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Occupation and Breast Cancer Mortality in a Prospective Cohort of US Women

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The authors examined the association between main lifetime occupation and subsequent breast cancer mortality in a large prospective study of US adults. After 9 years of follow-up, 1,780 cases of fatal breast cancer were observed among 563,395 women who were cancer-free at interview in 1982. Main lifetime occupation was derived based on self-reports of current and former occupational titles and was classified into 14 broad occupational groups and 16 more narrowly defined occupational titles. Results from Cox proportional hazards models, adjusted for breast cancer risk factors, revealed little variability in breast cancer mortality by occupation. Two significant associations were observed: In comparison with housewives, women in "administrative support, including clerical" occupations were at a small increased risk (rate ratio (RR) = 1.14, 95% confidence interval (CI) 1.01–1.31), and an increased risk was seen for "executives" (RR = 1.93, 95% CI 1.03–3.62), based on 10 breast cancer deaths. No significant increases in risk were observed for teachers and librarians (RR = 0.89), nurses (RR = 0.84), managers (RR = 0.89), or women employed in sales (RR = 0.88) or service (RR = 0.84) occupations. When analyses were limited to women who had worked in their occupation for 10 or more years, the results for each occupational title were virtually unchanged. These results offer little support for an association between occupation and breast cancer mortality in general or for particular occupational titles, including teachers and nurses. *Am J Epidemiol* 1998;148:191–7.

breast neoplasms; cohort studies; occupations; risk; women

Established risk factors for breast cancer include age, a personal or family history of the disease, certain types of benign breast disease, and a variety of hormone-related reproductive factors (1). In recent years, several investigators have focused on occupation as a possible contributor to breast cancer risk (2–13), either because workplace exposures may cause disease or because occupation potentially identifies groups of women at high risk for reasons other than actual workplace exposures. In these investigations, occupational title has served as a surrogate for potential exposures, and actual exposures have not been quantified. Results for specific occupational titles have varied considerably across studies; however, several studies have found increases in breast cancer risk among women in professional occupations (2, 5–8, 10, 11), including nursing (4, 5, 7, 9, 11) and teaching (2, 5–7, 11, 12), and in administrative and clerical support occupations (2, 3, 6, 8, 10–12).

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Abbreviations: CI, confidence interval; RR, rate ratio.

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Most previous studies have not controlled adequately for known breast cancer risk factors that may confound any observed associations with occupation (2, 5–8, 11–13). In addition, several have been proportional mortality studies (2, 11, 12) and, as such, cannot distinguish between the possibilities that an occupation is associated with increased risk of breast cancer death versus decreased risk of death from other causes. One such recent study (2) found teachers to be at twice the risk of breast cancer mortality as other women, an association considerably larger than had been observed previously. This study has received considerable attention both because of the magnitude of the suggested increased risk and because teachers comprise one of the largest single occupational groups among women in the United States. To investigate further the risk of breast cancer by occupational group and specifically among teachers, we examined the association of breast cancer mortality and occupation in a large prospective cohort of US women.

MATERIALS AND METHODS

Women in this study were selected from the 676,526 female participants of Cancer Prevention Study II, a prospective mortality study of about 1.2 million Amer-

ican men and women begun by the American Cancer Society in 1982 (14, 15). Participants were identified and enrolled by over 77,000 volunteers in all 50 states, the District of Columbia, and Puerto Rico. They completed a questionnaire in 1982 that included personal identifiers; demographic characteristics; personal and family history of cancer and other diseases; and various behavioral, environmental, occupational, and dietary exposures. The median age of female study participants in 1982 was 56 years; 75 percent of the women were between ages 45 and 70 years, and none was younger than 30 years.

The vital status of study participants was determined from the month of enrollment through December 31, 1991, using two approaches. Volunteers made personal inquiries in September 1984, 1986, and 1988 to determine whether their enrollees were alive or deceased and to record the date and place of all deaths. Automated linkage utilizing the National Death Index was used to extend follow-up through December 31, 1991 (16) and to identify deaths among 13,219 (2 percent) women lost to follow-up between 1982 and 1988. At the end of mortality follow-up in December 1991, 615,009 women (90.9 percent) were still living, 59,439 (8.8 percent) had died, and 2,078 (0.3 percent) had follow-up truncated on September 1, 1988, because of insufficient data for National Death Index linkage. Death certificates were obtained for 97.1 percent of all women known to have died.

Breast cancer deaths were defined as having occurred in those women who died through December 31, 1991, with breast cancer (International Classification of Diseases, Ninth Revision, codes 174.0–174.9) (17) as the underlying cause. We excluded from the analysis 57,122 women who had prevalent cancer (except nonmelanoma skin cancer) at study entry in 1982, and 56,009 women with missing data on occupational history. After 9 years of follow-up, 1,780 eligible cases of fatal breast cancer were observed among an analytic cohort of 563,395 women.

In the baseline questionnaire, women completed a section on occupational history that included a question about their current occupation and a second question that asked, "What other job have you held for the longest period of time?" Respondents were asked to report the number of years spent in each of these occupations. In addition, women who had already retired were asked to report their last occupation but not the number of years spent in the last occupation. Therefore, retired women who responded only to this question had missing values for number of years in that occupation and were assigned a value of 20 years; this assignment was based on an analysis of a subgroup of retired women who had reported an average of 19.5 years spent in the occupation from which they retired. The three occupation questions were used to assign each woman to a main lifetime occupational category in the following way. The majority of women (59 percent) reported only one occupation and were assigned accordingly. About 39 percent reported two different occupations, and 2 percent reported three different occupations. Women who reported more than one occupation were assigned to the occupation in which they spent the greatest number of years.

The reported occupations were categorized according to the 1980 Bureau of the Census occupational titles (18). All women were initially categorized into 14 broad occupational groups corresponding to 13 groups specified by the Bureau of the Census (18) plus housewives; these groupings are comparable with those used in two recent studies of breast cancer and occupation (2, 3). These 14 broad groups are mutually exclusive and include all women in the study. In addition, we looked at 16 more narrowly defined occupational titles that are subsets of the broader groups and in which at least 10 deaths from breast cancer occurred during the follow-up period.

We used Cox proportional hazards modeling (19) to compute rate ratios and to adjust for other risk factors when assessing the association of occupation and fatal breast cancer. All Cox models were stratified on single year of age at interview. Other potential confounders included in multivariate models were race (white, black, other), a history of breast cancer in a mother or sister (yes, no), a personal history of breast cysts (yes, no), body mass index (weight (kg)/height $(m)^2$) (<26, 26-<29, ≥ 29), number of livebirths (0, 1–2, ≥ 3), age at first livebirth (<20, 20–24, 25–29, ≥ 30), age at menarche (<12, 12, 13, ≥ 14), age at menopause (<45, 45–49, 50–54, ≥ 55, premenopausal), oral contraceptive use (ever, never), estrogen replacement therapy (ever, never), years of education (<12, 12, 13-<16, ≥ 16), exercise at work or play (none, slight, moderate, heavy), smoking (current, former, never), and alcohol use (none, three drinks per week to less than one drink per day, one drink per day, more than one drink per day, missing). Rate ratios reported in the text are those obtained from fully adjusted models. Rate ratios were not calculated for occupational categories with fewer than 10 breast cancer deaths. In all Cox models, housewives served as the reference group. The associations between each occupational category and fatal breast cancer were examined initially for all women; rate ratios were then calculated separately for women with long duration of work exposure, defined as those who had worked in the occupation for 10 or more years.

RESULTS

The majority of women in this cohort (94.0 percent) were white, and 36.4 percent were age 60 years or older at the time of enrollment. Overall, 26.6 percent were college graduates, and 88.6 percent had borne at least one child. Numerous studies of risk factors for fatal breast cancer in this cohort have been described elsewhere (20–24).

Among the entire analytic cohort, 216,633 women (38.5 percent) were classified as "housewife" for their main lifetime occupation. Among the 346,762 women who worked outside the home, hereafter called "working women," approximately 25 percent were retired at the time of enrollment. For working women, the average duration of time spent in their main lifetime occupation was 17 years. Table 1 shows age-adjusted (to the age distribution of the entire study population) percentages of both housewives and working women across categories of other potential breast cancer risk factors. Some differences were observed between housewives and working women, primarily for age, race, education, parity, and exercise. Working women tended to be younger and, after adjustment for age, were more likely to be nonwhite, to have more education, to have had fewer children, and to exercise somewhat less than housewives. Differences between housewives and working women for other potential breast cancer risk factors were small.

Rate ratios by broad occupational groupings and by more narrow occupational titles are shown in table 2. A significantly increased risk was observed for the occupational title "executives" (rate ratio (RR) = 1.93, 95 percent confidence interval (CI) 1.03–3.62), based on 10 breast cancer deaths. In addition, women in "administrative support, including clerical" occupations were at a small increased risk (RR = 1.14, 95 percent CI 1.01–1.31); this was explained largely by the risk among secretaries (RR = 1.14, 95 percent CI 0.98–1.32). Of the other occupational titles included in this category, telephone/telegraph operators and bank tellers had the highest estimates of risk (RR = 1.53 and 1.43, respectively), but these estimates were based on sparse data (10 and 17 deaths, respectively), and neither estimate was significantly different from 1.00. The risk of fatal breast cancer was also elevated for technicians (RR = 1.54, 95 percent CI 0.99–2.39); in this occupational category, all 21 breast cancer deaths occurred among laboratory and x-ray technicians. No increases in risk were observed for teachers and librarians (RR = 0.89), nurses (RR = 0.84), or other occupational titles, either before or after adjustment for covariates other than age. When analyses were limited to women who had worked in their occupation for 10 or more years (74 percent of all working women), the results for each occupational title were virtually unchanged (data not shown). Specifically, women who had been teachers for 10 or more years had no increased risk of breast cancer mortality (RR = 0.84, 95 percent CI 0.68–1.04).

DISCUSSION

These prospective data do not support the hypothesis that women who work in the teaching profession are at increased risk of breast cancer mortality. In addition, in this large study of a relatively homogeneous cohort of US women, there is little evidence of a substantial increase in breast cancer risk for any particular occupational group; only two of the rate ratios presented were significantly different from 1.00. Our finding of a small (16 percent), but significant, excess risk among administrative and clerical workers has been seen in several other studies (2, 3, 6, 8, 10–12). It has been hypothesized that this small excess risk may be due to the sedentary nature of these occupations and to the fact that previous studies have not controlled for physical activity level (3). Control for a relatively crude measure of physical activity (exercise at work or play) in our analysis did not change the estimates of risk. Our finding of an increased risk among women categorized as executives may represent a chance finding because it was based on few deaths (n = 10) and was dissimilar to the estimate of risk seen for the larger group of women who were categorized as managers.

Employment outside the home and in a specific occupation is likely to be highly correlated with educational status, socioeconomic status, and characteristics of reproduction, all of which may confound the association of occupation and breast cancer risk (11). Only three previously conducted studies were able to control for both sociodemographic and reproductive factors in their analyses of occupation and breast cancer (3, 4, 10). All three were population-based case-control studies of incident breast cancer. The results of these three studies were similar to those of this study; little variability was seen in breast cancer risk across occupational groups, and no significant excess risk was seen for teachers. In contrast, the consistent finding across studies that were not able to control for important confounders appears to be one of increased breast cancer risk among women of higher educational or socioeconomic status rather than a consistently observed association for any given occupational title (2, 5–8, 10, 11). This positive association between socioeconomic status and breast cancer is well established (1) and likely reflects differences in reproductive, dietary, and other factors.

In addition to inadequate control for confounders, a

TABLE 1. Age-adjusted percentages of working women and housewives by breast cancer risk factors, Cancer Prevention Study II, United States, 1982–1991

Characteristic	Working women		Housewives	
	No.*	Age-adjusted percentage†	No.*	Age-adjusted percentage†
Total	346,762		216,633	
Age (years) at interview				
29–39	23,136	6.7	7,095	3.3
40–49	87,804	25.3	43,489	20.1
50–59	118,795	34.3	78,145	36.1
60–69	79,685	23.0	58,681	27.1
≥70	37,342	10.8	29,223	13.5
Race				
White	321,021	92.6	208,789	96.4
Black	20,296	5.8	5,544	2.5
Other	3,864	1.1	1,377	0.7
Education				
Not high school graduate	34,383	10.3	36,933	16.2
High school graduate	98,883	28.6	72,845	33.7
Some college	108,462	31.1	62,225	29.0
College graduate	101,332	28.9	41,887	19.8
Body mass index				
<21	66,082	18.8	40,226	19.0
21–<25	145,221	41.9	90,293	41.7
25–<29	77,965	22.7	49,222	22.3
≥29	50,507	14.6	31,644	14.6
Family history of breast cancer				
No	321,950	92.8	200,125	92.5
Yes	24,812	7.2	16,508	7.5
Livebirths				
0	51,954	15.1	12,131	5.4
1	41,801	12.1	18,977	8.5
2	93,721	26.9	55,453	25.8
3	73,656	21.1	53,070	24.8
≥4	71,275	20.6	66,782	32.2
Age (years) at first livebirth (among parous women)				
<20	38,338	12.7	24,900	12.6
20–24	128,127	42.9	94,439	47.0
25–29	78,205	26.8	55,738	26.8
≥30	32,109	11.3	19,400	9.0

Table continues

second explanation for some previously reported associations may be the use of inappropriate controls. In proportional mortality studies (2, 11, 12), cases are defined as deaths from breast cancer, and controls are selected from all other deaths. A necessary assumption for this type of analysis is that the probability of death from causes other than breast cancer (from which controls are selected) is not related to the exposure, in this case, occupation (25). However, this assumption is unlikely to be met, given that women in lower socioeconomic status occupations are more likely to die of cardiovascular disease and lung cancer (26–29). Thus, what appears to be an excess of breast cancer deaths among women in high socioeconomic status occupations may more accurately reflect a deficit of deaths from other causes among these women.

One limitation of our study is the reliance on mortality due to breast cancer rather than incidence to identify disease. Thus, our results reflect the potential effect of occupation on breast cancer incidence, survival, or both. In addition, we have no information on mammography screening and other factors that may

TABLE 1. Continued

Characteristic	Working women		Housewives	
	No.*	Age-adjusted percentage†	No.*	Age-adjusted percentage†
History of breast cysts				
No	288,423	83.3	182,464	84.1
Yes	58,339	16.7	34,169	15.9
Age (years) at menarche				
<12	62,689	17.8	35,796	16.9
12	85,873	24.7	51,892	24.2
13	95,721	27.6	60,909	28.2
≥14	90,543	26.4	60,237	27.3
Age (years) periods stopped				
<45	56,802	16.7	34,454	15.5
45–49	53,966	16.2	36,726	16.0
50–54	68,749	20.8	51,278	22.0
≥55	17,535	5.4	13,080	5.5
Premenopausal	102,499	27.1	51,419	27.7
Oral contraceptives				
No	229,648	67.9	154,891	68.9
Yes	103,647	28.0	52,724	27.2
Estrogen replacement therapy				
No	201,036	56.9	118,679	56.5
Yes	111,143	32.7	74,589	33.2
Alcohol				
None	74,392	21.4	43,333	20.2
3 drinks/week	41,812	12.0	24,737	11.5
1 drink/day	34,669	9.9	20,380	9.5
>1 drink/day	49,222	14.1	31,212	14.5
Unknown	146,667	42.7	96,971	44.3
Smoking status				
Never	179,121	51.9	119,363	54.6
Current	73,494	20.9	39,515	18.7
Former	72,768	20.9	42,981	20.0
Exercise				
None	7,777	2.3	4,247	1.9
Slight	89,948	25.6	43,767	20.5
Moderate	222,759	64.5	151,216	69.6
Heavy	20,065	5.8	12,951	6.0

* Columns not summing to total reflect missing data.
† Percentages are directly adjusted to the age distribution of the entire study population.

influence survival. In this study, we cannot rule out the possibility that an occupational group with no elevated mortality risk may actually have increased incidence of breast cancer combined with higher rates of mammography screening and thus earlier diagnosis and better survival.

The prospective design of our study and the exclusion of women with cancer at baseline eliminate the possibility that disease status might influence participation in the study or bias the reporting of exposures. In addition, our study was able to control for many other important breast cancer risk factors when assessing the association with occupation. Finally, study participants are, on average, more educated and affluent that the US population as a whole. While these differences may influence comparisons of absolute rates of disease or exposure between this population and that of the United States, they are unlikely to compromise internal validity. In fact, the relatively homogenous nature of this cohort may be a benefit in this analysis given the potential for uncontrolled confounding by socioeconomic status that can result in spurious associations between breast cancer risk and various occupational groups.

TABLE 2. Breast cancer mortality by occupation, Cancer Prevention Study II, United States, 1982–1991

Occupation	No. of deaths	Person-years	Minimally adjusted rate ratio*	95% confidence interval	Fully adjusted rate ratio†	95% confidence interval
Executive, administrative, and managerial	80	239,309	0.99	0.79–1.25	0.95	0.75–1.20
Executive	10	14,506	2.03	1.09–3.79	1.93	1.03–3.62
Manager	70	224,803	0.93	0.72–1.18	0.89	0.69–1.14
Professional	318	979,489	0.96	0.84–1.10	0.88	0.75–1.03
Nurse	85	290,538	0.89	0.71–1.12	0.84	0.67–1.07
Health assessment and treatment	10	43,571	0.69	0.37–1.30	0.63	0.33–1.18
Teacher/librarian	203	595,977	0.99	0.85–1.16	0.89	0.73–1.08
Technician and related support	21	42,697	1.62	1.05–2.50	1.54	0.99–2.39
Sales	144	463,563	0.89	0.74–1.06	0.88	0.73–1.06
Administrative support, including clerical	384	1,005,607	1.15	1.02–1.30	1.14	1.01–1.31
Secretary	261	697,256	1.14	0.98–1.31	1.14	0.98–1.32
Financial records processing	72	179,793	1.15	0.90–1.47	1.15	0.90–1.47
Telephone/telegraph	10	18,724	1.55	0.83–2.90	1.53	0.82–2.86
Bank teller	17	38,623	1.39	0.86–2.25	1.43	0.88–2.32
Administrative assistant	23	60,848	1.21	0.80–1.84	1.17	0.77–1.78
Service	72	222,636	0.91	0.72–1.16	0.84	0.65–1.08
Food preparation and service	33	110,463	0.83	0.59–1.18	0.77	0.54–1.10
Health service occupations	11	29,329	1.09	0.60–1.98	1.02	0.56–1.85
Maid (domestic)	10	25,415	0.98	0.53–1.86	0.76	0.39–1.47
Beautician	16	46,433	1.04	0.63–1.71	1.02	0.62–1.69
Farming, forestry, and fishing	4	18,688				
Mechanics and repairers	1	5,504				
Construction trades	3	9,178				
Precision production	5	13,931				
Machine operators, assemblers, and inspectors	39	115,652	0.92	0.66–1.26	0.88	0.63–1.22
Sewer, stitcher (textile)	14	41,059	0.84	0.49–1.43	0.81	0.47–1.38
Factory worker	19	50,711	1.0	0.66–1.65	0.99	0.63–1.58
Transportation and material moving	5	12,894				
Handlers, equipment cleaners, helpers, and laborers	0	495				
Housewives	704	1,942,212	1.0	Reference	1.0	Reference

* Adjusted for age.

† Adjusted for age, race, family history of breast cancer, body mass index, education, smoking, alcohol, exercise, breast cysts, age at menarche, age at menopause, oral contraceptive use, estrogen replacement therapy, number of livebirths, and age at first livebirth.

The lack of an observed association between occupation and breast cancer mortality in this study does not invalidate efforts to institute workplace screening programs. Age-appropriate mammography screening should take place among all women, whether or not their occupation puts them at higher risk. If the workplace offers an appropriate environment in which to offer women accessible screening services, then such programs should be encouraged. While workplace screening is unlikely to impact older women who are no longer in the workforce, it can encourage the habit of regular screening among working women that may then be maintained in later life.

In summary, our results offer no support for an association between occupation and breast cancer mortality in general or for an association with particular occupational titles, including teachers. This agrees with recent results from two case-control studies (3, 4)

that were also able to control adequately for important breast cancer risk factors and in which controls were appropriately selected from the underlying populations that generated the cases. Further analyses of occupational titles without consideration of known breast cancer risk factors or actual workplace exposures (30) are unlikely to be informative.

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