

# Cancer and Occupation in Women: Identifying Associations Using Routinely Collected National Data

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Some potentially important findings from an analysis of 119,227 cancers registered in women in England over the 7-year period 1981 to 1987 are discussed. Data are presented for four cancer sites with established occupational etiologies (bladder, pleura, lung, larynx), three occupational groups in which women predominate (teachers, nurses, barstaff), and the main female cancers of the reproductive system (breast, uterus, cervix, ovary). Excesses of bladder cancer in female rubber workers (proportional registration ratio [PRR] 350, 95% confidence interval [CI] 141–723), pleural cancer in female carpenters (PRR 1596, 95% CI 329–4665) and lung cancer in female construction workers (PRR 269, 95% CI 154–437) and barstaff (PRR 138, 95% CI 124–156) are noted. It is concluded that analyses of routinely collected data on cancer and occupation in women have the potential to provide valuable pointers for further research. — *Environ Health Perspect* 107(Suppl 2):299–303 (1999). <http://ehpnet1.niehs.nih.gov/docs/1999/Suppl-2/299-303carpenter/abstract.html>

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Relatively few epidemiologic studies have specifically examined cancer risks in female workers. A systematic review of more than 1200 studies of occupation and cancer published in eight major journals from 1971 to 1990, for example, found that only 35% mentioned women at all, and even fewer (14%) presented data on women (1). This contrasts with the proportion of women contributing to the economically active population which, for countries in the European Union during the 1980s, increased from 36% to almost 40% (2). A recent international conference devoted to women's health concluded that there was a critical need to stimulate further research in the area of occupational cancer in women (3).

Ad hoc studies, which have attempted to investigate occupational cancer risks in women, have tended to be inconclusive, either because (in cohort studies) small numbers of cancers have been observed or because (in case-control studies) few women have been occupationally exposed. A further possible explanation for the underrepresentation of women in

epidemiologic studies of occupational cancer is that they have tended to focus on industrial workforces, whereas women tend to be employed in the service sector. In member states of the European Union in 1991, women comprised over 45% of the service sector but less than 25% of the industrial sector (2).

The relative lack of data on cancer and occupation in women means that it is difficult to assess priority areas for future research. One way forward is to exploit

routine health data collection systems, many of which can (or could) obtain occupational information. Population-based cancer registries are one such source. In some European countries, occupational information is routinely collected at cancer registration, whereas in others—most notably the Nordic countries—occupational information can be obtained by linking cancer registry files with census files. Table 1 lists those countries in which cancer registries have reported collecting data on occupation, together with the estimated annual number of cancers recorded in women. The variation in numbers of cases is largely a function of the population coverage provided by the cancer registry (3).

Routinely collected data offer a relatively cheap and simple means to investigate cancer risks in women across a wide range of occupational groups using large population-based data sets. This paper presents selected results of such an analysis, based on cancer registry data for women diagnosed in England from 1981 to 1987. The analysis and interpretation of these data are not straightforward, and several methodologic

**Table 1.** European cancer registries reporting collection of occupational information.<sup>a</sup>

Country	Total number of registries	Registries collecting occupational information	
		Number of registries	Estimated annual number of cancers registered in women
England	14	13	112,778
Denmark	1	1	12,895
Scotland	5	5	12,523
Belarus	1	1	10,943
Russia	1	1	8,645
Slovakia	1	1	7,188
Poland	6	5	5,822
Switzerland	6	5	5,589
France	6	5	4,971
Latvia	1	1	3,403
Spain	6	3	2,937
Germany	2	1	2,442
Estonia	1	1	2,364
Italy	9	2	2,175
Hungary	2	2	1,185
Ireland	1	1	906
Romania	1	1	700
Iceland	1	1	382
Portugal	1	1	272
Total	66	51	198,120

<sup>a</sup>Data from IARC (12).

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Abbreviations used: ICD, International Classification of Diseases; PRR, proportional registration ratio.

issues are discussed in the context of the results presented here.

**Materials and Methods**

The cancer registration scheme in England aims to achieve national coverage, and during the 1980s, all but 1 of the 14 contributing registries recorded occupation. The information collected relates to last (or most recent) occupation at the time of cancer registration. Between 1981 and 1987, over half a million cancers were reported in women 20 to 74 years of age (Table 2). Of these, an adequately described occupation was provided for 119,227 (22%). At 51%, the equivalent percentage for men was more than twice as high. The relatively low percentage for women partly reflects that a woman's own occupation is only recorded if she has been employed most of her life or if she is unmarried.

The 119,227 cancers registered in women with an adequately described occupation form the basis for the analyses described here. Cancers were classified according to the *International Classification of Diseases, 9th Revision (ICD-9)* (4). Occupations were coded according to the Office of Population Censuses and Surveys' (OPCS) 1980 Classification of Occupations and subsequently grouped to form 194 job groups. A full description of these jobs groups and the exposure criteria used to define them can be found elsewhere (5).

Associations between cancer and occupation are assessed using the proportional registration ratio (PRR) calculated with adjustment for age (in 5-year-old age groups), social class (using the six-category British Registrar General's classification), and region of registration (13 regions). All cancers registered in women with an adequately described occupation form the standard for comparison. Further details of the methods are given elsewhere (6). PRRs are shown when statistically significant at the 5% level and are ordered according to the magnitude of the lower 95% confidence interval (CI).

Selected results are presented and are organized under the following four headings: cancers for which, on the basis of data in men, occupational associations have already been established; cancers of the female reproductive system; occupational groups in which women predominate; a number of specific occupation-cancer combinations for which associations recently have been reported in women.

Further results of analyses of the data for women presented here as well as those for men are published elsewhere (6).

**Results**

Almost 50% of cancers registered with an adequately described occupation in women

in England between 1981 and 1971 were either breast, *in situ* cervical, or lung cancer. The fifteen most common cancers, which comprise 80% of the total, are listed in Table 3. Similarly, almost 80% of the occupations provided fell into 1 of the 15 job groups listed in Table 4. The commonest

**Table 2.** Number of cancer registrations for patients 20 to 74 years of age in England from 1981 to 1987.

	Women		Men	
	Number	%	Number	%
All registrations	538,607	100	496,152	100
Total included	119,227	22	252,663	51
Total excluded	419,380	78	243,489	49
Occupational code incorrect/incomplete	77,308	14	67,357	14
Registry of origin unknown	1,804	<1	1,809	<1
Occupational code not supplied	340,268	63	174,323	35

**Table 3.** Fifteen most commonly registered cancers in women 20 to 74 years of age in England from 1981 to 1987.

Cancer (ICD-9 revision code) <sup>a</sup>	Registrations	%
Breast (174)	26,376	24
<i>In situ</i> cervix (233.1)	16,799	15
Lung (162)	11,439	10
Skin other than melanoma (173)	6,554	6
Ovary (183)	5,727	5
Cervix (180)	5,511	5
Colon (153)	5,407	5
Ill-defined and secondary (195-199)	4,406	4
Uterus (179, 181, 182)	3,862	3
Rectum (154)	3,027	3
Stomach (151)	2,973	3
Non-Hodgkin lymphoma (200, 202)	2,109	2
Bladder (188, 189.1, 189.9)	2,068	2
Melanoma of skin (172)	2,046	2
Brain (191)	1,682	2
All other cancers	19,241	16
Total	119,227	100

<sup>a</sup>Data from ICD-9(4).

**Table 4.** Fifteen most commonly reported occupations at cancer registration for women 20 to 74 years of age in England from 1981 to 1987.

Job group (code no.) <sup>a</sup>	Registrations	%
Office workers and cashiers (53)	29,843	27
Other service occupations (60)	14,621	13
Retailers and dealers (44)	10,910	10
Nurses (17)	8,037	7
Teachers (not elsewhere classified)	6,321	6
Caterers (46)	5,015	5
Sewers and embroiderers (100)	4,115	4
Cooks and kitchen porters (59)	3,522	3
Publicans and barmaids (45)	2,590	2
Packers and sorters (164)	1,937	2
Welfare workers (13)	1,689	2
Hospital porters and ward orderlies (61)	1,322	1
Other textile workers (74)	1,157	1
Hairdressers (52)	1,061	1
Literary and artistic occupations (24)	924	1
All other occupations	26,163	22
Total	119,227	100

<sup>a</sup>From Roman and Carpenter (6).

group was office workers and cashiers, and the second largest was "other service occupations," comprising a diverse group including housekeepers, caretakers, hotel porters, nursery nurses, and cleaners.

**Cancers for Which Occupational Associations Are Already Well Established**

Findings for four cancers with well-known occupational associations are presented in Table 5: bladder (ICD-9 188, 189.1-189.9), pleura (ICD-9 163), lung (ICD-9 162), and larynx (ICD-9 161). Results for men are presented for comparative purposes, as most of the previously published evidence for occupational links with these cancers has been derived from data on men.

As for men, a clear excess of bladder cancer is evident for female rubber manufacturers (Table 5). Although a larger excess was seen among female brewery workers, this was based on only three cases. For pleural cancer, among women only two occupational groups had statistically significantly raised PRRs, and both were based on only three cases—carpenters and bus conductors. For cancers of the lung, a number of statistically significantly raised PRRs were evident, reflecting in part the relatively large number of cancers registered from this cause. Highest PRRs were seen for construction workers, sales representatives, publicans and barstaff, plastics workers, and metal polishers. For some (but not all) occupational groups with significantly raised PRRs for women, significant excesses were also seen in men. For cancers of the larynx, the highest PRR in women was that for petrol pump attendants. Although this was based on only two cases, it is notable that a marked statistically significant excess was also evident among men employed in this group.

**Cancers of the Female Reproductive System**

Only a few occupations have significantly raised PRRs for cancers of the female reproductive system (Table 6). For breast cancer, teachers had the highest PRR, but this is only marginally raised. Teachers also had a significantly raised PRR for uterine cancer, as did women clergy and security workers. For cancer of the cervix, a number of occupational groups had significantly raised PRRs, those for publicans and barstaff, retailers and dealers, and tobacco workers being among the highest. For two of these occupational groups (publicans,

barstaff, retailers, dealers), raised PRRs were also seen for *in situ* cervical cancer, although the highest PRR for this cancer was seen in professional engineers not elsewhere classified. Only three occupational groups had statistically significant PRRs for cancer of the ovary—printing machine minders, launderers, and dry cleaners and other administrators.

**Occupational Groups in Which Women Predominate**

For occupations in which women predominate, results are given for three of the groups listed in Table 4—teachers, nurses, and publicans and barstaff. Results are presented for cancers for which the PRR is significantly above or below 100.

**Table 5.** Well-known occupational associations: occupations with significant excess of cancer registrations for selected sites in workers 20 to 74 years of age in England from 1981 to 1987.

Job group (ICD-9 revision code) <sup>a</sup>	Women			Men		
	Registrations	PRR	95% CI	Registrations	PRR	95% CI
<b>Bladder cancer (188, 189.1-189.9)</b>						
Rubber manufacturers	7	350	(141-723)	58	226	(172-293)
Brewery workers	3	589	(122-1723)	16	91	(52-149)
Knitters	14	193	(106-324)	15	119	(67-197)
Nurses	138	120	(101-142)	58	124	(94-161)
<b>Pleural cancer (163)</b>						
Carpenters	3	1,596	(329-4665)	70	206	(161-261)
Bus conductors and drivers' mates	3	753	(156-2203)	0	0	-
<b>Lung cancer (162)</b>						
Construction workers	16	269	(154-437)	1,144	114	(109-122)
Sales representatives	54	165	(124-216)	794	89	(84-96)
Publicans and barstaff	293	138	(124-156)	816	122	(115-131)
Plastics workers	7	306	(123-631)	48	108	(80-145)
Metal polishers	16	191	(109-310)	157	120	(102-141)
Retailers and dealers	1,036	112	(106-120)	2,536	114	(110-119)
Carpenters	20	171	(105-266)	1,314	91	(87-97)
Machine and tool operators	94	129	(105-159)	3,319	90	(87-94)
Vocational trainers, social scientists, etc.	15	180	(101-297)	135	121	(102-144)
Press and automatic machine operators	69	127	(100-162)	147	110	(93-130)
<b>Laryngeal cancer (161)</b>						
Petrol pump attendants	2	1,683	(205-6080)	6	368	(135-801)
Other motor drivers	2	1,052	(128-3804)	19	81	(49-128)
Machine tool operators	5	325	(106-759)	169	104	(89-121)

<sup>a</sup>From ICD-9(4).

**Table 6.** Cancers of the female reproductive system: occupations with significant excess of cancer registrations in women 20 to 74 years of age in England from 1981 to 1987.

Cancer (ICD-9) <sup>a</sup>	Job group	Registrations	PRR	95% CI
Breast (174)	Teachers nec	1,942	118	(113-123)
	Physiotherapists	71	128	(100-162)
	Other service occupations	3,003	103	(100-108)
Uterus (179, 181, 182)	Clergy	23	165	(105-248)
	Security workers	20	165	(101-255)
	Teachers (not elsewhere classified)	244	114	(101-130)
Cervix (180)	Electricians	3	625	(129-1828)
	Publicans and barstaff	198	140	(122-162)
	Retailers and dealers	547	125	(113-136)
	Tobacco workers	6	281	(103-612)
	Tailors and dressmakers	42	142	(103-193)
	Storekeepers	47	138	(102-184)
<i>In situ</i> cervix (233.1)	Professional engineers nec	19	187	(113-292)
	Publicans and barstaff	640	116	(108-126)
	Sales representatives	140	123	(104-146)
	Retailers and dealers	1,536	107	(103-113)
Ovary (183)	Printing machine minders	10	233	(112-429)
	Launderers and dry cleaners	48	139	(103-185)
	Other administrators	54	135	(102-177)

<sup>a</sup>From ICD-9(4).

In addition to the previously noted excesses of cancer of the breast and uterus in teachers, significantly raised PRRs in this occupational group were also seen for melanoma, skin cancers other than melanoma, and colon cancer. Significantly low PRRs were seen for cancers of the lung, cervix, stomach, and larynx (Table 7). For nurses, significantly raised PRRs were seen for three cancers—nasopharyngeal, bladder, and skin cancers other than melanoma. No PRRs were significantly below 100. For publicans and barstaff, statistically significantly raised PRRs were seen for cancers of the mediastinum, oropharynx, gum, ill-defined lip and pharynx, lung, and cervical cancer. Statistically significantly low PRRs were also seen for a number of cancers in this job group.

**Recently Reported Associations**

Results relating to three associations, which have recently been reported in studies of European women, have been examined. Excesses of 20% for cancer of the ovary and for non-Hodgkin lymphoma among hairdressers have been reported in data from the Nordic countries (7). Our data

provide little support for either of these associations (PRR = 124, 95% CI 92–165 and PRR = 81, 95% CI 44–136, respectively), nor is there evidence of an excess of nose and nasal sinus cancers in textile workers, recently reported to be high in data from France (8) (PRR = 100, 95% CI 27–256). In addition, an excess risk of breast cancer found among female electrical workers in the United States (9) was not supported by these data (PRR = 89, 95% CI 72–112).

**Discussion**

The analyses presented here demonstrate that occupational information collected at cancer registration can be used to identify groups of women who may be at increased risk. Of the results presented, the excesses of bladder cancer in rubber workers, and of pleural cancer in carpenters, are most likely to reflect occupational exposures. These associations have already been well documented in men, but to our knowledge, this is the first time that similar associations have been reported for women. Although a number of other statistically significant associations were also found, these require careful interpretation. We

therefore discuss these results in the context of several methodologic issues that need to be considered.

**Exclusion of Cancers with an Inadequately Described Occupation**

These analyses excluded cancers with an inadequately described occupation. This has advantages for interpretation because it excludes cancers registered in women not engaged in work outside the home. This is important, as it prevents the appearance of some spurious occupational associations, particularly among cancers that are strongly associated with reproductive risk factors. However, some women who have worked outside the home for whom no occupational information was obtained are also excluded. Although this may have introduced bias, the extent of the bias cannot be assessed in these data.

**Classification of Occupation**

Individuals may change jobs or retire from work completely during the prediagnosis symptomatic stages of certain cancers. This could lead to underestimation of the strength of association if most recent, rather than longest held, occupation is recorded at cancer registration. Moreover, because the carcinogenic effects of occupational exposures may take years or even decades to develop, occupation recorded at cancer registration may be less relevant than occupation held several years previously.

Industrial compensation for occupational cancer is a further issue to consider, as it could increase the likelihood of a particular cancer being recorded for individuals engaged in certain occupations. One possible example would be pleural cancer and work involving exposure to asbestos, as in the United Kingdom, pleural mesothelioma is a compensatable disease.

**Confounding**

Although these analyses were adjusted for age, social class, and region of registration, confounding by other factors needs to be considered. Interpretations of results for lung cancer, for example, are especially difficult because smoking habits have not been adjusted for. Further, parity, a factor that needs to be considered for women, is particularly important for malignancies of the female reproductive system. Although the potential confounding effects of parity were ameliorated by restricting the analyses to employed women, occupational parity variations are still the most likely

**Table 7.** Occupations in which women predominate: occupations with significantly high or low PRRs in women 20 to 74 years of age in England from 1981 to 1987.

Occupation	Significantly high/low PRR	Registrations	PRR	95% CI
Teachers (not elsewhere classified)	Significantly high			
	Melanoma of skin (172)	223	145	(128–166)
	Breast (174)	1,942	118	(113–123)
	Skin other than melanoma (173)	400	117	(107–130)
	Colon (153)	315	116	(104–130)
	Uterus (179, 181, 182)	244	114	(101–130)
	Significantly low			
	Lung (162)	231	51	(46–59)
	Cervix (180)	177	64	(55–75)
	Stomach (151)	72	68	(54–75)
	Larynx (161)	6	42	(16–93)
Nurses	Significantly high			
	Nasopharyngeal (147)	13	204	(109–350)
	Bladder (188, 189.1, 189.9)	138	120	(101–142)
	Skin other than melanoma (173)	460	110	(101–122)
	Significantly low			
None	–	–	–	–
Publicans and barstaff	Significantly high			
	Mediastium (164.1–164.9)	7	691	(278–1426)
	Oropharynx (146)	8	524	(227–1034)
	Gum (143)	6	554	(203–1206)
	Ill-defined lip and pharynx (149)	5	490	(159–1145)
	Lung (162)	293	138	(124–156)
	Cervix (180)	198	140	(122–162)
	Significantly low			
	Skin other than melanoma (173)	80	62	(50–78)
	Melanoma of skin (172)	26	59	(39–87)
	Uterus (179, 181, 182)	45	65	(48–88)
Breast (174)	416	73	(73–88)	
Kidney (189.0)	9	46	(21–89)	

explanations for some of the breast and uterine cancer findings.

### Use of the Proportional Registration Ratio as the Measure of Effect

The limitations of proportional measures of effect are well known (10,11). Despite these problems, there has been a conscious decision in the United Kingdom not to base occupational analyses of routinely collected data on denominators estimated from other sources such as census because of serious concerns over numerator-denominator biases. It should be borne in mind, however, that individual cause-specific PRRs could be distorted by unusually high or low rates for other cancers.

### Multiple Comparisons

Statistical inference is a particularly difficult problem for the analysis of routinely collected data because, inevitably, many associations are examined simultaneously. Under these circumstances, it is not obvious how best to identify associations requiring further investigation, as some may be high or low by chance alone. In the United Kingdom we are in the process of developing new methods designed specifically to identify groups at increased risk of adverse health outcomes (11). These methods are being developed to be generally applicable to a wide range of routinely collected data sets and to be relatively simple and easy to use.

## Summary

Analyses of routinely collected data on cancer and occupation in women have the potential to provide valuable pointers for further research. The data contributing to the analyses presented here are a subset of those currently available for analysis in the United Kingdom, which currently cover the 17-year period from 1971 to 1987. We are in the process of developing new methods to deal with several of the problems outlined above (11) and plan to apply these in the analysis of more extensive data available for the United Kingdom and, if possible, in analysis of similar data for other European countries.

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