Cancer Causes and Control 1994, **5**, 449 - 457

Cancer risks among female farmers in Sweden

Kerstin Wiklund and Jan Dich

(Received 24 January 1994; accepted in revised form 6 June 1994)

There are few studies on cancer risks among female farmers, particularly on breast cancer and cancer in female genital organs. We have conducted a cohort study of cancer risk among 50,682 women with occupations in agriculture according to the Swedish 1970 census. The cohort was followed up in the nationwide, population-based, Cancer-Environment Register from 1 January 1971 until death or until 31 December 1987. Expected number of cases was based on annual cancer incidence in five-year age groups. The standardized incidence ratio (SIR) was computed as the ratio between observed and expected number of cases. A total of 4,474 cases of cancer were observed in the cohort from 1971 until 1987 *cf* 5,273 expected, resulting in a significantly decreased SIR of 0.85 (95 percent confidence interval [CI] = 0.82-0.87). SIR for breast cancer was significantly decreased (0.83, CI = 0.78-0.88), as was the SIR for cervix uteri (0.40, CI = 0.31-0.50). For the other female genital organs, SIR was close to one. Other cancer sites with significantly decreased SIRs were: colon (0.90, CI = 0.81-1.00); rectum (0.86, CI = 0.74-1.00); lung (0.46, CI = 0.37-0.57); kidney (0.81, CI = 0.68-0.97); urinary organs (0.57, CI = 0.45-0.72); connective tissue and muscle (0.62, CI = 0.39-0.95); and non-Hodgkin's lymphomas (0.78, CI = 0.63-0.96). *Cancer Causes and Control* 1994, **5**, 449 - 457

Key words: Cancer risks, female farmers, lifestyle, pesticide exposure.

Introduction

Development and changes in the recent decades in agricultural practices have entailed increased use of pesticides, fertilizers, and other agricultural chemicals. Many and varied tasks are performed on a farm, and there may be contacts with a number of potentially hazardous agents such as solvents, motor vehicle fuels, lubricants, dusts, infectious agents of animal origin, manure-gases, molds, antibiotics, and fungi, some of which are known or suspected carcinogens.[1-3] On the other hand, farmers are thought to lead healthier lives with physically active hard work, less air pollution, little or no stress, and home-grown food, which may reduce the hazards.

Farmers have lower overall mortality but also lower cancer incidence and cancer mortality. From a public health perspective, it would be worthwhile to study the lifestyle of farmers and use that knowledge for primary prevention, but it is also important to identify risk factors associated with increased morbidity and mortality.

Previously, we have studied cancer risks in a cohort of some 250,000 Swedish men who worked in agriculture according to the 1960 Population and Housing Census.[4-12] Those studies showed that the overall cancer risk and the risk for many individual sites were significantly lower for farmers than for other gainfully employed men, especially for cancers of the respiratory organs. The relative risk (RR) of lip cancer, however, was almost double. Other sites with RRs higher than unity were malignant melanoma and skin carcinoma of the head and neck region, mainly due to occupational

Authors are with the Department of Cancer Epidemiology, Karolinska Institute, Stockholm, Sweden. Address correspondence to Dr Wiklund, Department of Cancer Epidemiology, Radiumhemmet, Karolinska Hospital, S-17176 Stockholm, Sweden. *This study was supported by grant from Kungliga Skogs- och Lantbruksakademien.*

sun exposure. Multiple myeloma and stomach cancer also showed increased risks.

We have also studied cancer risks in a cohort of some 20,000 licensed pesticide applicators in agriculture. The pattern of relative cancer risks was almost identical to that of agricultural workers, except for testicular cancer, which was increased among applicators.[10,13-16]

Associations between phenoxy-acid herbicide exposure and malignant lymphomas and soft tissue sarcomas (STS) were first reported from Swedish case-control studies.[17-19] A number of studies have since been conducted, with supporting and contradicting results.[20-24] Our studies have not indicated any increased risk for these tumors among licensed pesticide applicators or male farmers.

A review of more than 20 cohort studies and a number of case-control studies concerning cancer among farmers showed lower risks of overall cancer and for esophagus, colon, bladder, and lung. Increased risks were found for leukemia, malignant lymphomas, multiple myeloma, and cancers of the lip, stomach, skin, prostate, brain, testis, and connective tissue.[21]

Most of the studies concerning cancer among farmers have focused on pesticide exposure and typical male tasks on a farm, such as machinery and engine repair, welding, painting, carpentry, operation of heavy equipment, truck driving, applying pesticides, etc.

There are few studies on cancer risks among female farmers, particularly on breast cancer and cancer in female genital organs. In a Japanese study,[25] the risks were decreased significantly for breast and corpus cancer while the risk of stomach cancer was significantly high. Blair *et al*[26] found that White female farmers had nonsignificant excesses of multiple myeloma and leukemia. In our earlier studies, based on the 1960 census, it was not possible to study women working in agriculture, due to a high percentage of occupational misclassification, particularly in this group. This was improved, however, in the 1970 census, where occupation was registered for those who worked at least 20 hours per week.

In Sweden, female farmers have not been working with the physically demanding or technically advanced tasks on the farm. Traditionally, they have worked more with livestock, mainly through milking. Few women have licenses for pesticide application in agriculture, and thus have not handled pesticides to the same extent as men. Only one percent of Sweden's licensed pesticide applicators are females. However, female farmers are likely to have experienced passive exposure to pesticides and other agricultural chemicals to a larger extent than the general population. Hazards of such chemicals, therefore, presumably would be seen first in those exposed occupationally, either actively or passively, and most certainly before they appeared in the general population.

The aim was to study cancer risks of female farmers in comparison with the general female population. More attention was paid to breast cancer and cancer in genital organs since there are so few studies on these cancer sites, but also to malignant lymphomas and STS, due to occupational exposure (active or passive) of female farmers to pesticides and other chemicals used in agriculture.

Materials and methods

The study cohort consisted of 50,682 women reporting in the 1970 Swedish Population and Housing Census that they worked at least 20 hours per week in agriculture.

The cohort was followed-up in the nationwide, population-based, Swedish Cancer-Environment Register from 1 January 1971 until death or until 31 December 1987. If a woman was deceased, her death date was derived from the Cause-of-Death Register. In the computerized record linkages, the unique personal-identification number was used for matching purposes. The personal identification number consists of 10 digits; two each for year, month, and day of birth, plus a three-digit serial number, and a check-digit.

Expected number of cases was calculated on the basis of annual cancer incidence among women in five-year age groups for the whole country.

The standardized incidence ratio (SIR) was computed as the ratio between observed and expected number of cases. The observed number of cases was assumed to be Poisson-distributed and the 95 percent confidence interval (CI) for SIRs was derived by means of Poisson distribution tables.

Since there is a lack of individual exposure data regarding pesticides or other agricultural chemicals, we obtained very crude and hypothetical surrogates for pesticide exposure by dividing the material into time periods, birth cohorts, and geographic areas. Neither are there any individual exposure data on smoking, alcohol consumption, dietary habits, physical activity, etc.

The follow-up period was divided into four groups: 1971-75; 1976-80; 1981-84; and 1985-87. The use of pesticides increased very steeply from their introduction in the late 1940s until the middle of the 1970s, after which it levelled out.[27-29] Birth cohorts were analyzed in five year-of-birth groups: to 1904; 1905-14; 1915-24; 1925-34; and 1935+, since younger persons tend to use more pesticides. Residence according to the census was split into six geographic production regions, according

to the principal type of agricultural crops and use of pesticides.

For climatologic reasons, different crops are cultivated in the northern and southern parts of the country. Since the use of agricultural chemicals varies considerably for different crops, there are regional differences in the amount and type of chemicals used.[27] Region 1[a] is the southernmost part of the country. About one-third of all pesticides in Sweden always has been used in this region. The use of pesticides has been lower in Regions 2 through 4, regarding size of area treated with pesticides and amount of pesticide per area treated. Region 6 consists of the four northernmost counties, where there is now and has been, in the past, little use of herbicides and almost no use of fungicides and insecticides. The most common herbicides in the country have been the phenoxy acetic acids MCPA (4-chloro-2-methyl-phenoxyacetic acid) and dichlorprop.[27-29] In Sweden, sales of phenoxy acetic acids increased from one metric ton in 1947 to 1,700 metric tons in 1975 and about 2,000 metric tons annually in 1976-84.[28-29]

Results

A total of 4,474 cases of cancer were observed in the cohort of women working in agriculture according to the 1970 census, during the follow-up period from 1971 until 1987, compared with 5,273 expected, resulting in a significantly decreased SIR of 0.85 (CI = 0.82-0.87; Table 1).

Individual sites with significantly decreased cancer risks were colon, rectum, lung, breast, cervix uteri, kidney, urinary organs, connective tissue and muscle, and non-Hodgkin's lymphoma (NHL) (Table 1). No individual cancer site showed any statistically significant increased risk. For cancer in other genital organs, the respective SIRs were not significantly different from one (Table 1).

Only the SIR for pancreatic cancer changes significantly over time, with a decrease from 1.21 in the first to 0.64 in the last period observed (Table 2).

There was no significant difference in cancer risk between birth cohorts, except for cancer in urinary organs. Notable is an SIR of 1.76 in the youngest birth cohort (Table 3). The SIR of breast cancer was less than one in all age groups.

SIR for overall cancer did not differ significantly in the six geographic areas studied (Table 4). There were significant differences for malignant melanoma of skin, cancer of the cervix uteri, and breast cancer.

The household expenditure studies from 1958 and 1978 have been presented and discussed previously.[7] Data from the 1989 survey are now available.[30] The 1989 ratio of expenditure per consumption unit of foodstuffs, alcoholic beverages, and tobacco, between farming and all households is presented in Table 5.

Table 1. Observed number of cases (Obs), standardized incidence ratio (SIR), and 95% confidence interval (CI) for SIR in the cohort of female agricultural workers for different cancer diagnoses, Sweden

Tumor site	ICD-7 code[a]	Obs	SIR	(CI)
All sites	140-205	4,474	0.85	(0.82-0.87)
Lip	140	7	0.94	(0.38-1.93)
Esophagus	150	22	1.04	(0.65-1.58)
Stomach	151	188	1.03	(0.89-1.19)
Colon	153	350	0.90	(0.81-1.00)
Rectum	154	175	0.86	(0.74-1.00)
Primary liver and biliary passages	155	152	0.91	(0.77-1.07)
Pancreas	157	138	0.86	(0.72-1.02)
Trachea, bronchus, and lung	162	94	0.46	(0.37-0.57)
Breast	170	1,159	0.83	(0.78-0.88)
Cervix uteri	171	75	0.40	(0.31-0.50)
Corpus uteri	172	331	0.96	(0.86-1.06)
Uterus, part unspecified	174	42	1.08	(0.78-1.47)
Ovary, tube and broad ligament	175	323	0.91	(0.81-1.01)
Other genital organs (vagina and vulva)	176	49	1.13	(0.84-1.50)
Kidney	180	126	0.81	(0.68-0.97)
Urinary organs	181	70	0.57	(0.45-0.72)
Malignant melanoma of skin	190	127	0.90	(0.75-1.07)
Skin	191	87	0.96	(0.77-1.19)
Nervous system	193	189	1.05	(0.91-1.22)
Connective tissue or muscle	197	21	0.62	(0.39-0.95)
Non-Hodgkin's lymphoma	200 + 202	94	0.78	(0.63-0.96)
Hodgkin's disease	201	25	1.13	(0.73-1.67)
Multiple myeloma	203	73	1.09	(0.86-1.37)
Leukemia	204	112	0.92	(0.75-1.10)

[a] World Health Organization. *International Classification of Diseases, Seventh Revision.* Geneva, Switzerland: WHO, 1957.

[a] Region 1: Kristianstad and Malmöhus counties.
Region 2: Kronoberg, Kalmar, Gotland, Blekinge, Halland, and Göteborg & Bohus counties.
Region 3: Östergötland, Jönköping, Älvsborg, and Skaraborg counties.
Region 4: Stockholm, Uppsala, Södermanland, Örebro, and Västmanland counties.
Region 5: Värmland, Kopparberg, and Gävleborg counties.
Region 6: Västernorrland, Jämtland, Västerbotten, and Norrbotten counties.

Table 2. Standardized incidence ratio (SIR) and observed number of cases (Obs) by time period in the cohort of female agricultural workers for selected cancer diagnoses, Sweden

Tumor site	ICD-7 code[a]	Time period							
		1971-75		1976-80		1981-84		1985-87	
		SIR	(Obs)	SIR	(Obs)	SIR	(Obs)	SIR	(Obs)
All sites	140-204	0.86	(988)	0.84	(1,249)	0.86	(1,221)	0.84	(1,016)
Stomach	151	0.90	(37)	1.09	(57)	1.16	(58)	0.92	(36)
Colon	153	0.80	(58)	0.87	(91)	0.91	(102)	0.98	(99)
Rectum	154	0.91	(34)	0.87	(47)	0.77	(46)	0.93	(48)
Primary liver and biliary passages	155	1.00	(28)	0.78	(37)	1.02	(50)	0.87	(37)
Pancreas	157	1.21	(34)	0.94	(40)	0.77	(37)	0.64	(27)
Trachea, bronchus and lung	162	0.38	(12)	0.49	(25)	0.37	(23)	0.59	(34)
Breast	170	0.85	(272)	0.80	(329)	0.83	(302)	0.85	(256)
Cervix uteri	171	0.46	(32)	0.31	(17)	0.58	(220)	0.16	(4)
Corpus uteri	172	1.04	(87)	0.91	(96)	0.83	(74)	1.08	(74)
Uterus, part unspecified	174	1.14	(12)	1.28	(14)	0.72	(7)	1.18	(9)
Ovary, tube and broad ligament	175	0.86	(80)	0.95	(99)	1.05	(95)	0.71	(49)
Other genital organs (vagina and vulva)	176	1.25	(11)	1.43	(16)	1.32	(17)	0.48	(5)
Kidney	180	0.95	(31)	0.81	(35)	0.74	(32)	0.77	(28)
Urinary organs	181	0.51	(12)	0.64	(21)	0.65	(22)	0.47	(15)
Malignant melanoma of skin	190	1.10	(31)	0.84	(35)	0.82	(31)	0.89	(30)
Skin	191	1.04	(13)	1.01	(20)	1.05	(28)	0.83	(26)
Nervous system	193	1.05	(43)	1.02	(51)	1.09	(52)	1.06	(43)
Connective tissue or muscle	197	0.39	(3)	0.75	(7)	0.83	(7)	0.47	(4)
Non-Hodgkin's lymphoma	200+202	0.64	(13)	0.80	(24)	0.90	(30)	0.81	(27)
Hodgkin's disease	201	1.03	(7)	1.36	(9)	1.61	(8)	0.27	(1)
Multiple myeloma	203	1.44	(20)	1.08	(19)	1.16	(22)	0.73	(12)

[a] World Health Organization. *International Classification of Diseases, Seventh Revision.* Geneva, Switzerland: WHO, 1957.

Discussion

The main aim of this study was to analyze cancer risks among Swedish female farmers, with special emphasis on breast cancer and cancer in female genital organs but also malignant lymphomas and STS. The approach was to use a cohort study in which the cohort was defined on the basis of the economic activity code in the 1970 census and by follow-up in the Cancer-Environment Register. Once the cohort had been defined, no more persons were included.

The data concerning economic activity apply to the particular week during which the census was taken. In order to obtain a person's whole occupational history, other sources must be consulted. There are considerable differences among individuals with the same occupation regarding exposure to a particular agent. The number of women that have been included incorrectly in the cohort of female farmers was estimated to be 12.5 percent (personal communication with National Central Bureau of Statistics, Sweden). The proportion of incorrectly-excluded female farmers is estimated to be 28 percent (personal communication with National Central Bureau of Statistics, Sweden). The implication of all these circumstances, despite an increased risk, is that the SIR inclines towards unity.

The Swedish female agricultural-workers have RRs which are below one for all tumor sites together and for many individual sites. Underdiagnosis or undernotifying of cancer might be one of the reasons for a false low risk among agricultural workers. Underreporting and undernotification to the Swedish Cancer Register is estimated at less than one percent.[31] No studies have been performed in farmers regarding this issue. However, agricultural workers have less contact with the health services, which means a greater chance of some tumor remaining undiscovered.[32]

Smoking has been considered for a long time to be the major determinant of cancer. However, epidemiologic studies have indicated that risks associated with dietary factors could be as important as smoking habits for human cancer.[33-34]

Agricultural workers smoke less than the population in general. In a mail survey on smoking habits in Sweden in 1963, 18 percent of females working in agriculture, forestry, or fishing, smoked tobacco daily compared with 27 percent in other occupational groups, and the daily quota of tobacco was lower among female farmers.[35] In 1980, the corresponding

Table 3. Standardized incidence ratio (SIR) and observed number of cases (Obs) by year of birth in the cohort of female agricultural workers for selected cancer diagnoses, Sweden

Tumor site	ICD-7 code[a]	Year of birth									
		to 1904		1905-1914		1915-1924		1925-1934		1935+	
		SIR	(Obs)	SIR	(Obs)	SIR	(Obs)	SIR	(Obs)	SIR	(Obs)
All sites	140-205	0.90	(408)	0.87	(1,584)	0.82	(1,543)	0.87	(741)	0.82	(197)
Stomach	151	1.16	(33)	1.10	(87)	0.88	(46)	1.08	(19)	0.72	(3)
Colon	153	0.97	(47)	0.91	(149)	0.90	(114)	0.78	(32)	0.92	(8)
Rectum	154	1.00	(22)	0.84	(67)	0.80	(57)	0.88	(21)	1.71	(8)
Primary liver and biliary passages	155	1.01	(24)	0.93	(69)	0.84	(42)	0.83	(13)	1.45	(4)
Trachea, bronchus and lung	162	0.49	(7)	0.50	(35)	0.40	(32)	0.75	(14)	0.87	(6)
Breast	170	0.83	(76)	0.85	(363)	0.82	(412)	0.86	(245)	0.77	(63)
Cervix uteri	171	0.51	(4)	0.40	(20)	0.43	(30)	0.38	(15)	0.27	(6)
Corpus uteri	172	0.79	(14)	0.91	(88)	0.93	(143)	1.13	(78)	0.94	(8)
Uterus, part unspecified	174	0.86	(2)	1.32	(14)	1.01	(15)	0.90	(8)	1.60	(3)
Ovary, tube and broad ligament	175	0.87	(17)	0.94	(99)	0.87	(126)	0.84	(59)	1.22	(22)
Other genital organs (vagina and vulva)	176	1.46	(8)	0.97	(17)	1.47	(20)	0.60	(3)	0.75	(1)
Kidney	180	0.55	(8)	0.85	(51)	0.79	(45)	0.83	(16)	1.79	(6)
Urinary organs	181	0.81	(11)	0.42	(22)	0.57	(24)	0.77	(9)	1.76	(4)
Malignant melanoma of skin	190	1.35	(9)	0.91	(32)	0.97	(49)	0.81	(26)	0.66	(11)
Skin	191	1.14	(18)	1.04	(41)	0.91	(23)	0.39	(3)	1.08	(2)
Nervous system	193	1.39	(15)	0.93	(51)	0.97	(65)	1.39	(48)	0.85	(10)
Connective tissue or muscle	197	0.72	(2)	0.68	(8)	0.53	(6)	0.53	(3)	0.97	(2)
Non-Hodgkin's lymphoma	200+202	0.46	(5)	0.86	(39)	0.89	(36)	0.47	(7)	1.37	(7)
Hodgkin's disease	201	1.42	(3)	1.03	(8)	1.14	(8)	1.33	(4)	0.93	(2)
Multiple myeloma	203	1.06	(8)	1.17	(35)	1.09	(24)	0.98	(6)	0	(0)[b]

[a] World Health Organization. *International Classification of Diseases, Seventh Revision.* Geneva, Switzerland: WHO, 1957.
[b] Expected 0.90.

figures were five percent *cf* 27 percent, and, in 1989, six percent and 26 percent, respectively.[36] Differences in smoking habits between female farmers and the population in general are more pronounced than among males. Assuming that 10 percent of female farmers are smokers and 25 percent in the reference group, and that the RR of a smoker for a specific cancer site is three, then the SIR would be around 0.80.

As seen in Table 5, farming households have, on average, relatively higher expenditures on fat, meat, eggs, dairy products, and sugar, and lower consumption of fish, fruit, and vegetables. Farming households have considerably lower expenditures on tobacco and alcohol.[7,30]

Breast cancer

Associations have been found between increased risk of breast cancer and early menarche and late menopause, low parity, older age at first birth, a diet high in fat, and obesity. A relation between high intake of fat and increased breast-cancer incidence among rats was shown as early as the 1940s.[37] International correlation studies have shown that a high intake of fat is associated with a higher mortality from breast cancer.[38] However, recent studies suggest no association or even an inverse relation between absolute fat intake and risk of postmenopausal breast cancer.[39] Persons with a high milk intake or low intake of meat and meat products have a lower risk of breast cancer.[40] The energy intake was lower among women who later developed breast cancer, a finding which is consistent with some studies[41-42] but not others.[43-45] It has been suggested that a high content of vitamin A in dairy products may account for a decreased risk of breast cancer.[46] Despite higher consumption of fat, female farmers have a decreased risk of breast cancer. This could be because female farmers were, on average, about one year younger than other women when they gave birth to their first child (personal communication with Anders Ericson, Medical Birth Register). They also could be protected by

Table 4. Standardized incidence ratio (SIR) and observed number of cases (Obs) by region in the cohort of female agricultural workers for selected cancer diagnoses, Sweden

Tumor site	ICD-7 code[a]	Region[b]											
		1		2		3		4		5		6	
		SIR	(Obs)	SIR	(Obs)	SIR	(Obs)	SIR	(Obs)	SIR	(Obs)	SIR	(Obs)
All sites	140-205	0.88	(769)	0.83	(1,023)	0.89	(1,032)	0.80	(538)	0.85	(481)	0.83	(631)
Stomach	151	1.00	(29)	0.79	(34)	1.16	(47)	0.79	(30)	1.02	(21)	1.05	(27)
Colon	153	0.97	(61)	1.01	(93)	0.95	(82)	0.78	(38)	0.90	(39)	0.66	(37)
Rectum	154	1.10	(36)	1.05	(50)	0.67	(30)	0.55	(14)	0.77	(17)	0.96	(28)
Primary liver and biliary passages	155	0.75	(20)	0.86	(34)	1.00	(37)	0.96	(20)	0.86	(16)	1.06	(25)
Trachea, bronchus and lung	162	0.39	(13)	0.44	(21)	0.54	(24)	0.58	(15)	0.37	(8)	0.44	(13)
Breast	170	0.72	(168)	0.78	(256)	0.91	(279)	0.78	(141)	0.88	(129)	0.92	(186)
Cervix uteri	171	0.31	(10)	0.36	(16)	0.27	(11)	0.79	(19)	0.21	(4)	0.55	(15)
Corpus, uteri	172	1.07	(62)	0.92	(74)	1.05	(79)	0.87	(39)	0.94	(34)	0.84	(43)
Uterus, part unspecified	174	0.46	(3)	1.77	(16)	1.07	(9)	0.60	(3)	0.74	(3)	1.42	(8)
Ovary, tube and broad ligament	175	1.09	(65)	1.03	(85)	0.93	(72)	0.76	(35)	0.72	(27)	0.75	(39)
Other genital organs (vagina and vulva)	176	1.00	(7)	0.88	(9)	1.25	(12)	0.92	(5)	2.31	(11)	0.81	(5)
Kidney	180	0.87	(22)	0.66	(24)	1.03	(35)	0.82	(16)	0.59	(10)	0.85	(19)
Urinary organs	181	0.46	(9)	0.73	(21)	0.70	(19)	0.52	(8)	0.30	(4)	0.51	(9)
Malignant melanoma	190	1.45	(35)	1.06	(35)	0.81	(25)	0.43	(8)	1.11	(16)	0.39	(8)
Skin	191	1.11	(16)	1.02	(22)	0.94	(19)	0.89	(10)	1.27	(13)	0.56	(7)
Nervous system	193	1.43	(43)	0.81	(34)	1.00	(39)	1.12	(26)	1.28	(24)	0.99	(23)
Connective tissue or muscle	197	0.72	(4)	0.25	(2)	0.94	(7)	0.69	(3)	1.11	(4)	0.21	(1)
Non-Hodgkin's lymphoma	200+202	1.25	(24)	0.62	(17)	0.79	(20)	0.74	(11)	0.63	(8)	0.83	(14)
Hodgkin's disease	201	1.09	(4)	1.41	(8)	0.82	(4)	0	(0)[c]	0.84	(2)	2.30	(7)
Multiple myeloma	203	1.58	(17)	1.09	(17)	0.95	(14)	0.84	(7)	0.95	(7)	1.15	(11)

[a] World Health Organization. *International Classification of Diseases, Seventh Revision.* Geneva, Switzerland: WHO, 1957.
[b] See text.
[c] Expected 2.8.

their higher intake of milk or other dairy products. Physical activity and alcohol may contribute to the lower risk for breast cancer. We have no data on age at menarche and menopause or height in relation to weight, neither do we have any data on lactation periods, to estimate the magnitude of the other known risk-factors for breast cancer.

Cancer of the cervix uteri

The significantly decreased SIR for cancer of the cervix uteri may be due to more regular sexual habits, mostly with one partner throughout life. More favorable smoking habits are also an explanation for the low risk, since smoking is considered to be a risk factor for this type of cancer.[47]

Malignant lymphomas and soft tissue sarcomas

Elevated risks of malignant lymphomas and STS after exposure to phenoxy acid herbicides or chlorophenols have been reported in studies based on Swedish materials. In the present study, the SIR for NHL was highest in the youngest birth cohort and in Region 1, where, on average, the use of pesticide was thought to have been highest. This gives some support to earlier findings. The SIR for Hodgkin's disease (HD), in contrast, was highest in the oldest birth cohort and in Region 6, where the use of pesticides was assumed to be lowest. The farms in the northern parts of the country are smaller and there are more farms with animals. As a matter of curiosity, the dwelling house and cowhouse were, and often still are, the same building and animal exposure thereby could be more intense. A plausible explanation to the elevated SIR for HD of 1.13 thus could be exposure to animals.[49]

Cancer in respiratory organs

The lowest risk of cancer among female farmers was found for cancer in respiratory organs and the risk did not change with time. Nor were there any differences in RR among geographic areas or among birth cohorts.

Table 5. Ratio of expenditure per consumption unit on foodstuffs, alcoholic beverages, and tobacco between farming households and all households in Sweden according to the national consumption surveys in 1958, 1978, and 1989

Foodstuff	Ratio		
	1958	1978	1989
Total	0.92	1.01	0.85
Flour, cereals, bread	1.24	0.90	0.92
Crisp bread	—	—	1.38
Soft dark bread	—	—	0.81
Soft light bread	—	—	0.71
Milk, cheese	1.40	1.09	1.15
Milk (3% fat)	—	—	2.91
Butter, other fats	1.17	1.23	1.30
Butter	—	—	2.28
Eggs	1.41	1.32	1.11
Meat	1.17	1.09	1.09
Fish	0.96	1.02	0.79
Potatoes[a]	1.51	1.46	1.36
French fries	—	—	0.48
Fruit	0.75	0.77	0.95
Vegetables	0.45	0.63	0.63
Sugar	1.47	1.73	1.83
Alcoholic beverages[b]	0.40	0.38	0.38
Tobacco[b]	0.49	0.45	0.35

[a] The 1989 figure refers to fresh potatoes.
[b] In adults.

If the difference in smoking habits in 1963 is taken into account by Axelson's method,[49] the RR comes to about 0.75. Thus, differences in smoking habits cannot explain all of the under-risk. Physical activity also may play a role in the origin of lung cancer.

Colorectal cancers

Decreased SIRs were found for colon and rectum cancer. These sites are considered to be diet-associated.[50] A high-fat diet has been considered to increase the risk of colon cancer.[51,52] The contradictory result in this study possibly can be explained by the protective effect of agricultural workers' greater physical activity[53-54] or by agricultural workers for some reason being at lower risk regarding initiating agents.

Multiple myeloma

Multiple myeloma is of B-lymphocyte origin, closely related to malignant lymphomas. Ionizing radiation, farming, domestic animals, gases and fumes, chemicals, pesticides, plastic compounds, formaldehyde, hair dyes, fresh wood, petroleum products, smoking and chronic immune stimulation are considered to be risk factors.[21,55-60] Elevated risk of multiple myeloma among farmers has been found in several studies.[9,21,60-68] In the present study, the SIR was not increased significantly and some other recent epidemiologic studies have not found any association between farming and multiple myeloma.[56,69-70]

Cancer in urinary organs and kidney

The main explanation for the low risk of cancer in urinary organs may be more favorable smoking habits. A newly performed study[71] reconfirms the excess of bladder cancer associated with cigarette smoking and the dose-response relation between the RR of bladder cancer and the number of cigarettes smoked per day. This is consistent with previous reports.[72-74] We have no explanation for the low SIR for kidney cancer.

In conclusion, this study shows that female farmers have a low relative risk of cancer, especially for cancers associated with smoking. Notable is the low risk of cancer of the cervix uteri, lung, and urinary organs. The SIR for cancer in other genital organs was close to one. Despite a high intake of fat, the incidence of breast cancer is about 15 percent less than expected. The study gives some support to the earlier findings of an association between NHL and exposure to pesticides.

References

1. International Agency for Research on Cancer. *Chemicals, Industrial Processes and Industries Associated with Cancer in Humans.* Lyon, France: International Agency for Research on Cancer, 1982; *IARC Monogr Eval Carcinog Risk Chem Humans* Suppl.4.
2. International Agency for Research on Cancer. *Some Halogenated Hydrocarbons and Pesticide Exposures.* Lyon, France: International Agency for Research on Cancer, 1986; *IARC Monogr Eval Carcinog Risk Chem Humans*, Vol. 41.
3. Dutkiewicz J, Jablonski L, Olenchock S. Occupational biohazards: A review. *Am J Ind Med* 1988; **14:** 605-23.
4. Wiklund K. Swedish agricultural workers. A group with a decreased risk of cancer. *Cancer* 1983; **51:** 566-8.
5. Blair A, Malker H, Cantor KP, Burmeister L, Wiklund K. Cancer among farmers: A review. *Scand J Work Environ Health* 1985; **11:** 397-407.
6. Wiklund K, Holm L-E. Soft-tissue sarcoma risk in Swedish agricultural and forestry workers. *JNCI* 1986; **76:** 229-34.
7. Wiklund K. Cancer risks among agricultural workers in Sweden. Cohort studies based on the Swedish Cancer-Environment Register. Doctoral thesis, Karolinska Institute (Stockholm, Sweden), 1986.
8. Steineck G, Wiklund K. Multiple myeloma in Swedish agricultural workers. *Int J Epidemiol* 1986; **15:** 321-5.
9. Wiklund K, Holm L-E. Trends in cancer risk in 1961-1979 among Swedish agricultural workers. *JNCI* 1986; **77:** 657-64.
10. Wiklund K, Dich J, Holm L-E. Testicular cancer among agricultural workers and pesticide applicators in Sweden. *Scand J Work Environ Health* 1986; **12:** 630-1.
11. Wiklund K, Lindefors B-M, Holm L-E. Risk of malig-

nant lymphoma in Swedish agricultural and forestry workers. *Br J Ind Med* 1988; **45:** 19-24.
12. Wiklund K, Steineck G. Cancer in respiratory organs among Swedish agricultural workers. *Cancer* 1988; **61:** 1055-8.
13. Wiklund K, Dich J, Holm L-E. Risk of malignant lymphoma in Swedish pesticide appliers. *Br J Cancer* 1987; **56:** 505-8.
14. Wiklund K, Dich J, Holm L-E, Eklund G. Risk of tumors in the nervous system among mercury and other seed disinfectant applicators. *Acta Oncologica* 1988; **27:** 865.
15. Wiklund K, Dich J, Holm L-E. Soft tissue sarcoma in Swedish licensed pesticide applicators. *J Occup Med* 1988; **30:** 801-4.
16. Wiklund K, Dich J, Holm L-E, Eklund G. Risk of cancer in pesticide applicators in Swedish agriculture. *Br J Ind Med* 1989; **46:** 809-14.
17. Hardell L, Sandström A. Case-control study: soft tissue sarcomas and exposure to phenoxyacetic acids or chlorophenols. *Br J Cancer* 1979; **39:** 711-7.
18. Eriksson M, Hardell L, Berg NO, Möller T, Axelson O. Soft tissue sarcomas and exposure to chemicals substances. A case-referent study. *Br J Ind Med* 1981; **38:** 27-33.
19. Hardell L, Eriksson M, Lenner P, Lundgren E. Malignant lymphoma and exposure to chemicals, especially organic solvents, chlorophenols and phenoxy acids: a case-control study. *Br J Cancer* 1981; **43:** 169-76.
20. Hardell L, Eriksson M. The association between soft tissue sarcomas and exposure to phenoxyacetic acids. A new case-referent study. *Cancer* 1988; **62:** 652-6.
21. Blair A, Hoar Zahm S. Cancer among farmers. *Occup Med* 1991; **6:** 335-54.
22. Sharp D, Eskenazi B, Harrison R, Callas P, Smith AH. Delayed health hazards of pesticide exposure. *Ann Rev Public Health* 1986; **7:** 441-71.
23. Sterling TD, Arundel AV. Health effects of phenoxy herbicides. *Scand J Work Environ Health* 1986; **12:** 161-73.
24. Bond GG, Bodner KM, Cook RR. Phenoxy herbicides and cancer: insufficient epidemiologic evidence for a causal relationship. *Fundam Appl Toxicol* 1989; **12:** 172-88.
25. Kato I, Tominaga S, Ikari A. An epidemiological study on occupation and cancer risk. *Jpn J Clin Oncol* 1990; **20:** 121-7.
26. Blair A, Dosemeci M, Heineman EF. Cancer and other causes of death among male and female farmers from twenty-three states. *Am J Ind Med* 1993; **23:** 729-42.
27. National Central Bureau of Statistics. *The Natural Environment in Figures. Third Edition; Official Statistics Sweden.* Stockholm, Sweden: Statistics Sweden, 1990. (In Swedish, figures and tables in English.)
28. Bäckström J. The phenoxy acid problem in Sweden. In: Chlorinated phenoxy acids and their dioxins. *Ecol Bull NFR (Naturvetenskapliga forskningsrådet)* 1978; **27:** 108-21.
29. Dich J, Wiklund K. The use of phenoxy acid herbicides in Sweden. *Chemosphere* 1989; **18:** 391-4.
30. National Central Bureau of Statistics. *The Family Food Expenditure Survey 1989.* Stockholm, Sweden: Statistics Sweden, 1991.
31. Mattsson B. Cancer registration in Sweden. Studies on completeness and validity of incidence and mortality registers. (Stockholm, Sweden), 1984. Doctoral thesis, Karolinska Institute.
32. Den jämlika sjukvården. *Hälso- och sjukvård inför 90-talet.* Stockholm, Sweden: Allmänna förlaget, 1984. (SOU 1984: 41) (In Swedish.)
33. Doll R, Peto R. The causes of cancer: Quantitative estimates of avoidable risk of cancer in the United States today. *JNCI* 1981; **66:** 1191-308.
34. Cancerkommitten. Cancer. Orsaker, förebyggande mm. Betänkande av cancerkommitten. Stockholm, Sweden: Statens Offentliga utredningar, 1984. (SOU 1984: 67) (Summary in English.)
35. National Central Bureau of Statistics. *Smoking Habits in Sweden. A Mail Survey—Spring 1963.* Stockholm, Sweden: NCBS, 1965.
36. National Central Bureau of Statistics. *Living Conditions. Report no. 76. Health and Medical Care 1980-1989.* Stockholm, Sweden: Statistics Sweden, 1992. (In Swedish.)
37. Tannenbaum A. The genesis and growth of tumors. III Effects of a high-fat diet. *Cancer Res* 1942; **2:** 468-75.
38. Armstrong B, Doll R. Environmental factors and cancer incidence and mortality in different countries with special reference to dietary practices. *Int J Cancer* 1975; **15:** 617-31.
39. Graham S, Hellman R, Marshall J, *et al.* Nutritional epidemiology of postmenopausal breast cancer in Western New York. *Am J Epidemiol* 1991; **134:** 552-66.
40. Knekt P, Albanes D, Seppänen R, *et al.* Dietary fat and risk of breast cancer. *Am J Clin Nutr* 1990; **52:** 903-8.
41. Katsouyanni K, Willett W, Trichopoulos D, *et al.* Risk of breast cancer among Greek women in relation to nutrient intake. *Cancer* 1988; **61:** 181-5.
42. Jones DY, Schatzkin A, Green SB, *et al.* Dietary fat and breast cancer in the national health and nutrition examination survey epidemiologic follow-up study. *JNCI* 1987; **79:** 465-71.
43. Miller AB, Kelly A, Choi NW, *et al.* A study of diet and breast cancer. *Am J Epidemiol* 1978; **107:** 499-509.
44. Rohan TE, McMichael AJ, Baghurst PA. A population-based case-control study of diet and breast cancer in Australia. *Am J Epidemiol* 1988; **128:** 478-89.
45. Willett WC, Stampfer MJ, Colditz GA, Hennekens CH, Speizer FE, Dietary fat and the risk of breast cancer. *N Engl J Med* 1987; **316:** 22-8.
46. Kato I, Miura S, Kasumi F, *et al.* A case-control study of breast cancer among Japanese women: with special reference to family history and reproductive and dietary factors. *Breast Cancer Res Treat* 1992; **24:** 51-9.
47. Hellberg D. On some possible etiological factors of cervix and penis cancer. With special reference to smoking, sexual behavior and contraception. Doctoral thesis, University of Uppsala (Sweden), 1987.
48. Burmeister LF. Cancer in Iowa farmers. Recent results. *Am J Ind Med* 1990; **18:** 295-301.
49. Axelson O. Aspects on confounding in occupational health epidemiology. *Scand J Work Environ Health* 1978; **4:** 98-102.
50. Willett WC, Stampfer MJ, Colditz GA, Rosner BA, Speizer FE. Relation of meat, fat, and fiber intake to the risk of colon cancer in a prospective study among women. *N Engl J Med* 1990; **323:** 1664-72.
51. McKeown-Eyssen GE, Bright-See E. Dietary factors in

colon cancer: International relationships. *Nutr Cancer* 1984; **6:** 160-70.
52. Newmark HL, Wargovich MJ, Bruce WR. Colon cancer and dietary fat, phosphate, and calcium: A hypothesis. *JNCI* 1984; **72:** 1323-5.
53. Garabrant DH, Peters JM, Mack TM, Bernstein L. Job activity and colon cancer risk. *Am J Epidemiol* 1984; **119:** 1005-14.
54. Gerhardsson de Verdier M. Epidemiologic studies on colorectal cancer. Doctoral thesis, Karolinska Institute (Stockholm, Sweden), 1990.
55. Cuzick J. Radiation-induced myelomatosis. *N Engl J Med* 1981; **304:** 204-10.
56. Linet MS, Harlow SD, McLaughlin JK. A case-control study of multiple myeloma in whites: Chronic antigenetic stimulation, occupation and drug use. *Cancer Res* 1987; **47:** 2978-81.
57. Flodin U, Fredriksson M, Persson B. Multiple myeloma and engine exhausts, fresh wood, and DDT: a case-referent study. *Br J Cancer* 1983; **48:** 853-7.
58. Symmons DPM. Neoplasia in rheumatoid arthritis (Editorial). *J Rheumatol* 1988; **15:** 1319-22.
59. Eriksson M. Epidemiological studies on multiple myeloma. Doctoral thesis, University of Umeå (Sweden), 1992.
60. Eriksson M, Karlsson M. Occupational and other environmental factors and multiple myeloma: a population based case-control study. *Br J Ind Med* 1992; **49:** 95-103.
61. Burmeister LF, Everett GD, Van Lier SF, Isacson P. Selected cancer mortality and farm practices in Iowa. *Am J Epidemiol* 1983; **118:** 72-7.
62. Milham S. Leukemia and multiple myeloma in farmers. *Am J Epidemiol* 1971; **94:** 307-10.
63. Cantor KP, Blair A. Farming and mortality from multiple myeloma: A case-control study with the use of death certificates. *JNCI* 1984; **72:** 251-5.
64. Gallagher RP, Spinelli JJ, Elwood JM, Skippen DH. Allergies and agricultural exposure as risk factors for multiple myeloma. *Br J Cancer* 1983; **48:** 853-7.
65. Pearce NE, Smith AH, Howard JK, Sheppard RA, Giles HJ, Teague CA. Case-control study of multiple myeloma and farming. *Br J Cancer* 1986; **54:** 493-500.
66. La Vecchia C, Negri E, D'Avanzo B, Francheschi S. Occupation and lymphoid neoplasms. *Br J Cancer* 1989; **60:** 385-8.
67. Bofetta P, Stellman SD, Garfinkel L. A case-control study of multiple myeloma nested in the American Cancer Society prospective study. *Int J Cancer* 1989; **43:** 554-9.
68. Pottern LM, Heineman EF, Olsen JH, Raffn E, Blair A. Multiple myeloma among Danish women: employment history and workplace exposures. *Cancer Causes Control* 1992; **3:** 427-32.
69. Brownson RC, Reif JS. A cancer registry-based study of occupational risk for lymphoma, multiple myeloma and leukemia. *Int J Epidemiol* 1988; **17:** 27-32.
70. Heineman EF, Olsen JH, Pottern LM, Gomez M, Raffn E, Blair A. Occupational risk factors for multiple myeloma among Danish men. *Cancer Causes Control* 1992; **3:** 555-68.
71. Anton-Culver H, Lee-Feldstein A, Taylor TH. Occupation and bladder cancer risk. *Am J Epidemiol* 1992; **136:** 89-94.
72. Claude J, Kunze E, Frenzel-Beyme R, Paczkowski K, Schneider J, Schubert H. Life-style and occupational risk factor in cancer of the lower urinary tract. *Am J Epidemiol* 1986; **124:** 578-89.
73. Augustine A, Hebert JR, Kabat GC, Wynder EL. Bladder cancer in relation to cigarette smoking. *Cancer Res* 1988; **48:** 4405-8.
74. Clavel J, Cordier S, Boccon-Gibod L, Hemon D. Tobacco and bladder cancer in males: increased risk for inhalers and smokers of black tobacco. *Int J Cancer* 1989; **44:** 605-10.