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CHAPTER 3. MORTALITY FROM CHRONIC OBSTRUCTIVE LUNG DISEASE DUE TO CIGARETTE SMOKING

CONTENTS

Introduction

The chronic obstructive lung diseases (COLD) that are causally related to cigarette smoking are chronic bronchitis, emphysema, and chronic obstructive pulmonary disease and allied conditions without mention of asthma, bronchitis, or emphysema. The last classification was introduced by the National Center for Health Statistics in response to the changes that occurred in the late 1960s in patterns of reporting causes of death on death certificates. During this period, physicians increasingly recorded deaths as due to "chronic obstructive lung disease" rather than the more specific categories of "emphysema" or "chronic bronchitis" (NCHS 1982). Because of this shift in patterns of reporting, and in recognition of the difficulty of clinically separating these categories from one another as a cause of death, the discussion in this chapter combines all of these categories for analysis, where possible, which should result in a more complete description of death rates from COLD.

COLD Mortality Patterns in the United States

The three chronic obstructive lung diseases related to smoking may account for almost 62,000 deaths in 1983, compared with 56,920 deaths in 1982, according to provisional mortality data recently published by the National Center for Health Statistics. This data is based on a 10 percent sample of all death certificates for the 12-month period ending in November (NCHS 1984). This is a dramatic increase from 1970, when slightly over 33,000 deaths were attributed to COLD.

Complete mortality data are available through 1980, and Table 1 presents the numbers of male and female deaths from COLD for 1970, 1975, and 1980. In addition to the relatively rapid rise in COLD deaths during these years, there was also a shift in the male to female ratio of these deaths. In 1970 male deaths outnumbered female deaths by a ratio of 4.3 to 1. By 1980 this ratio had declined to 2.36.

The age-adjusted death rates for COLD during the years 1960 through 1980 are presented in Figure 1 for white men, white women, and men and women of other races. As described in the previous chapter, however, COLD is a slowly progressive disease, and death from COLD usually occurs only after extensive damage has developed in the diseased lungs. Many individuals with COLD will die with their disease rather than because of it, and even those who do die of COLD are usually symptomatic for an extended period of time prior to death.

Therefore, death rate data may not accurately reflect the true prevalence or incidence of COLD in the U.S. population. In addition, COLD is often not recorded as a cause of death in hospital records

TABLE 1.—Number of and ratio of male to female chronic obstructive lung disease (COLD) deaths for three time periods, United States

Cause of death	1970		1975		1980	
	Men	Women	Men	Women	Men	Women
Chronic bronchitis	4,282	1,564	3,260	1,452	2,380	1,348
Emphysema	18,901	3,820	14,849	3,946	10,133	3,744
COLD and allied conditions	3,601	848	13,411	4,182	24,820	10,734
Total COLD deaths	26,784	6,227	31,520	9,580	37,333	15,826
M:F ratio	4.30		3.29		2.36	

SOURCE: National Center for Health Statistics (1982, and unpublished mortality data).

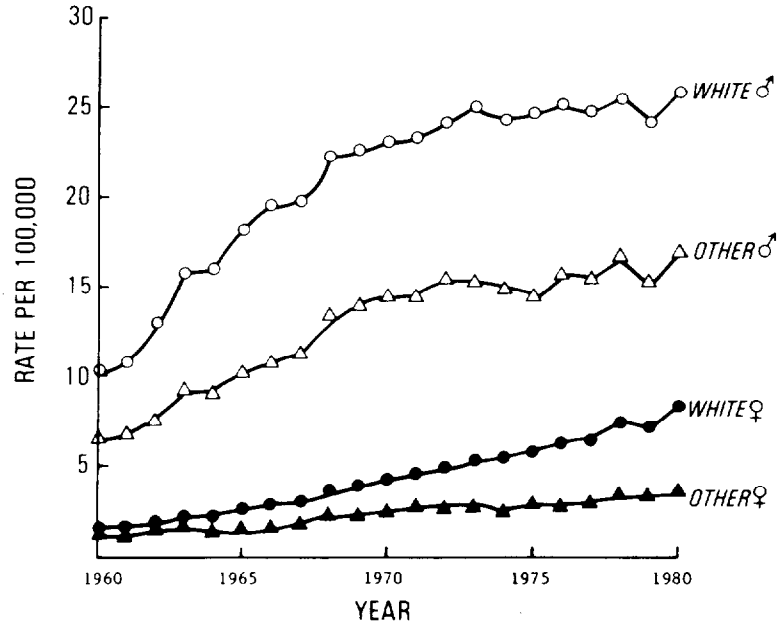

FIGURE 1.—Age-adjusted COLD mortality rates for whites and nonwhites in the United States, 1960–1980

SOURCE: National Center for Health Statistics (1982, and unpublished data).

(Moriyama et al. 1966) or on death certificates (Mitchell et al. 1968), even though it may have played an important role in a person's death. In a recent prospective study, nearly half of the excess mortality associated with significantly lowered FEV_1 was attributed to other causes (Peto et al. 1983). Relatively advanced lung disease (as judged by pathologic examination) may also exist without clinical

recognition because of the lung's large ventilatory reserve (Mitchell et al. 1968; Hepper et al. 1969). A joint committee of the American College of Chest Physicians and the American Thoracic Society (ACCP–ATS 1975) has developed standardized definitions of these conditions that may improve the accuracy of mortality reporting in the future.

As discussed in the chapter on morbidity in this Report, COLD in an individual is usually a combination of mucus hypersecretion, airway narrowing, and emphysema. The extent of damage represented by each of these three processes can vary substantially from individual to individual, both in the absolute magnitude of the damage and in the proportional contribution of each of these three components. The majority of those with smoking-induced lung damage do not have enough damage to result in clinically significant disease, and only some of those with clinically significant disease have damage to the lung that results in death from COLD. The progressive loss of FEV_1 in smokers described in the preceding chapter is one measure of the extent and progression of lung damage, and individuals with a markedly reduced FEV_1 are far more likely to die of COLD (Peto et al. 1983). These deaths commonly occur secondary to the failure of these severely damaged lungs to carry out the gas exchange required for survival.

Because death from COLD is the end result of lung damage accumulated over many years, these deaths would be expected to occur disproportionately in the older age groups; therefore, the presentation of a single age-adjusted death rate might not reflect a true picture of the changes in this disease with time. Figure 2 presents the age-specific death rates in 1977 for COLD in the different sexes and racial groups. Death rates increase rapidly over the age of 45, and this increase is particularly dramatic over the age of 65. In addition, the bulk of the difference between white men and men of other races, evident in Figure 2, occurs in those over age 65. Indeed, the COLD death rates for nonwhite men are actually higher than that for white men under age 55.

The examination of age-specific death rates over time also presents a somewhat different picture from that presented by the age-adjusted numbers in Figure 1. The age-adjusted rates for white men in Figure 1 seem to have changed only slightly between 1968 and 1980. However, when the age-specific rates for the years 1968 and 1977 are examined (Figure 3), this apparent stability can be seen to be a product of counterbalancing trends in those under and over 65 years of age. The death rates from COLD declined in white men under age 65 between 1968 and 1977, but COLD death rates increased in white men over age 65 during the same years; this increase was particularly dramatic in those over age 75.

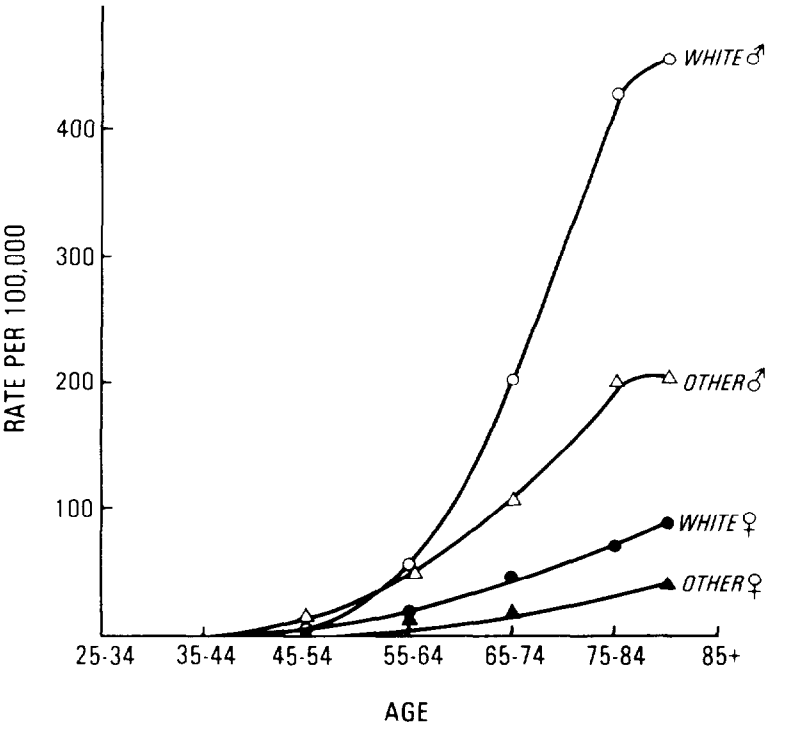

FIGURE 2.—Age-specific COLD mortality rates for whites and nonwhites in the United States, 1977

SOURCE: National Center for Health Statistics (1982).

Figure 4 presents the age-specific COLD mortality rates for white women in 1960, 1968, and 1977. As with the male rates, the female COLD death rates rise rapidly with age, but they are substantially lower than the male rates. In contrast with the male rates, however, the white female death rates increased steadily with time from 1960 through 1977 both above and below age 65. In each of the age groups over the age of 45, where significant numbers of COLD deaths would be expected, there was a steady increase in rates from 1960 to 1968 and from 1968 to 1977. As is discussed later in this chapter, these differences between men and women over time are consistent with their differences in smoking behavior.

The effect of the normal aging process on the lung is small, rarely limits maximal exercise, and never results in ventilatory failure. Therefore, death from chronic obstructive lung disease is never a natural part of the aging process; it is the result of an infectious or other disease process or of the cumulative damage of environmental respiratory toxins. The most important of these toxins in the United States is cigarette smoke.

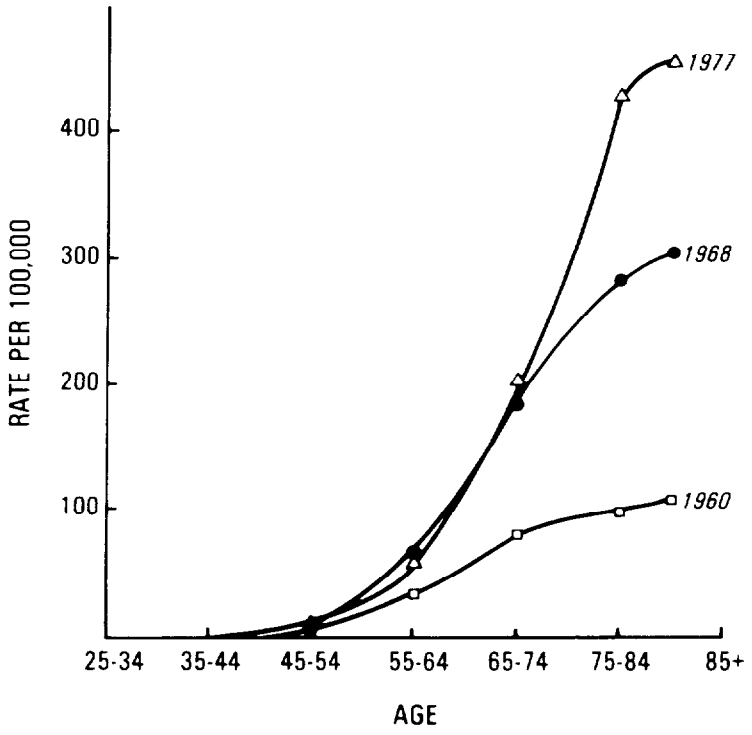

FIGURE 3.—Age-specific COLD mortality rates for white men in the United States, 1960, 1968, and 1977
SOURCE: National Center for Health Statistics (1982).

In spite of the large ventilatory reserve possessed by the lung, death from COLD is a major cause of U.S. mortality. This mortality is closely linked to cigarette smoking and has been examined extensively. Figure 5 shows the differences in COLD death rates for smokers and nonsmokers at different ages. From the rarity of COLD death in nonsmokers and the magnitude of the increased risk associated with smoking, it is clear that the overwhelming importance of cigarette smoking as a determinant of abnormal lung function demonstrated in the previous chapter is matched by the importance of cigarette smoking as a determinant of death from COLD. Examination of the death rates from COLD in smokers and nonsmokers suggests that from 85 to 90 percent of the COLD deaths in the United States can be attributed to cigarette smoking.

Prospective Studies

The relationship between smoking and death from COLD has been evaluated in a large number of prospective mortality studies. There are eight major prospective studies of the disease consequences of smoking. They involve large numbers of smokers and nonsmokers

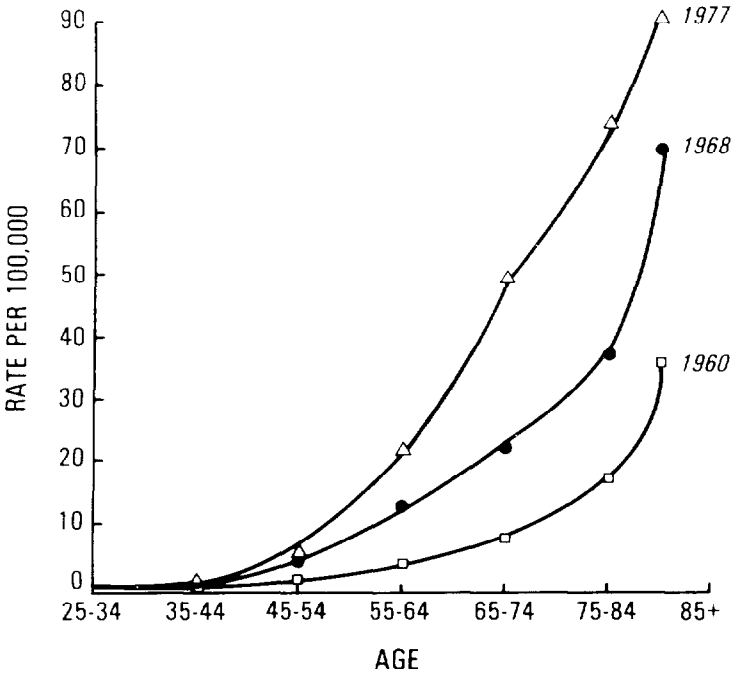

FIGURE 4.—Age-specific COLD mortality rates for white women in the United States, 1960, 1968, and 1977

SOURCE: National Center for Health Statistics (1982).

and have examined the death rates from COLD in both groups. These studies cumulatively represent more than 17 million person-years of observation and over 330,000 deaths. The size of the populations studied allows a detailed examination of the relationship between smoking and death rates. The characteristics of the populations studied are summarized in Table 2 and are briefly reviewed here.

The British Doctors Study

The British doctors study (Doll and Hill 1954, 1956, 1964a, 1964b, 1966; Doll and Peto 1976, 1977; Doll and Pike 1972; Doll et al. 1980) of 40,000 male and female physicians in Britain was the first prospective study and is the longest running. Deaths from chronic bronchitis and emphysema were combined. Deaths from cor pulmonale (i.e., heart failure secondary to lung disease) were separately analyzed by smoking category and probably include some deaths from chronic bronchitis and emphysema.

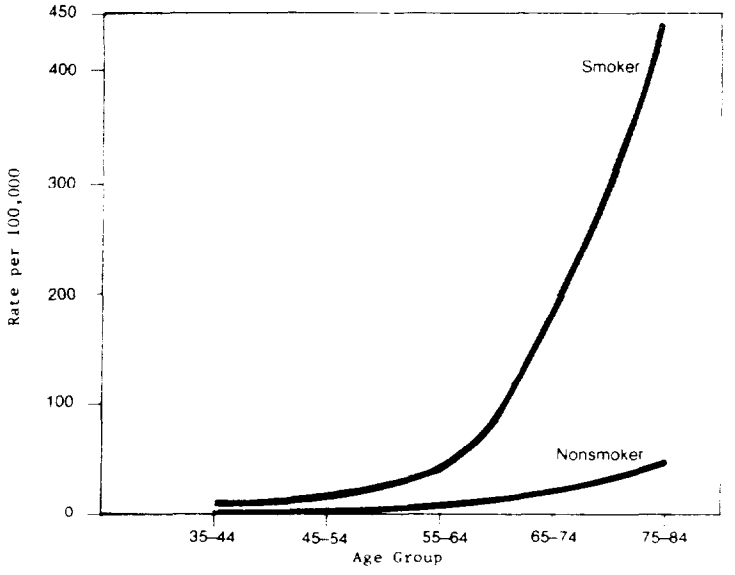

FIGURE 5.—Death rate for bronchitis, emphysema, or both, per 100,000 population, by age and smoking status[1], U.S. veterans study, 16-year followup

[1] Smoker is defined as all people who smoke cigarettes and those who have ever smoked other tobacco products
SOURCE: Adapted from Rogot and Murray (1980).

The American Cancer Society 25-State Study

The American Cancer Society 25-State study (Hammond 1965, 1966; Hammond and Garfinkel 1969; Hammond et al. 1976; Lee and Garfinkel 1981) represents the largest investigation. Deaths from emphysema were separately analyzed by smoking habit; deaths from cor pulmonale were also separately recorded.

The U.S. Veterans Study

The mortality experience of approximately 294,000 U.S. veterans who held U.S. Government life insurance policies in December 1953 was examined in the U.S. veterans study (Dorn 1959; Kahn 1966; Rogot 1974a, b; Rogot and Murray 1980). Deaths from COLD were recorded as "bronchitis and/or emphysema"; "bronchitis, underlying or contributory"; and "emphysema without bronchitis."

The Canadian Veterans Study

Initiated in 1955 by the Canadian Department of National Health and Welfare, the Canadian veterans study (Best 1966; Best et al. 1961) included 78,000 men and 14,000 women. Over the next 6 years of followup, there were 9,491 male and 1,794 female deaths. The cause of death in most of these cases was confirmed by autopsy.

TABLE 2.—Outline of eight major prospective studies

Authors	Doll Hill Peto Pike	Hammond	Dorn Kahn Rogot	Hirayama	Best Josse Walker	Hammond Horn	Weir Dunn Linden Breslow	Cederlof Friberg Hrubec Lorich
Subjects	British doctors	Males and females in 25 States	U.S. veterans	Total population of 29 health districts in Japan	Canadian pensioners	White males in nine States	California males in various occupations	Probability sample of the Swedish population
Population size Females	40,000 6,000	1,000,000 562,671	290,000 <1%	265,000 142,857	92,000 14,000	187,000	68,000	55,000 27,700
Age range	20–85 +	35–84	35–84	40 and up	30–90	50–69	33–64	18–69
Year of enrollment	1951	1960	1954 1957	1966	1955	1962	1954	1963
Years of followup reported	20–22 years	12 years	16 years	13 years	6 years	4 years	5–8 years	10 years
Number of deaths	11,166	150,000	107,500	39,100	11,000	12,000	4,700	4,500
Person years of experience	800,000	8,000,000	3,500,000	3,000,000	500,000	670,000	480,000	550,000

The American Cancer Society 9-State Study

In the American Cancer Society 9-State study (Hammond and Horn 1958a, b), 187,783 white men were followed for an average of 44 months by 22,000 American Cancer Society volunteers. All deaths from pulmonary disease (except pulmonary neoplasms) were considered as one group and included deaths from pneumonia, asthma, tuberculosis, lung abscess, pneumoconiosis, bronchiectasis, and emphysema.

California Men in Various Occupations

The study of California men in various occupations (Dunn et al 1960; Weir and Dunn 1970) examined the mortality experience of 68,153 men, aged 35 to 64, drawn from labor union rolls in specified occupations. Deaths from emphysema were separately categorized.

The Swedish Study

The study of a probability sample of 55,000 Swedish men and women (Cederlof et al. 1975), aged 18 to 69, represents a detailed analysis of mortality by smoking status over a period of 10 years. The cause of death was ascertained by death certificates collected by the Central Bureau of Statistics for all of Sweden.

The Japanese Study of 29 Health Districts

In the fall of 1965, a total of 265,118 men and women in 29 health districts in Japan were enrolled in a prospective study (Hirayama 1967, 1970, 1972, 1975a, 1975b, 1977, 1981). Mortality data regarding deaths from asthma and emphysema have recently been reported.

Cigarette Smoking and Overall COLD Mortality

The data from the major prospective studies relating smoking to mortality from COLD in men and women are presented in Table 3. These data demonstrate a uniform increase in death rates from COLD among male and female smokers when compared with nonsmokers of either sex. The mortality ratios for smokers compared with nonsmokers vary markedly, however, from 2.2 in the Japanese study to 24.7 in the study of British doctors. Some of this variability can be attributed to different patterns of certification of cause of death in different countries, but a number of other factors are also important. Perhaps the most important other factor is the age range of the population studied. As described earlier in this chapter, death rates from COLD rise steeply with age, particularly over the age of 65. Studies of populations under age 65 may significantly underestimate the impact of cigarette smoking on COLD because of the long duration of smoking required to damage enough lung to result in

death from COLD. The population under 65 contains large numbers of individuals who have significant airflow obstruction and who will die of COLD, but who have not done so prior to age 65. This effect is demonstrated in the American Cancer Society 25-State study, in which the COLD mortality ratio for male smokers aged 45 to 64 was 6.55, but increased to 11.41 in male smokers aged 65 to 79.

A second reason for differences in mortality ratios is the selection of study populations who are currently employed, particularly if the duration of followup is relatively short. The incremental nature of the lung injury in COLD often results in a prolonged period of disability prior to resulting in death. This disability is usually incompatible with full-time work, particularly in those occupations requiring substantial exertion. Therefore, the study of a working population excludes those with significant existing disability from COLD and underestimates the COLD death rates in the general population. Unless the followup period is long enough to observe the progression of COLD from its asymptomatic stages through the development of disability and finally death, the impact of cigarette smoking on COLD death rates will be underestimated. This effect is particularly important because cigarette smoking is overwhelmingly the major determinant of COLD risk, and therefore an underestimation of the true COLD prevalence leads to an underestimation of the relative risk of smoking. As the followup period is extended for a duration sufficient to allow the full time course of COLD to be observed, the impact of cigarette smoking on COLD death rates also emerges from the small background rate of COLD death certification in nonsmokers (which includes those classified in error and those with disease induced by agents that results in a more rapid progression to death).

This "healthy worker" effect is present to varying extents in all of the prospective studies and is one of the reasons the studies with the longest followup periods also tend to have the largest COLD mortality ratios. This is particularly evident in the study with the longest followup. The British doctors study, with a followup of 20 years, revealed a mortality ratio for male smokers of 24.7.

A final reason for the differences in mortality ratios is the differences in the smoking habits of the various populations. As was discussed in the previous chapter, the extent of lung injury is influenced by both the number of cigarettes smoked per day and the duration of the smoking habit. As is shown in Table 4, some of the variability in mortality ratios among the studies disappears when the mortality ratios are reported by number of cigarettes smoked per day. However, there are also substantial differences in the pattern of cigarette use in different countries, particularly in the use of the milder types of tobacco cigarettes that are more likely to be inhaled and are smoked in the United States. For example, these cigarettes

TABLE 3.—COLD mortality ratios by disease category, eight prospective studies

Study	Size of population	Nonsmoker	Emphysema		Bronchitis	Both	Other	Comments
British physicians								
Men	34,000	1.00				24.7		Ratio for women by amount smoked only; see Table 4
Women	6,195	1.00						
California men in various occupations	68,000	1.00	12.33					
Canadian veterans								
Men	78,000	1.00	5.85		11.42			
American Cancer Society 25-State			45–64 [1]	65–79 [1]				[1] Age range
Men	440,500	1.00	6.55	11.41				
Women	562,700	1.00	4.89	7.50				
U.S. veterans								
Men	290,000	1.00	14.82		5.11	12.07		
American Cancer Society 9-State								
Men	188,000	1.00					2.85	All pulmonary diseases other than cancer (pneumonia, influenza, TB, asthma, bronchitis, lung abscess, etc.)

TABLE 3.—Continued

Study	Size of population	Nonsmoker	Emphysema	Bronchitis	Both	Other	Comments
Swedish							
Men	27,000	1.00				*	*Number of deaths too small for statistical analysis; includes deaths due to asthma
Women	28,000	1.00				2.20	
Japanese							
Men	122,000	1.00					Data by amount smoked only; see Table 4
Women	143,000	1.00					