be classified as coal miners in the census. Liddell's work shows the results of relating deaths to census figures for coal miners in Great Britain—inflated death rates, particularly for face workers.

Scarano et al.,[6] in a study involving 11 years experience with carcinoma of the lung in relation to anthracosilicosis in the Veteran's Administration Hospital at Wilkes-Barre, Pennsylvania, found that cancer of the lung was diagnosed in 7 per cent of anthracosilicotics and in 1.08 per cent of nonanthracosilicotics. This difference was highly significant. However, other than for the subsample of cancer patients, no data were published on the ages of the nonminers versus miners. Without such information the inferences made from this study must remain open to doubt. It should be pointed out that Wilkes-Barre is in the center of the major anthracite coal field in the United States.

Summary

The data obtained in the present Appalachian miner study tend to confirm the British findings in regard to lung cancer in coal miners and indicate that they have a lower than normal death rate from lung cancer.

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