

Mortality Patterns Among U.S. Veterans by Occupation. I. Cancer¹

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ABSTRACT—The mortality experience of a nation-wide cohort of 293,958 veterans was analyzed by occupation and industry to generate hypotheses in occupational cancer. Results are presented on 107,563 deaths occurring between 1954 and 1970. Information on usual employment (occupation and industry) and smoking habits was available from questionnaires completed in 1954 and 1957. Complete enumeration of these results by occupation and industry is available as special National Cancer Institute monographs from the author (A. B.). This report presents the mortality experience for selected occupations. Excesses of lung cancer among shipyard workers, truck drivers, and plumbers are consistent with previous reports. Elevated risks for stomach cancer among carpenters and machinists may reflect exposure to dusts, abrasives, and cutting oils. —JNCI 1985; 75:1039-1047.

Studies of occupational groups have played a major role in identifying environmental carcinogens. Many of the well-established occupation-cancer associations were first noted in anecdotal reports by physicians. Recently, the need for more systematic surveys has become evident, and in several countries projects linking occupational data with mortality or morbidity statistics have been developed to meet this need (1-4).

In the United States, no national survey linking occupation-industry information with vital statistics has been attempted since the report by Guralnick in 1963 (5). Several surveys using data from state or local areas, however, have appeared recently. These reports, although valuable, suffer from one or more limitations including 1) limitation in geographic coverage, 2) reliance on occupational designations from death certificates, 3) lack of information on tobacco use, and 4) small numbers. Resources available for systematic surveys of occupational and industrial groups in the United States have recently been reviewed by the Occupational Cancer Risk Subcommittee of the Department of Health and Human Services (6).

This paper presents the results of the analysis of the mortality experience, by occupation, of a cohort of U.S. veterans established by Harold Dorn in 1954. The general and smoking-related mortality experiences of this cohort have been evaluated by Dorn (7), Kahn (8), and Rogot (9), but mortality by occupation has not been previously reported. The major strength of these data is the availability of detailed smoking histories on each subject which can be analyzed in conjunction with information on occupation and industry. Occupation is generally believed to be a more precise indicator of workplace exposures than industry, and for brevity only mortality by occupation is presented here.

MATERIALS AND METHODS

This cohort is comprised of 293,958 veterans aged 31-84 who held active U.S. government life-insurance policies in December 1953 and responded to questionnaires in 1954 and 1957 requesting a detailed smoking history and information on usual occupation and industry. Those not responding to the first questionnaire were sent a follow-up questionnaire in 1957. A total of 85% of the cohort responded to one of the two questionnaires (9).

A total of 107,563 veterans were known to be deceased as of January 1, 1970, and death certificates were obtained for 97.6% of the decedents. Underlying cause of death was coded according to the seventh revision of the International Classification of Diseases. Usual occupation as reported by the subjects on the questionnaire was classified according to the 1950 Census codes. Occupations were included in this paper if the total number of observed or expected deaths for a specific cause was 5 or greater in the all-groups category.

The method of analysis is similar to that reported elsewhere (10). The observed number of deaths by cause for a specific occupation by smoking is compared with an expected number based on the experience of the entire cohort for that smoking category, adjusted for each year of follow-up and for each given age (in single years). Expected numbers of deaths by cause were summed over all ages, and cause-specific mortality ratios were computed for each occupation (ratio of observed to expected numbers of deaths multiplied by 100). SMR for cancers by occupation and smoking category are presented when 5 or more deaths are expected. Since the crude and smoking-adjusted SMR were similar for all smoking groups combined, only the crude SMR is presented in table 1. Statistical significance of ratios of

ABBREVIATIONS USED: NEC=not elsewhere classified; NIH=National Institutes of Health; SMR=standardized mortality ratio(s).

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TABLE 1.—Standardized mortality ratios for cancers by occupation and smoking status^a

(Census code) Occupation	Never smoked ^b			Ever smoked ^c			All groups ^d		
	Obs	Exp	SMR	Obs	Exp	SMR	Obs	Exp	SMR
I. Stomach									
(544) Machinists	4	1.6		9	6.2	144	17	9.9	173*
(510) Carpenters	3	3.0		16	7.2	223	22	13.3	165*
(690) Operatives and kindred workers, NEC	4	2.8		14	9.3	151	24	15.3	157*
(773) Policemen and detectives	0	0.8		4	3.0		8	5.1	167
(612) Compositors and typesetters	2	0.9		5	3.6		9	6.0	149
(335) Mail carriers	1	2.8		12	6.0	200	15	11.1	135
(515) Electricians	1	1.2		8	4.8		9	7.4	122
(093) Teachers, NEC	14	7.9	177	7	10.8	64	28	24.4	115
(523) Foremen, NEC	1	1.1		5	4.4		8	7.0	114
(043) Civil engineers	3	3.9		13	13.2	98	24	21.9	109
(100) Farmers	15	18.6	81	34	25.6	132	60	56.1	107
(595) Members of the armed forces	1	1.9		14	10.1	138	15	14.7	102
(075) Physicians and surgeons	8	6.3	128	18	20.4	88	34	35.5	96
(290) Managers, officials, and proprietors, NEC	24	22.4	107	70	82.8	84	132	137.1	96
(490) Salesmen and sales clerks	7	7.5	93	42	43.2	97	63	65.4	96
(390) Clerical and kindred workers, NEC	10	12.7	79	38	42.8	88	64	70.8	90
(574) Plumbers and pipe fitters	0	1.0		3	3.3		5	5.6	89
(029) College professors	3	2.9		4	4.6		8	9.5	85
(000) Accountants and auditors	5	4.8		15	17.3	86	24	28.7	84
(055) Lawyers and judges	4	6.1	65	20	18.8	106	28	33.8	83
(450) Insurance agents and brokers	0	1.9		7	8.6	81	11	13.4	82
(554) Mechanics and repairmen, NEC	0	1.3		5	4.8		6	7.7	78
(042, 045, 047-049) Chemical, industrial, metal, and mineral engineers	5	4.0		7	14.8	47	18	23.8	76
(550) Automobile mechanics and repairmen	4	1.7		2	5.0	40	6	8.2	73
(044) Electrical engineers	3	2.6		2	6.3	31	7	11.2	63
(470) Real estate agents and brokers	2	1.2		0	4.2		4	7.0	57
(009) Clergymen	1	2.9		2	1.7		3	6.1	50
(032) Dentists	0	1.9		3	6.5	46	5	10.7	47
(046) Mechanical engineers	0	1.5		3	4.5		3	7.8	39
(073) Pharmacists	0	1.1		2	4.9		2	7.9	25*
II. Intestines									
(300) Agents, NEC	1	1.3		13	5.1	253	16	8.7	184*
(099) Professional, technical, and kindred workers, NEC	2	1.3		6	2.8		9	5.1	175
(007) Chemists	5	2.7		13	6.5	235	18	10.4	172
(773) Policemen and detectives	4	1.9		6	5.5	109	18	10.5	172
(762) Firemen, fire protection	1	1.0		6	3.4		8	5.7	141
(540) Telegraph, telephone, and power line servicemen	0	1.2		9	5.5	164	12	8.6	139
(210) Inspectors and public administration officials	2	1.1		5	3.6		8	6.3	126
(512) Compositors and typesetters	3	2.1		10	7.0	142	15	12.7	119
(055) Lawyers and judges	9	14.3	63	50	38.9	128	87	74.2	117
(595) Members of the armed forces	2	4.4		27	20.3	192	35	31.7	110
(032) Dentists	5	4.6		17	13.0	131	26	22.9	109
(250) Officials and administrators, NEC	0	1.6		6	6.1	98	11	10.3	107
(490) Salesmen and sales clerks	21	17.6	119	81	85.1	95	147	137.5	107
(000) Accountants and auditors	9	11.2	80	38	34.7	109	65	61.3	106
(044) Electrical engineers	5	6.1	82	14	13.1	107	26	24.5	106
(075) Physicians and surgeons	21	14.2	148	43	43.7	98	85	80.3	106
(290) Managers, officials, and proprietors, NEC	65	52.6	124	167	167.5	99	309	294.9	105
(390) Clerical and kindred workers, NEC	41	29.6	138	83	84.8	97	158	150.5	105
(450) Insurance agents and brokers	4	4.4		20	17.2	116	30	28.6	105
(554) Mechanics and repairmen, NEC	3	3.0		10	8.8	113	16	15.6	102
(574) Plumbers and pipe fitters	1	2.3		7	6.4	109	12	11.7	102
(690) Operatives and kindred workers, NEC	5	6.6	76	17	17.3	98	31	32.4	99
(036) Editors and reporters	3	1.5		7	6.4	109	10	10.3	98
(380) Ticket, station, and express agents	2	1.0		2	3.5		6	6.1	98
(583) Stationary engineers	3	2.0		3	5.7	62	10	10.2	98
(042, 045, 047-049) Chemical, industrial, metal, and mineral engineers	7	9.3	76	30	30.0	99	60	51.3	97
(310) Bookkeepers	3	1.9		2	3.6		7	7.3	96

^a Obs=observed; Exp=expected.^b Never smoked tobacco.^c Includes current cigarette and ex-cigarette smokers.^d Includes never smoked, ever smoked, and cigar and pipe smokers plus unknown smoking categories.^e $P \leq .05$.

TABLE 1 (continued).—Standardized mortality ratios for cancers by occupation and smoking status^a

(Census code) Occupation	Never smoked ^b			Ever smoked ^c			All groups ^d		
	Obs	Exp	SMR	Obs	Exp	SMR	Obs	Exp	SMR
(740) Barbers, beauticians, and manicurists	1	1.1		4	3.7		6	6.3	96
(009) Clergymen	8	6.6	121	1	3.7		13	13.8	94
(073) Pharmacists	3	2.5		6	9.6	62	15	16.7	90
(093) Teachers, NEC	19	18.5	103	17	22.2	76	49	54.2	90
(544) Machinists	2	3.7		11	11.6	95	18	20.0	90
(029) College professors	4	6.8	59	12	9.6	125	18	21.1	85
(541) Locomotive engineers	1	1.0		2	3.6		5	6.1	82
(335) Mail carriers	6	6.5	93	8	11.6	68	19	23.7	80
(470) Real estate agents and brokers	0	2.8		8	8.5	93	12	16.2	79
(510) Carpenters	3	7.1	42	11	13.8	79	22	28.4	77
(550) Automobile mechanics and repairmen	4	3.9		8	9.5	84	13	17.0	76
(523) Foremen, NEC	1	2.5		9	8.6	105	11	14.6	75
(325) Express messengers and railway mail clerks	2	1.8		4	4.2		6	8.1	74
(515) Electricians	2	2.7		8	8.8	90	11	14.8	74
(583) Truck and tractor drivers	2	1.5		3	4.7		6	8.3	72
(100) Farmers	29	43.5	67	34	50.4	67	87	122.2	71*
(046) Mechanical engineers	5	3.6		4	9.4	42	12	17.1	70
(043) Civil engineers	5	8.8	57	22	27.4	80	33	48.0	69*
(970) Laborers, NEC	2	1.7		1	4.1		6	8.0	63
(051-069) Natural scientists	2	1.7		1	3.4		4	6.7	60
(003) Architects	0	1.6		2	4.2		4	7.4	54
(564) Construction and maintenance painters	0	1.9		3	5.7	52	5	9.6	52
(035) Draftsmen	0	1.4		3	4.3		3	7.5	40
(650) Mine operatives and laborers	0	1.6		3	3.9		3	7.5	40
III. Rectum									
(554) Mechanics and repairmen, NEC	0	1.0		6	3.4		12	5.7	211*
(335) Mail carriers	5	2.3		8	4.0		17	8.1	209*
(470) Real estate agents and brokers	1	0.9		2	2.9		8	5.0	159
(450) Insurance agents and brokers	2	1.5		8	5.9	135	15	9.8	153
(029) College professors	4	2.5		5	3.1		10	7.2	139
(595) Members of the armed forces	3	1.4		5	6.9	72	13	10.3	125
(046) Mechanical engineers	1	1.3		5	3.2		7	5.9	119
(523) Foremen, NEC	1	0.9		3	3.0		6	6.0	119
(000) Accountants and auditors	4	4.0		18	11.9	150	25	21.1	118
(510) Carpenters	3	2.3		4	4.9		11	9.5	116
(544) Machinists	2	1.2		2	4.2		8	6.9	116
(390) Clerical and kindred workers, NEC	3	10.4	29	44	29.0	151	57	51.4	111
(690) Operatives and kindred workers, NEC	1	2.2		6	6.2	97	12	10.8	111
(290) Managers, officials, and proprietors, NEC	24	18.5	130	48	56.6	84	95	100.1	95
(055) Lawyers and judges	4	4.9		14	12.9	108	23	24.4	94
(490) Salesmen and sales clerks	8	6.1	131	24	29.0	82	43	46.5	92
(043) Civil engineers	6	3.0		4	9.0	44	13	15.6	83
(044) Electrical engineers	2	2.3		3	4.5		7	8.7	80
(075) Physicians and surgeons	4	4.6		11	13.5	81	19	24.0	79
(100) Farmers	10	14.6	69	16	17.3	92	32	40.7	79
(515) Electricians	1	0.9		3	3.3		4	6.4	75
(042, 045, 047-049) Chemical, industrial, metal and mineral engineers	4	3.3		7	10.3	67	13	17.7	74
(093) Teachers, NEC	5	6.6	76	5	7.5	66	12	18.6	64
(550) Automobile mechanics and repairmen	1	1.3		2	3.4		3	5.9	51
(073) Pharmacists	1	0.9		1	3.2		2	5.6	36
(032) Dentists	0	1.6		1	4.4		2	7.7	26*
IV. Lung and bronchus									
(002) Pilots and navigators	0	0.3		21	9.7	217	21	10.3	204*
(574) Plumbers and pipe fitters	1	0.9		35	18.6	188	39	21.2	184*
(682) Taxicab drivers and chauffeurs	0	0.2		11	6.0	183	11	6.7	163
(054) Funeral directors and embalmers	0	0.2		10	5.6	179	10	6.4	157
(683) Truck and tractor drivers	0	0.6		23	15.0	153	25	16.7	149
(541) Locomotive engineers	1	0.4		13	9.7	133	16	11.0	146
(740) Barbers, beauticians, and manicurists	1	0.4		13	10.7	121	17	11.9	142
(564) Construction and maintenance painters	0	0.8		23	17.2	134	27	19.1	141

^a Obs=observed; Exp=expected.^b Never smoked tobacco.^c Includes current cigarette and ex-cigarette smokers.^d Includes never smoked, ever smoked, and cigar and pipe smokers plus unknown smoking categories.* $P \leq .05$.

TABLE 1 (continued).—Standardized mortality ratios for cancers by occupation and smoking status^a

(Census code) Occupation	Never smoked ^b			Ever smoked ^c			All groups ^d		
	Obs	Exp	SMR	Obs	Exp	SMR	Obs	Exp	SMR
(240) Ship officers, pilots, pursers, and engineers	1	0.1		7	5.2	134	8	5.7	140
(591) Tinsmiths, copper, and sheet metal workers	0	0.2		8	5.2	155	8	5.7	140
(544) Machinists	1	1.4		48	35.4	135	55	39.5	139
(380) Ticket, station, and express agents	0	0.4		12	9.2	130	14	10.5	134
(970) Laborers, NEC	2	0.7		17	13.0	130	20	14.9	134
(650) Mine operatives and laborers	0	0.6		17	11.2	161	17	13.0	131
(300) Agents, NEC	0	0.5		20	14.3	139	21	16.1	130
(540) Telegraph, telephone, and power line servicemen	0	0.5		23	16.3	141	23	17.8	129
(490) Salesmen and sales clerks	11	6.8	162	316	250.0	126	351	276.5	127
(773) Policemen and detectives	1	0.7		22	17.6	126	25	20.0	125
(250) Officials and administrators, NEC	1	0.6		20	15.8	126	22	17.8	123
(400) Advertising agents and salesmen	0	0.1		7	6.2	112	8	6.7	119
(515) Electricians	2	1.1		32	27.5	116	36	30.4	118
(583) Stationary engineers	0	0.8		17	15.7	108	21	17.9	117
(210) Inspectors and public administration officials	0	0.4		12	9.8	122	13	11.2	116
(000) Accountants and auditors	4	4.3		109	98.8	110	127	111.9	113
(762) Firemen, fire protection	0	0.4		11	10.4	106	13	11.5	113
(036) Editors and reporters	0	0.5		21	17.8	117	22	19.7	111
(480) Stock and bond salesmen	0	0.2		10	8.4	118	10	9.3	108
(335) Mail carriers	3	2.6		36	34.4	104	43	40.1	107
(325) Express messengers and railway mail clerks	1	0.7		9	11.3	79	14	13.2	106
(055) Lawyers and judges	5	5.4	93	107	101.4	105	122	118.6	103
(550) Automobile mechanics and repairmen	2	1.5		26	28.5	91	33	32.0	103
(554) Mechanics and repairmen, NEC	0	1.2		29	26.9	107	31	30.2	103
(035) Draftsmen	1	0.5		13	12.2	106	14	13.7	102
(098) Veterinarians	1	0.3		4	5.0	80	6	5.9	101
(512) Compositors and typesetters	0	0.8		21	20.8	100	24	23.7	101
(290) Managers, officials, and proprietors, NEC	21	20.3	104	469	467.8	100	533	530.7	100
(470) Real estate agents and brokers	1	1.0		23	23.1	99	26	26.3	99
(390) Clerical and kindred workers, NEC	12	11.4	105	246	245.7	100	272	277.5	98
(510) Carpenters	2	2.7		38	39.8	95	46	46.8	98
(644) Meatecutters except slaughter and packing house	0	0.2		4	4.5		5	5.2	97
(450) Insurance agents and brokers	1	1.7		48	48.2	99	51	53.8	95
(685) Welders and flamecutters	1	0.3		4	5.7	70	6	6.5	93
(042, 045, 047-049) Chemical, industrial, metal, and mineral engineers	3	3.5		72	81.9	87	83	92.3	90
(690) Operatives and kindred workers, NEC	1	2.6		46	52.9	87	54	59.7	90
(003) Architects	1	0.6		10	11.1	90	11	12.6	87
(099) Professional, technical, and kindred workers, NEC	0	0.5		6	8.2	72	8	9.3	86
(595) Members of the armed forces	1	1.5		46	54.2	84	51	59.5	86
(100) Farmers	15	16.9	89	116	141.4	82	144	174.1	83
(504) Brickmasons	0	0.3		5	5.4	93	5	6.1	82
(545) Airplane mechanics and repairmen	0	0.2		6	6.7	88	6	7.3	82
(046) Mechanical engineers	1	1.4		20	24.8	80	23	28.5	81
(072) Personnel and labor relations workers	1	0.2		4	5.7	70	5	6.2	81
(004) Artists and art teachers	0	0.2		4	5.6	70	5	6.3	80
(592) Toolmakers, diemakers, and setters	0	0.2		6	5.6	89	5	6.3	80
(043) Civil engineers	2	3.3		54	71.8	76	64	81.5	79
(076) Physicians and surgeons	7	5.4	130	89	107.4	82	99	124.6	79
(534) Jewelers, watchmakers, gold and silversmiths	0	0.3		5	5.9	85	5	6.7	76
(032) Dentists	2	1.8		28	37.3	76	31	42.1	74
(073) Pharmacists	1	1.0		21	28.9	72	24	32.4	74
(280) Purchasing agents and buyers, NEC	0	0.3		5	7.5	66	6	8.5	71
(044) Electrical engineers	2	2.3		23	34.3	67	27	39.7	68
(523) Foremen, NEC	0	1.0		18	25.6	70	19	28.6	66
(200) Buyers and department store heads	0	0.3		6	8.5	70	6	9.4	64
(533) Inspectors, NEC	0	0.3		4	7.0	56	5	7.8	64
(061-069) Natural scientists	1	0.6		4	8.3	48	6	9.9	61
(093) Teachers, NEC	4	7.1	56	34	60.0	56	40	74.9	53
(081-084) Social scientists	0	0.3		3	5.0	60	3	5.8	52
(310) Bookkeepers	1	0.7		4	10.2	39	6	12.0	50
(007) Chemists	1	1.0		7	15.0	46	8	17.3	46

^a Obs=observed; Exp=expected.^b Never smoked tobacco.^c Includes current cigarette and ex-cigarette smokers.^d Includes never smoked, ever smoked, and cigar and pipe smokers plus unknown smoking categories.^e P≤.05.

TABLE 1 (continued).—Standardized mortality ratios for cancers by occupation and smoking status^a

(Census code) Occupation	Never smoked ^b			Ever smoked ^c			All groups ^d		
	Obs	Exp	SMR	Obs	Exp	SMR	Obs	Exp	SMR
(009) Clergymen	2	2.4		2	8.5	23	6	12.9	46
(029) College professors	2	2.6		9	24.5	36	12	29.8	40 ^e
(632) Deliverymen and routemen	0	0.2		2	4.6		2	5.1	39
V. Prostate gland									
(773) Policemen and detectives	2	1.8		10	4.8		18	9.0	199 ^e
(061-062) Natural scientists	2	1.4		4	2.8		8	5.7	141
(046) Mechanical engineers	7	3.2		12	8.4	142	21	15.1	139
(042, 045, 047-049) Chemical, industrial, metal, and mineral engineers	10	8.1	123	39	27.2	143	63	45.7	138 ^e
(970) Laborers, NEC	2	1.7		6	3.9		10	7.5	134
(075) Physicians and surgeons	27	16.0	169	56	47.3	118	114	88.1	129 ^e
(250) Officials and administrators, NEC	4	1.3		7	5.3	131	11	9.0	123
(470) Real estate agents and brokers	5	2.7		7	8.0	87	17	14.1	121
(029) College professors	6	6.0	100	10	8.7	114	23	19.1	120
(490) Salesmen and sales clerks	22	16.0	138	87	77.9	111	146	123.7	118 ^e
(641) Locomotive engineers	2	1.0		5	3.5		7	6.0	117
(683) Truck and tractor drivers	1	1.3		5	4.2		8	7.2	111
(674) Plumbers and pipe fitters	4	2.2		5	6.0	82	12	10.9	110
(055) Lawyers and judges	8	13.9	58	46	36.3	126	75	69.3	108
(640) Telegraph, telephone, and power line servicemen	0	1.0		4	4.9		8	7.5	107
(100) Farmers	43	41.3	104	65	47.9	114	120	113.7	106
(550) Automobile mechanics and repairmen	3	3.5		9	8.7	103	16	15.2	105
(043) Civil engineers	8	8.8	91	24	26.4	90	48	46.5	103
(325) Express messengers and railway mail clerks	1	1.5		4	3.7		7	6.8	103
(523) Foremen, NEC	3	2.2		7	7.8	89	13	12.9	101
(740) Barbers, beauticians, and manicurists	0	1.1		4	3.6		6	6.0	101
(390) Clerical and kindred workers, NEC	27	26.8	101	78	77.5	100	135	135.3	100
(036) Editors and reporters	0	1.4		8	5.7	141	9	9.1	99
(335) Mail carriers	8	5.8	137	9	10.6	84	21	21.2	99
(644) Machinists	3	3.3		11	11.0	99	18	18.6	97
(044) Electrical engineers	4	5.2	76	8	11.2	71	20	20.9	96
(093) Teachers, NEC	23	16.7	137	14	19.6	71	46	47.9	96
(450) Insurance agents and brokers	4	3.9		13	15.4	84	24	25.3	95
(510) Carpenters	5	6.8	74	18	13.0	138	25	26.6	94
(690) Operatives and kindred workers, NEC	7	6.1	115	14	16.5	84	27	29.1	93
(007) Chemists	3	2.1		3	4.8		8	8.7	92
(695) Members of the armed forces	6	4.5		18	21.0	85	30	33.1	91
(035) Draftsmen	0	1.3		6	3.9		6	6.7	90
(310) Bookkeepers	1	1.8		5	3.3		6	6.7	90
(000) Accountants and auditors	7	9.9	70	32	31.1	102	47	54.0	87
(290) Managers, officials, and proprietors, NEC	41	47.5	86	134	152.6	87	231	264.0	87 ^e
(515) Electricians	1	2.2		6	7.6	78	11	12.5	87
(032) Dentists	1	4.1		9	12.1	74	16	20.8	77
(073) Pharmacists	3	2.3		6	9.3	64	11	15.4	71
(380) Ticket, station, and express agents	0	0.9		2	3.3		4	5.6	71
(300) Agents, NEC	0	1.1		3	4.5		5	7.6	66
(554) Mechanics and repairmen, NEC	0	2.6		7	7.9	88	9	13.6	66
(583) Stationary engineers	0	1.8		5	5.1	98	6	9.1	66
(009) Clergymen	5	6.3	80	1	3.4		8	13.0	61
(512) Compositors and typesetters	2	2.0		4	6.5	61	7	11.4	61
(650) Mine operatives and laborers	1	1.4		3	3.6		4	6.9	58
(003) Architects	2	1.5		1	4.0		4	7.1	56
(564) Construction and maintenance painters	0	2.0		3	5.5	64	4	9.3	43
(210) Inspectors and public administration officials	0	1.0		1	3.3		2	5.7	35
VI. Bladder									
(470) Real estate agents and brokers	1	0.8		6	3.5		9	5.2	173
(073) Pharmacists	1	0.7		7	4.1		9	5.9	173
(044) Electrical engineers	2	1.6		7	5.0	138	12	7.9	163
(515) Electricians	1	0.6		5	3.6		7	5.0	140
(000) Accountants and auditors	4	3.0		20	14.3	139	26	21.0	124
(554) Mechanics and repairmen, NEC	2	0.7		4	3.5		6	5.2	116

^a Obs=observed; Exp=expected.^b Never smoked tobacco.^c Includes current cigarette and ex-cigarette smokers.^d Includes never smoked, ever smoked, and cigar and pipe smokers plus unknown smoking categories.^e $P \leq .05$.

TABLE 1 (continued).—Standardized mortality ratios for cancers by occupation and smoking status^a

(Census code) Occupation	Never smoked ^b			Ever smoked ^c			All groups ^d		
	Obs	Exp	SMR	Obs	Exp	SMR	Obs	Exp	SMR
(690) Operatives and kindred workers, NEC	2	1.8		7	7.3	95	12	10.9	110
(046) Mechanical engineers	1	0.9		6	3.7		5	5.6	107
(490) Salesmen and sales clerks	5	4.7		39	35.7	109	52	48.7	107
(290) Managers, officials, and proprietors, NEC	13	14.1	92	76	68.8	110	106	100.9	105
(544) Machinists	1	1.0		4	4.9		7	7.0	100
(075) Physicians and surgeons	8	4.8		15	17.6	85	28	28.3	99
(523) Foremen, NEC	1	0.7		2	3.6		5	5.1	99
(042, 045, 047-049) Chemical, industrial, metal, and mineral engineers	3	2.5		9	12.0	74	17	17.4	98
(055) Lawyers and judges	3	4.0		15	15.7	95	23	24.9	92
(390) Clerical and kindred workers, NEC	7	7.9	89	28	35.3	79	48	52.0	92
(450) Insurance agents and brokers	2	1.1		5	7.0	71	9	9.8	91
(335) Mail carriers	2	1.7		3	4.9		7	7.9	85
(595) Members of the armed forces	2	1.4		5	8.2	60	9	11.4	79
(043) Civil engineers	2	2.5		9	11.1	80	13	16.6	78
(029) College professors	4	1.8		0	3.8		5	6.7	74
(093) Teachers, NEC	1	4.9		8	8.9	90	12	17.1	70
(550) Automobile mechanics and repairmen	1	1.1		3	4.0		4	5.9	67
(032) Dentists	0	1.2		3	5.4	65	5	7.9	63
(510) Carpenters	0	2.0		4	6.7	70	5	9.4	63
(100) Farmers	8	12.0	67	9	20.9	42	20	39.6	50*
VII. Malignant lymphoma									
(523) Foremen, NEC	2	1.4		5	4.4		14	7.2	194*
(007) Chemists	1	1.6		6	2.8		7	5.3	132
(512) Compositors and typesetters	2	1.2		4	3.6		8	6.1	131
(044) Electrical engineers	2	3.6		11	6.7	164	16	12.4	129
(075) Physicians and surgeons	12	7.7	157	23	19.8	116	42	35.8	117
(544) Machinists	0	2.1		8	6.3	126	12	10.3	117
(595) Members of the armed forces	1	2.4		16	10.4	154	18	15.5	116
(450) Insurance agents and brokers	1	2.5		10	8.7	114	16	14.0	114
(583) Stationary engineers	1	1.1		4	3.1		6	5.2	114
(290) Managers, officials, and proprietors, NEC	36	29.7	121	89	83.1	107	159	142.2	112
(100) Farmers	27	23.9	113	26	25.3	102	66	59.9	110
(032) Dentists	2	2.6		7	6.4	108	12	11.1	108
(550) Automobile mechanics and repairmen	3	2.2		4	6.1	78	9	8.7	104
(043) Civil engineers	7	4.8		12	13.0	92	23	22.4	103
(690) Operatives and kindred workers, NEC	5	3.7		8	9.2	86	16	15.8	101
(490) Salesmen and sales clerks	15	9.9	152	39	43.0	90	66	66.4	99
(470) Real estate agents and brokers	1	1.5		5	4.2		7	7.2	98
(000) Accountants and auditors	5	6.4	79	16	17.5	91	29	29.9	97
(093) Teachers, NEC	8	10.5	76	11	11.0	99	26	26.8	97
(029) College professors	3	3.9		6	4.6		10	10.4	96
(042, 045, 047-049) Chemical, industrial, metal, and mineral engineers	3	5.3	56	16	15.3	104	24	25.3	95
(073) Pharmacists	2	1.4		6	4.8		7	7.9	88
(390) Clerical and kindred workers, NEC	19	16.8	113	34	42.8	79	64	73.7	87
(515) Electricians	0	1.6		4	6.2	77	7	8.0	87
(055) Lawyers and judges	4	7.9	50	19	18.8	100	28	35.0	80
(773) Policemen and detectives	0	1.1		1	3.1		4	5.5	73
(510) Carpenters	2	3.9		8	7.2	110	10	13.9	72
(046) Mechanical engineers	3	2.1		2	4.7		5	8.4	60
(554) Mechanics and repairmen, NEC	2	1.7		1	5.2	19	5	8.4	60
(335) Mail carriers	3	3.6		0	6.0		5	11.8	43
(009) Clergymen	1	3.7		1	1.7		2	6.7	30
(574) Plumbers and pipe fitters	0	1.3		0	3.3		1	5.8	17
VIII. Leukemia									
(595) Members of the armed forces	0	1.7		22	9.6	228	25	14.2	176*
(470) Real estate agents and brokers	1	1.0		5	3.8		9	6.2	146
(009) Clergymen	5	2.4		0	1.6		7	5.2	134
(512) Compositors and typesetters	1	0.8		5	3.2		7	5.2	134
(032) Dentists	0	1.6		12	6.8	205	12	9.4	128

^a Obs=observed; Exp=expected.^b Never smoked tobacco.^c Includes current cigarette and ex-cigarette smokers.^d Includes never smoked, ever smoked, and cigar and pipe smokers plus unknown smoking categories.* $P \leq 0.05$.

TABLE 1 (continued).—Standardized mortality ratios for cancers by occupation and smoking status^a

(Census code) Occupation	Never smoked ^b			Ever smoked ^c			All groups ^d		
	Obs	Exp	SMR	Obs	Exp	SMR	Obs	Exp	SMR
(043) Civil engineers	4	3.3		19	12.0	158	25	19.7	127
(093) Teachers, NEC	7	6.6	108	13	9.7	133	26	21.1	123
(055) Lawyers and judges	5	5.1	97	22	16.9	129	36	29.8	121
(073) Pharmacists	1	0.9		4	4.4		8	6.9	116
(100) Farmers	16	15.6	103	26	23.2	112	55	48.8	113
(544) Machinists	0	1.3		9	5.7	156	10	8.9	113
(490) Salesmen and sales clerks	5	6.3	80	37	38.5	96	63	67.3	110
(042, 045, 047-049) Chemical, industrial, metal, and mineral engineers	4	3.3		14	13.4	104	23	21.2	108
(075) Physicians and surgeons	4	5.8	69	20	18.9	105	36	33.5	107
(590) Operatives and kindred workers, NEC	2	2.4		9	8.4	106	14	13.6	103
(044) Electrical engineers	2	2.1		4	5.8	69	10	9.9	101
(290) Managers, officials, and proprietors, NEC	20	18.5	108	66	74.3	88	115	120.1	97
(029) College professors	3	2.4		4	4.1		8	8.3	96
(450) Insurance agents and brokers	2	1.5		7	7.7	91	11	11.8	93
(000) Accountants and auditors	3	3.9		15	16.5	96	21	25.0	84
(574) Plumbers and pipe fitters	1	0.8		3	3.1		4	5.0	80
(390) Clerical and kindred workers, NEC	9	10.4	86	30	38.3	78	47	61.9	76
(515) Electricians	1	0.9		4	4.5		5	6.7	75
(335) Mail carriers	2	2.2		4	6.3	75	7	9.6	73
(046) Mechanical engineers	2	1.3		2	4.2		5	7.0	72
(510) Carpenters	3	2.5		4	6.6	60	8	11.8	68
(550) Automobile mechanics and repairmen	1	1.4		4	4.6		5	7.3	68
(523) Foremen, NEC	1	0.9		3	3.9		4	6.1	66
(554) Mechanics and repairmen, NEC	1	1.1		1	4.4		3	7.1	42

^a Obs=observed; Exp=expected.

^b Never smoked tobacco.

^c Includes current cigarette and ex-cigarette smokers.

^d Includes never smoked, ever smoked, and cigar and pipe smokers plus unknown smoking categories.

^e $P \leq .05$.

observed and expected numbers is based on the ratio of a Poisson variable to its expectation (11).

Smoking as reported on the questionnaire was summarized for three types of tobacco: cigarette, cigar, and pipe. A three-digit number, in which the first, second, and third digits represent cigarette, cigar, and pipe smoking, respectively, was used to code the usage data for each type of tobacco as follows: 0=never smoked, 1=ex-smoker (regular smoker in the past but not now), 2=regular smoker now or current smoker, i.e., at time of questionnaire, 6=either never smoked or ex-smoker, 7=either never smoked or current smoker, 8=either current or ex-smoker, and 9=unknown whether never, ex-smoker, or current smoker. (Categories 6-9 represent the different kinds of unknowns.)

Mortality data were calculated separately for 1) non-smokers (category 000), 2) ex-cigarette smokers (category 1..), and current cigarette smokers (category 2..) (i.e., current as of time of questionnaire), and miscellaneous or unknown smoking categories. Cigar and pipe smokers who had never smoked cigarettes were included in the latter group. The proportions of the cohort in each smoking category are: nonsmokers=.222, ex-cigarette smokers=.196, current cigarette smokers=.379, and all other categories=.203. Cause-specific mortality is reported for two smoking status categories: 1) "never smoked," (category 000) and 2) "ever smoked" (categories 1.. and 2..) which includes ex-cigarette smokers and current cigarette smokers because smoking status

has not been updated since the original questionnaire data were collected, and for 3) the "all-groups" total, which includes the miscellaneous and unknown smoking categories in addition to the "ever smoked" and "never smoked." Cigar-pipe smokers and ex-smokers were not presented separately because numbers were too small for analysis in nearly all occupations.

RESULTS

SMR for specific cancers are shown ranked by occupation in table 1. For many cancers, the number of deaths was small in specific occupations, particularly for the never-smoked category.

DISCUSSION

This paper presents the mortality experience of a nation-wide cohort of U.S. veterans which can be used for generating hypotheses on the occupational determinants of cancer. Comprehensive tables for all occupations-industries are available from the author (A. B.) as special National Cancer Institute monographs [NIH publication No. 85-2747 (industry) and 85-2756 (occupation)].

Surveys of this type inevitably have limitations that must be considered in interpreting the results. First, the information on occupation was based on self-reported "usual" occupation on the 1954 or 1957 questionnaires.

Job changes subsequent to those years were not available. Second, despite the size of this cohort (293,958 persons), the large number of cause-of-death and occupation combinations resulted in many categories with too few deaths to compute reliable cause-specific SMR, particularly among the nonsmokers. This unreliability, coupled with the numerous comparisons made, ensures that some associations in these data would arise by chance alone. Also, this population of veterans is not a random sample of the general population and contains a larger proportion of white-collar workers than found in the general population. Finally, although information on smoking is available, we lacked information on other important life-style factors, such as diet and alcohol, that are major determinants for certain cancers.

Despite limitations, the availability of information on tobacco use for each study subject makes this an extremely valuable resource. Although several large record systems with broad occupational data are available (1-5, 12, 13), few include information on tobacco use (14, 15). The variation in tobacco use among persons with different occupations (16, 17) and the strong association between tobacco smoking and certain cancers (18, 19) make results from occupational surveys lacking information on tobacco use difficult to interpret for all except the strongest associations.

Comments on selected associations.—No statistically significant associations with occupation were observed for cancers of the buccal cavity, pharynx, esophagus, liver, pancreas, larynx, kidney, or brain, and these sites are not presented in the table.

Stomach cancer.—Mortality from cancer of the stomach was elevated among persons employed as machinists, carpenters, and operatives (NEC). Among carpenters the excesses occurred only among smokers. Excess risk has previously been reported among carpenters and machinists (5, 14, 20, 21) where exposures to cutting oils, abrasives, and wood dusts may be involved.

Intestinal cancer.—Elevated SMR for intestinal cancer were seen among veterans in white-collar occupations (agents, professional and kindred workers, chemists, wholesale trade, and public administration). This association has been observed in other surveys (1, 5, 20, 21) and is assumed to reflect life-style factors, rather than occupational exposures. Farmers are at low risk for colon cancer as has been noted previously (22). Physical activity has recently been suggested as a protective factor for colon cancer (23). High-activity occupations at low risk among veterans include miners and farmers, but there is no clear grouping of low-activity occupations in the high-risk category.

Rectal cancer.—Mortality from cancer of the rectum was slightly elevated in some white-collar occupations (real estate, insurance, and college teaching), resembling the pattern for colon cancer. Mortality was highest, however, among smokers who are mechanics and repairmen or mail carriers, associations not previously reported.

Lung cancer.—Mortality from lung cancer was excessive among pilots and navigators and plumbers and

pipefitters. Smaller excesses were noted for taxi driver, funeral directors and embalmers, truck drivers, locomotive engineers, barbers and beauticians, painters, ships officers, metal workers, and machinists. Although not shown in the table, workers in the shipbuilding and repair industry had significantly elevated mortality for lung cancer (SMR=180).

Exposure to asbestos is the likely explanation for the excess risk among shipbuilders (24). The excess of lung cancer among truck drivers has been reported in several other surveys (1, 5, 15, 20, 21, 25), and polycyclic aromatic hydrocarbons are suspected agents. The excess of lung cancer among plumbers has been reported before (1, 5, 21, 26). Plumbers may have contact with several respiratory carcinogens, especially asbestos, but also arsenic, beryllium, and acrylonitrile (25). The excess among funeral directors and embalmers has not been noted in other studies of this group where information of tobacco use was lacking (27, 28).

Slight, but not statistically significant, excesses were noted among machinists and painters, as has been reported by others (1, 5, 14, 20, 21, 25). On the other hand, we saw no evidence of the reported associations with mechanics and repairmen (5, 14, 20, 21, 25), meatcutters (29-31), brickmasons (1, 20, 21), or welders (1, 25, 32). Deficits among physicians and surgeons, electrical engineers, chemists, and college professors were most striking among smokers, probably reflecting the lesser intensity of smoking among persons in professional groups as compared to those in blue-collar occupations (16).

Prostate cancer.—Mortality from prostate cancer was elevated among policemen and detectives, engineers, physicians, and salesmen and clerks. These occupations lack obvious common exposures to workplace carcinogens. The risks may reflect socioeconomic and life-style factors or simply chance associations from multiple comparisons.

Bladder cancer.—No significantly elevated SMR were identified, although farmers experienced a deficit of bladder cancer in contrast to the positive association with dairy farming reported in New York (14). The low risk among farmers occurred among nonsmokers as well as smokers and thus cannot be entirely attributed to differences in smoking habits.

Malignant lymphoma and leukemia.—The occupational categories showing an association with malignant lymphoma (foremen, not elsewhere classified) and leukemia (members of the armed forces) are too broad to suggest any particular exposure. Neither lymphoma nor leukemia showed much of an association with agriculture (SMR=110 and 113, respectively) as has been previously reported (22). Nonsignificant excesses were noted for compositors and typesetters (lymphoma and leukemia) and chemists (lymphoma), occupations previously associated with these cancers (33-35).

Occupations were scanned for evidence of elevated mortality for several sites to identify areas requiring special attention, but no occupation showed significantly elevated mortality for more than one cancer. Composi-

tors and typesetters, however, had nonsignificant elevations for lymphoma and leukemia and cancer of the stomach.

In summary, this survey of U.S. veterans can be used to generate hypotheses for productive new areas of research in occupational epidemiology. The availability of data on tobacco use is particularly important, but the small numbers of deaths in certain occupations is a major limitation. We are, however, updating the vital status of this cohort from 1970 to 1980 and have identified approximately 100,000 additional deaths. This additional information will enhance the usefulness of this surveillance system for the monitoring of occupational cancer risks.

REFERENCES

- (1) Registrar General for England and Wales. Occupational mortality 1970-72: Decennial supplement. London: Her Majesty's Stat Off, 1978.
- (2) HOWE GR, LINDSAY JP. A follow-up study of a ten-percent sample of the Canadian labor force. I. Cancer mortality in males, 1965-73. *JNCI* 1983; 70:37-44.
- (3) WIKLUND K, EINHORN J, WENNSTRÖM G, et al. A Swedish cancer-environmental registry available for research. *Scand J Work Environ Health* 1981; 7:64-67.
- (4) MCMICHAEL AJ, HARTSHORNE JM. Mortality risks in Australian men by occupational groups, 1968-1978. *Med J Aust* 1982; 1:253-256.
- (5) GURALNICK L. Mortality by occupation and cause of death. *DHEW Vital Stat Special Rep* 55:92-339, 1963.
- (6) Committee to Coordinate Environmental and Related Programs. On occupational cancer risks: Report of the Occupational Cancer Risk Subcommittee. Washington, DC: DHHS, 1983.
- (7) DORN HF. Tobacco consumption and mortality from cancer and other diseases. *Public Health Rep* 1959; 74:581-593.
- (8) KAHN HA. The Dorn study of smoking and mortality among U.S. veterans: Report on eight and one-half years of observation. *Natl Cancer Inst Monogr* 1966; 19:1-25.
- (9) ROGOT E. Smoking and mortality among U.S. veterans. *J Chron Dis* 1974; 27:189-203.
- (10) ———. Smoking and life expectancy among U.S. veterans. *Am J Public Health* 1978; 68:1023-1025.
- (11) BAILAR J, EDERER F. Significance factors for the ratio of a Poisson variable to its expectation. *Biometrics* 1964; 20:639-643.
- (12) MILHAM S JR. Occupational mortality in Washington State 1950-1979, 1983 [DHHS (NIOSH) publication No. 83-116].
- (13) PETERSEN GR, MILHAM S JR. Occupational mortality in the state of California, 1959-1961. 1980 [DHEW (NIOSH, NIH) publication No. 80-104].
- (14) DECOUFLE P, STANISLAWCZYK K, HOUTEN L, et al. A retrospective survey of cancer in relation to occupation, 1977 [DHEW (NIOSH) publication No. 77-178].
- (15) WILLIAMS RR, STEGENS NL, GOLDSMITH JR. Associations of cancer site and type with occupation and industry from the Third National Cancer Survey Interview. *JNCI* 1977; 59: 1147-1185.
- (16) STERLING TD, WEINKAM JJ. Smoking patterns by occupation, industry, sex, and race. *Arch Environ Health* 1978; 33:313-317.
- (17) COVEY LS, WYNDER EL. Smoking habits and occupational status. *J Occup Med* 1981; 23:537-542.
- (18) FRIEDMAN GD, SIEGELAUB AB, SELTZER CC. Cigarette smoking and exposure to occupational hazards. *Am J Epidemiol* 1973; 98:175-183.
- (19) HOFFMAN D, WYNDER EL. Smoking and occupational cancers. *Prev Med* 1976; 5:245-261.
- (20) DUBROW R, WEGMAN DH. Cancer and occupation in Massachusetts: A death certificate study. *Am J Industr Med* 1984; 6:207-230.
- (21) MILHAM S. Occupational mortality in Washington State 1950-1971, Vol. I-III. 1976 [NIOSH publication No. 76-175].
- (22) BLAIR A. Cancer risks associated with agriculture: Epidemiologic evidence. In: Fleck RA, Hollaender A, eds. *Genetic toxicology*. New York: Plenum Press, 1982:93-111.
- (23) GARABRANT DH, PETERS JM, MARK TM, et al. Job activity and colon cancer risk. *Am J Epidemiol* 1984; 119:1005-1014.
- (24) BLOT WJ, HARRINGTON JM, TOLEDO A, et al. Lung cancer after employment in shipyards during World War II. *N Engl J Med* 1978; 299:620-625.
- (25) MENCH HR, HENDERSON BE. Occupational differences in rates of lung cancer. *J Occup Med* 1976; 18:797-801.
- (26) KAMINSKI R, GEISERT K, DACEY E. Mortality analysis of plumbers and pipefitters. *J Occup Med* 1980; 22:183-184.
- (27) WALRATH J, FRAUMENI JF JR. Cancer and other causes of death among embalmers. *Int J Cancer* 1983; 31:407-411.
- (28) ———. Mortality patterns among embalmers. *Cancer Res* 1984; 44:4638-4641.
- (29) FOX AJ, LYNCE E, MALKER H. Lung cancer in butchers. *Lancet* 1982; 1:165-166.
- (30) LYNCE E, ANDERSEN O, KRISTENSEN TS. Lung cancer in Danish butchers. *Lancet* 1983; 1:527-528.
- (31) JOHNSON ES, FISCHMAN HR. Cancer mortality among butchers and slaughterhouse workers. *Lancet* 1982; 1:913-914.
- (32) BEAUMONT JJ, WEISS NS. Lung cancer among welders. *J Occup Med* 1981; 23:839-844.
- (33) GREENE MH, HOOVER RN, ECK RL, et al. Cancer mortality among printing plant workers. *Environ Res* 1979; 20:66-73.
- (34) LI FP, FRAUMENI JF JR, MANTEL N, et al. Cancer mortality among chemists. *J Natl Cancer Inst* 1969; 43:1159-1164.
- (35) OLIN GR. The hazards of a chemical laboratory environment—a study of mortality in two cohorts of Swedish chemists. *Am Ind Hyg Assoc J* 1978; 39:557-562.