

The utility of regional cancer mortality data for identifying occupations at high risk

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KRAUS JF, FRANTI CE, NEWMAN B. The utility of regional cancer mortality rates for identifying occupations at high risk. *Scand j work environ health* 8 (1982): suppl 1, 65—71. Mortality rates by geographic areas have been used successfully in the past to identify occupations with a high risk of cancer. The 1975 *Atlas of Cancer Mortality for U.S. Counties: 1950—1969* for white males showed that mortality rates in three California counties (Alameda, Sacramento, and San Francisco) were significantly elevated compared to other US counties, and in Sacramento County the lung cancer death rate was significantly high also. This current study was to determine if the excess in the cancer mortality rate found in Sacramento County was possibly related to specific occupational categories. Death certificates for all white males dying of cancer were retrieved. Last occupation, industry, and length of service were coded according to the Index of Industries and Occupations prepared by the US Bureau of the Census. Observed frequencies of cancer deaths were compared to an expected number which was based on US census data by occupation for Sacramento County. Elevated standardized mortality ratios (SMRs) for cancer deaths were found for technicians, metal craftsmen, nonfarm laborers, construction workers, and drivers. SMRs were high for cancer of the esophagus, pancreas, respiratory tract, skin, and central nervous system.

Key terms: census data, occupational cancer, standardized mortality ratio.

Differences in cancer mortality rates among countries have provided, in the past, important epidemiologic clues toward the identification of populations at high risk. Until recently the identification of worker groups at high risk has been difficult because of the masking effect inherent in comparisons of mortality rates according to large population aggregates represented by entire countries. Finer geographic divisions were necessary before correlational studies fully accounting for the contribution of employment to na-

tional figures on cancer mortality could be carried out. The publication of cancer mortality rates by county³ (4) and later the *Atlas of Cancer Mortality for U.S. Counties: 1950—1969* for whites (5) and blacks (6) offered a unique opportunity to evaluate geographic differences in cancer mortality rates by smaller and more homogeneous geographic units, and, in so doing, the opportunity to identify occupations possibly related to the differences observed. Cancer mortality possibly related to occupations based on county analysis has been reported by Mason (3), Blot and his associates (1), and many others.

Geographic correlational studies based on death certificate information are not without certain disadvantages (7): namely, the occupational information may not be accurate or reflect all or most of the important exposures to carcinogens; causes

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³ Largest territorial division for local government within a state in the United States.

of death may be inaccurate; some important confounding factors such as smoking or socioeconomic status cannot be adjusted for; and there is no information on duration, intensity, or specificity of exposure. In addition, studies which use standardized mortality ratios (SMRs) often employ dif-

ferent coding schemes for deaths [numerator versus denominator (census counts) data] or derive expected values from the mortality experience in the general population that lead to the so-called "healthy worker effect" on the SMR. Despite the limitations associated with information on

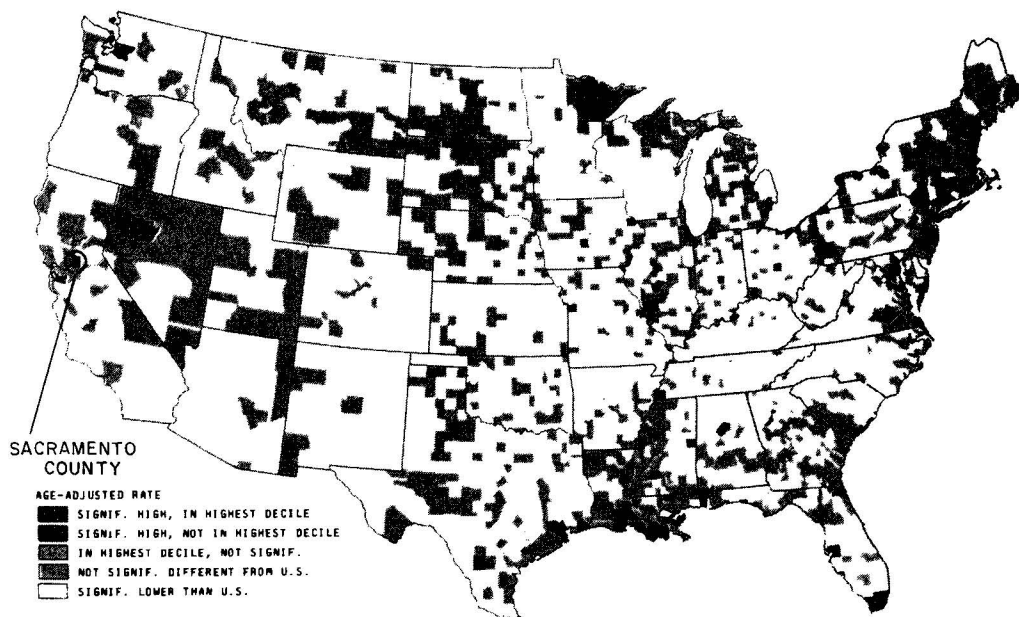


Fig 1. Age-adjusted cancer mortality rates, 1950—1969, by county, all sites combined, white males [See the report of Mason et al, p 2 (5)]

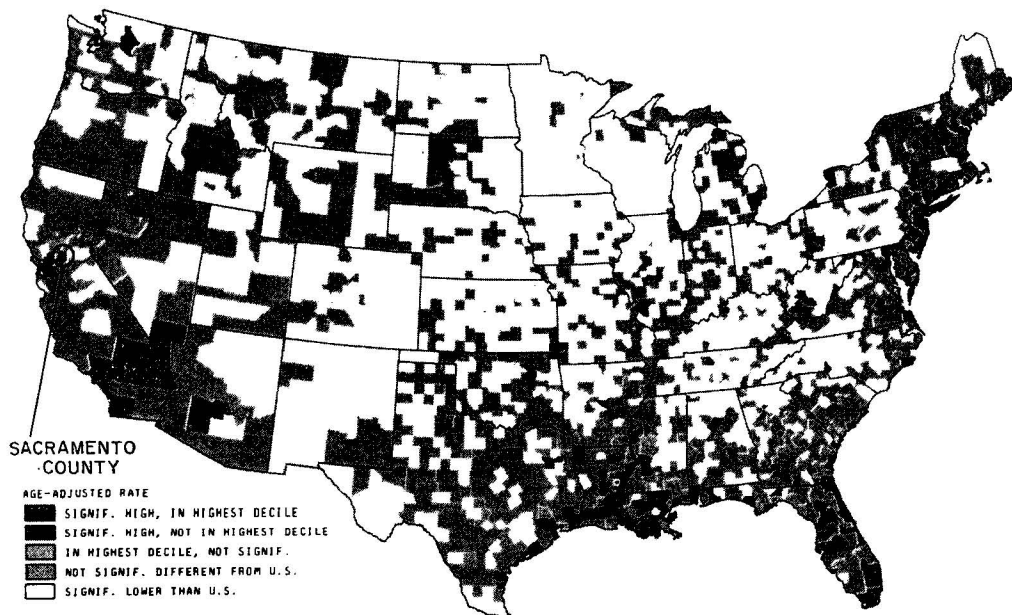


Fig 2. Age-adjusted lung cancer mortality rates, 1950—1969, by county, white males. [See the report of Mason et al, p 14 (5).]

death certificates, the availability of cancer mortality data by county for the entire United States in the form of an atlas has prompted many investigators to search for geographic patterns in the distribution of high, intermediate, and low cancer death rates.

Among the 3,056 counties in the United States, 1,500 are west of the Mississippi River (an arbitrary but often used east-west geographic division of the United States). As shown in fig 1, only 30 of the 1,500 western counties have statistically significantly elevated mortality rates for all sites of cancer combined for white males. Three of these counties are in California, Alameda, San Francisco and Sacramento (3).

For Sacramento County, the lung cancer death rate for white males was significantly high, that is, in the highest decile of the distribution of age-adjusted rates for the United States (fig 2).

Inasmuch as unpublished data from our earlier study on coronary heart disease risk factors and socioeconomic status (2) revealed that the percentage of cigarette smokers among white males, aged 35 to 57 a, was less than the national figure of 43 % (9), other possible explanations were sought for the unusual excess in all-site or lung-cancer mortality death rates in Sacramento County. The explanations and their analyses included the following:

1. Variation in cancer diagnosis over the 18-a period among the counties in California would account for some differences in rates. This, however, seemed a highly unlikely occurrence.

2. Variations in reporting or coding cancer as a cause of death would explain some differences in rates. This was considered a remote possibility in that death certificates are coded by trained nosologists employed by the Office of Vital Statistics, California State Department of Human Services, and a reason for selecting only Sacramento, Alameda or San Francisco counties for misclassification is not apparent.

3. Failure to adjust for confounding factors other than age, sex, or race would also account for differences in rates.

4. Differences in efficacy in cancer treatment could explain some of the variation in the cancer mortality rates. Treatment efficacy in Sacramento County is, in the opinion of oncologists both in and out of the region, as good or better than in other California counties.

5. The absence of programs of early cancer detection might result in higher death rates from cancer. There is, however, no evidence of the absence of such programs in Sacramento County. In fact, local volunteer and government agencies have been quite active in cancer screening programs.

6. The in-migration of persons with a high risk of cancer, such as retirees, or those with an early stage of cancer, could inflate the cancer mortality rates. There was no evidence of such an event occurring in Sacramento County as compared to other adjacent counties.

7. The elevated cancer mortality rates for the three California counties could be a chance phenomenon.

8. The elevated cancer mortality rates could reflect unusual exposure to known or unknown carcinogens.

There was no evidence to suggest unusually high tobacco consumption among residents of Sacramento County, and other possibilities for exposure to carcinogens exists, namely, occupational exposures. The purposes of the current report were to determine whether the excess in cancer death rates in Sacramento County was related to specific occupations in that area and to illustrate the utility of census data for such analysis.

Methods

For purposes of this study the analysis of cancer deaths by occupation was limited to white males, usual residents of Sacramento County. The cancer death certificates examined were restricted to those whose age at death was from 40 to 64 a so as to ensure a more accurate reflection of "usual" occupation and to reduce the influence of the categories "retired" and

"unknown," which often appear on the death certificate for older decedents. All cancer deaths for Sacramento County residents were identified from the mortality computer file for the state of California for the years 1969 to 1977, and death certificates were obtained. This 8-a interval was selected for three reasons: (i) it covered the 1970 census, (ii) the most consistent occupational classifications are found for the most recent years available, and (iii) only one International Classification of Diseases revision (eighth) would be included. Last occupation, industry, and years in that occupation were coded according to the *Classified Index of Industries and Occupations* from the 1970 US Department of Commerce, Bureau of the Census (8).

The *Classified Index* has about 2,300 different titles organized into 455 different codes. Twenty-four logical categories were selected a priori. (The complete list appears in table 2.) Site specific cancers were not recorded but were regrouped into 1 of 20 groups, as given in table 1.

The initial analysis was restricted to the SMRs. For the SMR, expected numbers of deaths for each age group were derived from the percentage distribution of the

same occupational categories used in the 1970 US census for white male residents of Sacramento County, California, aged 40 to 64 a. Only SMRs based on expected values of five or more are reported herein.

Results

There were 1,997 cancer deaths among males aged 40–64 a among Sacramento County male residents during the period of 1969 through 1977. An edit of death certificates yielded 238 (11.9 %) exclusions: 119 (50 %) were nonwhites, 60 (25 %) had no occupation recorded, and 60 (25 %) had a military occupation. The latter exclusion was necessary since US census information for residents of Sacramento County excluded such persons.

The observed and expected numbers of cancer deaths and the SMRs for each of the major occupational groups are given in table 2. As seen in this table, technicians, construction craftsmen and cabinetmakers, metal craftsmen, and nonfarm laborers showed SMRs in excess of 140. SMRs of less than 70 ($= 1 \div 1.40 \times 100$) were found for lawyers, physicians, scientists, teachers, social and religious workers, and sales clerks. Table 3 shows the SMRs for the high and low SMR occupational groups according to two age groups (40–54 and 55–64). Elevated SMRs are seen for technicians, metal craftsmen, and nonfarm laborers in each age group. Construction craftsmen and drivers exhibited excessive SMRs in the older age group. Low SMRs (ie, < 70) were found for teachers, social/religious workers, and sales clerks in both age groups and for younger lawyers, physicians, and scientists.

Table 4 gives SMRs in excess of 140 by occupational category and cancer site. The SMRs for metal craftsmen and engineers were excessive for cancer of the esophagus and central nervous system. Construction workers and drivers had high SMRs for cancer of the esophagus and skin. Technicians showed a high SMR for cancer of the bowel and central nervous system.

Table 5 presents SMRs of 70 or less by occupational category and cancer site. Several occupational categories showed low SMRs for cancer of the lung, including engineers, teachers, social or religious

Table 1. Organ site and ICDA^a codes included in the regrouped cancer sites, cancer mortality among white males, Sacramento County, California, 1969–1977.

Site	ICDA Codes
Oropharynx	141–149
Esophagus	150
Stomach	151
Bowel	152, 153, 154, 159
Hepatic	155, 156
Pancreas	157
Peritoneum	158
Respiratory	160–163
Bone/CT	170, 171
Skin	172, 173
Breast	174
Prostate	185
Male genital	186, 187
Bladder	188
Other urinary	189
Central nervous system	191, 192
Endocrine	193, 194
Undefined	195
Secondary	196–199
Lymphoma/leukemia	200–207

^a ICDA = International Classification of Diseases, adjusted (eighth revision).

workers, writers, artists, architects, clerical workers, stationary engineers, mechanics, foremen, operatives, farmers or farm managers, and police and fire and safety officers. In addition, clerical workers and operatives had low SMRs for leukemia and lymphoma.

Discussion

The search for specific industries having excess SMRs is continuing. But it must be recalled that the occupation recorded on the death certificate is generally the last one before death and not necessarily the

Table 2. Expected and observed numbers of cancer deaths and standardized mortality ratios (SMRs) by occupational categories, Sacramento County, California, 1966—1977.

Occupation	Expected number	Observed number	SMR
Accountants, computer programmers	35.36	32	90.5
Engineers	75.12	75	99.8
Lawyers, physicians, scientists	51.54	32	62.1
Technicians (all fields)	35.53	50	140.7
Teachers, social workers, religious workers	69.13	29	42.0
Writers, architects, other professionals	64.91	55	84.7
Managers and administrators (excluding farm)	276.16	281	101.8
Sales (manufacturers' representatives, wholesale sales), insurance, real estate	83.20	80	96.2
Sales clerks (construction supplies and retail sales), other sales	62.27	34	54.6
Clerical workers, bank tellers, postal workers	149.33	113	75.7
Construction craftsmen, cabinetmakers	95.34	140	146.8
Foremen	53.48	63	117.8
Linemen, servicemen, locomotive engineers and firemen	17.77	13	73.2
Mechanics and repairmen	138.96	116	83.5
Metal craftsmen	24.63	49	198.9
Printing craftsmen	11.08	12	108.3
Stationary engineers, power station attendants	54.88	48	87.5
Operatives, except transport	111.34	91	81.7
Drivers (bus, truck, taxi, other transport operatives)	88.65	112	126.3
Laborers, nonfarm	82.32	124	150.6
Farmers and farm managers	25.15	22	87.5
Farm laborers	30.61	34	111.1
Service workers	87.07	115	132.1
Policemen, firemen, security personnel	34.65	39	112.6

Table 3. Occupations having an overall standardized mortality ratio (SMR) equal to or greater than 140 or equal to or less than 70, by age, all cancer sites, Sacramento County, California, 1969—1977.

	Age (a)		Overall (40—64)
	40—54	55—64	
Occupations with high SMRs			
Technicians	222	134	141
Metal craftsmen	164	222	200
Laborers (except farm)	140	143	151
Construction craftsmen	110	143	147
Drivers	114	142	126
Occupation with low SMRs			
Lawyers, physicians, scientists	45	89	62
Teachers, social/religious workers	53	51	42
Sales clerks (all types)	69	45	55

Table 4. Standardized mortality ratios (SMRs) in excess of 140 by occupation and organ site, Sacramento County, California, 1969–1977.

Occupation	Site	SMR
Metal craftsmen	Esophagus	376
Metal craftsmen	Bowel	160
Metal craftsmen	Lung	144
Metal craftsmen	Central nervous system	268
Engineers	Esophagus	370
Engineers	Central nervous system	176
Construction workers	Esophagus	194
Construction workers	Pancreas	146
Construction workers	Skin	185
Construction workers	Lymphoma, leukemia	150
Drivers, transport operatives	Esophagus	208
Drivers, transport operatives	Skin	238
Foremen	Bowel	219
Technicians	Bowel	165
Technicians	Central nervous system	186
Lawyers, physicians, scientists	Bowel	171
Managers, administrators	Skin	153
Sales personnel	Central nervous system	185
Accountants	Lymphoma, leukemia	174

Table 5. Standardized mortality ratios (SMRs) of 70 or less by occupation and organ site, Sacramento County, California, 1969–1977.

Occupation	Site	SMR
Engineers	Lung	34
Teachers, social/religious workers	Lung	18
Writers, artists, architects	Lung	47
Clerical workers	Lung	61
Clerical workers	Esophagus	62
Clerical workers	Leukemia/lymphoma	68
Stationary engineers, etc	Lung	51
Mechanics	Lung	43
Mechanics	Bowel	35
Foremen	Lung	66
Operatives	Lung	68
Operatives	Leukemia/lymphoma	55
Farmers/farm managers	Lung	50
Police, fire & safety officers	Lung	51

one in which possible carcinogenic exposure occurred. By restricting the SMR analysis to those aged 40 to 64, we have included those who died still in the usual period of employment and, hence, possibly in the line of work where carcinogenic exposure might have taken place. This, of course, is an unproved assumption, but, nonetheless, the epidemiologic evaluation of such data is useful in elucidating hypotheses to explain the unusual occurrences of cancer by occupation.

The use of US census data by age, race, sex, and occupation is, we feel, a unique contribution in deriving SMRs. The use of

census data by occupation negates the criticism leveled at SMRs in general, namely, the use of general population mortality rates to derive expected values for SMRs in *occupational* groups.

The excess numbers of esophageal cancer among metal craftsmen, engineers, construction workers, and drivers has not been reported earlier to our knowledge. Our finding on the excess of central nervous system cancers among metal craftsmen, engineers, and drivers is of equal interest and hopefully will form the basis for confirmatory studies. This report is only a preliminary step in identifying oc-

occupations at potential high risk, but it serves to illustrate the utility of death certificates and census data in searching for explanations for high (or low) cancer mortality rates in small geographic areas.

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