

## BRIEF COMMUNICATION

# Mortality Among Female Registered Nurses and School Teachers in British Columbia

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The mortality profile of female nurses and teachers in British Columbia (BC) was examined using age-standardized proportional mortality ratios (PMRs) calculated for the period 1950-1984. Lowered overall mortality among nurses was seen for degenerative heart disease and for cerebrovascular accidents. Significantly elevated PMR values were observed for cancer of the breast and ovary in nurses of age 20-65 years. PMRs were significantly elevated for cancer of the pancreas and leukemia among those age 20 years and older. Elevated values were also observed for motor vehicle accidents and suicide among nurses in both age groups.

Lower than expected mortality from degenerative heart disease and cerebrovascular accidents was seen in working age teachers (age 20-65 years). However, elevated PMRs were detected for carcinoma of the colon, breast, endometrium, brain, and melanoma. Among those 20 years and over, significantly elevated PMRs were also observed for cancers of the ovary and other digestive organs. Elevated PMRs were found for motor vehicle and aircraft accidents.

Mortality from cirrhosis of the liver was lower than anticipated in both teachers and nurses.

A number of significant PMRs declined when deaths of "homemakers" were withdrawn from the comparison group used to generate PMR values, suggesting that risk of death from various causes among women working outside the home differ from those seen in women who are predominantly in the home. © 1994 Wiley-Liss, Inc.

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## INTRODUCTION

Mortality data have been useful in exploring occupational disease patterns, particularly in Washington state [Milham, 1983] and in the United Kingdom [Office

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of Population Census and Survery (OPCS), 1986]. However, with relatively few exceptions [Katz, 1983], most of the occupational studies have dealt primarily with male risks.

The present paper examines mortality among 2,806 female nurses and 2,686 female school teachers who died in British Columbia (BC) during the years 1950–1984.

These occupations were selected for analysis as they are professional jobs in which women remain for an extended period of time [Division of Health Services Research and Development, 1985], thus increasing the likelihood that the job statement on the death registraton describes the woman's true occupation.

## METHODS

Information on 216,213 deaths among women 20 years or over occurring in BC from 1950–1984 was obtained from the BC Division of Vital Statistics (DVS). Age of 20 years was selected as the lower limit for this analysis, as deaths prior to this age are unlikely to be related to occupation. Cause of death information coded by DVS nosologists over the 35-year period according to the 6th, 7th, 8th, and 9th revision of the International Classification of Diseases (ICD) was reconciled to the 7th format [ICD 7th Revision, 1957] for the study. Two different occupational coding schemes had been used by nosologists during the period 1950–1984, and the earlier 1951 census scheme [Classification of Occupations, 1951] was reconciled to the later 1961 format [Occupational Classification Manual, 1961].

Age-standardized proportional mortality ratios (PMR) were calculated for 157 causes of death and 194 occupational groups, including nurses and teachers, using the method described by Monson [1980] for all deaths age 20 or over, and the subset of deaths among women of working age [20–65]. The significance of elevated or lowered PMRs was assessed by comparison with the Poisson distribution [Armitage, 1971].

Preliminary analysis of the mortality data indicated that about 90% of female decedents were described as "homemaker" in the occupational statement on the death registration. In an earlier paper [Threlfall et al., 1985], inclusion and exclusion of homemakers in the PMR evaluation produced somewhat different values for cancers of the breast and ovary for several female jobs. Because of this, PMR values for each cause of death examined in this paper were calculated with and without homemakers included in the file.

## RESULTS

Table I shows mortality for nurses age 20 years and up, as well as for the subset of deaths occurring at age 20–65 years. In general, the patterns are similar in both age groups. The PMR values presented in Table I were calculated with homemakers included in the reference group. Significantly reduced PMR values are seen for degenerative heart disease, cerebrovascular accident, and cirrhosis of the liver. Mortality from all cancers combined is higher than expected. Nurses appear to have substantially elevated mortality from all accidents combined and, in particular, from motor vehicle and aircraft accidents. Suicide is also more common than expected in all nurses (age 20 years and up) as well as working age nurses (age 20–65 years).

**TABLE I. Proportional Mortality in BC Female Nurses 1950–1984: PMRs Calculated With Homemakers Included in Reference Group\***

Cause of death	Age 20–65			Age 20 and over		
	No. deaths	PMR	95% CI	No. deaths	PMR	95% CI
Degenerative heart disease	96	74 <sup>a</sup>	60–91	734	91 <sup>a</sup>	84–98
Cerebrovascular accident	51	74 <sup>b</sup>	56–97	332	87 <sup>b</sup>	78–98
All cancers	397	117 <sup>a</sup>	106–130	744	114 <sup>c</sup>	105–123
Pancreas	17	122	70–195	48	136 <sup>b</sup>	102–180
Breast	121	135 <sup>a</sup>	112–161	170	120 <sup>b</sup>	103–140
Cervix	11	52 <sup>b</sup>	25–95	20	67	41–105
Ovary	44	148 <sup>a</sup>	109–199	75	156 <sup>c</sup>	124–195
Leukemia	19	162	97–254	32	144 <sup>b</sup>	102–204
Cirrhosis of liver	17	48 <sup>c</sup>	27–77	28	62 <sup>a</sup>	41–90
All accidents	165	144 <sup>c</sup>	123–168	235	139 <sup>c</sup>	122–159
Motor vehicle accidents	89	164 <sup>c</sup>	132–202	103	158 <sup>c</sup>	129–192
Aircraft accidents	10	328 <sup>a</sup>	157–603	10	319 <sup>a</sup>	153–587
Suicide	64	150 <sup>a</sup>	117–193	75	159 <sup>c</sup>	126–200

\*PMR, proportional mortality ratios; CI, confidence interval.

<sup>a</sup>p < .01.

<sup>b</sup>p < .05.

<sup>c</sup>p < .001.

Cancers of the breast and ovary are more common than expected among nurses age 20 years and up and age 20–65 years. Leukemia and pancreatic cancers are also higher than anticipated in nurses age 20 years and up.

Table II shows substantial alterations in PMR values when mortality is recalculated excluding homemakers from the reference group. Degenerative heart disease and cerebrovascular accident mortality is still low for nurses age 20–65 years, but the values are not statistically significant. As well the PMRs for accidental deaths, although still elevated, are no longer statistically significant for the age group 20–65 years. Suicide is still elevated in nurses age 20 years and up.

Although PMRs for breast and ovarian cancer and leukemia are still higher than expected among nurses dying at age 20–65 years, the PMR values are not statistically significant.

Teachers' mortality patterns when examined with inclusion of homemakers in the reference group demonstrated decreased mortality from degenerative heart disease, cerebrovascular accident, and cirrhosis of the liver (Table III). Mortality from accidents is somewhat higher than anticipated. A number of cancer sites show significantly elevated PMRs including colon, melanoma, breast, endometrium, ovary, and brain.

Lung cancer and cervix cancer deaths appear to be less common than expected, although the PMR values reach statistical significance only for cervix cancer.

When homemakers are excluded from the PMR calculation (Table IV) degenerative heart disease and cerebrovascular accident mortality are no longer significantly reduced, although deaths from cirrhosis are still lower than anticipated. Motor

**TABLE II. Proportional Mortality in BC Female Nurses 1950–1984: PMRs Calculated With Homemakers Excluded From Reference Group\***

Cause of death	Age 20–65			Age 20 and over		
	No. deaths	PMR	95% CI	No. deaths	PMR	95% CI
Degenerative heart disease	96	90	73–111	734	101	93–109
Cerebrovascular accident	51	87	65–114	332	97	86–108
All cancers	397	104	94–115	744	98	91–106
Pancreas	17	102	59–165	48	108	81–143
Breast	121	115	95–137	170	99	85–116
Cervix	11	64	31–115	20	82	49–126
Ovary	44	120	89–162	75	115	91–144
Leukemia	19	166	99–259	32	135	95–192
Cirrhosis of liver	17	53 <sup>a</sup>	30–85	28	66 <sup>b</sup>	43–96
All accidents	165	116	99–136	235	116 <sup>b</sup>	101–132
Motor vehicle accidents	89	119	97–148	103	119	97–144
Aircraft accidents	10	198	95–365	10	193	92–355
Suicide	64	127	99–163	75	135 <sup>a</sup>	107–169

\*PMR, proportional mortality ratios; CI, confidence interval.

<sup>a</sup>p < .01.

<sup>b</sup>p < .05.

vehicle and aircraft accidents remain more common than anticipated for teachers age 20 years and up.

Mortality from colon cancer, melanoma, and breast cancer remains significantly elevated for teachers 20 years and up, and brain cancer mortality remains elevated for teachers age 20–65 years at death. Endometrial and ovarian cancer PMRs remain elevated but are no longer statistically significant. Both lung and cervical cancer mortality are now significantly lower than anticipated in teachers age 20 years and up.

## DISCUSSION

Studies based on death registrations are subject to several limitations. Cause of death data are less precise than hospital records and are less reliable. Moriyama et al. [1958] reviewed available clinical data on 2,122 deaths and found that the death registration recorded the most probable cause in only 80% of cases. Cancer, however, fared better than other causes in terms of accuracy with more than 85% of the assigned cancers being rated on review as correct. A more recent study [Engel et al., 1980] showed similar findings.

The proportional mortality statistic also has weak and strong points [Decouflé et al., 1980]. The PMR statistic generates expected values internally and, consequently, avoids the healthy worker effect produced in comparing mortality of a working group with that of the general population [Monson, 1980]. For rare causes of death (including individual cancer sites), the age-standardized PMR is in general a good approximator of the standardized mortality ratio (SMR), the usual measure of choice in assessing occupational mortality when data are available on number of

TABLE III. Proportional Mortality Among BC Female Teachers 1950-1984: PMRs Calculated With Homemakers Included in Reference Group\*

Cause of death	Age 20-65			Age 20 and over		
	No. deaths	PMR	95% CI	No. deaths	PMR	95% CI
Degenerative heart disease	75	74 <sup>a</sup>	58-93	740	90 <sup>a</sup>	83-97
Cerebrovascular accident	39	73 <sup>b</sup>	53-100	371	97	87-108
All cancers	339	132 <sup>c</sup>	118-147	729	124 <sup>c</sup>	115-134
Colon	33	150 <sup>b</sup>	106-211	93	139 <sup>a</sup>	113-171
Melanoma	11	328 <sup>a</sup>	163-587	18	332 <sup>c</sup>	196-525
Breast	115	170 <sup>c</sup>	141-205	203	168 <sup>c</sup>	146-193
Lung	20	74	45-115	47	86	64-114
Cervix	7	44 <sup>b</sup>	17-92	10	41 <sup>a</sup>	19-75
Endometrium	15	219 <sup>a</sup>	122-361	27	156 <sup>b</sup>	102-227
Ovary	32	141	99-200	62	148 <sup>a</sup>	115-190
Brain and central nervous system	22	213 <sup>a</sup>	133-322	25	173 <sup>b</sup>	111-255
Cirrhosis of liver	13	49 <sup>a</sup>	25-84	18	49 <sup>c</sup>	29-78
All accidents	106	124 <sup>b</sup>	102-150	181	126 <sup>a</sup>	109-147
Motor vehicle accidents	64	157 <sup>c</sup>	122-201	88	169 <sup>c</sup>	136-208
Aircraft accidents	8	345 <sup>a</sup>	148-680	9	374 <sup>a</sup>	171-710

\*PMR, proportional mortality ratio; CI, confidence interval.

<sup>a</sup>p < .01.

<sup>b</sup>p < .05.

<sup>c</sup>p < .001.

subjects in the group who are at risk of death. Because, by definition, the overall PMR for each group must equal 100, a markedly high or low PMR for a common cause of death can result in some distortion of the PMR values obtained for uncommon causes [Milham, 1983]. Hence, a relative excess of deaths (elevated PMR) from a cancer in the occupational group of interest does not necessarily indicate an absolute excess in the death rate due to that cancer [Kupper et al., 1978].

Because of the potential shortcomings of the PMR, the shifts in PMR values seen on inclusion and exclusion of homemakers are of major concern in interpreting the findings. The implication of the shift is that the overall force of mortality in female working groups is different from that seen in homemakers. Labor force participants in general experience lower mortality rates than homemakers after controlling for marital status and age [Passannante and Nathanson, 1987] although this, naturally, will not hold true for all causes at all ages [Passannante and Nathanson, 1985]. When homemakers are eliminated from calculations for both nurses and teachers, the PMR values for degenerative heart disease and cerebrovascular accidents for both occupational groups increase, indicating that homemakers have higher mortality from these causes than women working outside the home.

When examining cancer patterns in nurses and teachers with and without homemakers included, changes in PMR values occur particularly for breast and ovarian cancer. When homemakers are excluded from calculations, the significant excess mortality from breast and ovarian cancer in nurses is attenuated to the point where

**TABLE IV. Proportional Mortality Among BC Female Teachers 1950–1984: PMRs Calculated With Homemakers Excluded From Reference Group**

Cause of death	Age 20–65			Age 20 and over		
	No. deaths	PMR	95% CI	No. deaths	PMR	95% CI
Degenerative heart disease	75	90	71–113	740	99	92–107
Cerebrovascular accident	39	86	62–118	371	107	96–118
All cancers	339	116 <sup>a</sup>	104–130	729	106	98–115
Colon	33	138	98–195	93	127 <sup>b</sup>	103–156
Melanoma	11	271 <sup>a</sup>	135–485	18	250 <sup>a</sup>	148–395
Breast	115	145 <sup>c</sup>	120–174	203	137 <sup>c</sup>	119–158
Lung	20	55 <sup>a</sup>	33–85	47	62 <sup>a</sup>	46–83
Cervix	7	54	21–112	10	49 <sup>b</sup>	23–90
Endometrium	15	171	95–282	27	126	82–184
Ovary	32	113	80–161	62	107	83–137
Brain and central nervous system	22	186 <sup>b</sup>	116–282	25	133	85–197
Cirrhosis of liver	13	55 <sup>b</sup>	29–94	18	53 <sup>a</sup>	31–83
All accidents	106	100	82–121	181	106	91–123
Motor vehicle accidents	64	115	90–148	88	129 <sup>b</sup>	104–159
Aircraft accidents	8	206	88–406	9	224 <sup>b</sup>	102–425

PMR, proportional mortality ratio; CI, confidence interval.

<sup>a</sup>p < .01.

<sup>b</sup>p < .05.

<sup>c</sup>p < .001.

PMR values are no longer statistically significant. It may be that, historically, women who work outside the home may delay childbearing and have fewer children, factors which could raise risk of breast and ovarian cancer [Threlfall et al., 1985]. If BC homemakers had a lower age at first birth and more liveborn children, the effect of their inclusion in the PMR calculation would have been to reduce the expected numbers of breast and ovarian cancers among nurses, thus driving up the PMR for these diseases when deaths among nurses and other professional groups are evaluated.

Notwithstanding these concerns, the PMR values for nurses dying at age 20–65 years from breast and ovarian cancer are still 15 and 20% higher, respectively, than expected. The elevated PMR for leukemia in nurses needs further evaluation in light of concerns about exposure of nurses to radiation and chemical agents [Neuberger and Hartley, 1988]. The elevated PMR for cancer of the pancreas in nurses, prior to exclusion of homemakers from the reference group, has not been seen before and requires confirmation.

Elevated mortality due to suicide among nurses is not new and has been seen on other PMR datasets [Milham, 1983; OPCS, 1986; Katz, 1983]. A study of licensed vocational nurses in California also demonstrated an increase in suicide in this occupation [Doebbert et al., 1988].

Teachers were found to have a number of elevated cancer PMRs. Several studies have demonstrated an increased risk of colon cancer in sedentary occupations [Garabrant et al., 1984; Vena et al., 1985; Gerhardsson et al., 1986] and if teaching

is an occupation requiring relatively little vigorous activity, this might explain the finding of excess mortality due to colon cancer. It is well known that melanoma risk is higher in managerial and professional occupations [Cooke et al., 1984], although this is likely to be due to their recreational sun exposure patterns [Gallagher et al., 1987] rather than any occupational exposure. The excess of brain cancer among teachers seen in this study confirms the similar finding of Milham [1983] and deserves further study.

Finally, the elevated PMRs for accidents, particularly motor vehicle accidents, may be due to the fact that nurses and teachers are frequently stationed in isolated area and are required to drive on poor roads where risk of accident might be high.

In summary, the findings from this PMR investigation suggest that nurses and teachers may experience favorable mortality rates from degenerative heart disease and from cerebrovascular accident by comparison with homemakers. At the same time, however, there are indications that their cancer mortality pattern may be unfavorable. Some of these risks may be artifactual and due simply to shortcomings of the PMR statistic. If the high cancer PMRs are strictly artifactual however, it is difficult to explain why the same degree of risk attenuation in individual cancers seen in nurses, with exclusion of homemakers, is not seen in female teachers. Even after exclusion of homemakers, teachers still have significantly elevated risks of death from breast cancer and colon cancer, while endometrial cancer remains very close to significance. Only the PMR for ovarian cancer drops below statistical significance, and the PMR values at age 20–65 years still remain elevated.

It is evident that more detailed analytic studies of female occupational risks are indicated.

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