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Is There a Healthy Worker Effect for Cancer Incidence Among Women in Sweden?

Gloria Gridley, MS,[1]* Olof Nyren, MD, PhD,[2] Mustafa Dosemeci, PhD,[1] Tahereh Moradi, MPH,[2] Hans-Olov Adami, MD, PhD,[2] Leslie Carroll, BS,[3] and Shelia Hoar Zahm PhD[1]

Background *Our aim was to evaluate whether there is a healthy worker effect (HWE) for cancer incidence among women. HWE is a bias found in occupational studies that compare rates of disease among employed people to disease rates for the general population, which includes unemployed people (who may be less healthy than those who are employed).*
Methods *Data from the 1960 and 1970 Swedish censuses were used to identify all 1,659,940 Swedish women who were employed in either year. They were followed during 1971–1989 through linkages to the national cancer and death registers. Standardized incidence ratios (SIRs) were computed comparing employed women to the 1,627,873 women who were not employed in either 1960 or 1970.*
Results *For the 545,857 women employed in both 1960 and 1970, the SIR for all cancers combined was 1.05 (1.04–1.06). When specific cancer sites were analyzed separately, the highest cancer risks were for cancers of the lung and bladder (SIR = 1.2) and reproductive organs (breast, ovary, endometrium, and cervix SIR = 1.1). Overall cancer risks were highest among full-time workers, younger workers, urban workers, and workers with the highest socioeconomic status (based on the woman's job title).*
Conclusions *These results show no general HWE for cancer incidence among employed Swedish women.* Am. J. Ind. Med. 36:193–199, 1999. *Published 1999 Wiley-Liss, Inc.*†

KEY WORDS: occupation; healthy worker effect; epidemiology; cancer; risk factors

INTRODUCTION

The healthy worker effect (HWE) is a bias found in occupational studies that compare rates of disease among employed people to disease rates for the general population, which includes unemployed people who may have a greater prevalence of disease than those who are employed. The HWE can be strong for some chronic illnesses, such as chronic obstructive pulmonary disorders, renal disease, and cardiovascular disease. However there is little evidence for a strong HWE for cancer risk among men [Choi, 1992]. Not much is known about HWE and risk of cancer among women.

Occupational studies of women have been more likely to use female worker comparison groups, rather than all women in the general population, than have occupational studies of men [Moser and Goldblatt, 1991; Seniori Costantini et al., 1994; Lynge, 1994]. This has probably been due to concern that, with the lower employment rates among women than men, some factors associated with employment may affect disease risk and produce bias. Some attempt has previously been made to assess the effect of lifestyle and reproductive factors, socioeconomic status, and employment on risk of cancer in women [Martikainen, 1995]. We had the unique opportunity to evaluate HWE using unemployed women as our comparison group. We used Swedish data

[1]Division of Cancer Epidemiology and Genetics, National Cancer Institute, Rockville, Maryland, USA
[2]Department of Medical Epidemiology, Karolinska Institutet, Stockholm, Sweden
[3]Information Management Services, Silver Spring, Maryland, USA
Contract grant sponsor: the intramural program of the National Cancer Institute.
*Correspondence to: Gloria Gridley, NCI, EPS 8034-7244, Rockville, MD 20892-7244 USA. E-mail: gridleyg@exchange.nih.gov

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from two decennial censuses linked to cancer registry data [Moradi et al., 1998] to evaluate cancer risk among employed women, compared to women not gainfully employed in either census.

METHODS

Data Linkages

This data linkage has been previously described [Moradi et al., 1998]. Briefly, in the Swedish National Population and Housing Censuses of 1960 and 1970, Statistics Sweden gathered information, through questionnaires to every household, about the entire Swedish population. The information included place of birth, home and work addresses, employment status, job title, and industry for each household member [OSS, 1975]. The ''background'' register of all individuals (including 3,311,460 women) who took part in both the 1960 and 1970 censuses was linked to the Swedish Register of Causes of Death [SS, 1971–1989] for dates of death occurring from January 1, 1971, through December 31, 1989.

The Cancer Environment Register III (CERIII) links the Swedish Cancer Register [SCR, 1997] for 1971–1989 to the national population censuses from both 1960 and 1970 [NBHW, 1994]. Only incident cancer cases, a total of 313,684 women contributing 335,618 tumors, are recorded in CERIII. We merged the two datasets (the CERIII and the ''background'' register) on all data fields (dates, residence, occupation, and industry) to form our analytic file.

Employment Characteristics

Employed women were classified as employed in 1960 only, 1970 only, or both. Our analysis focused primarily on the women employed in both 1960 and 1970, with the assumption that these women were employed for the intervening 10 years. We categorized these women by age at start of follow-up (January 1, 1971) in three levels: age <45, 45–54, 55+. The census variable for part-time versus full-time work was only ascertained in the 1970 census, with three levels: <20 hours/week, 20–34, 35+. Women were classified according to residence into two categories: ''urban'' residence, in one of the three largest cities (Stockholm, Gothenburg, or Malmo) versus the rest of Sweden (''nonurban''). Socioeconomic status (SES) was categorized into five levels (from lowest to highest income and education) based solely on the woman's job title (not head of household), as described in detail elsewhere [SS, 1995], and modified by us (we split the top/fourth level into two).

Analysis

Each cohort member contributed person-years from January 1, 1971, until death or end of follow-up (December 31, 1989). The expected number of cancers was calculated by multiplying the observed number of person-years in the cohort by 5-year age- and calendar-year-specific cancer incidence rates, derived from the 1,627,873 women reporting no employment in both the 1960 and 1970 censuses. Cancer risk was estimated by computation of the standardized incidence ratio (SIR), defined as the ratio of observed number of cancers to those expected. All (including second) primary cancers were counted in both the observed and expected rates. The 95% confidence intervals (CI) and chi-square significance tests (for *P*-values in Tables I–IV) were calculated on the assumption that the observed number of cancers follows a Poisson distribution. A chi-square test was also used to assess trend in the SIR for ordered exposure levels [Breslow and Day, 1987]. SIR were stratified by the employment characteristics one at a time, and in combinations to assess effect modification (none was found). Cancers were grouped into two categories: smoking-related cancers (buccal, esophagus, pancreas, lung, larynx, bladder, kidney, cervix [Schottenfeld and Fraumeni, 1996]) and ''not'' smoking related cancers (all the rest). Cancer sites not shown in Tables I–V were unremarkable (not associated with significantly increased or decreased cancer risk).

RESULTS

Compared to the 1,627,873 Swedish women who reported no employment in either the 1960 or 1970 Swedish census, the 1,659,940 women who reported employment in either 1960 or 1970 had a similar incidence of cancer overall (SIR = 1.01 (1.01–1.02)) (Table I). The 750,793 (45%) women who reported employment only in 1970 had a slight deficit of cancer overall (SIR = 0.96 (0.95–0.97)); however, the 363,290 (22%) women employed only in 1960 and the 545,857 (33%) women employed in both 1960 and 1970 had a minimal excess of cancer overall (SIR = 1.03 (1.02–1.04) and SIR = 1.05 (1.04–1.06), respectively).

For these latter two groups of women, the increased cancer risk appeared to be mostly for smoking-related cancers — SIR = 1.10 (1.07–1.13) for women employed in 1960 only, and SIR = 1.14 (1.12–1.16) for women employed in both 1960 and 1970 — although there was a significantly increased risk for some nonsmoking related cancers for women employed in both 1960 and 1970, specifically breast (SIR = 1.09 (1.07–1.11)), ovary (SIR = 1.12 (1.08–1.15)), and endometrium (SIR = 1.08 (1.04–1.11)). There was a notable decreased risk of gallbladder cancer for women employed in 1960 or 1970 (SIR = 0.81 (0.77–0.84)).

Overall cancer risk was not decreased in the first 4 years of follow-up (Table II). The risk of smoking-related cancers was lower in the first 4 years ($P = 0.02$); however, the risk in the first 4 years was still above 1.0 (SIR = 1.09). The only cancer risk below 1.0 in the first 4 years was for gallbladder

TABLE I. Cancer Risk (SIR)[a] Among Swedish Women, Based on Employment Status in 1960 and 1970 Censuses

Selected cancers	Employed in 1960 or 1970			Employed in 1970 only			Employed in 1960 only			Employed in both 1960 + 1970		
	(Obs)	(SIR)	(95% CI)[b]	(Obs)	(SIR)	(95% CI)[b]	(Obs)	(SIR)	(95% CI)[b]	(Obs)	(SIR)	(95% CI)[b]
Number of women	1,659,940			750,793			363,290			545,857		
All cancers	151,704	1.01	1.01–1.02	51,366	0.96	0.95–0.97	40,189	1.03	1.02–1.04	60,149	1.05	1.04–1.06
Smoking-related[c]	26,284	1.07	1.06–1.08	8,488	0.98	0.96–1.00	7,239	1.10	1.07–1.13	10,557	1.14	1.12–1.16
Pancreas	4,158	1.05	1.02–1.08	1,238	1.02	0.96–1.08	1,338	1.08	1.02–1.13	1,582	1.05	1.00–1.11
Lung	5,596	1.08	1.05–1.11	1,708	0.90	0.85–0.94	1,389	1.16	1.10–1.22	2,499	1.19	1.15–1.24
Bladder	3,669	1.07	1.03–1.10	969	0.89	0.84–0.95	1,128	1.09	1.02–1.15	1,572	1.20	1.14–1.26
Cervix	6,278	1.05	1.02–1.08	2,476	0.96	0.93–1.00	1,438	1.15	1.09–1.21	2,364	1.09	1.05–1.14
Not smoking-rel.[d]	125,420	0.99	0.98–1.00	42,878	0.96	0.95–0.97	32,950	0.98	0.97–0.99	49,592	1.02	1.01–1.03
Gallbladder	1,996	0.81	0.77–0.84	677	0.90	0.83–0.97	629	0.81	0.75–0.88	690	0.73	0.68–0.79
Breast	42,479	1.02	1.01–1.03	14,640	0.95	0.94–0.97	10,362	1.03	1.01–1.05	17,477	1.09	1.07–1.11
Ovary	10,170	1.04	1.02–1.06	3,627	0.97	0.94–1.00	2,226	1.03	0.99–1.07	4,317	1.12	1.08–1.15
Endometrium	9,192	1.00	0.98–1.02	3,245	0.93	0.90–0.97	1,924	0.99	0.94–1.03	4,023	1.08	1.04–1.11

[a]Standardized incidence ratios (SIR) adjusted in 5-year age and calendar-year intervals; cancer rates compared to cancer rates for women not ''employed'' in 1960 or 1970.
[b]95% Confidence intervals (CI).
[c]Smoking-related cancers = buccal, esophagus, pancreas, lung, larynx, bladder, kidney, cervix.
[d]Non-smoking-related cancers = all other cancers combined.

TABLE II. Cancer Risk (SIR)[a] Among Swedish Women Employed in Both 1960 and 1970, by Years of Follow-up

Selected cancers	Follow-up 1971–74			Follow-up 1975–79			Follow-up 1980–84			Follow-up 1985–89		
	(Obs)	(SIR)	(95% CI)[b]	(Obs)	(SIR)	(95% CI)[b]	(Obs)	(SIR)	(95% CI)[b]	(Obs)	(SIR)	(95% CI)[b]
All cancers	8,597	1.04	1.02–1.06	13,725	1.07	1.05–1.08	16,856	1.03	1.02–1.05	20,971	1.06	1.04–1.07
Smoking-related[c]	1,546	1.09	1.04–1.15	2,319	1.17	1.12–1.22	2,974	1.14	1.10–1.18	3,718	1.17	1.13–1.21
Pancreas	184	1.12	0.97–1.30	337	1.16	1.04–1.29	448	1.02	0.92–1.11	613	1.08	0.99–1.17
Lung	218	1.19	1.04–1.36	492	1.51	1.38–1.65	738	1.24	1.16–1.34	1,051	1.37	1.29–1.46
Bladder	191	1.29	1.11–1.49	304	1.14	1.01–1.28	447	1.23	1.12–1.35	630	1.35	1.25–1.46
Cervix	640	1.18	1.09–1.28	661	1.23	1.14–1.33	579	1.23	1.14–1.34	484	1.12	1.03–1.23
Not smoking-related[d]	7,051	1.03	1.01–1.05	11,406	1.05	1.03–1.07	13,882	1.01	0.99–1.03	17,253	1.04	1.02–1.06
Gallbladder	62	0.66	0.51–0.85	147	0.80	0.68–0.94	207	0.67	0.58–0.77	274	0.77	0.68–0.87
Breast	2,561	1.11	1.07–1.16	4,213	1.13	1.10–1.17	4,757	1.08	1.05–1.11	5,946	1.11	1.08–1.14
Ovary	762	1.12	1.04–1.20	1,087	1.12	1.06–1.19	1,223	1.18	1.11–1.25	1,245	1.14	1.08–1.21
Endometrium	607	1.03	0.95–1.11	1,065	1.11	1.05–1.18	1,148	1.05	0.99–1.12	1,203	1.03	0.97–1.09

[a]Standardized incidence ratios (SIR) adjusted in 5-year age and calendar-year intervals; cancer rates compared to cancer rates for women not ''employed'' in 1960 or 1970.
[b]95% Confidence intervals (CI).
[c]Smoking-related cancers = buccal, esophagus, pancreas, lung, larynx, bladder, kidney, cervix.
[d]Non-smoking-related cancers = all other cancers combined.

cancer, which was below 1.0 for the entire follow-up period, not just the first 4 years.

Thirty percent of women employed in both 1960 and 1970 worked part-time (less than 35 hours per week) in 1970. Full-time workers had the highest risk of total cancers, including both smoking- (SIR = 1.19 (1.16–1.22)) and nonsmoking-related cancers (SIR = 1.04 (1.03–1.05)). Part-time workers had lower cancer risks than full-time workers, especially for smoking-related cancers (SIR = 1.06 (1.02–1.10)). Gallbladder cancer was similarly decreased in both full- and part-time workers.

Cancer risks were mainly elevated for urban workers (Table III). Forty-two percent of women employed in both 1960 and 1970 resided in one of Sweden's three largest cities in both 1960 and 1970. Urban workers had elevated risks of both smoking- (SIR = 1.25 (1.22–1.28)) and nonsmoking-

TABLE III. Cancer Risk (SIR)[a] Among Swedish Women Employed in Both 1960 and 1970, by Urban Residence (Stockholm, Goteborg, or Malmo)

Selected cancers	Urban residence			Not urban residence		
	(Obs)	(SIR)	(95% CI)[b]	(Obs)	(SIR)	(95% CI)[b]
Number of women	228,428			282,752		
All cancers	28,576	1.10	1.08–1.11	28,945	1.01	0.99–1.02
Smoking-related[c]	5,231	1.25	1.22–1.28	4,855	1.05	1.02–1.08
Pancreas	746	1.07	1.00–1.15	786	1.09	1.02–1.17
Lung	1,350	1.59	1.51–1.68	1,020	1.08	1.02–1.15
Bladder	854	1.46	1.36–1.56	657	1.07	0.99–1.15
Cervix	1,121	1.34	1.26–1.42	1,104	1.08	1.02–1.15
Not smoking-related[d]	23,345	1.07	1.05–1.08	24,090	1.00	0.98–1.01
Gallbladder	287	0.65	0.57–0.73	378	0.82	0.74–0.90
Breast	8,366	1.19	1.16–1.21	8,239	1.03	1.01–1.06
Ovary	2,025	1.20	1.15–1.25	2,103	1.10	1.05–1.15
Endometrium	1,855	1.07	1.03–1.12	2,007	1.05	1.00–1.09

[a]Standardized incidence ratios (SIR) adjusted in 5-year age and calendar-year intervals; cancer rates compared to cancer rates for women not ''employed'' in 1960 or 1970.
[b]95% Confidence interval (CI).
[c]Smoking-related cancers = buccal, esophagus, pancreas, lung, larynx, bladder, kidney, cervix.
[d]Non-smoking-related cancers = all other cancers combined.

related cancers (SIR = 1.07 (1.05–1.08)) compared to all unemployed women (the denominator was not stratified by urban residence). The highest risks for urban workers were seen for lung cancer (SIR = 1.59 (1.51–1.68)), urinary bladder (SIR = 1.46 (1.36–1.56)), and cervix (SIR = 1.34 (1.26–1.42)).

Nearly half (47%) of the women employed in both 1960 and 1970 were less than 45 years of age at the start of follow-up, January 1, 1971 (Table IV). The younger workers (age <45) had a significantly higher cancer risk for nonsmoking-related cancers (SIR = 1.13 (1.11–1.15)), particularly breast (SIR = 1.26 (1.23–1.29)) and ovary (SIR = 1.24 (1.18–1.31)), than the older workers.

Younger employed women with urban residence were at the highest risk of cancer overall (SIR = 1.22 (1.19–1.25)). The same cancer risk patterns by age were seen for urban and nonurban workers, except that for nonurban workers the smoking-related cancer risks increased with age (P for trend = 0.0004) from SIR = 0.96 to SIR = 1.10, in inverse of the nonsmoking-related cancer risks (from SIR = 1.09 to SIR = 0.94).

The overall risk of cancer was lowest for the lowest SES level (1) workers (SIR = 1.02 (1.01–1.04)) (Table V). Nearly half (48%) of the women employed in both 1960 and 1970 were in SES level 1 jobs. There was a surprising trend ($P < 0.0001$) of increased risk of cancer with increased SES. This trend was due to the increased cancer risk for nonsmoking-related cancers only, particularly breast and endometrium (P for trend < 0.0001 for both). Risk of gallbladder cancer was lowest for the highest SES level (P for trend = 0.006). Smoking-related cancers were elevated for all SES levels except level 4 (except bladder cancer, which was also elevated for SES level 4).

DISCUSSION

We found no evidence for a general HWE for cancer incidence among women employed in Sweden in 1960 and 1970. There was a slight excess of cancer overall (5%) for women who were employed in both 1960 and 1970, with increased risk seen mainly for smoking-related cancers (risk increased by 20% for lung and bladder cancers) and reproductive organs (risk increased by 10% for cancers of the breast, ovary, cervix, and endometrium). Cancer risks were not below expected in the first 4 years of follow-up. Cancer risks were highest among full-time workers, urban workers, younger workers, and workers with the highest SES level (based on the woman's job title, not head of household). The only decreased risk for cancer incidence observed among employed women was for gallbladder cancer, which was consistently decreased regardless of work-hours, age, residence, or SES.

The use of computerized record linkage data has several advantages over previous studies of HWE: prospective self-reported occupation, coverage of the whole population in a defined geographic area, long-term complete follow-up, and more reliable disease assessment. Studies that have found HWE for cancer among women have all studied

TABLE IV. Cancer Risk (SIR)[a] Among Swedish Women Employed in Both 1960 and 1970, by Age at Start of Follow-up (January 1, 1971)

Selected cancers	Age <45 in 1/1/71			Age 45–54 in 1/1/71			Age 55+ in 1/1/71		
	(Obs)	(SIR)	95% CI[b]	(Obs)	(SIR)	95% CI[b]	(Obs)	(SIR)	95% CI[b]
Number of women	258,644			151,155			136,058		
All cancers	15,873	1.12	1.11–1.14	20,517	1.06	1.05–1.07	23,759	1.00	0.99–1.01
Smoking-related[c]	2,373	1.12	1.08–1.17	3,625	1.17	1.13–1.21	4,559	1.14	1.11–1.17
Pancreas	209	1.12	0.97–1.28	513	1.08	0.99–1.18	860	1.07	1.00–1.14
Lung	580	1.27	1.17–1.38	953	1.36	1.27–1.45	966	1.36	1.28–1.45
Bladder	207	1.14	0.99–1.30	523	1.31	1.20–1.43	842	1.27	1.18–1.36
Cervix	893	1.05	0.98–1.12	745	1.23	1.15–1.33	726	1.39	1.29–1.49
Not smoking-related[d]	13,500	1.13	1.11–1.15	16,892	1.03	1.01–1.05	19,200	0.97	0.96–0.98
Gallbladder	91	0.64	0.52–0.79	202	0.71	0.62–0.82	397	0.77	0.70–0.85
Breast	5,907	1.26	1.23–1.29	5,768	1.08	1.05–1.11	5,802	1.01	0.99–1.04
Ovary	1,315	1.24	1.18–1.31	1,644	1.16	1.10–1.21	1,358	1.05	0.99–1.10
Endometrium	1,007	1.11	1.05–1.18	1,803	1.14	1.09–1.20	1,213	0.91	0.86–0.97

[a]Standardized incidence ratios (SIR) adjusted in 5-year age and calendar-year intervals; cancer rates compared to cancer rates for women not ''employed'' in 1960 or 1970.
[b]95% Confidence interval (CI).
[c]Smoking-related cancers = buccal, esophagus, pancreas, lung, larynx, bladder, kidney, cervix.
[d]Non-smoking-related cancers = all other cancers combined.

TABLE V. Cancer Risk (SIR)[a] Among Swedish Women Employed in Both 1960 and 1970, by Socioeconomic Status (Based on Job Title) in 1960

Selected cancers	Socioeconomic status (based on job title)														
	1 (Low)			2			3			4			5 (High)		
	(Obs)	(SIR)	95% CI[b]	(Obs)	(SIR)	95% CI[b]	(Obs)	(SIR)	95% CI[b]	(Obs)	(SIR)	95% CI[b]	(Obs)	(SIR)	95% CI[b]
Number of women	259,495			38,620			143,346			61,936			10,802		
All cancers	28,720	1.02	1.01–1.04	4,296	1.05	1.02–1.09	14,744	1.10	1.08–1.12	7,435	1.06	1.04–1.09	1,420	1.08	1.02–1.14
Smoking-related cancers[c]	5,480	1.21	1.18–1.24	792	1.21	1.13–1.30	2,365	1.11	1.07–1.16	1,002	0.90	0.85–0.96	249	1.17	1.03–1.32
Pancreas	831	1.12	1.05–1.20	123	1.16	0.96–1.38	328	1.04	0.93–1.15	164	0.92	0.79–1.07	37	1.04	0.73–1.43
Lung	1,261	1.39	1.31–1.47	197	1.50	1.29–1.72	603	1.37	1.26–1.48	194	0.83	0.72–0.96	62	1.44	1.10–1.84
Bladder	804	1.28	1.20–1.37	95	1.05	0.85–1.29	349	1.28	1.15–1.42	192	1.27	1.10–1.47	49	1.64	1.21–2.16
Cervix	1,296	1.37	1.30–1.45	156	1.12	0.95–1.31	549	1.07	0.99–1.17	168	0.73	0.63–0.85	45	1.13	0.82–1.51
Not smoking-related[d]	23,240	0.99	0.98–1.00	3,504	1.03	1.00–1.06	12,379	1.10	1.08–1.12	6,433	1.10	1.07–1.13	1,171	1.06	1.00–1.12
Gallbladder	370	0.79	0.71–0.87	58	0.85	0.65–1.10	122	0.59	0.49–0.70	79	0.68	0.54–0.85	10	0.44	0.21–0.81
Breast	7,510	0.99	0.96–1.01	1,215	1.09	1.03–1.16	4,834	1.27	1.23–1.31	2,519	1.30	1.25–1.36	444	1.25	1.14–1.37
Ovary	2,094	1.15	1.10–1.20	308	1.16	1.03–1.30	1,057	1.16	1.09–1.23	513	1.11	1.02–1.21	88	1.04	0.83–1.28
Endometrium	1,810	0.98	0.94–1.03	292	1.10	0.98–1.23	991	1.10	1.03–1.17	590	1.23	1.13–1.34	104	1.18	0.96–1.42

[a]Standardized incidence ratios (SIR) adjusted in 5-year age and calendar-year intervals; cancer rates compared to cancer rates for women not ''employed'' in 1960 or 1970.
[b]95% Confidence intervals (CI).
[c]Smoking-related cancers = buccal, esophagus, pancreas, lung, larynx, bladder, kidney, cervix.
[d]Non-smoking-related cancers = all other cancers combined.

cancer mortality [Vena et al., 1986; Martikainen, 1995] rather than incidence. Perhaps HWE is a phenomenon of mortality rather than incidence studies. Cancer surveillance may be increased for certain groups of workers (urban, young, higher SES), and cancer survival may thereby be improved for these workers, in which case cancer incidence

may be high but mortality low for these workers and thus the employment characteristics which we found to be associated with increased cancer incidence might not be associated with increased cancer mortality.

There have been several studies of occupation and cancer mortality in women based on occupation from census data [Moser and Goldblatt, 1991; Seniori Costantini et al., 1994; Martikainen, 1995], and also one study based on cancer incidence rather than mortality [Lynge, 1994]. The key limitations of census data are the incomplete information about lifetime occupational histories and important covariates, such as smoking and reproductive factors, although the linkage of two decennial censuses strengthens our assessment of occupation. The strengths of occupational studies based on record linkage data are the large numbers of workers, coverage of the whole population in a defined geographic area, and long-term complete (passive) follow-up. In fact, our numbers were so large that very small effects were statistically significant.

Census data are a much better source of occupation information than data based on death certificates, which are often missing or incomplete, or have only the last or most recent occupation (such as ''retired'' or housewife), are based on reporting by next of kin, and may involve elevation of job title [Steenland and Beaumont, 1984]. Census occupation is based on self-report, not surrogate information. Cancer registry linkage not only provides extra information on histology, but also avoids the outcome (cancer) misclassification problem of mortality studies.

Another advantage of our study was that women employed in both 1960 and 1970 were on average over 45 years of age at the start of follow-up in 1971, and over 65 years of age at the end of follow-up in 1989. This is a perfect age range to assess cancer risk. These women were old enough, and our follow-up interval was sufficiently long (almost 20 years), for us to obtain meaningful estimates of cancer risk. We used ''nonemployed'' women as the comparison group to maximize our detection of HWE. Since there were as many ''nonemployed'' as ''employed'' women in this time period, our cancer rates were quite stable. Unfortunately, the study of employed women is a moving target in calendar time. As more and more women enter the job market, the assessment of HWE for women may become more similar to results reported for men.

One of the indications of HWE is a reduction in disease risk in the early follow-up period, followed by a return to expected disease rates as follow-up continues [McMichael, 1976; Choi, 1992]. We found no risk below 1.0 for the first 4 years of follow-up, except for gallbladder cancer, which was below 1.0 for the entire study period.

In our study, cancer risks among gainfully employed compared with nonemployed women were higher for smoking-related cancers than for nonsmoking-related cancers in most of the strata examined (part-time, full-time, urban, nonurban, older workers, and several levels of SES). We found that part-time workers had a lower cancer risk than full-time workers, especially for the smoking-related cancers. This could be related to reduced work exposures, types of jobs, or to lifestyle factors [Herold and Waldron, 1985].

Urban workers had the highest risk of both smoking-related and nonsmoking-related cancers in our study. Similar results were found in Russia, where cancer risks for women who worked in an urban area were compared to unemployed women in the same urban area [Bulbulyan et al., 1992]. They found urban workers to have a 5% excess of cancer overall, including an increased risk of cancers of the breast and cervix — very similar results to our study. Our finding of increased cancer risks for urban residents were also consistent with the earliest studies based on geography [Hoover et al., 1974].

Past studies of male workers would predict that HWE would be strongest (i.e., relative risks lowest) among the youngest workers [Checkoway et al., 1989]; however, we found the opposite effect in women. Younger workers had the greatest risk of nonsmoking-related cancers, particularly breast, ovary, and endometrium. This could be due to work exposures, their susceptible age, or reduced or delayed parity. All three of these cancers would be increased in women with decreased parity [Schottenfeld and Fraumeni, 1996]. Perhaps younger working women have delayed or reduced childbearing compared to nonworking women, but perhaps older working women have not. Lower parity has been reported among working women [Boffetta et al., 1995; Kryston et al., 1983]. A Finnish mortality study based on census data found cancer risk in women to be affected by parity and employment, but they found reduced cancer mortality for employed women, particularly breast cancer [Martikainen, 1995]. Moser and Goldblatt [1991] found an increased risk of breast cancer that was greater at younger ages for women employed in the service, sport, and recreation industries. Icelandic nurses were found to have an increased breast cancer incidence; however, without evidence of reduced parity or late age at first birth [Gunnarsdottir and Rafnsson, 1995].

Our assessment of SES-related cancer risks was not the usual direct analysis of income and education, but rather an examination of risk differences by categories of employment. SES (based solely on the woman's job title) in our study was associated with a significant trend of increasing overall cancer risk with higher SES, consistent with the findings of Seniori Costantini et al. [1994]. Smoking-related cancers were elevated for four of the five SES levels. Cancers at these sites (lung, bladder, etc.) could be related to work exposures [Moser and Goldblatt, 1991; Seniori Costantini et al., 1994; Gunnarsdottir et al., 1995; Beall et al., 1995] as well as increased smoking among working women, or other environmental exposures (such as urban residence). Smoking-related cancers are known to be increased for

women in specific occupational groups, such as waitresses [Siegel, 1993; Kjaerheim and Andersen, 1994]. Cervical cancer was particularly elevated at the lowest SES level, which is consistent with other studies [Savitz et al., 1995].

The only reduction in cancer incidence in our data was for gallbladder cancer, which showed a consistently decreased cancer risk for employed women in every stratum. This finding is consistent with our theory of decreased parity among employed women, since increased parity may be a risk factor for this disease [Schottenfeld and Fraumeni, 1996].

In summary, we found no evidence of HWE for cancer incidence among Swedish women employed in 1960 or 1970. Cancer risks were slightly elevated overall (5%) and for several specific types of cancer (10–20%), and for women who were employed full-time, lived in urban areas, and for younger workers. Our data will be analyzed in more detail in future studies that focus on specific occupations and occupational exposures. Hopefully, other researchers in other countries will test the hypotheses that we have generated in this study.

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REFERENCES

Beall C, Delzell E, Macaluso M. 1995. Mortality patterns among women in the motor vehicle manufacturing industry. Am J Ind Med 28:325–337.

Boffetta P, Kogevinas M, Franceschi S. 1995. Occupation and women's reproductive habits (Abstract). Epidemiology 6:584.

Breslow NE, Day NE. 1987. Statistical methods in cancer research. Vol. II. The design and analysis of cohort studies. Lyon, France: International Agency for Research on Cancer, IARC Sci Pub No 92.

Bulbulyan M, Zahm SH, Zaridze DG. 1992. Occupational cancer mortality among urban women in the former USSR. Cancer Causes Control 3:299–307.

Checkoway H, Pearce N, Crawford-Brown DJ. 1989. Research methods in occupational epidemiology. New York: Oxford University Press.

Choi BCK. 1992. Definition, sources, magnitude, effect modifiers, and strategies of reduction of the healthy worker effect. J Occup Med 34:979–988.

Gunnarsdottir H, Rafnsson V. 1995. Cancer incidence among Icelandic nurses. J Occup Environ Med 37:307–312.

Gunnarsdottir H, Aspelund T, Rafnsson V. 1995. Cancer incidence among female manual workers. Epidemiology 6:439–441.

Herold J, Waldron I. 1985. Part-time employment and women's health. J Occup Med 27:405–412.

Hoover R, Mason TJ, McKay FW, Fraumeni JF Jr. 1974. Geographic patterns of cancer mortality in the United States. In: Persons at high risk of cancer — an approach to cancer etiology and control. New York: Academic Press.

Kjaerheim K, Andersen A. 1994. Cancer incidence among waitresses in Norway. Cancer Causes Control 5:31–37.

Kryston K, Higgins M, Keller J. 1983. Characteristics of working and non-working women in Tecumseh (Abstract). Am J Epidemiol 118:419.

Lynge E. 1994. Danish cancer registry as a resource for occupational research. J Occup Med 36:1169–1173.

Martikainen P. 1995. Women's employment, marriage, motherhood and mortality: a test of the multiple role and role accumulation hypotheses. Soc Sci Med 40:199–212.

McMichael AJ. 1976. Standardized mortality ratios and the ''healthy worker effect'': scratching beneath the surface. J Occup Med 18:165–168.

Moradi T, Nyren O, Bergstrom R, Gridley G, Linet M, Wolk A, Dosemeci M, Adami HO. 1998. Risk of endometrial cancer in relation to occupational physical activity: a nationwide cohort study in Sweden. Int J Cancer 76:665–670.

Moser KA, Goldblatt PO. 1991. Occupational mortality of women aged 15–59 years at death in England and Wales. J Epidemiol Community Health 45:117–124.

NBHW (National Board of Health and Welfare). 1994. The Swedish Cancer Environment Register 1960–70. Stockholm: National Board of Health and Welfare.

OSS (Official Statistics of Sweden). 1975. Census of the Population and Housing in 1970, Part 13. Occupation and Education. Stockholm: Statistics Sweden.

Savitz DA, Andrews KW, Brinton LA. 1995. Occupation and cervical cancer. J Occup Environ Med 37:357–361.

Schottenfeld D, Fraumeni JF Jr. 1996. Cancer epidemiology and prevention, 2nd ed. New York: Oxford University Press.

Seniori Costantini A, Pirastu R, Lagorio S, Miligi L, Costa G. 1994. Studying cancer among female workers: methods and preliminary results from a record-linkage system in Italy. J Occup Med 36:1180–1186.

Siegel M. 1993. Involuntary smoking in the restaurant workplace, a review of employee exposure and health effects. JAMA 270:490–493.

SCR (Swedish Cancer Register). 1997. Cancer incidence in Sweden 1994. Stockholm: National Board of Health and Welfare.

SS (Statistics Sweden). 1971–1989. Yearly reports of causes of death 1971–1989. Stockholm: Statistics Sweden.

SS (Statistics Sweden). 1995. Swedish socioeconomic classification, 4. Reports on Statistical Co-ordination 1982. Stockholm: Statistics Sweden.

Steenland K, Beaumont JJ. 1984. The accuracy of occupation and industry data on death certificates. J Occup Med 26:288–296.

Vena JE, Cookfair DL, Fiedler RC, Barnes RE. 1986. Mortality of a municipal worker cohort. II. Females. Am J Ind Med 9:159–169.