Occupation as a Risk Identifier for Breast Cancer

ABSTRACT

Objectives. Breast cancer mortality may be reduced if the disease is detected early through targeted screening programs. Current screening guidelines are based solely on a woman's age. Because working populations are accessible for intervention, occupational identification may be a way of helping to define and locate risk groups and target prevention.

Methods. We used a database consisting of 2.9 million occupationally coded death certificates collected from 23 states between 1979 and 1987 to calculate age-adjusted, race-specific proportionate mortality ratios for breast cancer according to occupation. We performed case–control analyses on occupational groups and on stratifications within the teaching profession.

Results. We found a number of significant associations between occupation and frequency of breast cancer. For example, white female professional, managerial, and clerical workers all had high proportions of breast cancer death. High rates of breast cancer in teachers were found in both proportionate mortality ratio and case–control analyses.

Conclusions. These findings may serve as in an aid in the effective targeting of work-site health promotion programs. They suggest that occupationally coded mortality data can be a useful adjunct in the difficult task of identifying groups at risk of preventable disease. (*Am J Public Health.* 1993;83:1311–1315)

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Introduction

In 1713, Bernardino Ramazzini observed that nuns suffered disproportionately from cancers of the breast. He attributed this to a "mysterious sympathy" between uterus and breasts that was disturbed by the occupational celibacy of nuns.[1] A century later, Rigoni-Stern actually quantified an excess of breast cancer in the nuns of Verona, Italy.[2] Consistent with these earlier observations, current epidemiological research has identified nulliparity and delayed childbirth as risk factors for postmenopausal breast cancer.[3]

Secondary prevention is effective in reducing breast cancer mortality.[4–6] At present, a woman's age is the only criterion used for recommending asymptomatic screening (breast self-examination, clinical breast exam, and mammography).[7,8] Given the historical association between breast cancer and occupation, we sought to investigate the distribution of breast cancer by occupation. Our goal was to evaluate whether occupational groups could be used to target breast cancer prevention programs.

Methods

We used occupationally coded mortality data to calculate the frequency of breast cancer according to occupation and industry. All death certificates record usual occupation and industry as well as cause of death. However, only a limited number of states, with assistance from the National Center for Health Statistics, code the occupation information uniformly. Our analyses involved mortality data from 23 states that contribute to a database maintained at the National Institute for Occupational Safety and Health (NIOSH) (Table 1). These data span the years 1979 through 1987 and represent more than 2.9 million death certificates coded for usual occupation and industry of the decedent according to the 1980 Bureau of the Census classification system.[9] The *International Classification of Diseases* (ICD, 9th revision) was used to code underlying cause of death.[10,11]

We calculated age-standardized race-specific proportionate mortality ratios for breast cancer within each occupational category, using a computer program developed at NIOSH. The proportionate mortality ratio is commonly used in mortality analyses when the true population at risk is unknown.[12,13] In this case, because the actual number of women employed in a specific occupation during the years and in the geographical areas for which we had death certificates was not available, we compared the observed proportion of breast cancer deaths within a selected occupational group with the expected proportion of breast cancer deaths across all occupations in the study population. If the observed number of deaths for a cause of death within a specific occupational group was equal to or less than 1000, the statistical test used was the ratio of an observed value of a Poisson variable to its expectation.[14] If the observed number of deaths for a cause of death within an occupational group was greater than 1000, the Mantel-

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TABLE 1—National Institute for Occupational Safety and Health Occupationally Coded Death Certificates, 1979 through 1987

State	Years	No. Deaths
Alaska	1987	1 800
California	1979–1981	176 816
Colorado	1985–1987	58 962
Georgia	1984–1987	183 694
Indiana	1986–1987	95 216
Kansas	1984–1987	83 900
Kentucky	1984–1987	131 286
Maine	1982–1987	63 477
Missouri	1984–1986	143 820
Nebraska	1984–1985	28 274
Nevada	1984–1987	26 929
New Hampshire	1984–1987	30 151
New Mexico	1986–1987	18 896
New York	1980–1987	350 477
North Carolina	1984–1987	204 069
Ohio	1985–1987	286 574
Pennsylvania	1983–1987	590 280
Rhode Island	1979–1987	79 191
South Carolina	1984–1987	104 270
Tennessee	1985–1987	127 787
Utah	1984–1987	16 905
Vermont	1986–1987	9 605
Wisconsin	1984–1986	158 104
Total deaths		2 971 483

TABLE 2—Proportionate Mortality Ratios (PMRs) for Breast Cancer in Women, by 15 Broad Occupational Groups

	No. Breast Cancer Deaths		PMR	
Occupational Group	White	Black	White	Black
Executive/administration/managerial	2 816	143	109*	139*
Professional	6 001	560	129*	150*
Technicians and related support occupations	753	106	94	107
Sales	3 231	135	99	134*
Administrative support, including clerical	8 502	424	113*	133*
Service	3 960	1517	74*	83*
Farming, forestry, and fishing	124	73	75*	61*
Mechanics and repairers	95	7	117	114
Construction trades	24	5	64**	127
Precision production	847	95	97	121**
Machine operators and assemblers	3 682	435	84*	103
Transportation	132	15	83**	82
Equipment cleaners, laborers, and helpers	915	149	76*	81*
Armed forces	18	2	66	83
Housewives	26 690	1852	91*	85*

*$P < .01$; **$P < .05$.

Haenszel chi-square was used to test significance.[15] A proportionate mortality ratio above 100 indicates that breast cancer occurs with a greater proportional frequency in the occupational group under consideration than in all occupations.

We also performed a series of case–control analyses. Case subjects were defined as all White women for whom breast cancer was recorded as the underlying cause of death (n = 59 196). An equal number of control subjects was randomly selected (according to a SAS randomization procedure[16]) from all White women whose deaths were not due to breast cancer. These controls were frequency-age-matched to case subjects by 5-year age intervals. The analysis was repeated, excluding from the control group all deaths attributed to ovarian or cervical malignancies or other malignancies of the female reproductive system (n = 56 483). A third case–control analysis was run, excluding all deaths due to ischemic heart disease (ICD 410–414) from eligible controls (n = 59 196). Odds ratios[15] (ORs) and test-based 95% confidence intervals (CIs)[17] were calculated for 15 broad occupational categories. Separate analyses were run for the teaching profession, subdivided into all teachers, primary and secondary teachers, and postsecondary teachers. Each of these groups was further subdivided into two age groups: older than 40 years or 40 years of age and younger.

Results

The proportionate mortality ratios for breast cancer in White women (Table 2) were significantly elevated within three occupational groups: executives, including administrators and managers (total n = 38 692); professionals (total n = 89 735); and administrative support workers, including clerical workers (total n = 111 421). Significantly elevated proportionate mortality ratios were found for Black women in the same groups: executives (total n = 1809); professionals (total n = 7717); and administrative support workers (total n = 4814), Black women in sales (total n = 1867) and precision production occupations (total n = 1540) also had elevated proportionate mortality ratios. Occupations with the lowest proportionate mortality ratios for both Black and White women included service, farming, transportation, and labor.

Selected individual occupations within the groupings with elevated proportionate mortality ratios are listed in Table 3. For White women, the proportionate mortality ratios for clergywomen, librarians, and teachers were statistically significant and were more than 50% higher than expected breast cancer mortality rates for all White women. Black clergywomen and librarians had similarly elevated proportionate mortality ratios. Black teachers had double the expected frequency of breast cancer mortality. For both Black and White women, these elevated ratios were constant for primary and secondary as well as postsecondary teachers. Teachers accounted for more than 5% of all breast cancer deaths in the data set.

The results of case–control analyses for White women according to broad occupational categories are displayed in Table 4. In calculating the odds ratios, controls were chosen from all deaths excluding those attributed to breast, ovarian, cervical, or other reproductive-tract malignancies. To evaluate the impact of the "healthy worker effect" in our analysis, we also calculated odds ratios using controls selected from all deaths excluding those due to breast cancer or ischemic heart disease. We found no substantial differences between the odds ratios derived from the two different control groups. For example, in the control group that excluded ischemic heart disease, the odds ratios for breast cancer were 1.20 (95% CI = 1.14, 1.27) for executives and managers, 1.55 (95% CI = 1.49, 1.62) for professionals, and 0.83 (95% CI = 0.81, 0.85) for housewives.

Table 5 reports results of the case–control analyses for White teachers (total, primary and secondary, and postsecondary), stratified into two age groups: 40 years and older and younger than 40 years. All of the odds ratios are statistically significant at the 95% level and suggest that teachers have a greater chance of breast cancer death than do members of other occupational groups. These eleva-

TABLE 3—Proportionate Mortality Ratios (PMRs), Confidence Intervals (CIs), Total Deaths, and Breast Cancer Deaths in White and Black Women, by Selected Occupations

	PMR[a]		Total Deaths		Breast Cancer Deaths	
Occupation	White (95% CI)	Black (95% CI)	White	Black	White	Black
Clergy, religious	165 (139, 196)	152 (87, 247)	2 259	280	136	16
Librarians	163 (142, 186)	158 (64, 325)	2 551	92	213	7
Teachers	162 (158, 167)	214 (191, 239)	48 529	3 794	3 135	309
Counselors	143 (103, 194)	260 (139, 445)	368	79	42	13
Mathematicians, computer scientists	139 (104, 181)	238 (77, 555)	501	28	53	5
Secretaries	132 (129, 136)	168 (140, 200)	44 158	1 263	3 634	125
Finance officers	132 (120, 145)	189 (117, 289)	5 253	191	468	21
Pharmacists	127 (78, 197)	366 (75, 1068)	341	16	20	3
Supervisors	126 (109, 145)	144 (77, 247)	2 329	149	194	13
Bank tellers	125 (106, 145)	186 (68, 405)	2 076	64	169	6
Clerks	121 (118, 124)	147 (129, 166)	60 792	3 080	4 356	255
Lawyers, judges	121 (80, 176)	395 (82, 1156)	377	12	27	3
Managers, administrators	117 (113, 122)	153 (125, 186)	29 340	1 396	2 037	102
Nurses	109 (104, 114)	125 (107, 144)	28 294	3 020	1 635	177
Dietitians	105 (86, 126)	104 (68, 151)	2 154	548	112	27
Physicians	97 (64, 142)	590 (237, 1215)	459	19	27	7

[a]In descending order for White women.

TABLE 4—Odds Ratios (ORs) and Confidence Intervals (CIs) for Breast Cancer in White Women, by Broad Occupational Groups

Occupational Group	OR (95% CI)
Executive, administrative, managerial	1.27 (1.20, 1.35)
Professional	1.55 (1.48, 1.61)
Technicians and related support occupations	1.06 (0.97, 1.16)
Sales	1.20 (1.14, 1.27)
Administrative support, including clerical	1.35 (1.30, 1.40)
Service	0.81 (0.77, 0.84)
Farming, forestry, and fishing	0.84 (0.66, 1.07)
Mechanics and repairers	1.72 (1.24, 2.40)
Construction trades	0.99 (0.64, 1.56)
Precision production	1.12 (1.01, 1.23)
Machine operators and assemblers	0.90 (0.88, 0.97)
Transportation	0.80 (0.70, 1.07)
Equipment cleaners, laborers, and helpers	0.82 (0.75, 0.90)
Armed forces	0.75 (0.40, 1.38)
Housewives	0.82 (0.80, 0.83)

Note. Control subjects exclude all deaths due to breast and reproductive-tract malignancies.

tions were also true when teachers were stratified by age.

Discussion

Both proportionate mortality ratio and case–control analyses identified several occupational groups as being at increased risk of dying from breast cancer. No established predisposing workplace exposure explains this increased risk. It is most likely that occupational choices and accompanying life-styles reflect some of the established or hypothesized nonoccupational risk factors for breast cancer, such as parity, maternal age at first birth, diet, and contraceptive use.[18] For example, according to 1988 census figures, 36% of births to women in the 30 through 44-year-old age group (an age group considered to represent advanced maternal age) with 5 or more years of college were first births. Among women in this age group with only a high school education, less than 16% of the births were first births. Similarly, in the same age group, 32% of births to women in the managerial and professional occupations were first births, compared with 21% of births to women in service occupations.[19] Census data provide indirect evidence that one of the well-established risk factors for breast cancer, maternal age at first birth,[20,21] is prominent in women with educational and occupational profiles like those identified as high-risk in our analyses.

However, several surveys also indicate increased utilization of mammography with higher educational attainment.[22–25] The increased breast cancer mortality that we observed in teachers and other professionals may represent the deaths that remain even after adequate screening and medical care; alternatively, these deaths may represent additional opportunities for prevention. White female physicians (a group assumed to have excellent health care access and reported to exhibit delayed childbearing[26]) did not manifest the same excess mortality for breast cancer that we found in other professions; the proportionate mortality ratio for this group was 97. Although it is possible that this low proportionate mortality ratio may represent an attainable goal for other professional women, it is a finding that needs further description and interpretation.

The occupational profiles of breast cancer mortality according to race show more similarities than differences. Although the smaller number of Black

TABLE 5—Proportionate Mortality Ratios (PMRs), Odds Ratio (ORs), and Confidence Intervals (CIs) for Breast Cancer Deaths in Teachers

				Aged ≤ 40y	Aged > 40y
	PMR (95% CI)	OR[a] (95% CI)	OR[b] (95% CI)	OR[a] (95% CI)	OR[a] (95% CI)
All teachers	162 (158, 167)	1.76 (1.66, 1.86)	1.77 (1.67, 1.88)	2.26 (1.81, 2.82)	1.72 (1.62, 1.83)
Primary and secondary	161 (157, 165)	1.73 (1.63, 1.84)	1.76 (1.66, 1.87)	2.27 (1.81, 2.85)	1.70 (1.60, 1.80)
Postsecondary	186 (159, 216)	2.21 (1.70, 2.88)	1.76 (1.50, 2.08)	2.00 (0.82, 4.88)	2.23 (1.70, 2.14)

[a]Control subjects (n = 59 196) were frequency-age-matched by 5-year intervals from all deaths excluding deaths due to breast cancer.
[b]Control subjects (n = 56 483) were frequency-age-matched by 5-year intervals from all deaths excluding deaths attributed to breast, ovarian, or cervical cancer or miscellaneous malignancies of the female reproductive system.

women in the study leads to several associations that are not statistically significant, the association between breast cancer mortality and occupations that require high levels of education remains. In fact, in occupations requiring the highest education levels, proportionate mortality ratios are consistently more elevated for Black women than for White women.

Other data sources confirm our finding of an increased frequency of breast cancer deaths among teachers. This association has been incidentally observed in state-based reports of occupational morbidity and mortality in the United States[27–30] and in British Columbia[31] as well as in the Third National Cancer Survey, conducted between 1969 and 1971.[32] The size of our data set allowed us to consider the occupational distribution of breast cancer for a larger cohort of women according to more occupational categories.

Limitations

Our results are subject to several limitations, including those inherent in death certificate data and proportionate mortality ratio analysis. Mortality studies based on death certificates are limited by the accuracy of the occupational information found on those certificates.[33] Agreement between the usual occupation recorded on the death certificate and other sources, such as next-of-kin interviews,[22] previously gathered survey information and city directory records,[34] and personnel and union records,[35] varies from 35% to 85% depending on the decedent's race, sex, socioeconomic status, and employment duration.

Death certificate analysis may also be limited by the accuracy of cause-of-death coding. Researchers addressing this question have compared underlying-cause-of-death coding on death certificates with hospital discharge,[36] clinical,[37] and autopsy records[38] and have found varying levels of comparability, ranging from 50% agreement for cardiovascular disease to 90% for neoplasms.[39] In a study conducted by the National Cancer Institute, death certificates' coding of cancer as underlying cause of death was compared with hospital diagnosis. The study found both high detection rates and high confirmation rates for breast cancer, indicating that for this and several other cancers, mortality data are a reliable and accurate resource.[40]

Additional limitations accompany the use of proportionate mortality ratio calculations. A proportional increase in one cause of death for a particular occupational group may simply be a reflection of decreased mortality from other causes, such as heart disease, which are known to exhibit a healthy worker effect.[41,42] This limitation may be overcome by using case–control analysis if controls are chosen to exclude causes of death that are in deficit.[13,43] In the analyses of breast cancer in teachers, we repeated our original case–control analysis, removing control subjects who died of any reproductive tract malignancy. We also conducted one case–control study excluding control subjects who died of ischemic heart disease from control selection. Our results were substantially the same for all of these analyses.

Implications with Regard to Breast Cancer Prevention

At present, age is the primary criterion for determining when breast cancer screening should be undertaken. The National Cancer Institute Breast Cancer Screening Consortium has published consensus guidelines that recommend clinical breast exams for all women older than 40 years. Mammograms are recommended every 1 to 2 years for women 40 through 49 years old and every year thereafter.[44,45] Similar, although less rigorous, age-based recommendations have been published by the US Preventive Services Task Force.[46] In addition to age, research has uncovered other potential risk factors for breast cancer, ranging from reproductive and hormonal status[47] to dietary habits.[3,48] However, these associations are for the most part not useful in accessing an individual or groups of individuals for delivery of prevention services. For example, it is not practical to recommend mammography protocols and locate women for mammography according to their parity status or self-assessed dietary fat consumption.

We are not suggesting a change in breast cancer screening guidelines. Rather, our findings indicate that the identification of occupational groups at high risk for breast cancer may be useful in targeting groups for delivery of prevention services such as mammography. Such targeting efforts are distinct from screening guidelines, which apply to the population of women at large. Breast cancer is one of the most successfully treated cancers. For the one out of nine women who will develop breast cancer, early detection means an increased chance of survival.[49] Directing prevention toward occupational groups with a higher prevalence of disease[50] has the potential for increasing the likelihood of early detection and for improving access to services by localizing populations for on-site mammography.

The accessibility of employee groups is one of the factors accounting for the success of work-site health promotion programs. One hundred and eighteen million people in the United States go to work; thus 63% of the population can be described, located, and accessed to receive occupationally based prevention services. A recent survey of private sector work sites with 50 or more employees found that more than 65% were already providing some form of health promotion activity.[51] Analyses of this type may provide readily accessible guidance to employers making decisions as to which prevention service is most appropriate for their employees.[52]

The analyses in this paper are based on data collected between 1979 and 1987. An increase in the number of women in the work force, as well as changing career and birthrate patterns, may alter the distribution of breast cancer by occupation. Likewise, the increased use of mammography that has taken place in the past decade may have influenced the pattern of breast cancer mortality. These are trends that warrant ongoing monitoring.

Conclusion

This study provides evidence of the potential utility of surveillance information for identifying occupational groups at greatest risk of mortality from breast cancer. For some of our observations, such as the association between breast cancer and the teaching profession, corroborating data and biological plausibility suggest that these findings should be considered in targeting prevention efforts. Targeting preventable nonoccupational disease by occupation may be a useful adjunct in the difficult task of identifying groups at risk for preventable disease as well as an aid in the effective implementation of work-site health promotion programs. □

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