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Lung Cancer and Occupation in Alameda County: A Death Certificate Case-Control Study

K.L. Milne, BS, D.P. Sandler, PhD, R.B. Everson, MD, and Steven M. Brown, MD

A case-control comparison of lung cancer deaths versus deaths from all other cancers occurring in Alameda County, California, between 1958 and 1962 was conducted to investigate possible associations between lung cancer and occupation. Age-adjusted, sex-specific analyses indicated that a history of work in certain industries and occupations was associated with an increased risk of lung cancer. Among males, a significant positive association was found for glass, metal, furniture, professional and photographic equipment, rubber, leather and plastic manufacturing; water and air transportation; auto repair services; and construction. Specific occupations associated with a significant positive risk for males were: electricians, aircraft mechanics, painters, plasterers, machine operators, construction workers, bus and truck drivers, and guards and nightwatchmen. Among females, beauticians had a significantly high risk associated with lung cancer. These results were consistent with other studies of lung cancer related to occupation.

Key words: lung cancer, epidemiology, occupation

INTRODUCTION

Much attention has been focused on the occupational factors associated with lung cancer. Doll and Peto [1981] have attributed 15% of all male and 5% of all female lung cancer deaths in the US to occupational exposures. Several studies have investigated the occurrence of lung cancer among people working in a broad range of industries and occupations [DeCoufle and Stanislawcyzk, 1977; Dunn and Weir, 1968; Enterline and McKiever, 1963; Kennaway and Kennaway, 1936; Menck and Henderson, 1976; Menck et al, 1977; Milham, 1976; Williams et al, 1977]. Although they have used different methodologies, these studies have observed many of the same associations with certain occupational settings. However, each has also identi-

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fied elevated risks not reported by other investigators. Some of these may have escaped notice because there is no apparent hazardous chemical or industrial exposure. In addition, occupational exposures may vary from one geographic locale to another; studies undertaken in a particular area would miss risks associated with industries not located in the study region. Most of these studies of occupational factors have relied on proportionate mortality ratios (PMRs) as indicators of risk associated with employment. This method may introduce bias because the population under study may not share the same distribution of mortality as the standard population used to compute the rates and because the proportions for various causes of death or occupations are not independent.

To broaden the geographic and methodologic range of such studies, we undertook a death certificate case-control study of lung cancer and occupation in Alameda County, California. We then compared our results with those of other investigators who have reported on industrial/occupational associations with lung cancer, looking for consistency in the observed patterns of risk.

METHODS

This case-control study analyzes death certificates from all cancer deaths recorded among residents of Alameda County, California, between 1958 and 1962. We compared lung cancer deaths (cases) to deaths from all other malignancies (controls) to determine whether persons dying from lung cancer were more likely to have been employed in certain occupations than persons dying from other cancers.

Death certificate causes of death were coded according to the seventh revision of the ICDA [World Health Organization, 1965]. A total of 7,490 cancer deaths (including deaths from benign brain tumors) were collected. One hundred forty-five deaths occurring under the age of 18 were eliminated because they would not contribute to an analysis of occupational factors. Usual occupation and industry of employment were coded using the Bureau of Census Industrial and Occupational Classification System [US Bureau of Census, 1971]. Detailed employment histories were not available.

The 925 deaths from lung cancer were compared to all other cancer deaths for risk associated with exposure to specific industries and occupations. In addition, a smaller comparison group of cancers not known to be strongly associated with occupational risk factors [Doll and Peto, 1981; Higginson, 1980] was used to minimize potential exposure bias. To form this "reduced control group," we eliminated cancers of pancreas (ICDA 157), nasal sinus (ICDA 160), kidney (ICDA 180), bladder (ICDA 181), bone (ICDA 196–197), and all hematopoietic cancers (ICDA 200–204). This left 4,880 cancers in the second comparison group.

All analyses were stratified on age at death (< 50 years, 50–59 years, 60–69 years, 70–79 years, and $\geqslant 80$ years) and analyzed separately for males and females.

Combined risk estimates were provided by a computer program that computes the maximum likelihood estimate (MLE) of the odds ratio using Gart's modification of the extended Cornfield method [Gart, 1970]. Individual odds ratios and 95% confidence intervals are computed for each stratum specific table. A correction factor of 0.5 was added to each cell of the 2×2 contingency tables. The result of the test of significance for the summary MLE is indicated by a p value.

If the odds ratio was 1.0, then persons dying from lung cancer experienced the same risk as persons dying from other cancers for the occupation of interest. A risk

greater than 1.0 indicated an excess risk of lung cancer death associated with the occupation.

RESULTS

The study group consisted of 925 lung cancer deaths and 6,420 deaths with other cancers. Among the cases, 826 death certificates had lung cancer coded as a primary cause of death, and 99 had lung cancer listed as a significant condition also present at death. Table I gives the distribution of cancer sites for the control group for any mention of cancer on the death certificate. Numbers reflect the fact that 895 controls had multiple cancer sites recorded on their death certificate. Other and unspecified cancers are not shown.

Race was categorized as white and non-white. Blacks, Indians, Chinese, Japanese, and those with Spanish surname composed the non-white category. Because the number of non-white deaths was small (10.8% of all deaths), we did not conduct race-specific analyses. Table II shows the distribution of cases and controls by age and sex. Eighty-one percent of the lung cancer cases were male. Analyses were conducted separately for males and females because of differing occupational patterns.

In Table III, we have compared usual industry of employment for male cases with that for the control groups (all cancer deaths and nonoccupationally related

TABLE I. Distribution of Cancers Among Controls*

Site	Seventh revision ICDA code	No. of cancers
Buccal cavity and pharynx	140–148	183
Esophagus	150	148
Stomach	151	504
Colon	153	798
Rectum	154	331
Liver	155	225
Pancreas	157	359
Nasal sinus	160	23
Breast	170	714
Cervix	171	246
Uterus	172	54
Ovary	174	232
Prostate	177	472
Testis	178	17
Kidney	180	141
Bladder	181	267
Melanoma	190	41
Brain	193	193
Thyroid	194	29
Bone	196–197	32
Lymphoma	200	181
Hodgkin's disease	201	100
Multiple myeloma	203	108
Leukemia	204	290

*Number of cancers do not equal number of controls, since multiple sites included on a death certificate are listed and other and unspecified sites are not shown in this table.

TABLE II. Distribution of Lung Cancer Cases and Control Cancers by Sex and Age

Age (yrs)	Males		Females	
	Cases	Controls	Cases	Controls
< 50	73	312	32	488
50–59	195	475	37	574
60–69	258	868	45	815
70–79	175	990	48	860
⩾ 80	46	485	16	553
Total	747	3,130	178	3,290

cancer deaths). Overall age-adjusted odds ratios were computed for broad industrial groups and specific industries when numbers were sufficiently large or an a priori hypothesis suggested an occupational association. Because of the large number of potential categories, we did not pursue specific analyses for industries or occupations where there was no reason to suspect an environmental hazard and where numbers employed in these categories were too small (< five exposed) to assess a potential effect.

Male lung cancer cases had significant risk associated with employment in ten industries. Stone, clay, and glass manufacturing; all metal manufacturing; professional and photographic equipment manufacturing; water transportation; and auto repair services were significant at the 5% level. Construction; furniture manufacturing; rubber, leather, and plastics manufacturing; air transportation; and services to dwellings were all significant at the 1% level.

The associations with certain industries, namely agriculture, forestry and fishing, transportation manufacturing (specifically shipbuilding) and retail trade were significantly lower than expected (odds ratio = 0.6, 0.7, 0.8, respectively).

We also computed odds ratios for broad job categories and specific occupations among males using the criteria established for analysis by industry (Table IV). We observed significant excess risk among craftsmen (codes 401–575), particularly electricians, aircraft mechanics, painters, and plasterers. Significant associations for machine operators, bus drivers, truck drivers, construction laborers, and guards and nightwatchmen were also observed. Occupations associated with a significant deficit of risk were professional, technical, and kindred personnel and farmers.

Among employed females there were no specific occupational settings, with the exception of beauty shops, which had a significant risk for lung cancer. The risk of lung cancer associated with employment as a beautician was seven times that of other cancers. Table V gives the odds ratios for women within broad occupation categories. Numbers of working women were too sparse to pursue more detailed occupational analysis.

DISCUSSION

Results from our study are compared in Table VI with those of several earlier studies. Among the studies with which we drew comparisons were: 1) a prospective study that followed 68,000 employed men for an average of seven years to assess the risk of developing lung cancer by occupation [Dunn and Weir, 1968]; 2) a PMR study

TABLE III. Risk A

Industry and ICS co
Agriculture, forestr
Mining (047–058)
Construction (067–(
Lumber, furniture r
Sawmills (108)
Furniture mfg (1'
Stone, clay, glass r
Glass mfg only (11
All metal mfg (130
Blast furnaces an
iron, steel (139
Machinery mfg (17
Transportation mfg
Motor vehicle m
Shipbuilding (22
Professional, phot
mfg (239–267)
Food and kindred
Textile mfg (309–
Paper mfg (328–3
Printing, publishi
Chemical mfg (34
Paint mfg (359)
Petroleum, coal r
Rubber, plastic, l
Rubber mfg (3
Leather mfg (3
Transportation (4
Railroads (407
Trucking (417)
Water (419)
Air (427)
Communications
Utilities (467–47
Wholesale trade
Retail trade (60
Business repair
Auto repair (7
Serv. to dwel
Personal serv (7
Laundries (779
Entertainment a
Professional an
Banking, real e
Public adminis

No. = number
OR = odds rat
[a]US Census Bu
[b]Potentially oc
[c]significant at
[d]significant at

TABLE III. Risk Associated With Industry of Employment for Males

Industry and ICS codes[a]	Total group		Reduced control group[b]
	No. case/control	OR	OR
Agriculture, forestry, fishing (017–028)	16/144	0.6[c]	0.5[c]
Mining (047–058)	3/16	0.9	0.7
Construction (067–077)	100/290	1.6[d]	1.6[d]
Lumber, furniture mfg (107–118)	11/34	1.4	1.3
Sawmills (108)	3/17	0.8	0.8
Furniture mfg (118)	7/63	4.2[d]	3.6[d]
Stone, clay, glass mfg (119–138)	11/23	1.9[c]	1.8
Glass mfg only (119)	7/12	2.2[c]	2.0
All metal mfg (130–169)	29/82	1.6[c]	1.6[c]
Blast furnaces and other primary iron, steel (139,147)	16/38	1.8[c]	1.9[c]
Machinery mfg (177–209)	22/102	0.8	0.8
Transportation mfg. (219–229)	24/144	0.7[c]	0.6[c]
Motor vehicle mfg. (219)	5/28	0.7	0.6
Shipbuilding (228)	17/110	0.7[c]	0.6
Professional, photographic equipment mfg (239–267)	10/23	1.9[c]	1.6
Food and kindred products mfg (268–298)	25/106	1.0	1.1
Textile mfg (309–327)	5/13	1.9	2.5
Paper mfg (328–337)	3/18	0.6	0.7
Printing, publishing (338–339)	8/60	0.6	0.6
Chemical mfg (347–369)	9/48	0.8	0.8
Paint mfg (359)	3/14	1.0	0.7
Petroleum, coal mfg (377–378)	3/27	0.5	0.5
Rubber, plastic, leather mfg (379–397)	7/10	3.0[d]	3.3[d]
Rubber mfg (379)	4/6	2.5	2.6
Leather mfg (388,397)	3/4	3.2	4.5[c]
Transportation (407–429)	86/327	1.1	1.1
Railroads (407)	34/181	0.8	0.8
Trucking (417)	11/37	1.1	1.0
Water (419)	24/61	1.6[c]	1.9[d]
Air (427)	5/4	4.2[d]	5.3[d]
Communications (447–449)	5/31	0.7	0.7
Utilities (467–479)	11/62	0.8	0.8
Wholesale trade (507–588)	24/125	0.8	0.8
Retail trade (607–698)	70/373	0.8[c]	0.8[c]
Business repair services (727–759)	40/87	1.9[d]	1.8[d]
Auto repair (757)	10/16	2.3[c]	2.2[c]
Serv. to dwellings (728)	13/24	2.4[d]	1.8[c]
Personal serv (769–799)	28/93	1.4	1.2
Laundries (779)	7/21	1.5	1.2
Entertainment and recreation (807–809)	4/25	0.6	0.5
Professional and related services (828–897)	47/207	0.9	1.0
Banking, real estate, etc (707–719)	27/130	0.9	1.0
Public administration (907–947)	64/278	0.9	0.8

No. = number of exposed (cases/controls).
OR = odds ratio (Maximum Likelihood Estimate).
[a]US Census Bureau Industrial Classification System, U.S. Bureau of Census [1971].
[b]Potentially occupationally related cancers (as defined in text) removed.
[c]significant at $p \leq .05$.
[d]significant at $p \leq .01$.

TABLE IV. Risk Associated With Occupation for Male Lung Cancer Cases

Occupation and OCS code[a]	Total group No. case/control	Total group OR	Reduced control group[b] OR
All professional, technical and kindred (001–195)	51/283	0.8[c]	0.8
Engineers, accountants, lawyers (001–056)	25/139	0.8	0.8
Physicians and nurses (061–085)	8/52	0.6	0.9
Managers, administrators (201–245)	109/488	0.9	1.0
Sales workers (260–285)	40/205	0.8	0.8
Clerical workers (301–395)	44/199	0.9	0.9
All craftsmen (401–475)	215/771	1.2[c]	1.2[c]
Bakers (402)	2/21	0.4	0.4
Brickmasons (410)	3/7	2.1	1.8
Carpenters (415,750)	25/207	1.2	1.1
Cabinetmakers, furniture finishers (413,433)	4/19	1.0	1.1
Typesetters (422)	2/15	0.6	0.7
Electricians (430)	18/40	1.8[c]	1.8[c]
All foremen (441)	13/37	1.5	1.7
Machinists (461)	8/42	0.7	0.7
Aircraft mechanics (471)	5/5	3.6[c]	4.4[d]
Auto mechanics (473)	11/33	1.2	1.1
Heavy equip mech (481)	15/49	1.2	1.1
Painters (510)	24/59	1.7[c]	1.8[d]
Plasterers (520)	11/10	4.3[d]	4.4[d]
Plumbers (522,523)	8/34	1.1	1.1
All operatives except transport (601–695)	64/215	1.2	1.2
Assemblers (602)	5/9	2.3	1.6
Laundry, dry-cleaning operatives (630)	2/4	2.0	1.4
Machine operatives (645–660, 690–692)	15/28	2.1[d]	2.5
Welders (680)	5/16	1.2	
All transport operatives (701–715)	36/109	1.3	1.1
Bus drivers (703)	4/5	3.5[c]	2.8
Taxi drivers (714)	2/7	1.2	1.0
Truck drivers (715)	23/53	1.6[c]	1.3
Other transport (704–713)	7/44	0.7	0.6
All laborers, except farm (740–785)	73/328	0.9	0.9
Constr. laborers (751)	10/23	1.9[c]	1.7
Longshoremen (760)	7/27	1.0	0.9
Farmers & farm laborers (801–824)	14/95	0.8	0.7
Farmers (801)	7/73	0.5[c]	0.5[c]
All service workers (901–26)	16/216	1.1	1.2
Janitors (901–903)	36/125	1.2	1.2
Food service workers (910–916)	23/91	1.0	1.0
Guards (962)	12/32	1.9[c]	2.0[c]

No. = number of exposed (cases/controls).
OR = odds ratio (Maximum Likelihood Estimate).
[a]US Census Bureau Industrial Classification System, see U.S. Bureau of Census [1971].
[b]Potentially occupationally related cancers (as defined in text) removed.
[c]significant at $p \leq .05$.
[d]significant at $p \leq .01$.

of workers in Washington state [Milham, 1976]; 3) a PMR-SMR (Standard Mortality Ratio) study of deaths from lung cancer among US men by occupation using 1950 Vital Statistics data [Enterline and McKiever, 1963]; 4) a retrospective interview study comparing lung cancer patients with persons with nonneoplastic diseases using

TABLE V. Risk Associated With Occupation for Female Lung Cancers

Occupation and OCS code[a]	No. case/control	OR
All professional, technical and kindred (001–195)	10/232	0.8
Physicians and nurses (061–085)	5/81	1.3
Managers, administrators (201–245)	7/89	1.4
Sales workers (260–285)	4/74	1.0
Clerical workers (301–395)	21/318	1.1
All service workers (901–965)	15/184	1.4
Cleaners (901–903)	1/55	0.3
Food service workers (910–916)	3/61	0.9
Health service workers (921–926)	3/31	1.7
Personal service workers (931–954)	8/35	4.1
Beauticians (944)	7/17	7.0[b]
All private household workers (980–986)	4/49	1.5

No. = number of exposed.
OR = odds ratio (Maximum Likelihood Estimate).
[a]US Census Bureau Occupational Classification System, see U.S. Bureau of Census [1971].
[b]significant at $p \leq .01$.

persons whose primary lifetime employment was clerical work as the standard to which other occupations were compared [DeCoufle and Stanislawcyzk, 1977]: 5) a study comparing cases of lung cancer to other cancer controls [Williams et al, 1977]; and 6) a study calculating expected incident cases and deaths for each occupation and industry assuming equal age-specific rates across occupation/industry categories [Menck and Henderson, 1976]. In this latter study, the industry/occupation populations-at-risk were derived from two Public Use Samples of the Los Angeles County 1970 Census. The authors used the ratio expected/population-at-risk as a measure of risk among the individual occupations [Menck and Henderson, 1976].

These studies provide results obtained by at least four different methods for comparison. Not all occupational groups, however, were included in each study. There were 48 occupational groups that appear to be associated with an increased lung cancer risk in one or more of these studies. Among these 48, there are several occupations observed in our study that are hitherto not reported, namely aircraft mechanics, guards and night watchmen, and machine operators.

Findings were consistent across studies for a number of occupations. Including our study, there are six reports of significantly high lung cancer risk associated with painters [DeCoufle and Stanislawcyzk, 1977; Enterline and McKiever, 1963; Menck and Henderson, 1976; Milham, 1976; Williams et al, 1977]. We have also observed significantly elevated odds ratios for several other occupational groups that have been reported by others as having an increased lung cancer risk. These occupations include: plasterers, electricians, construction workers, and bus and truck drivers. We did not demonstrate significant risk for asbestos workers, cooks, or plumbers, each of which was reported by three or more studies.

Some of our observations may be due to occupational exposures known to be hazardous such as arsenic and benzene for painters, asbestos for construction workers, and cutting oils for mechanics [Cole and Goldman, 1975; Kusnetz and Hutchison, 1979; Doll, 1959; Selikoff et al, 1967]. Potential hazards such as dusts (plasterers),

TABLE VI. Occupations Reported to be Associated With Lung Cancer Risk

Occupation	Author Abbreviation						
	DeC [2]	D [3]	E [4]	Me [6]	Mil [8]	Mn	W [9][a]
Aircraft mechanics						x	
Auto mechanics			x				
Artists							x
Asbestos workers		x		x	x		
Bartenders				x			
Blacksmiths, forgemen, hammerers			x				
Bus drivers					x	x	
Clothing ironers				x			
Construction workers						x	x*
Cooks			x**	x	x		
Dental lab technicians				x			
Decorators				x			
Electricians	x*		x**			x	
Elevator operators			x				
Entertainers							x
Excavating, grading machine operators					x		
Guards, nightwatchmen						x	
Heat treaters				x	x		
Inspectors					x		
Janitors, cleaners				x			x
Longshoremen			x**	x			
Machine operators						x	
Machine shop workers				x			
Mechanics, except auto				x			
Metal molders			x				
Mine operatives			x**	x			
Officers, enlisted men Armed Services					x		
Oilers, greasers, except auto					x		
Orchardists					x		
Painters	x		x	x	x	x	x
Paperhangers					x		x
Photoengravers				x			
Plasterers			x**	x		x	
Plumbers			x	x	x		
Pressmen				x			
Railroad conductors					x		
Restaurant, bar managers				x			
Roofers				x			
Sheetmetal workers			x		x		
Shoe repairers				x			
Stationary engineers			x		x		
Tailors and furriers			x				
Taxi drivers			x**	x			
Telephone linemen					x		
Truck drivers				x	x	x	x*
Welders				x	x		
Writers							x

[a]Numbers in brackets indicate reference source. Mn is current Milne study.

x denotes a reported association significant at $p <= .05$. The absence of an x indicates either no association was found or that occupation was not evaluated.

* adjusted for smoking.

** Significant SMR but not significant PMR.

diesel fumes (bus and truck drivers), and hairsprays and dyes (beauticians) may also be responsible for increased lung cancer risks. Other observations may result from exposures not yet identified or may be due to biases introduced by the chosen methods of study.

Many death certificate studies have used proportionate mortality ratios (PMRs) to evaluate risks associated with occupational factors. By definition, all the proportions for various categories must sum to unity so a very high or very low PMR for one or two occupations affects the PMRs for all other job classifications.

The odds ratio analysis avoids this pitfall. However, one must be cautious in drawing conclusions about causality using other cancer deaths as controls. The implied assumption is that persons with other cancers are not biased with respect to exposures of interest [Axelson, 1979]. In an effort to minimize this bias, we also compared the lung cancers with a group of controls whose cancers are not known to be occupationally related. In several instances, an association was increased by deleting potentially occupationally related cancers from the comparison group. This was particularly true for the water transportaion industry and for leather manufacturing. In addition, the risk among aircraft mechanics, painters, machine operatives, and guards was increased when the occupation-related cancers were eliminated from the control series. In other cases, significant associations were reduced by removing these controls (glass manufacturing, professional and photographic equipment manufacturing, services to dwellings, bus and truck drivers and construction laborers). This reflects a proportionally greater number of controls dropping out of the nonexposed category.

Two problems arise when multiple comparisons are made between exposure categories. First, when there are many comparisons, significant results can occur by chance alone. Second, our exposure groups were defined as, for example, carpenters versus noncarpenters or shipbuilding versus nonshipbuilding. Thus, when those persons associated with high risk occupations become part of the nonexposed standard for testing other occupations, the result is a more conservative estimate of relative risk. DeCoufle and Stanislawcyzk [1977] used clerical workers as a group with which to compare each occupation. Since the lung cancer risk associated with clerical workers in our study was less than 1.0 when compared with all other occupations, using this group as a standard would have produced less conservative odds ratios.

We also performed a separate analysis using colorectal cancers (ICD 153, 154) as the case group to evaluate whether our approach produced spurious associations. Since colorectal cancer is not generally considered to be occupationally related [Doll and Peto, 1981; Higginson, 1980], we would not expect to see significant associations with particular occupational groups. In our data set, colorectal cancer was significantly associated only with white-collar occupations, typesetters, and farmers, which may reflect socioeconomic or demographic factors. Therefore, we feel fairly certain that the significant lung cancer risks among multiple industries and occupations were not due to chance alone. In addition, the overall consistency of our results with other published reports [DeCoufle and Stanislawcyzk, 1977; Enterline and McKiever, 1963; Menck and Henderson, 1976; Menck et al, 1977; Milham et al, 1976; Williams et al, 1977] enhances the validity of our observations.

Occupational histories obtained from death certificates may not be accurate. The industry and occupations coded on death certificates should reflect usual employment, but may in fact, reflect last known employment. In addition, occupations are

often reported by next-of-kin or someone else less familiar with the decedent. Enterline and McKiever [1963] noted that "craftsmen, foremen, and kindred workers" were overstated on death certificates compared with census schedules, and that "clerical and kindred workers" and operatives were underreported. Although adjusting for this bias did not reduce the significance of their results for these major categories, the associations for some subgroups were appreciably weakened [Enterline and McKiever, 1963].

Since our study was based on death certificate analysis, we did not have any information on tobacco use or socioeconomic status, which are potential confounders [Doll, 1959]. The association of smoking and occupational status has been evaluated in a recent report [Covey and Wynder, 1981]. According to the authors, the following occupations were found to have a greater proportion of current cigarette smokers than the national average (38%): painters, machinists, carpenters, taxi, truck, and bus drivers, and farmers. These groups also tended to be heavier smokers (21+ per day) and smokers of the high tar (21+ mg) cigarettes. Williams et al [1977] reported that construction workers also are more likely than others to be smokers. We did not find carpenters, machinists, or farmers to be associated with a higher risk for lung cancer than other cancers. Our results for construction workers and bus and truck drivers are consistent with those for studies that adjusted for smoking in the analysis [Dunn and Weir, 1968; Williams et al, 1977].

Our analyses of female deaths was limited by small numbers. The only significant association we observed was among beauticians. This finding has been reported previously [Menck et al, 1977; Garfinkel et al, 1977]; one of these reports utilized the same Alameda County lung cancer cases, but used a different comparison group [Garfinkel et al, 1977]. As larger numbers of women enter the work force, the analysis of occupationally related deaths in women should be more statistically sound.

The analysis of our data with regard to industrial classifications also produced results consistent with those of other investigators. Significant associations with auto repair services, construction, transportation, primary metal manufacturing, and leather manufacturing have been reported previously [Menck and Henderson, 1976; Williams et al, 1977].

One association usually reported for lung cancer, that of employment in the shipbuilding industry (ie. asbestos) was not found in our study. The lack of a demonstrated effect may be explained by lack of a long enough latent period. Lung cancer originating from asbestos exposure usually requires a minimum 20-year latency [Higginson, 1975: Selikoff et al, 1980]. If the height of exposure was during the 1940s at a naval ship repair base in Alameda County, an increased risk due to asbestos would not have been apparent in the period covered by our study (1958–1962). The lack of association may also be due to factors not accounted for by this study design.

Our study serves to corroborate the findings of other investigators who have used different methods to identify occupations that may contribute to the etiology of lung cancer. We have also identified some additional occupations that may have an increased risk. It is beyond the scope of a death certificate study to assess the interactions among occupation and socioeconomic or lifestyle factors. Future studies which focus on specific exposures as well as related factors may identify etiologic components of lung cancer risk among workers in the occupational settings that we and others have identified as potentially hazardous.

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