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Cancer Mortality Among Laundry and Dry Cleaning Workers

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A cancer mortality study of 8,163 deaths occurring among persons formerly employed as laundering and dry cleaning workers in 28 states is described. Age-adjusted sex–race cause-specific proportionate mortality ratios (PMRs) and proportionate cancer mortality ratios (PCMRs) were computed for 1979 through 1990, using the corresponding 28-state mortality as the comparison. For those aged 15–64 years, there were excesses in black men for total cancer mortality (PMR = 130, 95% confidence interval (CI) = 105–159) and cancer of the esophagus 1 (PMR = 215, 95% CI = 111–376), and in white men for cancer of the larynx (PMR = 318, 95% CI = 117–693). For those aged 65 years and over, there were statistically nonsignificant excesses for cancer of the trachea, bronchus, and lung in black women (PMR = 128, CI = 94–170) and for cancer of other and unspecified female genital organs in white women (PMR = 225, CI = 97–443). The results of this and other studies point to the need for the effective implementation of available control measures to protect laundry and dry cleaning workers. Am. J. Ind. Med. 32:614–619, 1997.

KEY WORDS: dry cleaning solvents; dry cleaning industry; laundering industry; organic solvents; chlorinated-hydrocarbons; chlorinated ethylenes; tetrachloroethylene; women; mortality data; malignant neoplasms; carcinogenicity

INTRODUCTION

Dry cleaning and some laundering operatives may have exposure to organic solvents used as cleaners, mainly the nonflammable synthetic solvent perchloroethylene, also called tetrachloroethylene [DHEW (NIOSH), 1978; Rubino, 1983; Seitz and Briotet, 1983]. Before the 1960s, dry cleaning establishments primarily used other organic solvents such as carbon tetrachloride, trichloroethylene, and flammable petroleum derivatives, especially Stoddard solvent. The potential exposures of dry cleaning workers to organic solvents differs according to their job category and proximity to the solvent cleaning machines [Seitz and Briotet, 1983; Rubino, 1983]. In 1979, National Institute for Occupational Safety and Health (NIOSH) air sample data from 44 dry cleaning establishments in California, Illinois, Michigan, New York, and Ohio indicated that, across the five states, the operators of dry cleaning machines have the greatest potential exposure to solvents, and that other dry cleaning employees have much lower potential exposure [Solet et al., 1990; Ludwig et al., 1983].

Several recent reports have described the mortality of laundry and dry cleaning workers [Blair et al., 1990; Asal et al., 1988; Nakamura, 1985; Katz and Jowett, 1981], the most recent a report, by Ruder et al. [1994], of a cohort of dry cleaning union members previously studied by Brown and Kaplan [1987]. Epidemiologic data have suggested that persons employed as dry cleaning workers who are exposed to tetrachloroethylene and other solvents have an increased risk of cancer of the esophagus [Ruder et al., 1994; Blair et al., 1990], intestine excluding rectum [Ruder et al., 1994; Fredriksson et al., 1989], and bladder [Ruder et al., 1994; Brown and Kaplan, 1987]. Other studies of workers in the laundry and dry cleaning industry have suggested an increased risk of cancer of the liver [Lynge and Thygesen, 1990; Nakamura, 1985], pancreas (Ruder et al., 1994; Asal

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et al., 1988], lung [Brownson et al., 1993], and kidney [Duh and Asal, 1984]. Many of the reports that specifically deal with laundry and dry cleaning workers are cohort mortality studies of employees of selected companies or of members of particular dry cleaning unions, while other reports are population-based mortality studies. The sample sizes for the industrial cohorts were under 2,000 except for two which were 3,315 [Asal et al., 1988] and 5,365 [Blair et al., 1990]; the number of deaths in the industrial cohorts under 2,000 ranged from 500 to 1,200 deaths. The deaths in all the industrial cohorts occurred from the 1940s through the 1980s.

Through a collaborative effort with the National Center for Health Statistics, the National Cancer Institute, and State health departments, NIOSH maintains a large database of coded occupational data from death certificates with wide geographical coverage of the United States [Burnett and Dosemeci, 1994]. The National Occupational Mortality Surveillance (NOMS) system currently includes data from 28 states for two or more years. Although the NOMS database lacks information on length of employment, specificity of occupations and industries, or estimates of workplace exposures, its advantages over recent studies include its size, its broad geographic coverage, and the recent date of death of the cases.

MATERIALS AND METHODS

We assessed the mortality experience of laundering and dry cleaning workers using NOMS data for 28 states[1] collected for 1979–1990 for decedents aged 15 years and over. Sources of information for the NOMS are death certificates, where the cause of death is entered by the attending physician, medical examiner, or coroner, and industry and occupation are entered by the funeral director with information supplied by informants or next of kin. The usual occupation and industry of each decedent in the NOMS is coded according to the 1980 Census classification system [U.S. Bureau of the Census, 1980]. The underlying cause of death is coded according to the International Classification of Diseases (ICD), Ninth Revision [WHO, 1977]. There were 8,163 deaths in total, with 2,157 deaths for ages 15–64 years (307 black men, 582 white men, 659 white women, and 609 black women) and 6,006 deaths for ages 65 years and over (358 black men, 1,293 white men, 3,074 white women, and 1,281 black women). We computed proportionate mortality ratios (PMRs) by comparing the proportion of all deaths that was due to specific causes, in laundering and dry cleaning workers, with a parallel estimate for decedents in all occupations. Age-adjusted PMRs were computed for deaths occurring for ages 15–64 years and for ages 65 years and over, stratified by race and sex. Age 65 years was chosen to correspond with the typical age of retirement, with greater likelihood of inaccurate occupational information after retirement. We also computed proportionate cancer mortality ratios (PCMRs) by comparing the proportion of all cancer deaths that was due to specific types of cancer among laundering and dry cleaning workers, with a parallel estimate for decedents in all occupations. To test for statistical significance of the PMR, two-sided 95% confidence intervals (95%CI) were calculated, based on the Poisson distribution for observed deaths [Bailar and Ederer, 1964], and using the normal approximation to the Poisson for large numbers [Mantel and Haenszel, 1959].

1. Alaska, California, Colorado, Georgia, Idaho, Indiana, Kansas, Kentucky, Maine, Missouri, Nebraska, Nevada, New Hampshire, New Jersey, New Mexico, New York except New York City, North Carolina, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Carolina, Tennessee, Utah, Vermont, Washington, West Virginia, and Wisconsin.

RESULTS

Results for selected malignant neoplasms for those aged 15–64 years and those aged 65 years and over are presented in Tables I and II, respectively. Complete results for all causes are available on request.

Review of the data for those aged 15–64 years shows that the highest and statistically significant PMR values were seen for all cancer in black men (97 observed, PMR = 130; 95%CI = 105–159), cancer of the esophagus in black men (12 observed, PMR = 215; 95%CI = 111–376), and cancer of the larynx in white men (6 observed, PMR = 318, 95%CI = 117–693; PCMR = 315; 95%CI = 116–685) (Table I). Cancer of the esophagus was elevated but not statistically significant in black women (PMR = 184; 95%CI = 84–349; PCMR = 164; 95%CI = 75–311) and white women (PMR = 189; 95%CI = 51–483; PCMR = 205; 95%CI = 56–526). Cancer of the trachea, bronchus, and lung was also elevated, but not statistically significant, in all groups (PMR = 132, 106, 106, and 109, and PCMR = 102, 104, 120, 126 for black and white men and black and white women, respectively). Cancer of the penis and other male genital organs was elevated in white men based on two deaths (PMR = 1,490; 95%CI = 180–5,381; PCMR = 1,493; 95%CI = 181–5,393).

We also found increases for those aged 65 years and over, including cancer of the trachea, bronchus, and lung in black women (48 observed, PMR = 128; 95%CI = 94–170) (Table II). A statistically significant PMR (4 observed, PMR = 1,275; 95%CI = 347–3,263) and PCMR (4 observed, PCMR = 1,277; 95%CI = 348–3,269) were seen for breast cancer in white men. The PCMR for cancer of the breast was reduced in black women aged 65 years and over (PCMR = 63; 95%CI = 39–95). Cancer of other and unspecified female genital organs in white women was elevated but not statistically significant (8 observed, PMR = 225; 95%CI = 97–443) (not shown). Cancer of the colon was lower than expected in white women aged 65 years and over (PCMR = 76; 95%CI = 57–98). The rubric,

TABLE I. Summary of Cancer Mortality Experience for Laundering and Dry Cleaning Machine Operators, Aged 15–64 Years, by Race and Sex, from 28 States*: 1979–1990†

	Black men (307 deaths)			White men (582 deaths)			Black women (609 deaths)			White women (659 deaths)		
Cause of death (ICD9 codes)	**Obs deaths**	**PMR and 95%CI PCMR and 95%CI**		**Obs deaths**	**PMR and 95%CI PCMR and 95%CI**		**Obs deaths**	**PMR and 95%CI PCMR and 95%CI**		**Obs deaths**	**PMR and 95%CI PCMR and 95%CI**	
Malignant neoplasms (140–208)	97	130	105–159	151	101	86–119	179	90	78–104	257	85	75–96
		100			100			100			100	
Esophagus (150)	12	215	111–376	3	75	16–219	9	184	84–349	4	189	51–483
		168	87–294		73	15–212		164	75–311		205	56–526
Colon (153)	6	106	39–231	10	83	40–152	12	70	36–123	14	59	32–99
		98	36–214		81	39–150		79	41–138		70	38–118
Liver (155)	0			2	95	12–342	1	49	1–271	0		
					92	11–333		55	1–305			
Pancreas (157)	4	118	32–302	9	128	58–243	8	78	34–154	6	51	19–111
		92	25–235		125	57–236		92	40–181		61	22–132
Larynx (161)	1	60	2–332	6	318	117–693	2	168	20–605	0		
		44	1–247		315	116–685		143	17–517			
Lung (162)	39	132	94–181	61	106	81–137	43	106	77–143	75	109	86–137
		102	73–140		104	80–134		120	87–162		126	99–158
Bone (170)	0			0			0			1	189	5–1,051
											256	6–1,427
Skin (172)	0			3	74	15–216	0			2	40	5–145
					70	15–205					53	6–192
Cervix (180)	0			0			11	118	59–212	8	105	46–208
								118	59–212		117	50–230
Ovary (183)	0			0			3	35	7–103	8	105	46–208
								41	8–119		117	50–230
Prostate (185)	7	162	65–335	5	102	33–238	0			0		
		125	50–258		105	34–245						
Penis (187)	0			2	1,490	180–5,381	0			0		
					1,493	181–5,393						
Bladder (188)	2	309	37–1,116	0			1	58	2–323	3	170	35–497
		241	29–871					60	2–335		192	40–562
Kidney (189.0–189.2)	1	70	2–388	1	24	1–135	3	132	27–385	3	64	13–188
		54	1–303		23	1–130		139	29–407		75	16–220
Thyroid (193)	0			0			0			0		
Lymphatic and hematopoietic	4	83	23–211	15	101	57–167	7	53	21–108	21	96	59–146
(200–208)		62	17–159		104	58–172		60	24–125		117	72–178

*Alaska, Colorado, Georgia, Idaho, Indiana, Kansas, Kentucky, Maine, Missouri, Nebraska, Nevada, New Hampshire, New Jersey, New Mexico, New York except New York City, North Carolina, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Carolina, Tennessee, Utah, Vermont, Washington, West Virginia, and Wisconsin.
†Abbreviations: ICD9, International Classification of Diseases, Ninth Revision; PMR, proportionate mortality ratio; PCMR, proportionate cancer mortality ratio; 95%CI, 95% confidence interval; OBS, observed.

other lymphatic neoplasms and multiple myeloma, was lower than expected among white women (20 observed, PMR = 56; 95%CI = 35–87) (not shown).

DISCUSSION

A major finding by Ruder et al. [1994], an excess of esophageal cancer overall and in women dry cleaning workers, corresponded to the statistically significant excess for this classification that we observed for black men and the statistically nonsignificant increases in black and white women. There was a statistically nonsignificant deficit in white men. The PMR and PCMR analyses produced similar findings for esophageal cancer. The difference between black and white male mortality may be due to differences in alcohol consumption in black men compared to white men

TABLE II. Summary of Cancer Mortality Experience for Laundering and Dry Cleaning Machine Operators, Aged 65 Years and Over, by Race and Sex, from 28 States: 1979–1990*

	Black men (358 deaths)			White men (1,293 deaths)			Black women (1,281 deaths)			White women (3,074 deaths)		
Cause of death (ICD9 codes)	**Obs deaths**	**PMR and 95%CI PCMR and 95%CI**		**Obs deaths**	**PMR and 95%CI PCMR and 95%CI**		**Obs deaths**	**PMR and 95%CI PCMR and 95%CI**		**Obs deaths**	**PMR and 95%CI PCMR and 95%CI**	
Malignant neoplasms (140–208)	96	98	79–120	298	97	86–109	252	101	89–114	564	86	79–93
		100			100			100			100	
Esophagus (150)	5	140	45–326	4	62	17–159	7	148	60–305	7	106	43–218
		134	44–314		64	18–164		140	56–289		126	51–259
Colon (153)	7	88	35–180	39	124	88–170	40	109	78–149	56	65	49–84
		91	37–188		128	91–175		111	79–151		76	57–98
Liver (155)	0			5	112	36–262	5	123	40–287	8	98	42–192
					115	38–269		126	41–294		106	46–210
Pancreas (157)	4	86	23–219	9	65	30–123	19	94	56–146	24	61	39–91
		89	24–227		67	31–127		93	56–145		71	45–105
Larynx (161)	2	167	20–603	5	156	51–365	1	206	5–1,149	0		
		167	20–603		162	53–378		162	4–901			
Lung (162)	27	89	59–130	103	99	81–120	48	128	94–170	109	88	73–107
		89	58–129		103	84–124		131	97–174		106	87–128
Bone (170)	0			1	244	6–1,361	0			4	419	114–1,074
					252	6–1,404					437	119–1,120
Skin (172)	0			1	33	1–187	1	118	3–658	6	113	41–246
					35	1–193		124	3–693		123	45–268
Breast (174, 175)	2	1–587	192–5,734	4	1,275	347–3,263	22	63	40–96	98	91	74–111
		1,478	179–5,340		1,277	348–3,269		63	39–95		110	89–134
Cervix (180)	0			0			7	99	40–205	11	143	71–255
								88	36–182		161	81–289
Ovary (183)	0			0			12	125	65–219	36	98	69–136
								118	61–207		118	83–164
Prostate (185)	27	120	79–175	29	68	46–98	0			0		
		128	84–186		71	47–102						
Penis (187)	0			1	384	10–2,142	0			0		
					383	10–2,133						
Bladder (188)	2	106	13–384	4	39	11–100	7	140	56–288	11	95	47–169
		112	14–406		40	11–102		132	53–272		109	55–196
Kidney (189.0–189.2)	3	209	43–611	8	119	51–234	3	102	21–298	14	121	66–203
		214	44–627		123	53–243		92	19–269		134	74–226
Thyroid (193)	0			0			1	187	5–1,043	1	54	1–300
								148	4–826		58	2–324
Lymphatic and hematopoietic (200–208)	4	65	18–166	26	98	64–143	18	85	50–134	46	71	52–94
		66	18–170		101	66–148		86	51–135		82	60–109

*See Table I footnotes.

and in urban versus rural residence patterns for black men compared to white men [Rubin, 1988]. An important difference between our study and that of Ruder et al. [1994] is that our population consists of laundering and dry cleaning workers, while the cohort in the study conducted by Ruder et al. [1994] was limited to dry cleaning workers. If the increased esophageal cancer in this study is associated with an exposure in the dry cleaning workplace, we would expect that combining dry cleaners and laundry workers might have led to an underestimation of the true risk.

We also observed an increase similar to that found by Blair et al. [1990] for laryngeal cancer in all race–sex groups

combined. We found excess laryngeal cancer in white men aged 15–64 years; there were too few deaths in other groups to give results. Cancer of the larynx is related to tobacco and alcohol use [Muscat and Wynder, 1992; Freudenheim et al., 1992]. Information on these factors was not available. However, analyses of noncancer causes of death related to smoking and alcohol use, such as chronic obstructive pulmonary disease and allied conditions, and chronic liver disease and cirrhosis, did not show a pattern consistent with excess smoking and alcohol use, although based on small numbers.

We found increased cancer of other and unspecified female genital organs in white women aged 65 years and over, decreases in white and black women under 65, and no increase or decrease for black women over age 65. However, these results were not statistically significant, and may be due to chance variation. Genital cancer (unspecified) has been found to be increased among female laundry and dry cleaning workers [Katz and Jowett, 1981]. These cancers are most common in older women (over age 60) [Cotran et al., 1989]. Although the causes are unknown, risk factors include low socioeconomic status, possibly related to increased sexual behavior [Brinton et al., 1990a,b], and cigarette smoking [Rubin and Farber, 1988]. We did not have information on other possible risk factors.

Another increase we observed was cancer of the trachea, bronchus, and lung, which was moderately elevated, but not statistically significant, in black men and white and black women aged 15–64 years (PMRs and PCMRs) and in black women aged 65 years and over (PMRs only). Although these statistically nonsignificant results may be due to chance variation, the increases are consistent with the results of Brownson et al. [1993], who found increased lung cancer in dry cleaning workers. Although information on cigarette smoking in this population was not available, data from the National Health Interview Survey indicates that laundry operators and dry cleaners have a higher proportion of current and former smokers than in the general population [Brackbill et al., 1988]. However, smoking may not have been highly prevalent in the study population, since analysis of noncancer causes of death related to smoking use among white decedents did not show a pattern consistent with excess smoking. There were too few deaths due to chronic bronchitis and emphysema in black men and women to conclude anything about the level of smoking in these two groups.

This is a large study including more than 2,000 deaths of individuals under 65 years of age and about 6,000 deaths of individuals 65 years of age and over. This PMR study is based on deaths occurring from 1979 to 1990, rather than over decades, and has broad geographical coverage for the United States. However, occupational mortality data are not without limitations. The information on usual occupation and industry listed on the death certificate may be inaccurate [Schade and Swanson, 1988; Schumacher, 1986; Steenland and Beaumont, 1984]. There is no information on possible confounders, such as smoking and alcohol use. There is no direct information on length of employment or possible occupational exposures. However, employees in service industries tend to have fewer years with their employer compared with other industries, which indicates that laundry and dry cleaning workers may have reduced exposures, possibly diluting the PMRs [U.S. Department of Labor, 1992]. Furthermore, cancer mortality will underestimate cancer morbidity and in varying degrees across the different types of cancer [Lynge, 1992].

Proportionate mortality studies are useful for hypothesis generation [Checkoway et al., 1989]. However, in a PMR study, the PMR for one cause of death may be relatively high if proportions of other causes of death are relatively low [Decouflé et al., 1980]. Excesses in PMR studies may be biased away from the null because of the ''healthy worker effect,'' resulting from a worker study population being healthier than a nonworker referent population [McMichael, 1976]. For instance, PMRs for long-term chronic diseases such as cardiovascular disease may be low, causing PMRs for other causes to be inflated [Howe et al., 1988]. In this study, PMRs due to circulatory disease (9th Rev ICD 390-459) ranged from 90 to 114 for all age and race groups (not shown), and none was statistically significant. The results in this study may not be affected by the healthy worker effect, as the referents are also workers. In addition, the healthy worker effect is less likely to occur for PCMRs, since the PCMR excludes nonmalignant chronic diseases [McMichael, 1976]. Finally, some elevations could be due to chance, because of the large number of study subjects and the multiple comparisons made.

This study adds to the evidence that laundry and dry cleaning workers may be at excess risk of specific causes of mortality, particularly esophageal cancer, laryngeal cancer, lung cancer, and cancer of other and unspecified female genital organs. That the excesses were not entirely consistent by race and sex makes inference from these data difficult, but the results suggest possible hypotheses for further study. Although limited, the findings, especially for esophageal and lung cancer, fit well with data from other epidemiological studies, all pointing to the need for the effective implementation of available control measures to protect laundry and dry cleaning workers [Solet et al., 1990; Materna, 1985; Stricoff, 1983].

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