Mortality From Six Work-Related Cancers Among African Americans and Latinos

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Abstract:
Background: Ethnic minorities have been omitted from many occupational health studies, despite their substantial contributions to the labor force and documented cases of high exposures in some settings. To describe the occurrence of potentially work-related cancers among African American and Latino Workers, we conducted an epidemiologic study based on death certificate data.
Methods: Data were obtained from 21 states during 1985-1992. Directly adjusted proportionate mortality ratios (PMRs) and standardized mortality rate ratios (SRRs) for ages 20-64 years were computed for cancers of the lung, nasal cavity, pleura, and peritoneum, malignant melanoma and leukemia using the mortality data and population counts from the 1990 census.
Results: Proportionate mortality was generally low for both groups, but African Americans had higher than expected mortality rates for leukemia and cancers of the lung, nasal cavity, and peritoneum. Industry-specific analyses indicate excess leukemia among African American men in the rubber industry (PMR 2.08, 95% confidence interval (CI) 1.29-3.35), Latino men in textile (PMR 2.31, 95% CI 0.81-5.13) and wood industries (PMR 2.03, 95% CI0. 81-5.13), and Latino women in the chemical industry (PMR 2.18, 95% CI 0.59-8.10), among other findings. Excess cancer of the pleura and peritoneum was observed among workers with a variety of usual occupations, consistent with widespread exposure to asbestos.
Conclusions: This study demonstrates the utility of surveillance data bases for generating basic epidemiologic information on historically neglected workers. Leads about specific workplace exposure can be followed up in more detailed studies.
KEY WORDS: occupation; industry; cancer; Blacks; Hispanic Americans; occupational diseases; minority groups; epidemiology

Article:
INTRODUCTION
Groups that are classified as racial and ethnic minorities of the United States population currently comprise some 18% of the labor force. Historically, new immigrants and racial minorities performed some of the dirtiest and most dangerous work [Baron, 1983]. Nevertheless, epidemiologic data concerning the health of minority workers are exceedingly meager. The paucity of information is reflected in surveillance data collected by the Bureau of Labor Statistics, which only began to provide information on occupational illness and injury by race and ethnicity in 1992.

Data concerning cancer among minority workers are similarly sparse. Despite the extensive epidemiologic literature devoted to occupation and cancer, most studies have focused on white men; minority workers are frequently omitted from occupational studies, or included only via race-adjusted analyses in which Whites predominate. A search of 1,233 English language occupational epidemiologic cancer studies published during 1971-1990 found that only 9% presented any data for non-White workers [Zahm et al., 1994]. Small numbers, logistical difficulties in assembling and following less numerous populations, and biological heterogeneity are frequently cited reasons for excluding minority workers from epidemiologic studies [Zahm et al., 1994].

Despite the paucity of information, there are compel-ling reasons to suspect that studies of Whites may not reflect the experience of minority workers. Cancer incidence and mortality vary significantly by race and ethnic origin in the population at large [DHHS, 1986], and this diversity of epidemiological patterns carries over to relationships between cancer and occupation. A review of occupational cohort studies found a tendency for non-White workers to have higher cancer mortality than White workers [Kipen et al., 1991], and studies frequently find excess cancer risk to be associated with different occupations among Black and White men [Pickle and Gottleib, 1980; Loomis and Savitz, 1991; Swanson et al., 1993]. Within the workplace itself, exposures may also vary by race or ethnic group member-ship [Davis et al., 1995]. In several well-documented historical instances, minority workers were selected for jobs that exposed them to high levels of carcinogens [Lloyd, 1971; Cherniak, 1986].

To address the need for basic epidemiologic data on the health of minority workers, we conducted an extensive analysis of a database of death certificates from some 20 states that has been used in several previous studies of occupation and cancer [e.g., Loomis and Savitz, 1990, 1991; Hayes et al., 1993; Rubin et al., 1993; Burnett and Dosemeci, 1994; Loomis et al., 1994; Ward et al., 1997). Despite acknowledged limitations, these routinely collected data facilitate study of small worker groups by combining data across workplaces and geographic areas, and provide an opportunity to examine the full spectrum of occupations and industries. No other source of information so easily facilitates a large, comprehensive epidemiological study of cancer among minority workers in diverse occupations and industries.

Here we present descriptive data on the associations of six work-related cancers with occupation and industry among African Americans and Latinos, the largest minority groups of the U.S. population.

METHODS

Cancer deaths were identified from public use death records obtained from the National Center for Health Statistics (NCHS). The NCHS provides standard death certificate items in electronic form, including a demographic description of the decedent, the place of death and residence, the usual occupation and industry, and the underlying cause of death. These data are collected by the state and local vital statistics units and provided to the NCHS, which compiles and issues the information for public use. Twenty-one states (Colorado, Georgia, Ldaho, Indiana, Kansas, Kentucky, Maine, Nebraska, Nevada, New Jersey, New Mexico, North Carolina, Ohio, Rhode Island, South Carolina, Tennessee, Utah, Vermont, Washington, West Virginia, and Wisconsin) provided information on both occupation and ethnic origin for at least 1 year between 1985 and 1992 [DHHS, 1987, 1989, 1900, 1992, 1993a, 1993b, 1994]. Four other states (Alaska, Missouri, New Hampshire, Oklahoma), provided occupational data during this period, but did not give information about ethnic origin in the same year.

Persons eligible for the study were residents of the preceding 21 states age 20 years or older who died between 1985 and 1992, and who had a usual occupation, according to the death certificate, in the paid labor force. Membership in the paid labor force was defined as having any occupation other than "retired," "homemaker," "student," "volunteer," or "unemployed/never worked/disabled" coded in the electronic death certificate record. Occupational information is collected by funeral directors and is intended to reflect the decedent's longest held occupation and the industry in which that occupation was located (DHHS, 1988). Occupation and industry are coded by state vital statistics units, with oversight and quality control provided by NCHS, using the 1980 Census System for the Classification of Industries and Occupations [Census Bureau, 1982]. To reduce the number of occupation and industry categories, we grouped three-digit Census occupation and industry codes (the most detailed coding level) using a scheme similar to those we have used in previous studies [Loomis, 1991; Loomis and Savitz, 1991], with adaptations to emphasize occupations and industries where minority workers are concentrated or where exposures to potential carcinogens may occur.

Race and ethnicity are complex constructs with cultural, historical, social, and biological dimensions. Ethnicity refers to national origin, while race, in its usual meaning, refers largely to phenotype. Race, national origin, and place of birth are coded according to standard categories from information obtained from next-of-kin by funeral directors for death certificates or self-reported in the census. Because of the limited information available, race and ethnicity were classified for this study using simple, operational criteria based on items in the electronic data bases. U.S.-born persons of "Black" race or "other African" ethnic origin were classified as African Americans. Those with ethnic origin classified as "Mexican," "Puerto Rican," "Cuban," "Central or South American", or "Other or Unknown Spanish" for 1985-1988 deaths, or Hispanic origin indicated "yes" for deaths in 1989 or later were classified as Latinos.

For this study, we considered associations of occupation and industry with cancers of the trachea, bronchus, and lung (code 162) [International Classification of Diseases, Ninth Revision, (ICD-9)], pleura (ICD-9 163), peritoneum (ICD-9 158, 159), bladder (ICD-9 188), and malignant melanoma of the skin (ICD-9 172), and leukemia (ICD-9 204-208). These cancers have been judged by IARC [1987] to be associated with known occupational carcinogens or high risk industries.

We initially compared the number of deaths from each of the six cancers observed among African Americans and Latinos to the number expected if those groups' cause-specific mortality were the same as that of the entire labor force, using proportionate mortality ratios (PMRs). Proportionate mortality ratios can be thought of as the ratio of the observed number of deaths from a specific cause to the number expected from that cause based upon the structure of deaths in a referent population [Miettinen, 1972].

As the magnitude of PMRs is affected by between-group variation in all-cause mortality, we repeated this analysis using standardized rate ratios (SRRs) as the measure of comparison. Standardization was by the direct method, using 10-year age groups [Checkoway et al., 1989]. Population estimates for the denominators in the SRRs were obtained from the Public Use Microsample of the 1990 Census of Population [Census of Population and Housing, 1990]. Analyses using SRRs were restricted to people under the age of 65 years because the Census provides information only about work in the month before the survey, rather than usual, lifetime employment, as indicated on death certificates. "Retired" is an acceptable occupational category in the census, although it is not allowable for death certificates. We therefore judged that before the age of 65 years most people would report an occupation that could be coded to match death certificates, while beyond that age the number of persons reporting the uninformative job title "retired" was likely to increase rapidly.

Associations of specific cancers with occupation and industry were assessed via internal analysis of proportionate mortality. Within the African American and Latino groups, we used PMRs to compare occupation-and industry-specific proportionate mortality from each cancer to that expected if the occupation or industry had the same distribution of deaths as all workers of the same race or ethnic group. Intergroup differences in total mortality were unlikely to affect these comparisons, as they were internal to a single race or ethnic group, so we did not conduct additional analyses using the SRR.

Throughout the analysis, deaths for men and women were analyzed separately because of their different patterns of employment and mortality, and all measures of association were directly adjusted for age, using the age distribution of deaths among the total labor force. Ninety-five percent confidence intervals (CIs) for PMRs and SRRs were computed using the equations given by Fleinbaum et al. [1981] for standardized risk ratios. Here we highlight selected results for which the PMR or SRR was at least 2.0 and at least three deaths were observed.

RESULTS

In total, 2,520,535 deaths were observed among the study population from 1985 to 1992. Of those deaths, 192,204 occurred among African American men and 105,275 among African American women, while Latino men experienced 30,168 and Latino women 7,602 deaths.

The proportions of African American workers dying from specific work-related cancers were generally low relative to the workforce as a whole (Table I). Only the PMR for nasal cancer among men was elevated (PMR 1.30, 95% CI 0.99-1.72), relative to expectations. The PMR for nasal cancer was also higher than expected among Latino men (PMR 1.44, 95% CI 0.74-2.80). Other cancers with excess proportionate mortality among

Latinos were cancer of the peritoneum among both women and men (Table I), and cancer of the pleura among women. The PMR for the latter cancer was based on only two deaths, however. PMRs for other cancers were unity or less among Latinos.

TABLE I. Proportionate Mortality From Six Work-Related Cancers Among African American and Latino Workers Aged 20 Years and Older in 21 States

	Men			Women		
	N	PMR[a]	95% CI	N	PMR[b]	95% CI
African Americans						
Lung	15,960	0.95	0.94–0.97	4339	0.66	0.64–0.68
Nasal cavity	64	1.30	0.99–1.72	27	0.95	0.63–1.43
Pleura	25	0.39	0.25–0.59	3	0.29	0.09–0.93
Peritoneum	132	0.75	0.62–0.91	99	0.78	0.63–0.96
Melanoma of skin	66	0.10	0.08–0.13	65	0.18	0.14–0.24
Leukemia	1,142	0.71	0.67–0.76	654	0.66	0.61–0.72
Latinos						
Lung	1,352	0.61	0.58–0.64	289	0.66	0.59–0.74
Nasal cavity	10	1.44	0.74–2.80	1	0.46	0.06–3.26
Pleura	7	0.86	0.40–1.83	2	2.94	0.71–12.16
Peritoneum	33	1.42	1.00–2.03	12	1.40	0.78–2.51
Melanoma of skin	43	0.35	0.25–0.50	18	0.65	0.40–1.08
Leukemia	217	0.79	0.68–0.91	74	0.96	0.75–1.22

[a]Proportionate mortality ratio, directly adjusted for age; referent group, all employed men.
[b]Proportionate mortality ratio, directly adjusted for age; referent group, all employed women.

For workers under the age of 65 years, analyses with SRRs gave a somewhat different impression than obtained with PMRs (Tables II and III). Differences were principally apparent among African Americans: none of the PMRs were elevated for this group, while both men and women had SRRs greater than unity for cancers of the lung, nasal cavity and peritoneum, and for leukemia (Table II). Associations that were particularly noteworthy in these analyses include lung cancer (SRR 2.02,95% CI 1.97-2.07) and nasal cancer (PMR 2.18, 95% 1.50-3.17) among African American men. Among Latinos, the results obtained with PMRs and SRRs were largely consistent. Both indicators were elevated for cancer of the pleura among Latino women (SRR 1.87, PMR 2.65), while SRRs and PMRs both indicated mortality as expected or lower for other cancers in both sexes.

TABLE II. Proportionate Mortality and Mortality Rates From Selected Work-Related Cancers Among African American Workers Relative to all U.S. Workers: Ages 20–64 Years

Group and cancer site	Deaths	SRR[a]	95% CI[a]	PMR[a]	95% CI
Men					
Lung	7,231	2.02	1.97 2.07	0.88	0.86 0.90
Nasal cavity	32	2.18	1.50 3.17	1.02	0.70 1.48
Pleura	7	0.58	0.27 1.24	0.23	0.11 0.50
Peritoneum	49	1.73	1.28 2.34	0.71	0.52 0.96
Malignant melanoma of skin	30	0.11	0.08 0.16	0.04	0.03 0.06
Leukemia	462	1.35	1.23 1.49	0.61	0.55 0.67
Women					
Lung	2,149	1.29	1.23 1.35	0.59	0.56 0.61
Nasal cavity	10	1.28	1.13 1.45	0.60	0.31 1.17
Pleura	2	0.81	0.19 3.42	0.37	0.09 1.58
Peritoneum	24	1.16	0.76 1.78	0.52	0.34 0.79
Malignant melanoma of skin	20	0.14	0.09 0.21	0.06	0.04 0.09
Leukemia	294	1.27	0.65 2.45	0.62	0.55 0.70

[a]PMR, proportionate mortality ratio, directly adjusted for age; SRR, standardized mortality rate ratio, directly adjusted by age; CI, confidence interval.

TABLE III. Proportionate Mortality and Mortality Rate Ratios From Selected Work-Related Cancers Among Latino Workers Relative to all U.S. Workers: Ages 20–64 years

Group and cancer site	Deaths	SRR[a]	95% CI[a]	PMR[a]	95% CI
Men					
Lung	511	0.41	0.37 0.45	0.47	0.43 0.51
Nasal cavity	5	0.93	0.38 2.28	1.05	0.41 2.70
Pleura	1	0.23	0.03 1.67	0.23	0.03 1.61
Peritoneum	8	0.80	0.40 1.61	0.82	0.39 1.73
Malignant melanoma of skin	27	0.26	0.18 0.38	0.22	0.14 0.33
Leukemia	117	0.95	0.79 1.14	0.91	0.74 1.11
Women					
Lung	140	0.38	0.32 0.44	0.51	0.43 0.60
Nasal cavity	1	0.65	0.09 4.67	1.04	0.15 7.49
Pleura	1	1.87	0.25 13.87	2.65	0.36 19.59
Peritoneum	4	0.85	0.31 2.30	1.10	0.40 3.02
Malignant melanoma of skin	10	0.29	0.15 0.54	0.31	0.16 0.59
Leukemia	45	0.73	0.39 1.36	1.05	0.77 1.43

[a]PMR, proportionate mortality ratio, directly adjusted for age; SRR, standardized mortality rate ratio, directly adjusted by age; CI, confidence interval.

Selected PMRs by industry are shown in Table IV. A two-fold excess of leukemia deaths (PMR 2.08, 95% CI 1.29-3.35), based on 18 deaths, was associated with employment in the rubber and plastic manufacturing industry among African American men. Latino women employed in chemical manufacturing also experienced excess proportionate mortality from leukemia, but with only two deaths observed. Among Latino men, excess leukemia mortality was associated with employment manufacturing textiles and clothing and lumber and wood products (Table IV). Proportionate mortality from malignant melanoma of the skin was higher than expected among African American women employed in transportation, communication, and public utilities, in the machinery and transportation equipment manufacturing sector, and in agriculture. Excess mortality from cancers of the pleura and peritoneum was observed in several diverse sectors of industry among African American women and men (Table IV).

TABLE IV. Selected Proportionate Mortality Ratios (PMRs)[a] and 95% Confidence Intervals (95% CIs) for Work-Related Cancers and Industry

Cancer site	Industry	Obs[b]	PMR[c]	95% CI
African American women				
Malignant melanoma of the skin	Agriculture, forestry, and fisheries	6	2.63	1.04 6.66
	Machinery and transportation equipment mfg	4	2.59	0.85 7.89
	Transportation, communication and utilities	5	3.96	1.40 11.22
Peritoneum	Transportation, communication and utilities	3	2.38	0.70 8.02
African American men				
Leukemia	Rubber and misc plastic mfg	18	2.08	1.29 3.35
Malignant melanoma of the skin	Business and repair services	8	4.23	1.87 9.56
Peritoneum	Business and repair services	9	2.48	1.21 5.05
Pleura	Other manufacturing	3	6.43	1.84 22.50
	Retail trade	5	2.61	0.93 7.31
	Public administration	3	2.01	0.60 6.78
Nasal cavity	Other manufacturing	5	2.79	0.94 8.28
	Entertainment and recreation services	3	5.88	1.57 22.09
Latino women				
Leukemia	Chemical and allied product mfg	2	2.18	0.59 8.10
Lung	Agriculture, forestry, and fisheries	9	2.28	1.20 4.34
	Printing and publishing	4	2.73	1.12 6.62
Latino men				
Leukemia	Textile and apparel mfg	4	2.31	0.81 6.58
	Lumber, wood products, furniture mfg	5	2.03	0.81 5.13
Malignant melanoma of the skin	Food and tobacco mfg	3	3.31	0.96 11.43
Nasal cavity	Construction	3	2.05	0.49 8.53

[a]PMR $\geq$ 2.0 and observed deaths > 2.
[b]Observed deaths.
[c]Proportionate mortality ratio directly adjusted for age using all deaths as the standard. Referent: all occupations within the same race/ethnic group.

TABLE V. Selected Proportionate Mortality Ratios (PMRs)[a] and 95% Confidence Intervals (95% CIs) for Work-Related Cancers and Occupation

Outcome	Occupation	Obs[b]	PMR[c]	95% CI	
African American women					
Malignant melanoma of the skin	Farming and agriculture	6	2.63	1.04	6.68
Lung	Construction trades	8	2.05	1.06	3.95
	Motor vehicle operators	30	2.14	1.19	3.82
Nasal cavity	Other handlers and cleaners	3	18.66	4.97	71.55
African American men					
Malignant melanoma of the skin	Administrative support and clerical	6	2.76	1.11	6.86
Pleura	Sales	3	3.22	0.90	11.56
Nasal cavity	Precision production workers	6	2.71	1.06	6.92
Latino women					
Malignant melanoma of the skin	Sales	3	2.26	0.60	8.51
Lung	Farming and agriculture	8	2.40	1.24	4.67
Latino men					
Leukemia	Other handlers and cleaners	3	3.99	1.05	15.17
Malignant melanoma of the skin	Construction trades	5	2.05	0.77	5.43
Peritoneum	Motor vehicle operators	3	2.87	0.86	9.57
Pleura	Services	3	4.67	1.19	18.37

[a]PMR $\geq$ 2.0 and observed deaths $>$2.
[b]Observed deaths.
[c]Proportionate mortality ratio directly adjusted for age using all deaths as the standard. Referent: all occupations within the same race/ethnic group.

Selected PMRs for associations of work-related cancer with specific occupations are shown in Table V. African American women employed in construction trades and as motor vehicle operators had approximately two times the expected number of deaths from lung cancer, as did female Latino agricultural workers. African American women working as cleaners and material handlers had a marked excess of deaths from nasal cancer (PMR 18.66), but with only three deaths observed. Latino men employed as cleaners and materials handlers experienced a four-fold increase in proportionate mortality from leukemia (PMR 3.99), although the confidence interval was wide (95% CI 1.05-15.17). Increased mortality from cancers of the pleura and peritoneum and from malignant melanoma was indicated in several occupations among men and women of both groups.

DISCUSSION

This is the first study to comprehensively describe mortality from work-related cancers among African American and Latino workers in the United States. By combining mortality surveillance data from death certificates from 21 states over an 8-year period, we were able to develop a large database offering greater breadth and statistical precision than in most previous studies. The study represents a significant step forward in characterizing the health experience of workers who were often omitted from previous studies. Besides computing directly standardized PMRs, we estimated directly standardized mortality rate ratios (SRRs) for workers aged 20-64 years, utilizing population data from the 1990 Census. Few occupational studies in the United States have presented SRRs based on population census and mortality data.

The only similar data available previously were published in a government report on occupational mortality in 24 states between 1984 and 1988 [Burnett et al., 1997]. That report presented industry-and occupation-specific PMRs for 192 causes of death among White and African American women and men, but did not provide data separately for Latinos. Our study also offers incremental, methodological improvements relative to the earlier work of Burnett and colleagues (1997) in that it is based on a longer time period and directly, rather than indirectly, adjusted mortality ratios to assure that the results are mutually comparable between study groups by virtue of having used the same standard for age-adjustment [Rothman and Greenland, 1998].

We found that relative to the average for all workers in the same age range, African Americans aged 20-64 years had higher mortality rates for lung cancer, nasal cancer, cancer of peritoneum and leukemia, with SRRs ranging from 1.3 to 2.0. Among Latinos, women had moderately elevated risk of cancer of the pleura, but only two cases were observed.

The principal purpose of the preceding comparisons was to relate the experience of African American and Latino workers to the average experience of U.S. workers. Such analyses may suggest insights about workplace exposures and help to address questions of justice that arise from the history of minority and immigrant workers being assigned to undesirable work entailing excessive exposure to hazardous agents.

Comparisons at this level tend to mirror known patterns of mortality in the population, however. Most men and women spend some part of their lives in the labor force, so people with some occupation listed on their death certificate can be expected to have mortality largely similar to that of the total population of the same age, sex, and ethnicity. Our observations of elevated lung and nasal cancer mortality among African American workers parallel observations of high incidence and mortality for these two cancers among African Americans in the general population [Baquet et al., 1991; Roush, 1996]. However, in contrast to general population statistics which indicate similar or lower mortality relative to whites [Groves et al., 1995; Blot and Fraumeni, 1996], we also observed higher mortality from leukemia and cancers of the pleura among African American workers. Such broad, population-level patterns of mortality reflect responses to numerous influences. Access to and quality of medical care, tobacco and alcohol consumption, diet, and ambient environmental exposures are all relevant, in addition to occupational exposures. In a population exposed to multiple determinants of disease risk, the relative importance of occupational and other exposures depends on both the joint distribution of the determinants and the proportion of disease attributable to each.

These two parameters have proven difficult to estimate for occupational exposures [Doll and Peto, 1981; Siemiatycki et al., 1991]. The large case—control study of Siemiatycki et al. [1991] provides extensive information regarding the proportion of specific cancers attributable to occupational exposures. For each of 11 common cancers, these investigators estimated the population attributable risk by three methods, which differed with respect to the exposures considered to be causal. The attributable risk was consistently high for lung cancer but, for other cancers, there was marked variation according to the estimation method. These findings illustrate the substantial challenges inherent in attempts to quantify the work-relatedness of cancer. In light of the level of knowledge in this area, possible differences in the proportions of the six cancers we studied that are attributable to work should be considered in comparing findings for these disease. The involvement of other factors does not mean that occupation is unimportant, however, but only that its specific contribution cannot be assessed directly with the data available.

The large size of the study made it possible to examine detailed combinations of race or ethnic group and sex with occupation or industry for specific cancers. Such internal analyses comparing the experience of minority workers in specific occupations or industries to the experience of others of the same race or ethnicity can provide insights about exposures associated with the workplace. A noteworthy finding of industry-specific analyses was a two-fold excess of leukemia among African American men in the rubber and plastic manufacturing industry. Numerous epidemiologic studies of rubber workers indicate increases in the risk of leukemia. Accumulated evidence suggests that several solvents, including benzene, are associated with leukemia in the rubber industry [IARC, 1982].

Several other groups potentially exposed to solvents also had excess proportionate mortality from leukemia in this study: Latino men with cleaning and material handling occupations had four times the expected number of leukemia deaths, and Latino women in chemical manufacturing industries had more than twice the expected number, although only two deaths were observed.

We also observed excess leukemia mortality among Latino men employed in textile manufacturing and wood products industries. Associations of wood and textile dusts with other lymphohematopoietic system tumors have been reported in some previous studies [Siemiatycki et al., 1986; Ward et al., 1997].

Our observation of excess mortality from cancers of the pleura and peritoneum among men and women of both groups is consistent with widespread exposures to asbestos. Although the usual occupations and industries reported for workers with these cancers were diverse, asbestos and asbestos products have been used in many industries and maintenance and cleanup activities with the potential for exposure may have been performed by a variety of occupational groups. Asbestos exposures may also have been incurred in occupations other than the longest held one listed on the death certificate. Malignant mesothelioma is frequently observed in workers with only short-term occupational exposures to asbestos [Bégin et al., 1996]. Risk assessments suggest that a small number of cancer deaths may arise from exposure to indoor air contaminated with asbestos fibers from construction materials [Health Effects Institute, 1991]. A limitation of our findings concerning these cancers, however, is that death certificate codes for pleural and peritoneal malignancies appear to be relatively insensitive surrogates for malignant mesothelioma [Selikoff, 1992].

Among other findings of interest were the two-fold excess of lung cancer deaths among African American women employed in construction trades and as motor vehicle operators. Increased risk of lung cancer in both occupations has been associated with exposure to diesel engine exhaust in some studies [Steenland et al., 1996]. Work in the construction industry may also involve expo-sure to asbestos, an established lung carcinogen. Increased proportionate mortality from malignant melanoma of the skin was observed in a diverse array of groups, including African American women employed in transportation, communication, and public utilities, in the machinery and transportation equipment manufacturing sector. These industry categories include electric power companies and electrical equipment manufacturers; malignant melanoma has been associated with exposure to polychlorinated biphenyls (PCBs) in both industries [Sinks et al., 1992; Loomis et al., 1997].

Other settings with excess mortality from malignant melanoma in this study included agriculture, construction, and sales and administrative support occupations. Previous studies of agricultural workers have reported excess malignant melanoma [Blair and Zahm, 1995]. Malignant melanoma also shows a social class gradient in many populations, with the highest risks observed among "white-collar" occupational groups, and lower risks among manual workers [Elwood, 1996]. Recent studies suggest that intermittent exposures, which may be associated with recreational activity, increase the risk of melanoma, while studies of chronic sun exposures like those sustained by outdoor workers are contradictory, indicating both increased and decreased risk [Armstrong and English, 1996; Elwood, 1996]. Little information is available about risk factors for melanoma skin cancer among African American and U.S. Latino populations, however, as most studies have been focused on light-skinned, European populations.

While the preceding analyses are suggestive of associations between cancer and several substances, the ability to identify specific exposures from the data we used is limited. Death certificates provide information about the decedent's work history only in the form of a code for the "usual" occupation and the industry in which he or she worked for the longest time, as reported to the funeral director by next of kin. This information is primarily useful for describing patterns of mortality, although it can also be used to infer occupational exposures to specific agents based on known or presumed associations of exposure with occupations and industries. Inferring specific exposures from job titles is challenging, however. Such inferences can rarely be validated directly, and it is likely that occupation and industry titles are neither sensitive nor specific as indicators of exposures to specific chemical or physical agents [Siemiatycki et al., 1989].

Death certificate data share characteristics of other general population surveillance systems, which frequently constrain the ability to detect occupational and environ-mental hazards [Rothman and Poole, 1988]. Nevertheless, analyses of job title information are useful for basic surveillance of known epidemiologic relationships and can be a valuable source of hypotheses for subsequent, in-depth investigation.

This study's other major limitations also derive from the nature of the information that can be obtained from death certificates. The quality of the occupational information available for minority workers is a such limitation worth considering. Some previous evaluations of death certificate data lead to inferences that the usual occupation and industry recorded on the death certificate may convey less about occupational history for minority and female workers than for white men [Steenland and Beaumont, 1984; Schade and Swanson, 1988]. This pattern could result from more frequent job changes and less stable career paths among workers who have historically been excluded from the nation's core work force. While Schade and Swanson [1988] urged caution in the use of occupational information from death certificates, their research nevertheless indicates similar quality of industry (but not occupation) data for all race and sex groups and suggests that grouping occupations and industries, as we did in the current study, may improve accuracy relative to the use of individual three-digit Census codes.

It is important to note, however, that the existing literature examining the classification of occupation and industry on death certificates [Buechley et al., 1956; Steenland and Beaumont, 1984; Gute and Fulton, 1985; Schumacher, 1986; Schade and Swanson, 1988] is based largely on data collected before the middle of the 1980s. The limitations reported in these studies led to multi-institutional efforts to improve the quality of death certificate occupational data [Dubrow et al., 1987]. The present study should have benefitted from these improvements, but there has been no formal evaluation of the quality of the occupational data currently available in NCHS mortality data files analogous to those conducted previously.

Data from death certificates and the census also provide an imperfect means of capturing the complexities of race and ethnicity [Herman, 1996]. We examined African American and Latino populations in the aggregate, although both groups are heterogeneous with respect to socioeconomic status, culture, and biology. Among Latinos, in particular, this approach may mask significant internal differences because mortality among Latino populations in the United States varies with national origin, recency of migration, and other factors [Rosenwaike, 1987; Zimmerman et al., 1994]. Because of small numbers, however, we could not examine subgroups defined by nationality or birthplace.

The quality of cancer diagnostic data on death certificates is generally good, but varies with the type of cancer, as well as with race and age [Percy et al., 1981]. The potential for this type of variation may be important to consider in interpreting some comparisons. The correspondence between cancer mortality and incidence should also be weighed in the interpretation of these results. Cancer survival varies significantly by race, with African Americans, in particular, having cancers of more advanced stage at diagnosis, poorer prognosis, and shorter survival, relative to whites [Horm et al., 1996].

The limitations of the PMR as a measure of epidemiologic association have been discussed extensively [Decouflé et al., 1980; Miettinen and Wang, 1981; Checkoway et al., 1989; Rothman and Greenland, 1998]. The PMR reflects the relative importance of a specific cause of death among all deaths, and approximates the relative rate of death only when the all-cause death rates of the compared populations are equal [Kupper et al, 1978; Miettinen and Wang, 198 1]. At the mid-point of the study period, however, the all-cause death rate for African Americans was 1.6 times that of Whites for all ages [MMWR, 1992], with a larger disparity for ages 20-64 years. Consequently, for between-population comparisons we conducted additional analyses using the SRR as the measure of association. As expected from their higher all-cause mortality. SRRs indicated more positive occupation—cancer associations for African Americans than PMRs did. These results suggest that PMRs may have poor sensitivity for detecting occupation—cancer associations when minority workers are compared to whites or to the entire work force.

While the SRR is usually preferred as a basis for inferences about the effect of exposure on the risk of disease, its disadvantage relative to the PMR is that computation of SRRs requires enumeration or estimation of the population at risk. With the data currently available in the United States, it is not possible to directly enumerate the size of the worker populations at risk of dying from cancer. This problem is exacerbated for populations whose last work experience was many years ago because the census provides information only on work in the previous year. To compensate, we restricted the analysis to people under the age of 65 years, who are most likely to have been working recently, and used the number of people who reported working in a given occupation or industry in the last census as a surrogate estimate of the population at risk.

This study generated a large number of PMRs and SRRs and hence a large number of statistical comparisons. Multiple comparisons are often cited as a potential source of spurious associations, but the application of this statistical idea to epidemiologic studies has been strongly questioned [Rothman, 1990; Savitz and Olshan, 1995]. There are sound reasons, nevertheless, for concern about studies that gene-rate large numbers of comparisons. Such studies are often based on surveillance data, which provide many observations but only a limited amount of information for each one. Hence, concern should be framed in terms of the inherent limitations of such data, rather than the number of comparisons such information permits.

A related limitation of this study is that precision was poor for some comparisons. The numbers of deaths from specific cancers were small for some combinations of race or ethnicity with occupation or industry, despite the large overall size of the study. For many comparisons, the confidence intervals were wide, even when unity was not included. This limitation reflects the nature of the original data, which have a fixed sample size and therefore do not afford the opportunity to augment study power by adding subjects. We used all of the data available at the time of this study, but future studies could have greater power if additional years of data were added or more states reported occupation and industry data to the NCHS. The database currently omits several of the largest states, which also have substantial minority populations, including New York, California, Texas, and Florida.

This study demonstrates the usefulness of a large mortality surveillance database for generating basic epidemiologic data on populations that have historically been neglected in occupational health studies. Findings suggesting carcinogenic exposures in the workplace can be followed up with focused studies. Continued efforts to improve the database should be encouraged. Analyses of the mortality data could be made more powerful by adding other states with large minority populations. In addition, the ability to use occupational data from the Census for epidemiologic mortality studies could be improved by adding questions about usual lifetime employment to the census questionnaire.

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