

# Former Cigarette Smoking and Mortality Among U.S. Veterans: A 26-Year Followup, 1954 to 1980

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**INTRODUCTION** This chapter presents a detailed analysis of data from the most recent mortality followup of almost 300,000 U.S. veterans whose tobacco use was surveyed by questionnaire in the 1950's. The study, commonly referred to as the Dorn study, was initiated by Harold Dorn in an effort to help resolve the then ongoing controversy regarding the role of smoking in the etiology of lung cancer. Together with six other large cohort studies (Doll and Hill, 1956; Hammond and Horn, 1958; Dunn et al., 1960 and 1963; Best et al., 1961; Hammond, 1963) and several case-control studies, the early results of this investigation (Dorn, 1958 and 1959) provided the basis for the first of a series of reports by the U.S. Surgeon General on the health effects of smoking, which identified lung cancer and a number of other causes of death as smoking related (U.S. Department of Health, Education, and Welfare, 1964). Subsequent followup of subjects in these investigations, including this study of veterans, has contributed to achieving a consensus on the harmful health effects of smoking and the benefits of cessation.

Although an important contribution at the time, Dorn's analyses of mortality in this cohort covered a short followup time and included few deaths. Mortality was evaluated for several major cause-of-death groups, but the main focus was on all deaths and on lung cancer (Dorn, 1958 and 1959). A definitive examination of a broad range of death causes, carried out by Kahn (1966), was based on a followup of 8.5 years through December 1962 and covered 46,270 deaths and 2,626,000 person-years, including nonrespondents. A subsequent comprehensive review extended followup to 16 years, through 1969 (Rogot, 1974; Rogot and Murray, 1980). It covered 107,563 deaths and 3,500,000 person-years. This chapter evaluates deaths by cause over 26 years through September 30, 1980. By that time, 198,172 of the subjects were deceased, and 5,429,000 person-years had accumulated in the entire cohort. The study covers a longer period of mortality monitoring and a greater number of person-years of observation than any single investigation of the long-term effects of exposure to tobacco.

Smoking status in this study was assessed from replies to the original questionnaire, and no information is available on subsequent changes in smoking. During the long mortality followup of these subjects, there was a considerable decline in smoking among men in the United States, which undoubtedly also occurred in this cohort. Therefore, the results presented here are restricted to those who reported never having smoked regularly or

having quit smoking cigarettes at the time of the study. Although some who reported quitting smoking later may have resumed it, few of the never-smokers in this group of mature men are likely to have started smoking following the questionnaire. The long followup period permits assessment of smoking-related mortality over the entire range of middle and older ages. Analyses by calendar period and by duration of cessation evaluate the persistence of the smoking-related excess mortality. This study work was designed to make the data in this chapter as comparable as possible with previous reports on the veterans' study and also with the other chapters in this volume.

**METHODS** The methods used have been described in detail (Dorn, 1958; Kahn, 1966; Rogot, 1974 and 1978; Rogot and Murray, 1980; Rogot and Hrubec, 1989a and 1989b). Study subjects were identified in 1953 as holders of active Government life insurance policies administered by the Veterans Administration (VA) and as veterans who had served in the U.S. Armed Forces at some time from 1917 through 1940. A questionnaire, mailed to these subjects early in 1954, inquired primarily about tobacco use, occupation, and industry of employment. The first mailing produced a 68-percent response rate, and a remailing to nonrespondents in 1957 resulted in a final response rate of 84 percent. Almost all the subjects were white, and less than 0.5 percent were females (Kahn, 1966).

In the 1962 and 1969 followups, mortality was ascertained by means of life insurance claims to the VA. In the most recent followup, through September 30, 1980, the entire sample was processed through the VA's Beneficiary Identification and Records Locator Subsystem (BIRLS). BIRLS records deaths of veterans even when they have allowed their policies to lapse and has been shown to be 96-percent complete for World War I veterans with more than 15 days of service who are thus eligible for life insurance (Beebe and Simon, 1969). This high level of completeness was confirmed independently of the VA's record systems by matching a systematic sample of 1,000 study subjects against the death tapes of the Social Security Administration. Causes of death were coded by nosologists trained in the *Manual of the International Statistical Classification of Diseases, Injuries, and Causes of Death (ICD-7)* (World Health Organization, 1957) to maintain consistency with the original coding. An underlying cause of death is coded for 95 percent of the deaths.

This analysis is based primarily on the 95,783 never-regular and former-regular cigarette smokers, as determined from either the 1954 or 1957 questionnaire. This group generated 60,549 deaths and 1,807,479 person-years of followup. Causes of death also have been obtained for nonrespondents and for those who at time of the questionnaire smoked cigarettes or used other forms of tobacco, but these data are not examined here. To achieve maximum comparability with the previous reports (Kahn, 1966; Rogot and Murray, 1980; Rogot and Hrubec, 1989a and 1989b) and with available analytic software (Monson, 1974), 50 death causes or cause-of-death groups have been constructed (see Appendix A at the end of this chapter).

Never-smokers are those who reported never regularly smoking cigarettes, cigars, or pipes (n = 55,049). Regular smoking is considered lifetime consumption (at time of questionnaire) of more than 5 to 10 packs of cigarettes, 50 to 75 cigars, or 3 to 5 packages of pipe tobacco if this consumption involved, respectively, smoking daily at least one cigarette, cigar, or pipeful of tobacco. Former cigarette smokers smoked cigarettes regularly at any time in the past but did not regularly smoke cigarettes, cigars, or pipes (n = 40,734) at time of questionnaire.

It would be useful to exclude from the former smoker group subjects who stopped smoking shortly prior to the questionnaire, because some of them may have later resumed smoking. The available data identify those who stopped smoking in the 5 years prior to the questionnaire, but these subjects cannot be subdivided into more detailed categories of time since smoking stopped. Excluding the 39 percent who stopped within 5 years of the questionnaire did not appreciably affect findings for all former smokers. The entire group was examined explicitly by years since smoking stopped for total deaths and for the major smoking-related death causes. Other variables employed in the analysis were the highest number of cigarettes formerly smoked per day (none, 1 to 9, 10 to 20, 21 to 39, 40+), age at which subject started smoking cigarettes (<15, 15 to 19, 20 to 24, 25+), calendar year interval of followup (1954 to 1959, 1960 to 1964, 1965 to 1969, 1970 to 1974, 1975 to 1980), and age attained at followup (in 5-year age groups from 30 to 34 to 100 to 104 and 105+).

The data were evaluated by means of internally standardized relative risks (RR's), standardized mortality ratios (SMR's), and standardized annual mortality rates. In these analyses, person-years were accumulated from the year of questionnaire response, January 1, 1954, or 1957, to the date of death or to September 30, 1980, for those then alive. The 181 subjects with unknown year of death were retained until the cutoff date.

The RR's were computed by fitting Poisson regression models with maximum likelihood methods using the above-described variable groupings (Breslow and Day, 1988). The RR's for former smokers were obtained with respect to the never-smokers (RR = 1.0). Score tests of significance of trends were carried out (Preston et al., 1990). The RR analyses were adjusted for attained age in 5-year groups and for the calendar-year periods given above. Time-specific RR's are based on never-smoker mortality in the corresponding period. The procedures are described in detail in the footnotes following the tables.

The SMR's were obtained through a modification of the program by Monson (1974), who developed expected numbers of deaths for a number of causes or cause-of-death groupings by applying U.S. white male mortality rates for 5-year age and calendar-year groups. Because these external rates were based on different revisions of the ICD codes in effect during the period of followup, acceptable consistency over time could be established only for a limited number of cause-of-death groups. The correspondence between the definitions of groups in the RR and SMR analyses is shown in Appendix A.

The SMR's also could not be obtained for some of the cause groups used in the Kahn (1966) and Rogot and Murray (1980) analyses or for other groups of particular interest. In some cases, SMR groupings correspond only approximately. When SMR's could not be obtained, only the internally standardized RR's are presented, which compare well with the methods used by Rogot and Murray (1980) and Kahn (1966). The definitions of the groups used in the earlier sources also are given in Appendix A.

The rates were standardized directly to the age distribution of the 1980 total U.S. population older than age 30. Within the same calendar periods used for standardizing the RR's, in each 10-year group of attained age, the number of deaths was divided by the corresponding person-years and then multiplied by the proportion of the U.S. population older than 30 years in that age group during that time. The standardized rate is the sum of these computations over the age and calendar-time groups.

## RESULTS

### All Deaths

In the entire cohort ( $n = 293,916$ ), including nonrespondents, mortality from all causes was low; the overall SMR was 77. Among all questionnaire respondents ( $n = 248,046$ ), the SMR was 73; among never-smokers, 58; and among former smokers, 70. Compared with the risk of death of never-smokers, the risk of death from all causes was elevated for former cigarette smokers ( $RR = 1.2$ ). Mortality was highest for those starting smoking younger than age 15, but even those who started at age 25 years or older were at excess risk (Table 1). The RRs were 1.3 from 1954 through 1964, 1.2 from 1965 through 1969, and 1.1 subsequently (Table 2). The SMR's were 70 in all periods, except 1970 through 1974, when the value was 69, but the standardized rates declined over time. Among never-smokers, with the 1954 to 1964 period as the baseline, the RR's for the 4 periods were, respectively, 1.0, 1.0, 0.9, and 0.8 (linear trend,  $p < 0.001$ ). The RR's increased with amount of former smoking ( $p < 0.001$ , Table 3). Former cigarette smokers did not experience an appreciably reduced risk until 5 or more years following cessation. The RR for all those who stopped 40 or more years ago was 1.0 and appreciably increased only for those who had smoked 40+ cigarettes per day ( $RR = 1.2$ , 95-percent lower confidence limit = 1.01) (see Table 3).

### Lung Cancer

The RR for lung cancer for former cigarette smokers of all ages was 3.6 (Table 1). Mortality was elevated among those who started smoking before age 15 and decreased regularly with later starting ages (Table 1). The RR varied unevenly in intervals of the 1954 to 1974 period but dropped to 2.8 in the 1975 to 1980 period with a significant linear trend (Table 2). The SMR was 54 during the 1954 to 1964 period but subsequently declined to 40. The RR's of never-smokers for lung cancer, with the 1954 to 1964 period as the baseline ( $RR = 1.0$ ), were elevated in the subsequent periods, but there was no linear trend ( $RR = 1.4, 1.1, \text{ and } 1.3$ , respectively). The RR was 6.9 for those smoking 40+ cigarettes per day (Table 4). During the first 5 years following stopping smoking, the risk of former cigarette smokers was high ( $RR = 16.1$ ), but as cessation continued, it declined steeply. After 40 years of stopping smoking and among those who had smoked fewer than 10 cigarettes per day, the risk approximated that of never-smokers.

Table 1

**U.S. veterans, former cigarette smokers:<sup>a</sup> relative risks based on never-smokers (RR = 1.0),<sup>b</sup> lower and upper 95-percent confidence limits on RR, standardized mortality ratio,<sup>c</sup> age-standardized rates per 100,000 person-years,<sup>d</sup> and number of deaths by cause<sup>e</sup> and age started cigarettes**

Age Started		All Deaths	Lung Cancer	Coronary Heart Disease	Chronic Obstructive Pulmonary Disease
Total— all ages <sup>f</sup>	RR	1.2	3.6	1.2	4.1
	LL	1.2	3.2	1.2	3.6
	UL	1.2	4.1	1.2	4.8
	SMR	70	45	68	—
	Rate	1,574	38	582	34
	Deaths	26,722	781	10,369	650
<15	RR	1.3	5.2	1.3	6.7
	LL	1.3	4.1	1.2	5.2
	UL	1.4	6.6	1.4	8.6
	SMR	77	64	72	—
	Rate	1,791	52	612	45
	Deaths	2,377	91	884	82
15-19	RR	1.2	4.4	1.2	4.7
	LL	1.2	3.8	1.2	4.0
	UL	1.3	5.1	1.3	5.6
	SMR	72	54	69	—
	Rate	1,585	47	568	35
	Deaths	10,998	388	4,258	295
20-24	RR	1.2	3.2	1.2	3.8
	LL	1.1	2.7	1.1	3.1
	UL	1.2	3.8	1.2	4.6
	SMR	68	39	67	—
	Rate	1,487	36	577	29
	Deaths	7,978	213	3,142	181
25+	RR	1.1	2.0	1.1	2.6
	LL	1.1	1.6	1.1	2.1
	UL	1.2	2.6	1.2	3.4
	SMR	66	27	64	—
	Rate	1,538	20	531	23
	Deaths	5,179	86	2,008	88
<i>p</i> of trend <sup>g</sup>		<0.001	<0.001	<0.001	<0.001

<sup>a</sup> No cigar or pipe at time of questionnaire, but includes former cigar or pipe.

<sup>b</sup> Estimated from a Poisson regression model, internally adjusted for attained age and (except Table 2) calendar time. See Tables 3 through 6 for never-smokers' SMR values, rate/100,000, and number of deaths.

<sup>c</sup> 100 x observed/expected number of deaths. The expected number is obtained by multiplying age- and calendar-time-specific mortality rates by the corresponding person-years and summing appropriately.

<sup>d</sup> Standardized to the age distribution of the total U.S. 1980 population within 5-year calendar periods.

<sup>e</sup> For 1954 and 1957 questionnaire respondents, deaths were counted from year of questionnaire response to September 30, 1980. The underlying cause was coded according to the Manual of the International Statistical Classification of Diseases, Injuries, and Causes of Death (World Health Organization, 1957).

<sup>f</sup> Includes unknown age started smoking cigarettes.

<sup>g</sup> Score test for linear trend, excluding unknown age started, the other age-started groups coded 12.5, 17.5, 22.5, and 33.5, adjusted for attained age and calendar time.

Key: RR = relative risk; LL = lower 95-percent confidence limit; UL = upper 95-percent confidence limit; SMR = standardized mortality ratio.

Table 2

**U.S. veterans, former cigarette smokers:<sup>a</sup> relative risks based on never-smokers (RR = 1.0),<sup>b</sup> lower and upper 95-percent confidence limits on RR, standardized mortality ratio,<sup>c</sup> age-standardized rates per 100,000 person-years,<sup>d</sup> and number of deaths by cause<sup>e</sup> and year of followup**

Age Started		All Deaths	Lung Cancer	Coronary Heart Disease	Chronic Obstructive Pulmonary Disease
1954-1964	RR	1.3	4.8	1.3	8.3
	LL	1.3	3.8	1.3	6.0
	UL	1.4	6.0	1.4	11.4
	SMR	70	54	77	—
	Rate	1,688	46	704	36
	Deaths	8,587	318	3,709	247
1965-1969	RR	1.2	3.0	1.1	4.3
	LL	1.2	2.3	1.1	3.1
	UL	1.2	3.9	1.2	6.0
	SMR	70	43	68	—
	Rate	1,662	39	608	38
	Deaths	5,636	165	2,200	128
1970-1974	RR	1.1	3.6	1.1	3.0
	LL	1.1	2.6	1.0	2.2
	UL	1.2	4.8	1.2	4.0
	SMR	69	38	61	—
	Rate	1,440	35	508	34
	Deaths	5,982	147	2,212	125
1975-1980 <sup>f</sup>	RR	1.1	2.8	1.1	2.7
	LL	1.1	2.1	1.1	2.1
	UL	1.2	3.6	1.2	3.5
	SMR	70	40	62	—
	Rate	1,337	35	454	26
	Deaths	6,517	151	2,248	150
<i>p</i> of trend <sup>g</sup>		<0.001	0.004	<0.001	<0.001

<sup>a</sup> No cigar or pipe at time of questionnaire but includes former cigar or pipe.

<sup>b</sup> Estimated from a Poisson regression model, internally adjusted for attained age and (except Table 2) calendar time. See Tables 3 through 6 for never-smokers' SMR values, rate/100,000, and number of deaths.

<sup>c</sup> 100 x observed/expected number of deaths. The expected number is obtained by multiplying age- and calendar-time-specific mortality rates by the corresponding person-years and summing appropriately.

<sup>d</sup> Standardized to the age distribution of the total U.S. 1980 population.

<sup>e</sup> For 1954 and 1957 questionnaire respondents, deaths were counted from year of questionnaire response to September 30, 1980. The underlying cause was coded according to the Manual of the International Statistical Classification of Diseases, Injuries, and Causes of Death (World Health Organization, 1957).

<sup>f</sup> Includes unknown duration of followup.

<sup>g</sup> Score test for linear trend, followup interval groups coded 1960, 1967, 1972, and 1977, adjusted for attained age and amount smoked.

Key: RR = relative risk; LL = lower 95-percent confidence limit; UL = upper 95-percent confidence limit; SMR = standardized mortality ratio.

Table 3

**U.S. veterans: relative risks based on never-smokers (RR = 1.0),<sup>a</sup> lower and upper 95-percent confidence limits on RR, standardized mortality ratio,<sup>b</sup> age-standardized rates per 100,000 person-years,<sup>c</sup> and number of deaths from all causes<sup>d</sup> among never-smokers and former cigarette smokers<sup>e</sup> by duration of nonsmoking**

Years Since Smoked at Followup		Smoking at Time of Questionnaire (1954 or 1957)					
		Never- Smoker	Former Smoker, by Number of Cigarettes				Total
			1-9	10-20	21-39	40+	
		All Deaths					
Total <sup>f</sup>	RR	1.0	1.0	1.2	1.3	1.5	1.2
	LL	—	1.0	1.2	1.3	1.4	1.2
	UL	—	1.1	1.2	1.4	1.5	1.2
	SMR	58	61	68	75	84	70
	Rate	1,429	1,450	1,545	1,661	1,932	1,574
	Deaths	33,827	5,014	12,103	6,953	2,652	26,722
<5	RR	—	1.5	1.8	1.9	2.2	1.8
	LL	—	1.2	1.6	1.7	1.8	1.7
	UL	—	2.0	2.0	2.2	2.7	2.0
	SMR	—	75	88	93	106	90
	Rate	—	649	882	896	998	879
	Deaths	—	59	287	200	87	633
5-9	RR	—	1.3	1.4	1.8	1.7	1.5
	LL	—	1.1	1.3	1.6	1.5	1.5
	UL	—	1.5	1.5	1.9	1.9	1.6
	SMR	—	67	71	90	86	78
	Rate	—	927	1,128	1,320	1,263	1,181
	Deaths	—	178	733	592	213	1,716
10-19	RR	—	1.2	1.3	1.5	1.6	1.4
	LL	—	1.1	1.3	1.4	1.5	1.3
	UL	—	1.2	1.4	1.6	1.8	1.4
	SMR	—	64	72	82	90	76
	Rate	—	1,394	1,481	1,602	1,946	1,539
	Deaths	—	757	2,974	2,020	813	6,564
20-29	RR	—	1.1	1.1	1.3	1.4	1.2
	LL	—	1.0	1.1	1.2	1.3	1.2
	UL	—	1.1	1.2	1.3	1.5	1.2
	SMR	—	63	67	75	84	70
	Rate	—	1,459	1,533	1,536	1,847	1,525
	Deaths	—	1,058	3,598	2,287	892	7,835
30-39	RR	—	1.0	1.1	1.1	1.2	1.1
	LL	—	0.9	1.0	1.0	1.1	1.0
	UL	—	1.1	1.1	1.2	1.4	1.1
	SMR	—	58	64	65	74	63
	Rate	—	1,421	2,093	1,504	1,600	1,964
	Deaths	—	1,004	2,226	1,049	395	4,674

Table 3 (continued)

Years Since Smoked at Followup		Smoking at Time of Questionnaire (1954 or 1957)						
		Never- Smoker	Former Smoker, by Number of Cigarettes					Total
			1-9	10-20	21-39	40+		
		All Deaths						
40+	RR	–	1.0	1.1	1.0	1.2	1.0	
	LL	–	1.0	1.0	1.0	1.0	1.0	
	UL	–	1.1	1.1	1.1	1.3	1.1	
	SMR	–	63	65	64	71	64	
	Rate	–	1,663	1,461	1,376	1,634	1,483	
	Deaths	–	1,303	1,755	656	226	3,940	
<i>p</i> of trend <sup>g</sup>		–	0.001	<0.001	<0.001	<0.001	<0.001	

<sup>a</sup> Estimated from a Poisson regression model, internally adjusted for attained age and (except Table 2) calendar time. See Tables 3 through 6 for never-smokers' SMR values, rate/100,000, and number of deaths.

<sup>b</sup> 100 x observed/expected number of deaths. The expected number is obtained by multiplying age- and calendar-time-specific mortality rates by the corresponding person-years and summing appropriately.

<sup>c</sup> Standardized to the age distribution of the total U.S. 1980 population within 5-year calendar periods.

<sup>d</sup> For 1954 and 1957 questionnaire respondents, deaths were counted from year of questionnaire response to September 30, 1980. The underlying cause was coded according to the Manual of the International Statistical Classification of Diseases, Injuries, and Causes of Death (World Health Organization, 1957).

<sup>e</sup> No cigar or pipe at time of questionnaire but includes former cigar or pipe.

<sup>f</sup> Includes unknown years since smoked.

<sup>g</sup> Score test for linear trend, excluding unknown years; the years-since-smoked groups coded 2.5, 7.5, 15.0, 25.0, 35.0, and 45.0, adjusted for attained age and calendar time.

Key: RR = relative risk; LL = lower 95-percent confidence limit; UL = upper 95-percent confidence limit; SMR = standardized mortality ratio.

**Coronary Heart Disease** The RR's of former cigarette smokers for coronary heart disease were similar to the RR's for all deaths (RR = 1.2, Table 1). The RR was slightly higher for those who started smoking younger than age 15 and was lower for those who started at age 25 or older ( $p < 0.001$ ). The RR was 1.3 in the 1954 to 1964 period and thereafter decreased to 1.1 (Table 2). The SMR was 77 during the 1954 to 1964 period but after 1970 stabilized at just more than 60. Among never-smokers, with the RR during the 1954 to 1964 period set to 1.0, the RR's in the subsequent periods were, respectively, 1.0, 0.9, and 0.8 (linear trend,  $p < 0.001$ ). Mortality increased with the amount formerly smoked ( $p < 0.001$ , Table 5). The RR's were not clearly reduced until 20 or more years after stopping smoking. After 30 or more years, the mortality of former smokers was comparable with that of never-smokers and was not appreciably affected by the amount they had smoked.

**Chronic Obstructive Pulmonary Disease** The RR for chronic obstructive pulmonary disease of former cigarette smokers was high (RR = 4.1), with those starting at younger ages having greater risks (Table 1). An RR of 8.3 in the 1954 to 1964 period declined progressively over time to 2.7 from 1975 through 1980 (Table 2). The standardized rate appreciably exceeded 30 per



Table 4

**U.S. veterans: relative risks based on never-smokers (RR = 1.0),<sup>a</sup> lower and upper 95-percent confidence limits on RR, standardized mortality ratio,<sup>b</sup> age-standardized rates per 100,000 person-years,<sup>c</sup> and number of deaths from lung cancer<sup>d</sup> among never-smokers and former cigarette smokers<sup>e</sup> by duration of nonsmoking**

Years Since Smoked at Followup		Smoking at Time of Questionnaire (1954 or 1957)					
		Never- Smoker	Former Smoker, by Number of Cigarettes				Total
			1-9	10-20	21-39	40+	
		Lung Cancer					
Total <sup>f</sup>	RR	1.0	1.4	3.3	5.0	6.9	3.6
	LL	—	1.0	2.8	4.2	5.6	3.2
	UL	—	1.8	3.9	5.9	8.5	4.1
	SMR	13	18	41	60	84	45
	Rate	21	15	36	54	65	38
	Deaths	325	62	332	262	125	781
<5	RR	—	7.6	12.5	20.6	26.9	16.1
	LL	—	2.3	7.1	11.9	13.6	10.4
	UL	—	24.9	21.7	35.6	53.4	24.8
	SMR	—	78	125	205	270	162
	Rate	—	36	61	91	112	73
	Deaths	—	3	20	22	11	56
5-9	RR	—	3.6	5.1	11.5	13.6	7.8
	LL	—	1.5	3.3	7.8	8.0	5.7
	UL	—	9.0	8.0	17.0	22.9	10.5
	SMR	—	38	52	111	132	77
	Rate	—	33	36	90	134	65
	Deaths	—	5	27	38	17	87
10-19	RR	—	2.2	4.3	6.8	7.8	5.1
	LL	—	1.3	3.4	5.4	5.6	4.2
	UL	—	3.6	5.4	8.7	10.9	6.1
	SMR	—	27	51	79	92	61
	Rate	—	40	39	78	58	51
	Deaths	—	15	104	100	42	261
20-29	RR	—	1.7	3.3	3.4	5.9	3.3
	LL	—	1.0	2.6	2.6	4.2	2.8
	UL	—	2.8	4.1	4.5	8.3	4.0
	SMR	—	22	42	42	74	42
	Rate	—	11	35	34	39	31
	Deaths	—	16	102	61	36	215
30-39	RR	—	0.5	2.1	2.8	4.5	2.0
	LL	—	0.2	1.5	1.9	2.6	1.6
	UL	—	1.3	2.9	4.3	7.9	2.6
	SMR	—	7	26	36	58	26
	Rate	—	5	22	26	50	21
	Deaths	—	5	39	25	13	82

Table 4 (continued)

Years Since Smoked at Followup		Smoking at Time of Questionnaire (1954 or 1957)						
		Never- Smoker	Former Smoker, by Number of Cigarettes					Total
			1-9	10-20	21-39	40+	Lung Cancer	
40+	RR	–	1.1	1.6	1.8	2.3	1.5	
	LL	–	0.6	1.0	0.9	0.9	1.1	
	UL	–	1.9	2.4	3.3	6.2	2.0	
	SMR	–	15	22	24	32	20	
	Rate	–	11	15	13	9	13	
	Deaths	–	12	23	10	4	49	
<i>p</i> of trend <sup>g</sup>		–	<0.001	<0.001	<0.001	<0.001	<0.001	

<sup>a</sup> Estimated from a Poisson regression model, internally adjusted for attained age and (except Table 2) calendar time. See Tables 3 through 6 for never-smokers' SMR values, rate/100,000, and number of deaths.

<sup>b</sup> 100 x observed/expected number of deaths. The expected number is obtained by multiplying age- and calendar-time-specific mortality rates by the corresponding person-years and summing appropriately.

<sup>c</sup> Standardized to the age distribution of the total U.S. 1980 population within 5-year calendar periods.

<sup>d</sup> For 1954 and 1957 questionnaire respondents, deaths were counted from year of questionnaire response to September 30, 1980. The underlying cause was coded according to the Manual of the International Statistical Classification of Diseases, Injuries, and Causes of Death (World Health Organization, 1957).

<sup>e</sup> No cigar or pipe at time of questionnaire but includes former cigar or pipe.

<sup>f</sup> Includes unknown years since smoked.

<sup>g</sup> Score test for linear trend, excluding unknown years, the years-since-smoked groups coded 2.5, 7.5, 15.0, 25.0, 35.0, and 45.0, adjusted for attained age and calendar time.

Key: RR = relative risk; LL = lower 95-percent confidence limit; UL = upper 95-percent confidence limit; SMR = standardized mortality ratio.

100,000 person-years from 1954 through 1974 but finally declined to 26 per 100,000. When the 1954 to 1964 period was taken as the baseline (RR = 1.0), the RR's of never-smokers in the subsequent periods were 1.2, 1.2, and 1.1, respectively, with no significant linear trend. Mortality was highest among those who had smoked 40+ cigarettes per day (RR = 6.7, Table 6). The RR's were much elevated during the first 10 years following cessation, and although appreciably lower after 20 years, they remained well in excess of 1.0. The pattern of decreased risk with longer cessation was consistent within groups based on amount of former smoking, except among those smoking fewer than 10 cigarettes per day.

**Other Causes of Death** Statistically significant ( $p < 0.05$ ) positive excess risks with former cigarette smoking were found for 27 of the 50 cause-of-death groups examined (Table 7). The cause-of-death groups for which there was no significantly deviant risk with former cigarette smoking are listed below with their RR estimates in parentheses. When the rounded values of the 95-percent confidence limits in Table 7 are ambiguous, more precise estimates of the confidence intervals are included with the RR's:

Table 5

**U.S. veterans: relative risks based on never-smokers (RR = 1.0),<sup>a</sup> lower and upper 95-percent confidence limits on RR, standardized mortality ratio,<sup>b</sup> age-standardized rates per 100,000 person-years,<sup>c</sup> and number of deaths from coronary heart disease<sup>d</sup> among never-smokers and former cigarette smokers<sup>e</sup> by duration of nonsmoking**

Years Since Smoked at Followup		Smoking at Time of Questionnaire (1954 or 1957)						
		Never- Smoker	Former Smoker, by Number of Cigarettes					Total
			1-9	10-20	21-39	40+		
		Coronary Heart Disease						
Total <sup>f</sup>	RR	1.0	1.1	1.2	1.3	1.4	1.2	
	LL	—	1.0	1.1	1.3	1.3	1.2	
	UL	—	1.1	1.2	1.4	1.5	1.2	
	SMR	57	60	66	74	79	68	
	Rate	528	536	551	594	849	582	
	Deaths	13,257	1,966	4,685	2,723	995	10,369	
<5	RR	—	1.3	1.7	1.9	1.7	1.7	
	LL	—	0.9	1.4	1.5	1.2	1.5	
	UL	—	1.9	2.1	2.3	2.4	1.9	
	SMR	—	76	101	108	99	100	
	Rate	—	262	386	390	343	372	
	Deaths	—	23	126	89	31	269	
5-9	RR	—	1.2	1.4	1.7	1.7	1.5	
	LL	—	0.9	1.2	1.5	1.4	1.4	
	UL	—	1.5	1.6	1.9	2.1	1.6	
	SMR	—	68	81	98	98	86	
	Rate	—	347	449	529	622	493	
	Deaths	—	71	325	253	96	745	
10-19	RR	—	1.1	1.4	1.5	1.4	1.4	
	LL	—	1.0	1.3	1.4	1.3	1.3	
	UL	—	1.3	1.4	1.6	1.6	1.4	
	SMR	—	66	78	84	82	78	
	Rate	—	455	640	599	752	604	
	Deaths	—	312	1,282	828	295	2,717	
20-29	RR	—	1.1	1.1	1.3	1.4	1.2	
	LL	—	1.0	1.0	1.2	1.3	1.1	
	UL	—	1.2	1.2	1.3	1.6	1.2	
	SMR	—	60	62	70	81	65	
	Rate	—	535	543	570	880	576	
	Deaths	—	404	1,329	851	343	2,927	
30-39	RR	—	1.0	1.0	1.1	1.1	1.1	
	LL	—	0.9	1.0	1.0	0.9	1.0	
	UL	—	1.1	1.1	1.2	1.3	1.1	
	SMR	—	59	60	62	64	60	
	Rate	—	509	947	535	773	984	
	Deaths	—	403	825	399	135	1,762	

Table 5 (continued)

Years Since Smoked at Followup		Smoking at Time of Questionnaire (1954 or 1957)						
		Never- Smoker	Former Smoker, by Number of Cigarettes					Total
			1-9	10-20	21-39	40+		
		Coronary Heart Disease						
40+	RR	–	1.1	1.0	1.0	1.1	1.0	
	LL	–	1.0	0.9	0.9	0.9	1.0	
	UL	–	1.2	1.1	1.2	1.4	1.1	
	SMR	–	60	56	59	64	58	
	Rate	–	981	423	404	359	568	
	Deaths	–	502	605	244	82	1,433	
<i>p</i> of trend <sup>g</sup>		–	0.251	<0.001	<0.001	0.025	<0.001	

<sup>a</sup> Estimated from a Poisson regression model, internally adjusted for attained age and (except Table 2) calendar time. See Tables 3 through 6 for never-smokers' SMR values, rate/100,000, and number of deaths.

<sup>b</sup> 100 x observed/expected number of deaths. The expected number is obtained by multiplying age- and calendar-time-specific mortality rates by the corresponding person-years and summing appropriately.

<sup>c</sup> Standardized to the age distribution of the total U.S. 1980 population within 5-year calendar periods.

<sup>d</sup> For 1954 and 1957 questionnaire respondents, deaths were counted from year of questionnaire response to September 30, 1980. The underlying cause was coded according to the Manual of the International Statistical Classification of Diseases, Injuries, and Causes of Death (World Health Organization, 1957).

<sup>e</sup> No cigar or pipe at time of questionnaire but includes former cigar or pipe.

<sup>f</sup> Includes unknown years since smoked.

<sup>g</sup> Score test for linear trend, excluding unknown years, the years-since-smoked groups coded 2.5, 7.5, 15.0, 25.0, 35.0, and 45.0, adjusted for attained age and calendar time.

Key: RR = relative risk; LL = lower 95-percent confidence limit; UL = upper 95-percent confidence limit; SMR = standardized mortality ratio.

- buccal cavity cancer (RR = 1.5);
- esophagus cancer (RR = 1.6, 0.99-2.17);
- stomach cancer (RR = 1.0);
- pancreas cancer (RR = 1.1);
- kidney cancer (RR = 1.1);
- skin cancer (RR = 1.1);
- brain cancer (RR = 1.1);
- malignant lymphoma (RR = 1.0);
- non-Hodgkin's lymphoma (RR = 1.0);
- Hodgkin's disease (RR = 0.9);
- multiple myeloma (RR = 1.0);
- chronic rheumatic heart disease (RR = 1.1);
- hypertension (RR = 1.1);

Table 6

**U.S. veterans: relative risks based on never-smokers (RR = 1.0),<sup>a</sup> lower and upper 95-percent confidence limits on RR, standardized mortality ratio,<sup>b</sup> age-standardized rates per 100,000 person-years,<sup>c</sup> and number of deaths from chronic obstructive pulmonary disease<sup>d</sup> among never-smokers and former cigarette smokers<sup>e</sup> by duration of nonsmoking**

Years Since Smoked at Followup		Smoking at Time of Questionnaire (1954 or 1957)					
		Never- Smoker	Former Smoker, by Number of Cigarettes				
			1-9	10-20	21-39	40+	Total
		Chronic Obstructive Pulmonary Disease					
Total <sup>f</sup>	RR	1.0	1.9	3.9	5.9	6.7	4.1
	LL	—	1.4	3.3	4.9	5.2	3.6
	UL	—	2.4	4.6	7.1	8.5	4.8
	Rate	9.3	16	29	63	49	34
	Deaths	243	64	282	218	86	650
<5	RR	—	0.0	22.7	37.7	21.1	24.1
	LL	—	0.0	9.2	15.1	4.6	11.2
	UL	—	—	56.2	93.8	97.0	51.8
	Rate	—	0	20	37	19	23
	Deaths	—	0	9	9	2	20
5-9	RR	—	7.6	17.8	20.5	10.2	16.5
	LL	—	2.7	11.1	12.2	4.0	10.9
	UL	—	21.5	28.5	34.4	26.2	24.9
	Rate	—	22	45	46	41	42
	Deaths	—	4	36	26	5	71
10-19	RR	—	1.3	6.9	9.8	15.4	7.8
	LL	—	0.5	5.3	7.4	11.0	6.3
	UL	—	3.1	9.0	13.0	21.6	9.7
	Rate	—	5	36	74	71	48
	Deaths	—	5	94	79	46	224
20-29	RR	—	1.7	2.8	5.4	4.6	3.5
	LL	—	1.0	2.1	4.1	3.0	2.8
	UL	—	2.9	3.6	7.0	7.1	4.2
	Rate	—	11	22	37	27	24
	Deaths	—	13	67	72	22	174
30-39	RR	—	2.4	2.4	2.2	2.6	2.4
	LL	—	1.5	1.7	1.4	1.2	1.9
	UL	—	4.0	3.4	3.6	5.6	3.1
	Rate	—	18	19	50	18	24
	Deaths	—	17	39	17	7	80

Table 6 (continued)

Years Since Smoked at Followup		Smoking at Time of Questionnaire (1954 or 1957)					
		Never- Smoker	Former Smoker, by Number of Cigarettes				Total
			1-9	10-20	21-39	40+	
Chronic Obstructive Pulmonary Disease							
40+	RR	–	1.4	1.5	1.9	1.8	1.6
	LL	–	0.8	1.0	1.0	0.6	1.1
	UL	–	2.4	2.4	3.6	5.7	2.1
	Rate	–	38	9	9	11	21
	Deaths	–	15	21	10	3	49
<i>p</i> of trend <sup>g</sup>		–	0.527	<0.001	<0.001	<0.001	<0.001

<sup>a</sup> Estimated from a Poisson regression model, internally adjusted for attained age and (except Table 2) calendar time. See Tables 3 through 6 for never-smokers' SMR values, rate/100,000, and number of deaths.

<sup>b</sup> 100 x observed/expected number of deaths. The expected number is obtained by multiplying age- and calendar-time-specific mortality rates by the corresponding person-years and summing appropriately.

<sup>c</sup> Standardized to the age distribution of the total U.S. 1980 population within 5-year calendar periods.

<sup>d</sup> For 1954 and 1957 questionnaire respondents, deaths were counted from year of questionnaire response to September 30, 1980. The underlying cause was coded according to the Manual of the International Statistical Classification of Diseases, Injuries, and Causes of Death (World Health Organization, 1957).

<sup>e</sup> No cigar or pipe at time of questionnaire but includes former cigar or pipe.

<sup>f</sup> Includes unknown years since smoked.

<sup>g</sup> Score test for linear trend, excluding unknown years, the years-since-smoked groups coded 2.5, 7.5, 15.0, 25.0, 35.0, and 45.0, adjusted for attained age and calendar time.

Key: RR = relative risk; LL = lower 95-percent confidence limit; UL = upper 95-percent confidence limit; SMR = standardized mortality ratio.

- phlebitis and pulmonary embolism (RR = 1.2, 0.98-1.42);
- general arteriosclerosis (RR = 1.1, 0.97-1.21);
- influenza and pneumonia (RR = 1.1, 0.998-1.23);
- pneumonia (RR = 1.1, 0.98-1.21);
- diabetes (RR = 0.9, 0.73-1.02);
- chronic nephritis (RR = 1.3);
- nephritis, nephrosis, other kidney diseases (RR = 1.0);
- intestinal obstruction (RR = 1.2);
- accidents other than motor vehicle (RR = 1.0); and
- motor vehicle accidents (RR = 1.0).

Mortality from Parkinson's disease was significantly lower among former smokers (RR = 0.78, 0.65-0.95,  $p < 0.012$ ) than among never-smokers.

The RR's of former smokers changed variously over time for the 50 different cause-of-death groups (Table 8). Although some still exceeded

Table 7

**U.S. veterans, former cigarette smokers:<sup>a</sup> relative risks based on never-smokers (RR = 1.0),<sup>b</sup> lower and upper 95-percent confidence limits on RR, standardized mortality ratio,<sup>c</sup> age-standardized rates per 100,000 person-years,<sup>d</sup> and number of deaths by cause<sup>e</sup>**

<i>ICD-7 Cause-Of-Death Code Group<sup>f</sup></i>			
All Deaths: E000-999			
RR	1.2		
LL	1.2		
UL	1.2		
SMR	70		
Rate	1,574		
Deaths	26,722		
All Cancer: 140-207			
RR	1.3		
LL	1.3		
UL	1.4		
SMR	69		
Rate	266		
Deaths	4,734		
Buccal Cavity Cancer: 140-144 (SMR: 140-148)			
RR	1.5		
LL	0.9		
UL	2.4		
SMR	26		
Rate	1.8		
Deaths	33		
Pharynx Cancer: 145-148 (For SMR see 140-148 above)			
RR	2.6		
LL	1.1		
UL	6.2		
SMR	—		
Rate	5.3		
Deaths	14		
Esophagus Cancer: 150			
RR	1.6		
LL	1.0		
UL	2.2		
SMR	33		
Rate	5.9		
Deaths	50		
Stomach Cancer: 151			
RR	1.0		
LL	0.9		
UL	1.2		
SMR	50		
Rate	13		
Deaths	230		
Colon Cancer: 153			
RR	1.4		
LL	1.2		
UL	1.5		
SMR	100		
Rate	45		
Deaths	740		
Rectum Cancer: 154			
RR	1.3		
LL	1.0		
UL	1.5		
SMR	71		
Rate	8.9		
Deaths	186		
Liver Cancer: 155 (SMR: 155-156)			
RR	1.5		
LL	1.2		
UL	2.0		
SMR	84		
Rate	6.7		
Deaths	95		
Pancreas Cancer: 157			
RR	1.1		
LL	0.9		
UL	1.3		
SMR	68		
Rate	18		
Deaths	265		
Larynx Cancer: 161			
RR	5.0		
LL	2.4		
UL	10.5		
SMR	33		
Rate	2.5		
Deaths	30		
Lung Cancer: 162-163			
RR	3.6		
LL	3.2		
UL	4.1		
SMR	45		
Rate	38		
Deaths	781		

Table 7 (continued)

<i>ICD-7 Cause-Of-Death Code Group<sup>f</sup></i>				
Prostate Cancer: 177			Non-Hodgkin's Lymphoma: 200	
RR	1.1		RR	1.0
LL	1.0		LL	0.8
UL	1.2		UL	1.2
SMR	92		SMR	124
Rate	37		Rate	8.7
Deaths	817		Deaths	152
Kidney Cancer: 180			Hodgkin's Disease: 201	
RR	1.1		RR	0.9
LL	0.9		LL	0.6
UL	1.4		UL	1.3
SMR	77		SMR	77
Rate	6.3		Rate	1.4
Deaths	111		Deaths	31
Bladder Cancer: 181			Multiple Myeloma: 203	
RR	1.3		RR	1.0
LL	1.1		LL	0.8
UL	1.6		UL	1.3
SMR	71		SMR	107
Rate	12.8		Rate	4.8
Deaths	220		Deaths	97
Skin Cancer: 190-191			Leukemia: 204	
RR	1.1		RR	1.3
LL	0.8		LL	1.1
UL	1.5		UL	1.5
SMR	79		SMR	104
Rate	3.6		Rate	16
Deaths	69		Deaths	299
Brain Cancer: 193			All Cardiovascular Disease: 330-334, 400-468	
RR	1.1		RR	1.2
LL	0.9		LL	1.1
UL	1.4		UL	1.2
SMR	133		SMR	70
Rate	7.6		Rate	947
Deaths	116		Deaths	16,586
Malignant Lymphoma: 200, 201, 203			Coronary Heart Disease: 420	
RR	1.0		RR	1.2
LL	0.8		LL	1.2
UL	1.1		UL	1.2
SMR	111		SMR	68
Rate	15		Rate	582
Deaths	280		Deaths	10,369



Table 7 (continued)

<i>ICD-7 Cause-Of-Death Code Group<sup>f</sup></i>			
Chronic Rheumatic Heart Disease: 410-416		Phlebitis, Pulmonary Embolism: 463-466	
RR	1.1	RR	1.2
LL	0.9	LL	1.0
UL	1.4	UL	1.4
SMR	86	SMR	—
Rate	9.7	Rate	11.6
Deaths	180	Deaths	202
Hypertensive Heart Disease: 440-443		General Arteriosclerosis: 450	
RR	1.2	RR	1.1
LL	1.1	LL	1.0
UL	1.3	UL	1.2
SMR	—	SMR	—
Rate	34	Rate	47
Deaths	523	Deaths	571
Hypertension: 444-447		Influenza and Pneumonia: 480-493	
RR	1.1	RR	1.1
LL	0.9	LL	1.0
UL	1.4	UL	1.2
SMR	—	SMR	—
Rate	7.2	Rate	33
Deaths	165	Deaths	620
Myocardial Degeneration: 422		Pneumonia: 490-493	
RR	1.1	RR	1.1
LL	1.0	LL	1.0
UL	1.2	UL	1.2
SMR	—	SMR	49
Rate	36	Rate	31
Deaths	650	Deaths	576
Stroke: 330-334		Emphysema: 527.1 (SMR: 527)	
RR	1.1	RR	5.9
LL	1.0	LL	4.8
UL	1.1	UL	7.3
SMR	68	SMR	77
Rate	159	Rate	21
Deaths	2,806	Deaths	428
Aortic Aneurysm: 451		Bronchitis: 500-502	
RR	2.6	RR	3.3
LL	2.2	LL	2.3
UL	3.1	UL	4.5
SMR	—	SMR	—
Rate	25	Rate	8.6
Deaths	406	Deaths	108

Table 7 (continued)

<i>ICD-7 Cause-Of-Death Code Group<sup>f</sup></i>		
Chronic Obstructive Pulmonary Disease: 501-502, 527.1, 527.2 for deaths in 1969-1980		
RR	4.1	
LL	3.6	
UL	4.8	
SMR	—	
Rate	34	
Deaths	650	
Asthma: 241		
RR	2.3	
LL	1.3	
UL	3.9	
SMR	39	
Rate	1.5	
Deaths	34	
Tuberculosis: 001, 002 (SMR: 001-019)		
RR	1.6	
LL	1.1	
UL	2.5	
SMR	30	
Rate	5.2	
Deaths	46	
Diabetes: 260		
RR	0.9	
LL	0.7	
UL	1.0	
SMR	38	
Rate	13	
Deaths	222	
Parkinson's Disease: 350		
RR	0.8	
LL	0.6	
UL	0.9	
SMR	—	
Rate	8	
Deaths	162	
Stomach Ulcer: 540 (SMR: 540-541)		
RR	1.6	
LL	1.1	
UL	2.2	
SMR	52	
Rate	4	
Deaths	62	
Duodenal Ulcer: 541 (For SMR see 540-541 above)		
RR	1.8	
LL	1.3	
UL	2.4	
SMR	—	
Rate	5.3	
Deaths	81	
Liver Cirrhosis: 581		
RR	1.5	
LL	1.2	
UL	1.9	
SMR	45	
Rate	9	
Deaths	168	
Chronic Nephritis: 592		
RR	1.3	
LL	0.9	
UL	1.8	
SMR	38	
Rate	4	
Deaths	55	
Nephritis, Nephrosis, Other Kidney Diseases: 590-594, 600-603 (SMR: 590-603)		
RR	1.0	
LL	0.8	
UL	1.1	
SMR	55	
Rate	21	
Deaths	243	
Intestinal Obstruction: 570		
RR	1.2	
LL	0.9	
UL	1.7	
SMR	—	
Rate	5.7	
Deaths	71	
Accidents Other Than Motor Vehicle: E800-E809, E836-E962 (SMR: E800-E962 less E810-E835)		
RR	1.0	
LL	0.9	
UL	1.1	
SMR	61	
Rate	37	
Deaths	383	

Table 7 (continued)

ICD-7 Cause-Of-Death Code Group <sup>f</sup>			
Motor Vehicle Accidents: E810-835		Suicide: E963, E970-E979	
RR	1.0	RR	1.3
LL	0.8	LL	1.1
UL	1.2	UL	1.5
SMR	57	SMR	74
Rate	22	Rate	16
Deaths	193	Deaths	220

<sup>a</sup> No cigar or pipe at time of questionnaire but includes former cigar or pipe.

<sup>b</sup> Estimated from a Poisson regression model, internally adjusted for attained age and (except Table 2) calendar time. See Tables 3 through 6 for never-smokers' SMR values, rate/100,000, and number of deaths.

<sup>c</sup>  $100 \times$  observed/expected number of deaths. The expected number is obtained by multiplying age- and calendar-time-specific mortality rates by the corresponding person-years and summing appropriately.

<sup>d</sup> Standardized to the age distribution of the total U.S. 1980 population.

<sup>e</sup> For 1954 and 1957 questionnaire respondents, deaths were counted from year of questionnaire response to September 30, 1980. The underlying cause was coded according to ICD-7 (World Health Organization, 1957).

<sup>f</sup> Unless indicated in the heading, the cause-of-death group used in the rate and RR analysis is identical to that used in the SMR analysis. When they differ, the number of deaths shown is that used for rate and RR. See Appendix A for full definition of groups.

Key: RR = relative risk; ICD-7 = Manual of the International Statistical Classification of Diseases, Injuries, and Causes of Death; LL = lower 95-percent confidence limit; UL = upper 95-percent confidence limit; SMR = standardized mortality ratio.

1.0 with  $p < 0.05$ , the RR's decreased in the most recent period for all deaths, all cancers, most cancers at specific sites, all cardiovascular disease, coronary heart disease, chronic rheumatic heart disease, hypertensive heart disease, aortic aneurysm, emphysema, chronic obstructive pulmonary disease, tuberculosis, and stomach and duodenal ulcers. There was no clear time trend for cancers of the stomach, colon, larynx, and prostate and for myocardial degeneration, stroke, phlebitis and pulmonary embolism, general arteriosclerosis, influenza with or without pneumonia, bronchitis, asthma, and diabetes. Using the 1954 to 1964 period as a base, RR's increased subsequently for pharynx cancer, rectum cancer, Parkinson's disease, liver cirrhosis, chronic nephritis and suicide.

**DISCUSSION** Tobacco smoking adversely affects mortality, and although consensus has developed about the major tobacco-related causes of death (International Agency for Research on Cancer, 1986; U.S. Department of Health and Human Services, 1989), the relationship of some death causes to smoking is unclear. The work presented here and comprehensive analyses of earlier followups of the veteran cohort (Kahn, 1966; Rogot and Murray, 1980) include most of these cause-of-death groups of primary interest (Appendix A).

This chapter compares the mortality experience of subjects who reported being former cigarette smokers with those who reported never smoking regularly. Our ability to evaluate risks for those who were current smokers in the 1950's is reduced by the lack of data on subsequent changes in their

Table 8

**U.S. veterans, former cigarette smokers:<sup>a</sup> Relative risks based on never-smokers (RR = 1.0)<sup>b</sup> for the entire followup period (1954 to 1980) and for 1970 to 1980, 1965 to 1969, and 1954 to 1964 by cause of death**

Cause-Of-Death Group <sup>c</sup>	Entire Followup	Followup		
		1970-1980	1965-1969	1954-1964
All Deaths	1.2 <sup>d</sup>	1.1 <sup>d</sup>	1.2 <sup>d</sup>	1.3 <sup>d</sup>
All Cancers	1.3 <sup>d</sup>	1.2 <sup>d</sup>	1.3 <sup>d</sup>	1.5 <sup>d</sup>
Buccal cavity cancer	1.5	1.2	0.7	2.3 <sup>d</sup>
Pharynx cancer	2.6 <sup>d</sup>	3.1	7.5	1.1
Esophagus cancer	1.5	1.1	2.0	2.0
Stomach cancer	1.0	0.9	1.4 <sup>d</sup>	1.0
Colon cancer	1.4 <sup>d</sup>	1.4 <sup>d</sup>	1.4 <sup>d</sup>	1.3 <sup>d</sup>
Rectum cancer	1.3 <sup>d</sup>	1.5 <sup>d</sup>	1.5	1.1
Liver cancer	1.5 <sup>d</sup>	1.5	1.0	1.9 <sup>d</sup>
Pancreas cancer	1.1	0.9	1.1	1.3 <sup>d</sup>
Larynx cancer	5.0 <sup>d</sup>	4.7 <sup>d</sup>	4.5	5.4 <sup>d</sup>
Lung cancer	3.6 <sup>d</sup>	3.1 <sup>d</sup>	3.0 <sup>d</sup>	4.8 <sup>d</sup>
Prostate cancer	1.1 <sup>d</sup>	1.1	1.2	1.2
Kidney cancer	1.1	0.9	0.9	1.5 <sup>d</sup>
Bladder cancer	1.3 <sup>d</sup>	1.3	1.3	1.5 <sup>d</sup>
Skin cancer	1.1	0.9	1.2	1.6
Brain cancer	1.1	1.0	0.9	1.3
Malignant lymphoma	1.0	0.9	0.8	1.1
Non-Hodgkin's lymphoma	1.0	0.9	0.9	1.2
Hodgkin's disease	0.9	0.6	0.4	1.1
Multiple myeloma	1.0	1.0	0.7	1.1
Leukemia	1.3 <sup>d</sup>	1.1	1.3	1.5 <sup>d</sup>
All Cardiovascular Diseases	1.2 <sup>d</sup>	1.1 <sup>d</sup>	1.1 <sup>d</sup>	1.3 <sup>d</sup>
Coronary heart disease	1.2 <sup>d</sup>	1.1 <sup>d</sup>	1.1 <sup>d</sup>	1.3 <sup>d</sup>
Chronic rheumatic heart disease	1.1	1.1	0.9	1.3
Hypertensive heart disease	1.2 <sup>d</sup>	1.0	1.2	1.3 <sup>d</sup>
Hypertension	1.1	1.1	1.0	1.1
Myocardial degeneration	1.1 <sup>d</sup>	1.1	1.2	1.2 <sup>d</sup>
Stroke	1.1 <sup>d</sup>	1.1	1.1	1.1
Aortic aneurysm	2.6 <sup>d</sup>	2.4 <sup>d</sup>	2.8 <sup>d</sup>	2.8 <sup>d</sup>
Phlebitis, pulmonary embolism	1.2	1.1	1.5	1.1
General arteriosclerosis	1.1	1.1	1.1	1.1
Influenza and Pneumonia	1.1	1.1	1.2	0.9
Pneumonia	1.1	1.1	1.1	0.9
Emphysema	5.9 <sup>d</sup>	3.9 <sup>d</sup>	4.4 <sup>d</sup>	11.9 <sup>d</sup>
Bronchitis	3.3 <sup>d</sup>	3.3 <sup>d</sup>	3.2 <sup>d</sup>	3.2 <sup>d</sup>
Chronic Obstructive Pulmonary Disease	4.1 <sup>d</sup>	2.8 <sup>d</sup>	4.3 <sup>d</sup>	8.2 <sup>d</sup>

Table 8 (continued)

Cause-Of-Death Group <sup>c</sup>	Entire Followup	Followup		
		1970-1980	1965-1969	1954-1964
Asthma . . . . .	2.3 <sup>d</sup>	2.5	1.7	2.6 <sup>d</sup>
Tuberculosis . . . . .	1.6 <sup>d</sup>	1.4	1.0	2.0 <sup>d</sup>
Diabetes . . . . .	0.9	0.8	0.9	0.8
Parkinson's Disease . . . . .	0.8 <sup>d</sup>	0.8	1.1	0.6 <sup>d</sup>
Stomach Ulcer . . . . .	1.6 <sup>d</sup>	1.0	2.1	2.4 <sup>d</sup>
Duodenal Ulcer . . . . .	1.8 <sup>d</sup>	1.3	1.5	2.2 <sup>d</sup>
Liver Cirrhosis . . . . .	1.5 <sup>d</sup>	1.5 <sup>d</sup>	2.0 <sup>d</sup>	1.4
Chronic Nephritis . . . . .	1.3	1.3	1.5	1.2
Nephritis, Nephrosis, Other Kidney Diseases	1.0	0.9	1.0	1.1
Intestinal Obstruction . . . . .	1.2	1.4	0.8	1.6
Accidents Other Than Motor Vehicle . . . . .	1.0	0.9	1.0	1.1
Motor Vehicle Accidents . . . . .	1.0	1.0	1.2	0.8
Suicide . . . . .	1.3 <sup>d</sup>	1.4 <sup>d</sup>	1.3	1.2

<sup>a</sup> No cigar or pipe at time of questionnaire but includes former cigar or pipe.

<sup>b</sup> Estimated from a Poisson regression model, internally adjusted for attained age and calendar time. See Tables 3 through 6 for never-smokers' SMR values, rate/100,000, and number of deaths.

<sup>c</sup> See Appendix A for definitions of cause-of-death groupings.

<sup>d</sup>  $p < 0.05$  on two-sided test of never-smokers vs. all former cigarette smokers.

Key: RR = relative risk; SMR = standardized mortality ratio.

smoking. For men in the United States, the prevalence of cigarette smoking was at a peak near the time of the questionnaires, and it has declined since then (U.S. Department of Health and Human Services, 1982 and 1991). Although some study subjects who reported former smoking may have later resumed it, there should not be many among those who stopped 5 years or more prior to the questionnaire. All the subjects were older than 30 years at the time of the questionnaire, and among never-smokers, few are likely to have started smoking subsequently. Over a wide age range, veterans tend to have more education and higher income than their civilian counterparts (Hammond, 1980). Higher educational and occupational levels are associated with smoking cessation (Kabat and Wynder, 1987). It may be assumed that these veterans maintained smoking cessation during the followup period at least as well as all U.S. males in the corresponding year-of-birth cohorts.

The three data analytic approaches used in this work give rather consistent results, particularly for the RR's and the SMR's, which are methodologically similar (Table 9). The SMR's and standardized rates considered only age and calendar time by evaluating the mortality of this group in terms of a synthetic U.S. population followed over the same period. The Poisson regression models fitted RR's based on never-smokers and also took into account the amount of smoking when evaluating cessation duration.

Estimates of RR's for former smokers in this veteran cohort correspond roughly to those for former smokers in a comprehensive review (U.S. Department of Health and Human Services, 1989), based in part on data from the first sample of the Cancer Prevention Study I (CPS-I). Table 10 compares, on a time-specific basis, eight cause-of-death groups in this analysis with the corresponding groups in CPS-I. The CPS-I subjects were enrolled during 1959 to 1960 and were followed for 6 years, from 1959 through 1965. Our RR values for the entire followup period (1954 through 1980) are considerably lower than those from the CPS-I, but the differences appear to be primarily caused by the long followup of the veterans. The followup to the 1954 to 1964 period approximates the CPS-I in calendar time and duration, and the two sets of risk estimates are similar.

The entire veteran cohort experienced lower mortality than all U.S. white males at the same age and calendar time for almost all causes evaluated. Among all respondents, the SMR for overall mortality was 73. Notably, the lowest SMR's were for diseases related to alcohol use (larynx cancer, 43; liver cirrhosis, 53; esophagus cancer, 57) and to socioeconomic factors and medical care accessibility (tuberculosis, 26; pneumonia, 55). Drinking problems and alcohol-related diseases are more common among veterans of World War II and the Korean conflict than among others in the U.S. population (Remer, 1983; Richard et al., 1989), but the extent of alcohol use in this cohort of mostly World War I veterans is unknown.

Many different factors contribute to the low mortality of this cohort. The subjects are veterans who were screened during an induction physical examination. The screening took place many years prior to this study, but the effect may have persisted and may have been enhanced by access to medical care through the VA. In another study, World War II veterans exhibited reduced SMR's for various death causes, with an SMR for all cancer of 55 from 1947 through 1951 and 89 from 1967 through 1969 (Seltzer and Jablon, 1974).

Table 9  
**Comparison of RR's<sup>a</sup> for former cigarette smokers<sup>b</sup> estimated from Poisson regression, SMR's, and annual mortality rates**

Source of Estimate	All Deaths	Lung Cancer	Coronary Heart Disease	Chronic Obstructive Pulmonary Disease
RR	1.2	3.6	1.2	4.1
SMR	1.2	3.5	1.2	--
Rate	1.1	1.8	1.1	3.7

<sup>a</sup> Table 7 SMR values or rate in smoking group divided by the respective value for never-smokers.

<sup>b</sup> No cigar or pipe at time of questionnaire but includes former cigar or pipe.

Key: RR = relative risk; SMR = standardized mortality ratio.

Table 10  
**Relative risk of death for former smokers by source of data, calendar period, and cause**

Cause of Death	Source of Smoking Data				
	Cancer Prevention Study, 1959-1965 <sup>a</sup>	Present Study <sup>b</sup>			
		1954- 1980	1970- 1980	1965- 1969	1954- 1964
Buccal Cavity Cancer	2.7	1.5	1.2	0.7	2.3
Esophageal Cancer	1.3	1.5	1.1	2.0	2.0
Pancreatic Cancer	1.3	1.1	0.9	1.1	1.3
Larynx Cancer	8.6	5.0	4.7	4.5	5.4
Lung Cancer	5.0	3.6	3.1	3.0	4.8
Kidney Cancer	1.8	1.1	0.9	0.9	1.5
Bladder Cancer	1.8	1.3	1.3	1.3	1.5
Coronary Heart Disease	1.3 <sup>c</sup>	1.2	1.1	1.1	1.3

<sup>a</sup>Source: U.S. Department of Health and Human Services, 1989.

<sup>b</sup>From Table 8.

<sup>c</sup>For ages 65+ at enrollment ; relative risk = 1.6 for ages 35 to 64.

The study subjects were further selected in that all held active Government life insurance policies in 1953. This self-selection may be related to lower frequency of cigarette smoking among them than among all white males and perhaps to other health-related characteristics. In a 1955 census-based survey, a greater proportion of U.S. veterans were current cigarette smokers than were all U.S. white males of the same age (Haenszel et al., 1956). Nevertheless, the proportion of current smokers in the present sample was lower than among U.S. veterans or white males generally (Table 11).

The study subjects obtained a mean value of 57.4 with a standard deviation of 9.1 on socioeconomic scores normalized at a mean of 50 and a standard deviation of 10. These scores were developed from income and education distributions associated with each occupation of U.S. males (Green, 1970). Reduced mortality rates in the higher social class groups have been reported in England, where in the period from 1970 through 1972, the SMR's for lung cancer among males ranged from 50 in Class I to 150 in Class V (Registrar General, 1978). Smoking-adjusted SMR's, obtained from the September 1985 sample of the U.S. Current Population Survey, varied inversely with education and income (Rogot et al., 1988).

**All Deaths** In the first 5 years following cessation of smoking, mortality from all causes was comparable with that of current smokers but became dramatically lower thereafter. Thirty years after cessation, the RR's of moderate smokers were indistinguishable statistically from those of never-smokers, as were RR's in the highest smoking group after 40 years. There is no question that survival in the United States would improve greatly with a comprehensive cessation of cigarette smoking. Most likely the improvement would occur

Table 11

**Percent of current cigarette smokers among veterans and U.S. males by source of smoking data and age group**

Age Group <sup>a</sup>	Source of Smoking Data		
	Study Sample	Bureau of Census, Current Population Survey, February 1955	
		Veterans	U.S. Veterans <sup>b</sup>
<34	63.1	61.1	59.9
35-44	55.8	59.7	59.1
45-54	46.1	58.4	54.1
55-64	35.7	43.4	41.5
>65	29.2	28.0	21.6
Total	37.9	43.7 <sup>c</sup>	41.1 <sup>c</sup>

<sup>a</sup> Age at time of questionnaire.

<sup>b</sup> Source: Haenszel et al., 1956.

<sup>c</sup> Standardized to the age distribution of the study sample.

more quickly than indicated by these data because some study subjects stopped smoking due to medical indications, and some of those who stopped shortly before the questionnaire resumed smoking after having responded as former smokers.

**Lung Cancer** The RR's of former cigarette smokers were higher for larynx cancer, emphysema, and chronic obstructive pulmonary disease than for lung cancer, but the excess lung cancer risk involved more deaths (Table 7). After 40 or more years of cessation, lung cancer mortality was much reduced, but it remained 50 percent higher than for never-smokers. Among never-smokers, there was no time trend in the RR's and SMR's.

**Coronary Heart Disease** During the past 30 years, mortality rates for coronary heart disease have been declining in the United States (Gordon and Thom, 1975; Havlik and Feinleib, 1978). The decline also occurred in the veteran cohort of this study, and it has been especially pronounced among never-smokers (Rogot and Hrubec, 1989a). In the present analysis, the RR's and SMR's considered calendar time, and, thus, the time-specific analysis has been corrected for the secular declining trend. Adjustment for calendar time also was carried out in the analysis showing reduced RR's with years since smoking ceased, and the decline in risks shown is not affected by the overall secular trend.

**Chronic Obstructive Pulmonary Disease** Chronic obstructive pulmonary disease is not included as a category in the ICD-7 code for causes of death (World Health Organization, 1957). The category was reconstructed in this analysis (see Appendix A) following guidelines by the National Center for Health Statistics that were developed by surveying trends in clinical diagnosis over time. Because all deaths in this study were coded by the same revision, the coding



should have good internal time consistency. Death rates from chronic obstructive pulmonary disease have been increasing in the United States since the late 1940's, and the veteran cohort reflects this increase (Rogot and Hrubec, 1989b). Chronic obstructive pulmonary disease mortality among never-smokers was higher in the later periods than in the 1954 to 1964 period ( $p < 0.001$ ), but the trend in the later time intervals was nonlinear. In contrast, the RR's of former smokers decreased steeply with calendar time and duration of nonsmoking; however, they remained elevated even 40 or more years after smoking stopped.

**Other Causes** It is accepted that smoking directly contributes to mortality from various forms of cancer and cardiovascular and respiratory diseases (International Agency for Research on Cancer, 1986; U.S. Department of Health, Education, and Welfare, 1964; U.S. Department of Health and Human Services, 1982). The meaning of the association of smoking with cancer sites also related to alcohol use is less clear, and it is difficult to interpret the association with renal diseases, liver cirrhosis, and intestinal obstruction. The low SMR's of the study subjects, particularly for liver cirrhosis, suggest that in this group there is less confounding of smoking with use of alcohol than in many other studies.

Although there was an overall decline in the RR estimates of former smokers over time, the RR's for many causes remained rather stable (Table 8). Despite the long duration of followup, among the 24 cause-of-death groups that had significantly ( $p < 0.05$ ) elevated RR's for former smokers during the 1954 to 1964 period, there were 11 groups that still had significantly elevated RR's during the 1970 to 1980 period. For rectum cancer, liver cirrhosis, and suicide, there were significant excess risks for the 1970 to 1980 period but not for the 1954 to 1964 period. The earliest time interval, 1954 through 1964, represents approximately the period covered by the Kahn (1966) report, and the 1965 to 1969 period represents roughly the information added to it by the next comprehensive mortality ascertainment (Rogot and Murray, 1980). Our definition of former smokers corresponds to that used by Rogot, but it differs from Kahn's, who distinguished between smokers who stopped because of medical indications and others. The 1965 to 1969 period is short, and, therefore, the sampling error of the estimates is somewhat larger than that for the earliest and most recent periods. Some comparisons with the earlier publications may be affected by variation in the definition of the cause-of-death groups (Appendix A) and other methodologic problems.

Of the 50 cause-of-death groups examined, risks were persistently decreased with former cigarette smoking only for Parkinson's disease. The association between smoking and reduced Parkinson's disease mortality was noted previously by Kahn (1966), and it was confirmed in a subsequent case-control study (Nefzger and Quadfasel, 1968). The deficit in Parkinson's disease risk diminished with duration of smoking cessation, and it is now slight. For the majority of smoking-related death causes, mortality of former smokers continues to be higher than that of never-smokers. Because of the special nature of the veteran cohort, residual risks for all former U.S. smokers may be greater than those presented here.

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# Appendix A

## Cause-of-Death Groups (ICD-7 [World Health Organization, 1957]) Used in SMR, Rate, and RR Analyses and in Kahn (1966) and Rogot and Murray (1980)

Cause Group	SMR <sup>a</sup>	Rate, RR	Kahn (1966)	Rogot and Murray (1980)
All Cancer	140-205	140-207 (WHO codes)	140-205	140-207
Buccal cavity cancer	140-148	140-144	140-144	140-144
Pharynx cancer	(See group above)	145-148	145-148	145-148
Esophagus cancer	150	150	150	150
Stomach cancer	151	151	151	151
Colon cancer	153	153	152-153	152-153
Rectum cancer	154	154	154	154
Liver cancer	155-156	155 (primary only)	—	155
Pancreas cancer	157	157	157	157
Larynx cancer	161	161	161	161
Lung cancer	162-163	162-163	162-163	162.1, 162.8, 163
Prostate cancer	177	177	177	177
Kidney cancer	180	180	180	180
Bladder cancer	181	181	181	181
Skin cancer	190-191	190-191	—	—
Brain cancer	193	193	—	193
Malignant lymphoma	Combined 200, 201, 203	200-201, 203	200, 201, 203	200, 201, 203, 206
Non-Hodgkin's lymphoma	200	200	—	—
Hodgkin's disease	201	201	—	—
Multiple myeloma	203	203	—	—
Leukemia	204	204	204	204, 207
All Cardiovascular Disease	Combined 300-334, 400-468	330-334, 400-468	330-334, 400-468	330-334, 400-468
Coronary heart disease	420	420	420	420
Chronic rheumatic heart disease	410-416	410-416	410-416	400-402, 410-416
Hypertensive heart disease	—	440-443	440-443	440-443
Hypertension	—	444-447	444-447	440-447
Myocardial degeneration	—	422	421-422	422
Stroke	330-334	330-334	330-334	330-334
Aortic aneurysm	—	451	451	451
Phlebitis, pulmonary embolism	—	463-466	—	463-466
General arteriosclerosis	—	450	450	450
Influenza and Pneumonia	—	480-493	480-493	480-481, 490-493
Pneumonia	490-493	490-493	(see group above)	
Emphysema	527	527.1	527.1	527.1
Bronchitis	—	500-502	500-502	500-502
COPD	—	501-502, 527.1, 527.2 for deaths in 1969-1980	—	—
Asthma	241	241	241	241
Tuberculosis	001-019	001, 002	001-008	001, 002
Diabetes	260	260	260	260

## APPENDIX A (continued)

Cause Group	SMR <sup>a</sup>	Rate, RR	Kahn	Rogot
Parkinson's Disease	—	350	350	350
Stomach Ulcer	540-541	540	540	540, 542
Duodenal Ulcer	(See group above)	541	541	541
Liver Cirrhosis	581	581	581	581
Chronic Nephritis	592	592	(see group below)	
Nephritis, Nephrosis, Other Kidney Diseases	590-603	590-594, 600-603	592-594	590-594, 600-603
Intestinal Obstruction	—	570	—	—
Accidents, Other Than Motor Vehicle	E800-E809, E836-E962	E800-E809, E836-E962	E800-E962, E970-E991	E800-E965, E980-E999
Motor Vehicle Accidents	E810-E835	E810-E835	(see group above)	
Suicide	E963, E970-E979	E963, E960-E979	—	E970-E979

<sup>a</sup> Entries in parentheses or with — indicate that corresponding SMR cause-of-death groups are not available. The SMR's were not obtained for these groups.

Key: ICD-7 = Manual of the International Statistical Classification of Diseases, Injuries, and Causes of Death; SMR = standardized mortality ratio; RR = relative risk; WHO = World Health Organization; COPD = chronic obstructive pulmonary disease.