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Cancer Mortality Among Women Employed in Fast-Growing U.S. Occupations

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Our study examined cancer mortality before the age of 65 for women employed in the fastest growing and/or traditionally female occupations. Analysis of mortality data from 28 U.S. states for 1984–1995 revealed elevated proportionate cancer mortality ratios (PCMRs). The highest PCMRs observed were thyroid cancer among health aides, lymphatic and multiple myeloma among computer programmers, and brain cancer among actresses and directresses. Some of the excess mortality occurred for occupations that have been previously cited. These included elevated breast and ovarian cancer among teachers, Hodgkin's disease among hairdressers and cosmetologists, and thyroid cancer among health aides and therapists. A few of the associations were new, i.e., had not been previously observed. These included cancer of the connective tissue and lymphatic system among computer programmers, ovarian cancer and leukemia among secretaries, and lymphatic cancer and multiple myeloma among child care workers. These findings should be further investigated with epidemiologic and environmental studies. Am. J. Ind. Med. 36:186–192, 1999. *Published 1999 Wiley-Liss, Inc.*†

INTRODUCTION

In the United States, the employed workforce is now 46% women. It is estimated to grow to 50% women by the year 2005 [U.S. Bureau of Labor Statistics, 1995]. The U.S. Bureau of Labor Statistics has projected that several occupations will show the most rapid growth by 2005. [U.S. Bureau of Labor Statistics, 1993]. We examined cancer mortality for women employed in these occupations. Our literature review showed that with the exception of stress, limited occupational health research has been published about women who work in the service and support occupations, sometimes called the traditionally female occupations. We evaluated recent mortality patterns for women in the occupations showing the most growth.

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MATERIALS AND METHODS

The source of data for age, sex, race, cause of death, and occupation were death certificates for women ages 18–90, from 28 U.S. states. The states included are evenly geographically distributed across the United States (Fig. 1). Included in the analysis were women who resided and died in one of the 28 U.S. states. Out of a total of seven million deaths during 1984–1995, we selected all black and white women except when usual occupation was ‘‘’’home maker,’’ which is about 50% of the deaths in women. Because occupation is often not specified if the deceased is retired, we limited our analysis to deaths that occurred before age 65.

Occupation refers to the usual occupation (longest held paid job). The usual occupation is reported by the next of kin and is recorded on the death certificate. Occupation was coded by qualified and experienced coders in the state vital statistics offices according to the Bureau of Census 1980 and 1990 classification systems [U.S. Census, 1982, 1992]. The occupational coding was supported through the collaborative efforts of the National Institute for Occupational Safety and Health (NIOSH), the National Cancer Institute (NCI), the National Center for Health Statistics (NCHS), and state health departments. Our study focused on the cancer mortal-

FIGURE 1. States included in the National Occupational Mortality Surveillance system for 2 or more years, 1984–1995.

ity of women whose usual occupation was one of the fast growing occupations reported by the Bureau of Labor Statistics [U.S. Bureau of Labor Statistics, 1993] (Table I).

Proportionate mortality studies suffer from the well-known problem that the proportions of deaths from different causes are not independent; a deficit in one cause will lead to an excess of another cause [Hernberg, 1992]. To avoid the problem of competing causes, we chose to focus on proportionate cancer mortality ratios (PCMRs).

Proportionate cancer mortality ratios (PCMRs) adjusted by race (white, black) and age (5-year age groups) were calculated for selected causes of death for women in fast growing occupations. We included all occupations listed in Table I that could be individually identified in the census occupation codes [U.S. Bureau of the Census, 1982, 1992]. A computer program developed at NIOSH was used in these calculations [Dubrow et al., 1993]. Proportionate cancer mortality ratios compared the proportion of deaths for a specific cancer in a selected occupation with the proportion of that cancer among women in all occupations. We calculated 95% confidence intervals using the Mantel-Haenszel Chi-square [Mantel and Haenszel, 1959]. When the observed number of deaths was fewer than 1,000, we used the variance from Poisson distribution [Bailar and Ederer, 1964].

We reported the PCMRs for the 12-year period, 1984–1995. We reported elevated proportionate mortality ratios based on 3 or more deaths if the lower bound of the confidence interval did not include 100. In addition, we reported PCMRs and 95% confidence interval for two 6-year strata, 1984–1989 and 1990–1995.

RESULTS

Table I shows the amount of employment growth that was projected for the future between 1992 and 2005 by the Bureau of Labor Statistics [U.S. Bureau of Labor Statistics, 1993]. The occupations of health aide and computer programmer are expected to more than double in size by the year 2005. Physical, respiratory, occupational, and speech therapist occupations will nearly double. Preschool and special education teachers will increase by 54 and 74%, respectively. Many other occupations that employ large numbers of women are expected to grow as shown in Table I.

We studied 458,690 U. S. women who died of cancer, between 1984 and 1995 among all black and white women whose usual occupation was not listed as homemaker on the death certificate. Table II shows excess mortality for several sites of cancer among women whose usual occupation was one of the occupations projected to and for which PCMRs were statistically significantly elevated during the study period. Among all deaths, teachers, except post-secondary, experienced modestly elevated PCMRs for several sites;

TABLE I. Occupations With the Most Growth Projected 1992 to 2005*

Occupation	Percent projected growth
Health aides	138
Computer programers	112
Physical therapists	92
Respiratory/speech/occupational therapists	83
Teachers, special education	74
Teachers, preschool	54
Physicians, assistants	70
Detectives and corrective officers	70
Travel agents	66
Child care workers	66
Radiologic technicians	63
Nursery (farm) workers	63
Medical records technicians	63
Subway and streetcar operators	57
Legal secretaries	57
Manicurists	54
Directors and actors	54
Flight attendants	51
Guards	51
Insurance adjusters	49

*U.S. Bureau of Labor Statistics, Monthly Labor Review, November 1993.

these included cancer of the colon (PCMR = 111), breast (PCMR = 132), ovary (PCMR = 122), brain (PCMR = 125), and multiple myeloma (PCMR = 123). Cancer of the connective tissue (PCMR = 126) and melanoma (skin) (PCMR = 122) and myeloid leukemia (PCMR = 121) were also significantly elevated, and their PCMRs rose over the two strata, being highest during the years 1990–1995.

Women whose usual occupation was health services (health aides) were observed to have statistically significant excess mortality for four sites: cancer of the thyroid (PCMR = 194), lung (PCMR = 110), cervix (PCMR = 132), and kidney (PCMR = 127). Thyroid cancer peaked in the most recent stratum, 1990–1995 (PCMR = 214), as did kidney cancer (PCMR = 141).

Secretaries had excess mortality for five sites for all years combined: cancer of the oral cavity and pharynx (PCMR = 117), ovary (PCMR =108), and breast (PCMR = 114); and melanoma (skin) (PCMR = 113) and acute lymphoid leukemia (PCMR = 137).

Overall, actors and directors experienced elevated mortality for cancer of the brain and nervous system (PCMR = 264) and this PCMR increased in the recent time interval (PCMR = 407), based on a small number of deaths. Hairdressers and cosmetologists were observed to have elevated mortality due to Hodgkin's disease (PCMR = 195); while child care workers had excesses due to non-Hodgkin's lymphoma (PCMR = 152) and lymphatic and multiple myeloma (PCMR = 134).

Women whose usual occupations were respiratory, occupational, or physical therapist, had a very high PCMR for cancer of the thyroid (PCMR = 820) and these persisted over both strata based on small numbers. Computer programmers experienced elevated cancer of the connective tissue (PCMR = 267) and lymphatic and multiple myeloma (PCMR = 185). Guards had elevated proportionate mortality for cancer of the colon (PCMR = 135), but were not statistically significant in the strata.

DISCUSSION

Analyses were conducted to evaluate variations in mortality patterns for U.S. women employed in occupations that were projected to show the most growth during the years 1992–2005. Some growing occupations are relatively new, for example, computer programmers, home health aides, and child care workers, and there has been little opportunity for epidemiologic studies of these work settings.

In our data, computer programmers were observed to have moderately elevated PCMRs for cancer of the connective tissue and lymphatic system and multiple myeloma. Computer programmers have not been previously noted to have increased mortality for either cancer site and these observations should be followed up with other studies. Connective tissue cancer has been associated with agricultural and other occupations [Zahm, 1988], and tumor registry and cohort studies have noted increased connective tissue cancer following radiation treatment [Harvey and Brinton, 1985]. Multiple myeloma has been associated with several occupations and occupational exposures, including solvents, ionizing radiation, and pesticides [Herrinton et al., 1996].

Table II shows moderately elevated excess thyroid cancer for health aides, with the highest PCMRs occurring between 1990 and 1995. Slight excess cancer mortality was noted for other sites including pancreas, lung, cervix, and kidney. Health aides may be exposed to chemotherapeutic agents and ionizing radiation through many diagnostic and therapeutic procedures [Lunn, 1987]. Excess thyroid cancer has been noted among British radiation workers enrolled in a registry [Kendall et al., 1992]. Lung and cervical cancer have been seen following radiotherapy [Boice et al., 1988; Travis, 1995].

Actors and directors had excess risk for brain cancer, which might be related to the use of hair dyes that have been found in some studies to increase risks [Burch et al., 1987; IARC, 1993]. For some occupation site combinations reported here, such as child care workers and lymphatic cancer and multiple myeoma, there does not appear to be a readily

TABLE II. Stratified Cancer PCMRs 1984–1995 for Women Aged 18–64 Employed in Fast-Growing Occupations in the United States

Site	Number of deaths	PCMR (95% CI) 1984–1995	Number of deaths	PCMR (95% CI) 1984–1989	Number of deaths	PCMR (95% CI) 1990–1995
Health aides (health services occupations) 445–447[a]						
Thyroid	23	194 (123–290)	10	172 (82–316)	13	214 (114–367)
Pancreas	297	112 (100–126)	162	125 (107–146)	135	100 (84–119)
Lung	1,616	110 (106–115)	765	111 (103–119)	851	110 (103–117)
Cervix	345	132 (118–147)	171	139 (119–161)	174	126 (108–146)
Kidney	134	127 (107–151)	58	113 (86–146)	76	141 (111–176)
Computer programmers 229						
Connective tissue	8	267 (115–527)	3	232 (48–678)	5	294 (96–687)
Lymphatic and multiple myeloma	15	185 (104–306)	8	256 (111–505)	7	141 (57–290)
Guards 415, 425–427						
Colon	54	135 (102–176)	29	139 (93–199)	25	131 (85–194)
Teachers 155–159 except post-secondary						
Colon	851	111 (104–119)	446	110 (100–121)	405	113 (102–124)
Breast	3,855	132 (129–135)	2,006	133 (129–137)	1,849	130 (126–135)
Ovary	837	122 (114–130)	438	126 (114–138)	399	117 (106–130)
Brain	439	125 (114–137)	216	124 (108–142)	223	126 (110–144)
Myeloid leukemia	219	121 (105–138)	119	125 (104–150)	100	116 (94–141)
Connective tissue	137	126 (106–149)	62	120 (92–153)	75	132 (104–166)
Melanoma skin	252	122 (108–138)	116	107 (88–128)	136	139 (117–165)
Multiple myeloma	174	123 (106–143)	80	113 (90–141)	94	133 (108–163)
Therapists (respiratory, occupational, physical) 98–105						
Thyroid	6	820 (301–1786)	3	945 (195–2760)	3	725 (150–2119)
Child care workers (except private household) 408, 468						
Non-Hodgkin's lymphoma	47	152 (112–203)	26	193 (126–283)	21	121 (75–185)
Lymphatic and multiple myeloma	56	134 (101–174)	28	162 (108–234)	28	114 (76–165)
Secretaries 313–315						
Oral cavity and pharynx	176	117 (101–136)	92	106 (85–130)	84	134 (107–166)
Melanoma, skin	333	113 (101–126)	194	116 (100–134)	139	109 (91–128)
Ovary	1,094	108 (102–114)	594	105 (96–113)	500	113 (103–123)
Breast	4,570	114 (111–116)	2,573	113 (110–116)	1,997	115 (111–118)
Acute lymphoid leukemia	59	137 (104–176)	38	165 (117–227)	21	104 (64–159)
Hairdressers and cosmetologists 458						
Hodgkin's disease	26	195 (127–286)	11	161 (80–288)	15	231 (129–381)
Actors and directors 187						
Brain and nervous system	8	264 (114–520)	1	—	7	407 (164–838)

[a]Refers to occupation codes [U.S. Bureau of Census, 1982, 1992]. (—) Indicates PMR and confidence interval were not calculated when number of deaths <3.

apparent occupational connection and the association may be due to nonoccupational risk factors or to chance.

Many occupations are difficult to study longitudinally because there are no organized personnel record systems, or there are many small workplaces involved. Service occupations, in particular, do not lend themselves to traditional cohort study. Because service and other occupations typically are focused in small shops or occur sporadically within other industries like hospitals, manufacturing, and retail, they may present interesting challenges as we attempt to study them further. While women and men contribute almost equally to the labor pool, there is marked gender-based segregation of work activities. Women predominate in clerical and services occupations [Wagener et al., 1997; U.S. Bureau of Labor Statistics, 1995]. This suggests that women have potentially different occupational exposures and health risks.

Our data showed that hairdressers and cosmetologists experienced excess mortality for Hodgkin's disease. Other studies have reported excess Hodgkin's disease among

hairdressers. The International Agency for Research on Cancer has reviewed these studies and concluded that there is inadequate evidence that use of hair dye entails exposure that is carcinogenic; however, occupation as a hairdresser entails exposures that are probably carcinogenic [IARC, 1993]. Industrial hygiene approaches to identifying and preventing hazardous exposures have only recently been instituted in hairdressing and nail care salons [Spencer et al., 1997]. Stellman suggested that manicurists might be exposed to epichlorhydrin, a suspect carcinogen found in solvent for nail polish [Stellman, 1994]. Known or suspected carcinogens are present in cosmetics and perfume, such as acetaldehyde, dimethyl sulfate, and 1–4 dioxane, ethyl acrylate, and hair dyes.

Teachers, except post-secondary, experienced small proportionate excesses of cancer for eight sites, compared to all other occupations (Table II). The largest PCMR was due to breast cancer, reported by a few studies to be increased among women in professional occupations, including teaching [Rubin et al., 1993; Morton, 1995]. In a British study of cancer and occupation, female teachers had the highest risk for breast cancer of all occupations. In addition, elevated proportionate mortality was reported for uterus, melanoma skin, and colon cancer [Carpenter and Roman, 1995]. A prospective cohort study and two case-control studies that controlled for important risk factors such as menarche, family history, age at and number of live births, reported finding no association with occupation [Calle et al., 1998; Coogan et al., 1996; Habel et al., 1995]. The possibility that teachers' elevated cancer ratios may reflect a diagnostic bias due to their elevated socioeconomic status cannot be ruled out by our data. These and other breast cancer risk factors may have confounded our data.

Teachers and secretaries experienced excess risk for ovarian cancer in our data. Exposures to asbestos and talc have been implicated by a cohort study of female gas mask assemblers [Acheson et al., 1982] and a case control study [Harlow and Hartge, 1989]. Tzonou reported women who use hair dyes were at greater risk of ovarian cancer (relative risk 2.2) [Tzonou et al., 1993]. No studies have implicated teaching or secretarial occupations [Weiss et al., 1996], although case control studies have identified major risk factors such as family history, drug treatments, delayed child bearing, or low nulliparity [John et al., 1993] and infertility [Rossing et al., 1994]. These risk factors may be present in our data and could explain our finding. Nulligravid women were recently reported [Rodriguez et al., 1998] to be at increased risk for fatal ovarian cancer. Nulligravid women may be overrepresented among career teachers and secretaries.

Although we noted an excess of colon cancer among teachers, it is not generally viewed as an occupational disease, but is more often associated with socioeconomic status and lifestyle risk factors [Schottenfeld and Winawer, 1996]. Teachers have been previously reported at risk by a British study of cancer and occupation [Carpenter and Roman, 1995]. Myloid leukemia has not previously been reported in excess among teachers although it has been associated with occupational exposure to benzene, ionizing radiation, and non-ionizing electromagnetic fields [Linet and Cartwright, 1996]. Previous studies have not associated brain cancer with the teaching occupation, but with other risk factors, host factors, non-ionizing radiation [Savitz and Loomis, 1995], and occupational exposure to petrochemicals and agricultural chemicals [Preston-Martin et al., 1989, 1993]. Increased risk for melanoma skin cancer was previously reported for teachers in the United Kingdom [Carpenter and Roman, 1995].

Secretaries in our data experienced elevated site-specific PCMRs for five sites of cancer, including oral, ovarian, and breast cancer and melanoma (skin) and acute lymphoid leukemia. Long duration of exposures to fluorescent lights have been associated with increased risk of melanoma in both males and females, in office workers and other indoor occupations after control for sun exposure and hair color [Beral et al., 1982], although other studies have reported negative results. Calle reported a slightly increased risk (rate ratio = 1.14) for breast cancer mortality women in administrative support, including clerical occupations, after controlling for breast cancer risk factors [Calle et al., 1998]. However, we were unable to control for breast cancer risk factors and these could explain our observed elevated PCMR. Delayed child bearing in career office workers could be a potential risk factor for ovarian and breast cancer in women who are career secretaries. With the exception of tetrachloroethylene, which is contained in correction fluid, the occupational exposures of secretaries have not been reported. Workplace exposures could be derived from reviews of air quality in the office [Mendell, 1993].

The limitations of PMR studies include inaccuracy of cause-of-death and imprecise exposure classification based on usual occupation. In addition, in our study, there may not have been sufficient statistical power to evaluate deaths for all occupations among black females. However, one study [Percy et al., 1981] showed that seven of the ten leading sites of cancer deaths were found to have a high detection and confirmation rate, when validated by autopsy. However, cancer of the colon and rectum, cancer of the uterus, and buccal cavity cancer were found to be over- or under-reported on death certificates.

The highest PCMRs observed in our study were thyroid cancer among health aides, lymphatic and multiple myeloma among computer programmers, and brain cancer among actresses and directresses. Some of the excess mortality occurred for occupations that have been previously cited.

These included elevated breast and ovarian cancer among teachers, Hodgkin's disease among hairdressers and cosmetologists, and thyroid cancer among health aides and therapists. A few of the associations were new, i.e., had not been previously observed. These included cancer of the connective tissue and lymphatic system among computer programmers, ovarian cancer and leukemia among secretaries, and multiple myeloma among child care workers. These findings should be further investigated with epidemiologic and environmental studies.

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