Occupational Differences in Rates of Lung Cancer

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Many investigators have associated lung cancer with occupational exposure.[1-17] In an earlier study, we reported an excess of lung cancer in males in the industrialized south-central area of Los Angeles County. This may have been the result of air pollution of industrial origin, specifically, elevated levels of polycyclic aromatic hydrocarbons.[18] However, since the excess was confined to males, occupational exposure would be an alternative explanation.

Interest in better understanding the different factors affecting lung cancer in Los Angeles County, in drawing clues toward identification of high risk occupations, and in setting a base line for future occupational observation and control programs led us to review five years of lung cancer data for white males in the county.

Methods

Subjects. — All 2,161 death certificates mentioning lung cancer (trachea, bronchus and lung) in white males, ages 20-64, for the period 1968-1970,* and all 1,777 incident cases of lung cancer in white males of the same age group reported to the Los Angeles County Cancer Surveillance Program (CSP)[19] for 1972-1973, were reviewed. These mortality and morbidity data were pooled; we consider this justified because of the high mortality rate of lung cancer and the relatively high accuracy of death certification regarding lung cancer.[20, 21] During this reporting period, the CSP abstracted all incident cancer cases from 198 hospitals and six private laboratories in Los Angeles County, including all hospitals known to treat cancer. The primary source of case selection was hospital pathology files, including hematology, cytology and autopsy reports. The medical chart was reviewed when necessary to establish primary site, or first date of diagnosis of the malignancy, or to determine missing demographic data. Pathology records of nearby out-of-county hospitals were searched for inclusion of residents of Los Angeles County who were cancer patients. All Los Angeles County death certificates mentioning malignancies were reviewed to further insure completeness of incident case ascertainment. The study was limited to the age group 20-64 to minimize the number of retired persons without stated occupations. Of the 3,938 subjects, 689 (424 deaths, 265 incident cases) had no reported occupation, and 1,222 (619 deaths, 603 incident cases) had no reported industry of employment.

Classification of Occupation. — One occupational title, and one industry of employment were obtained per subject. California death certificates include the subjects' last occupation, name of last employing firm, and type of industry. The CSP demographic data were abstracted from hospital admission sheets, and in some cases medical records, and represent the last occupation and industry of employment which the patient or next of kin reported at admission. The occupation and industry of each subject were coded into one of 417 occupational codes, and one of 215 industry codes, per the 1970 U.S. Census occupational classification system.[22]

Analytic Methods. — Detailed occupation and industry populations-at-risk for white males in age groups 20-24, 25-34, 35-44, 45-54, and 55-64 were developed from the two Public Use Samples (PUS) of Basic Records from the 1970 Census for Los Angeles County.[23] These included respondent information on current occupation and industry. Combined use of the two PUS provided a 1-in-50 sample of Los Angeles County. There were 31,216 white males, aged 20-64, in the combined sample.

Expected deaths and expected incident cases were calculated for each specific occupation assuming the age-specific rates of cancer in each occupation were the same as those for all occupations. The ratio (%) of observed deaths plus incident cases to expected deaths plus incident cases, hereinafter referred to as a Standard Mortality Ratio (SMR), was then used as the measure of risk for the individual occupations. In a similar way, an SMR was calculated for each industry assuming the age-specific rates of lung cancer in each industry were the same as those for all industries. The Mantel-Haenszel method was used to measure statistical significance.[24]

Results

The occupations with statistically significantly increased Standard Mortality Ratios for lung cancer are listed in Table 1. Among

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the populations in these occupations there were 942 observed lung cancers compared to an expected 537 cases. The Standard Mortality Ratio for lung cancer among these combined workers was 175. There were 16 occupational groups with an SMR of 200 or greater. Twenty-nine percent of the lung cancer in males ages 20-64, who reported an occupation, occurred in the high risk workers listed in Table 1 who comprise only 15% of that sex-age group. The number of deaths (1968-1970), and the number of incident cases (1972-1973) were listed separately; the proportion of lung cancer cases from death certificates and the CSP was consistent across the occupations listed with few exceptions. All but one of the high risk occupations were among craftsmen, operatives, laborers, and service workers. There were two occupations, bookbinders and blasters, which were calculated to be at greater than fourfold risk to lung cancer, but where the risk calculation was based on so few cases that any inference drawn would be speculative.

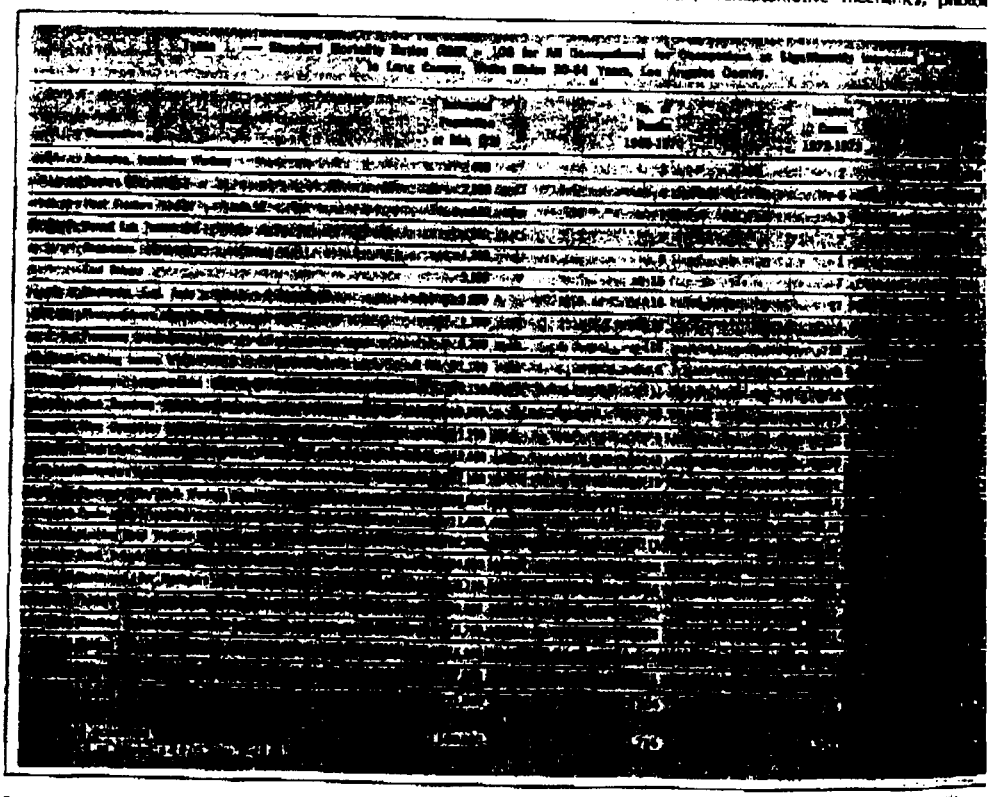
There were 16 occupations with an SMR below 70, including pharmacists, assemblers, craftsmen, physicians, barbers, foremen, sales managers, checkers, judges, secretaries, teachers, personnel workers, dentists, stock brokers, photographers, and school administrators.

The Standard Mortality Ratios of workers in Los Angeles County to lung cancer by industry are given in Table 2. Workers in 13 industries were at significantly increased risk with SMR's ranging from 127 to 279. Forty-two percent of the lung cancer in males reporting an industry of employment, age 20-64, occurr high risk workers who comprised 27% of that sex-age proportion of lung cancer cases from death certificat CSP in these industries were consistent with few e

Discussion

There were clear occupational differences in rates o cer among white males in Los Angeles County. These d broad occupational group, and by individual job cla However, there are limitations to the epidemiologic used and, whether these risk differences were the resu pational carcinogens, or reflected differences in smok and other factors (e.g., general air pollution), cannot mined. Thus, the absence of information on smoking ability to delineate the risk of lung cancer due to occupa posure alone. However, the pattern of these Los Ang their consistency with earlier reports of excess lung can certain occupational groups (asbestos workers, machini painters), and their consistency with reports of other occ diseases related to airborne agents (skin cancer, asbestosis, pneumoconiosis, bronchitis), suggest that the be generally indicative of the impact of occupational ex lung cancer rates.

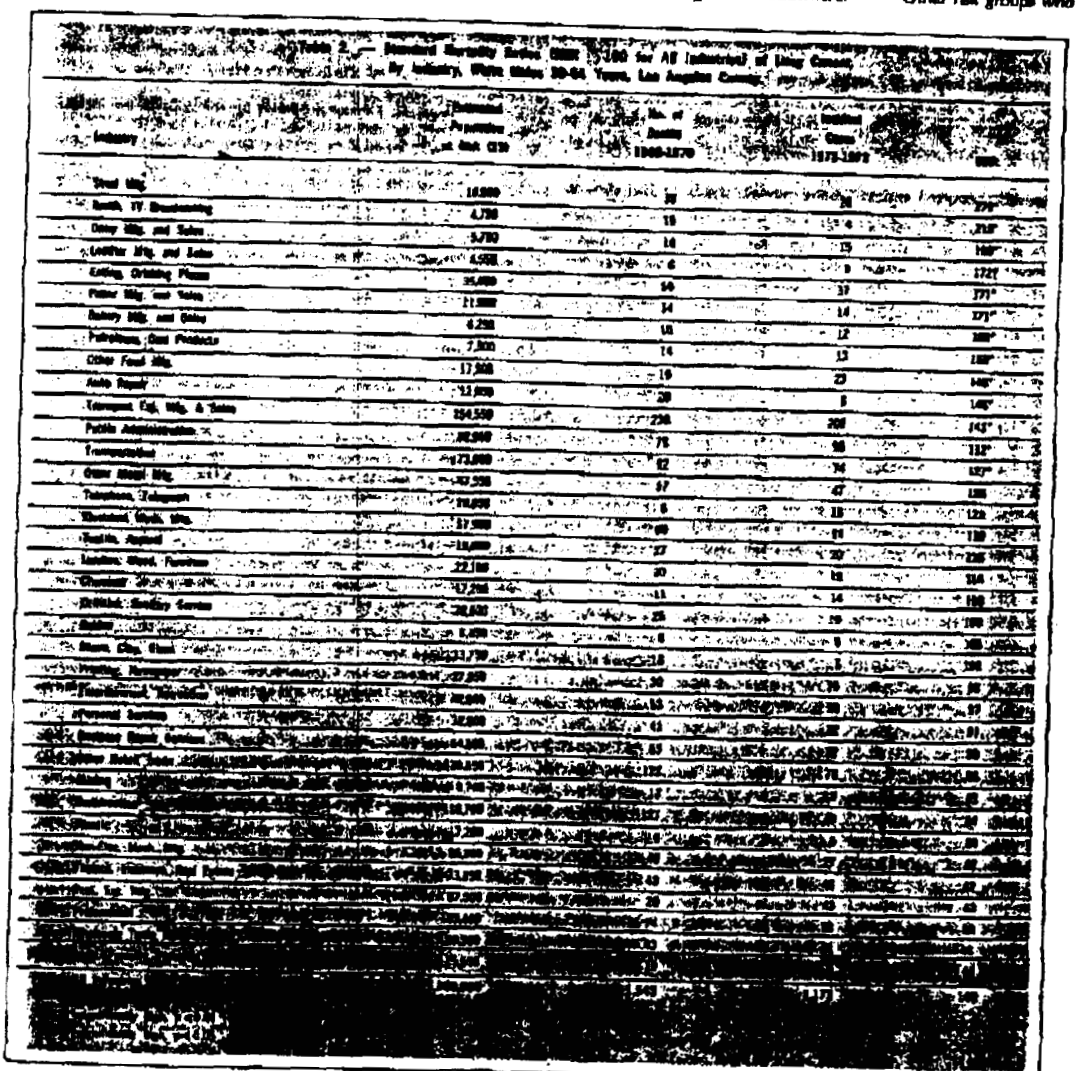
Occupational groups found to be at excess risk who been previously implicated included roofers, dental la cians, decorators, nonautomotive mechanics, photo



clothing ironers, electricians, bar and restaurant managers, and janitors. Occupational groups found at high risk who have been reported elsewhere included asbestos workers,[23-26] heat treaters,[15] machine shop workers,[2-5 15] pressmen,[2 27-29] longshoremen,[3 14 15] shoe repairmen,[2 5 15] mine operatives,[3 15] bartenders,[2 4 15] plasterers,[5 15] cooks,[5 14 16] taxi and truck drivers,[2 3 11 13 16] painters,[2-6 12 15] plumbers,[2 5 13 16] and welders.[2 13 16] Industry groups not previously implicated include radio-TV broadcasting, dairy, leather food and drink, bakery and auto repair. Industry groups at high risk to lung cancer in Los Angeles County which have been previously reported include steel,[30] paper,[31] petroleum refining,[32] and transportation.[33]

No significant risk to lung cancer was detected among chemical and rubber workers: both groups have been found to have elevated risks in other studies.[27-34] This discrepancy in our data may be due to the small number of such workers in Los Angeles County and to geographical variation in the types of exposure within the industry.

Most of the risk to lung cancer associated with the high risk occupations and industries listed in Tables 1 and 2 may be related to exposure to asbestos or polycyclic aromatic hydrocarbons (PAH) or both. Asbestos has been identified as a potent carcinogen both in animal studies and in occupational studies of humans.[25 26 35 36] Besides asbestos (insulation) workers, ship and shipyard workers, including stevedores, have been reported at excess risk to lung cancer elsewhere.[3 14 15] Other risk groups who



may have been exposed to asbestos include clothing ironers, plasterers, dry wall workers, electricians and plumbers.

PAH compounds have also been identified as carcinogenic in animal and human studies.[38] Exposure to PAH compounds is very characteristic of metal working occupations, and several of these occupations were at excess risk to lung cancer in Los Angeles County, including heat treaters,[39] metal machine shop workers,[40 41] welders,[42] and plumbers. In addition to these groups of metal workers, steel industry workers in Los Angeles County, when analyzed as a single group, were also at elevated risk to lung cancer. Others have reported elevated risk of respiratory disease, including lung cancer, in steel industry workers.[30 43 47] Other groups at high risk to lung cancer who have probably had exposure to PAH compounds include roofers,[48] vehicle drivers,[49-54] employees of auto repair companies, photoengravers,[55] printing trade pressmen,[27-29 48 56 57] cooks, bakers, employees of petroleum refineries,[58 59] and dental lab technicians.[60]

For the remaining occupations and industries at excess risk to lung cancer, specific carcinogenic hypotheses are difficult to propose. Shoe workmen and repairmen have been previously reported at excess risk to lung cancer.[3 5 19] Several investigators have also reported excess nasal cancer in the boot and shoe industry, with the excess apparently associated with the leather and cork dust areas rather than the spraying and lacquering areas.[61 62] Besides shoe repairmen, other workers in the leather industry also were at excess risk in these Los Angeles data. SMR's of 110[55] and 140[4] have previously been reported for such leather workers. Bartenders have previously been reported at greater risk to lung cancer, but to our knowledge no carcinogenic exposures have been suggested. It is possible that these bartenders are heavy smokers, have had heavy exposure to smoke filled barrooms, and thus smoking may have produced an occupational artifact. Janitors have seldom been reported at excess risk to lung cancer,[2] and it is possible that the relative weakness of their risk and their low social class may be indicative of a smoking rather than an occupational effect. Milk has been studied as an eluant of polycyclic aromatic hydrocarbons added to wax,[63] but we are aware of no other data suggesting excess risk in dairy workers. Further investigation of worker groups described herein and their relationship to lung cancer would seem warranted.

Summary

Lung cancer rates in Los Angeles County were reviewed for different occupations and industries. Employment groups found to be at excess risk who have not been previously implicated included roofers, dental lab technicians, decorators, nonautomotive mechanics, photoengravers, clothing ironers, electricians, bar and restaurant managers, janitors, and workers in the radio-TV broadcasting, dairy, leather, food and drink, bakery, and auto repair industries. Most of the occupational and industrial groups found to be at greater risk to lung cancer in Los Angeles County had exposure to asbestos, polycyclic aromatic hydrocarbon compounds (PAH), or both.

Supported by Contract No. NO1-CP-53509 and Grant No. PO ICA 17854-01 from the National Cancer Institute.

[a]Death certificate data were kindly supplied by Martin Donaldson, Los Angeles County Department of Health.

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