Level of Education and the Risk of Cancer in Sweden[1]

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Abstract

It is well known that certain cancers have shown clustering in educational and socioeconomic groups, but recent comprehensive data on clustering by education are limited. We determined standardized incidence ratios (SIRs), adjusted for several variables, for cancer among men and women in six educational groups based on the Swedish Family-Cancer Database. People were identified with a certain educational background in the census of year 1970; the comparison group was the largest group, those with <9 years of education. Cancers were followed from years 1971 to 1998. Total cancer risks did not differ much, but at individual sites, the trend was significant, either increasing or decreasing over all educational groups (for 27 of 29 male and 28 of 31 female cancers). University graduates had a decreased risk of tobacco-, alcohol-, and genital infection-related cancers, but male graduates had an excess of colon, prostate, squamous cell skin, nervous system cancer, and melanoma. Male graduates showed a low SIR of 0.50 for stomach cancer and a high SIR of 1.89 for melanoma; female graduates showed a low SIR of 0.43 for lung and cervical cancer and a high SIR of 1.57 for melanoma. The overall weighted population attributable fraction for educational level was 13.8% for men and 16.7% for women, and it was highest, >50%, for stomach cancer in both genders and for cervical and anal cancer in women.

Introduction

Educational level may influence the risk of cancer in many ways. Education is an important attribute guiding the selection of occupation. This, in turn, is a predictive factor for disposable income and many socioeconomic aspects of life, including residential and lifestyle factors. Health-contentious behavior, seeking and affordability of healthy food and participation in health promotional and screening programs, relates to education and socioeconomic factors. Access to and use of healthcare services may help to identify and remove tumors at an early stage before they have become cancers. For a more extensive discussion on social class difference in disease, the reader is referred to reviews on the topic (1, 2). There is ample literature from many developed countries that show consistent patterns of socioeconomic correlates in cancer (3, 4). Lung, stomach, esophageal, and upper aerodigestive tract cancer have been typically more common in deprived social groups, whereas breast and colorectal cancer have had the opposite socioeconomic gradient. The differences have been observed also in comparisons of cancer risks by education level (5–8). Sweden, as in most Western European countries, has a covering healthcare system, which collects only nominal charges from its users. However, socioeconomic differences have been reported in Sweden for many types of cancer, which are probably mainly because of factors other than the healthcare system (9). Occupational studies on cancer can focus on specific educational backgrounds. A large Nordic study on occupational cancer risks showed that university-educated men with natural science orientation and male physicians experienced a reduced risk of cancer overall but an increased risk at lifestyle-related sites such as colon, prostate, and skin (both melanoma and nonmelanoma skin) cancer (10). The overall cancer risk was increased in the corresponding groups of women, for which breast cancer was the main contributor; however, the data were not corrected for the reproductive history, which is likely to explain at least some of the noted increase.

Because of the limited recent data on cancer risks by educational level, we carried out a follow-up study on men and women for whom an educational level was recorded in the national census of 1970. The analysis was based on the latest update of the Swedish Family-Cancer Database covering 10.2 million people. We hypothesize that educational level influences the risk cancer largely in a similar way as socioeconomic status according to previous studies. PAFs[3] are calculated as a measure of the proportion of cancer that can be ascribed to educational factors.

Materials and Methods

The 2000 update of the nationwide Swedish Family-Cancer Database, covering over 10.2 million individuals and 0.76 million invasive cancers, was used to calculate site-specific cancer risks among men and women (11). The Database included cancer data from the nationwide Swedish Cancer Registry from years 1961 to 1998 (12). The analyses covered all men and women in the Family-Cancer Database, for whom information on a completed education was available in the national census of 1970 in one of the groups shown in Table 1.

The Swedish Cancer Registry is currently using the ICD-O-2/ICD-10 diagnostic coding system but for comparability with the earlier years all codes are translated to the ICD-7

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[3] The abbreviations used are: PAF, population attributable proportion; ICD, International Classification of Diseases; SIR, standardized incidence ratio; CI, confidence interval.

Table 1 Population and cases in male and female educational groups

Education	Men			Women		
	Population	Person-years	Cases	Population	Person-years	Cases
Less than 9 years	843,530	21,205,139	122,771	909,615	23,714,365	135,945
9 years	275,464	7,616,729	12,907	349,815	9,631,969	27,685
10–11 years	382,542	10,166,507	38,484	422,048	11,520,232	42,735
12 years	292,865	7,896,530	25,159	122,130	3,342,114	8,786
College < 3 years	49,956	1,319,173	6258	61,314	1,666,168	6,716
University graduate	93,015	2,450,640	11,234	63,848	1,740,773	6,971
Doctorate	7219	185,245	1054	832	21,794	119
All	1,944,591	50,839,963	217,867	1,929,602	51,637,415	228,957

codes. The following ICD-7 codes were pooled: upper aerodigestive cancer (larynx, lip, mouth, and pharynx) and leukemia (leukemia, polycythemia vera, and myelofibrosis). Rectal cancer was separated to anus and mucosal rectum. Skin cancer was squamous cell carcinoma because basal cell carcinoma of the skin has not been registered in the Cancer Registry. Follow-up was started January 1, 1970, and it was terminated on diagnosis of cancer, death, emigration, or the closing date of the study, December 31, 1998. All tumor incidence rates were based on the data in the Family-Cancer Database, and they are essentially similar to rates in the Swedish Cancer Registry. SIRs were calculated as the ratio of observed (O) to expected (E) number of cases. The expected numbers were calculated from 5-year-age-, sex-, tumor type-, 10-year period-, and region- (large cities, north and south Sweden) specific standard incidence rates for all men and women belonging to the largest educational group, <9 years of education, according to the census of year 1970. The data on residential region and socioeconomic status were obtained from a national census. For female cancers, additional adjustments were made for parity and age at first birth, both calculated from the Database (13). Some additional adjustments were done for socioeconomic status- (agriculture, manual workers, blue collar worker, professionals, self-employed, and other) specific standard incidence rates, but these results were not reported. Ninety-five percent confidence intervals were calculated assuming a Poisson distribution (14). Consistency of findings was tested by the χ^2-based trend test over all educational groups. PAFs were calculated for all cancer sites based on age-adjusted incidence rates using the formula: $(It - Io) / It$, where *It* was the age-adjusted incidence for all men or women with a defined education, and Io was the incidence for the least educated or the university educated, whichever was lower (15). *Io* was thus the incidence in the group lacking the risk factor for which education was an indicator. The given PAFs only consider the difference between the least and most educated groups. PAF for educational effect over all cancer was calculated from the PAF of all sites by weighting the number of cancers among all educational groups. Correlations between findings for men and women were tested by the Spearman test.

Results

Table 1 shows the study population in different educational groups as defined in the census of year 1970. Over 1.9 million men as well as women were recorded and the largest group, somewhat less than half of all, was those who had a minimal education, <9 years. The difference in male and female education was noted as a larger proportion of university graduates and, particularly doctorates, among men. In the subsequent analysis, we combined university graduate and doctorate because of the small number in the latter group. Men and women accumulated >50 million person-years at risk, and >200,000 cancers were diagnosed for each gender during the period.

SIRs for cancer were calculated for individuals in each of the six educational groups shown in Table 1 (combining university graduates and doctorates). However, because the results were either consistently increasing or decreasing or they remained unchanged by the educational group, we show data only for the least (<9 years) and most educated groups (university educated) and provide additionally results from a trend test across all educational groups as a test for consistency. The data were adjusted for age, period, and region. Table 2 shows SIRs for male cancer at 29 sites by the two educational groups, using the least educated as a reference, SIR of 1.00. The SIR for all cancer among university graduates was 0.93. University graduates had a significantly decreased risk of cancer at 9 sites: upper aerodigestive tract (0.60); esophageal (0.53); stomach (0.50); rectal (0.83); liver (0.68); pancreas (0.83); lung (0.47); kidney (0.79); and bladder (0.85) cancer. They had an increase risk at 7 sites: colon (1.11); breast (1.49); prostate (1.14); testis (1.44); nervous system (1.12) cancer; melanoma (1.89); and squamous cell skin cancer (1.47). A highly significant trend test showed the consistency of the findings across the six educational groups: in all, 27 of 29 trend tests were significant; only endocrine gland and bone tumors and myeloma did not show an educational level gradient. PAFs were calculated, based on the incidence rates, for the difference between the least and the most educated. PAFs with significant differences between the educational levels ranged from 51.2% of stomach and 38% of lung and testicular cancer to small values at sites such as the prostate and bladder. A weighted PAF overall cancer sites was 13.8%.

We adjusted the above data additionally for socioeconomic class in six categories (data not shown). The SIR for all cancer among the least educated did not change and that among university educated changed marginally. However, at individual sites, the changes were larger for the university-educated group: melanoma risk decreased from 1.89 to 1.58, which was the largest changes brought about by the additional adjustment.

Analysis by educational level was conducted for cancer at 31 female sites. The data were adjusted for the same variables as the male data of Table 2 and additionally for parity and age at first childbirth to allow comparison between groups with different obstetric histories. Although the SIR for all cancer was 0.99 among university graduates, as many as 16 sites showed a significant decrease, liver cancer with the lowest SIR of 0.41 and lung and cervical cancer with an SIR of 0.43. These were balanced by three sites that showed an excess: breast cancer, 1.37; melanoma, 1.57; and squamous cell skin cancer, 1.23. The trend test was significant for 28 of 31 of female cancer sites.

Table 2 SIR and trend for cancer in male educational groups[a]

Cancer site	Less than 9 years				University educated				Trend		PAF (%)
	Observed	SIR	95%	CI	Observed	SIR	95%	CI	χ^2	*P*	
Upper aerodigestive tract	4,546	1.00	0.97	1.03	334	**0.60**	**0.54**	**0.67**	752.41	**0.00**	28.1
Salivary gland	285	1.00	0.89	1.12	35	1.07	0.74	1.49	13.89	**0.00**	14.5
Esophagus	1,465	1.00	0.95	1.05	96	**0.53**	**0.43**	**0.65**	239.27	**0.00**	31.1
Stomach	6,227	1.00	0.98	1.03	310	**0.50**	**0.45**	**0.56**	1,012.93	**0.00**	51.2
Small intestine	625	1.00	0.92	1.08	77	1.11	0.88	1.39	4.01	0.05	0.2
Colon	8,337	1.00	0.98	1.02	966	**1.11**	**1.04**	**1.18**	20.59	**0.00**	3.9
Rectum	6,122	1.00	0.98	1.03	536	**0.83**	**0.76**	**0.91**	70.56	**0.00**	6.3
Anus	141	1.00	0.84	1.18	14	0.79	0.43	1.33	13.96	**0.00**	22.5
Liver	3,198	1.00	0.97	1.04	234	**0.68**	**0.59**	**0.77**	158.34	**0.00**	2.7
Pancreas	3,716	1.00	0.97	1.03	325	**0.83**	**0.74**	**0.92**	98.58	**0.00**	23.9
Lung	14,207	1.00	0.98	1.02	794	**0.47**	**0.44**	**0.50**	2,670.32	**0.00**	37.7
Breast	168	1.00	0.85	1.16	30	**1.49**	**1.01**	**2.14**	18.93	**0.00**	2.6
Prostate	29,152	1.00	0.99	1.01	3,256	**1.14**	**1.10**	**1.18**	266.96	**0.00**	3.3
Testis	649	1.00	0.92	1.08	124	**1.44**	**1.20**	**1.72**	349.72	**0.00**	38.6
Other male genitals	444	1.00	0.91	1.10	37	0.74	0.52	1.02	12.72	**0.00**	31.4
Kidney	4,871	1.00	0.97	1.03	416	**0.79**	**0.71**	**0.87**	36.69	**0.00**	17.9
Urinary bladder	8,999	1.00	0.98	1.02	845	**0.85**	**0.79**	**0.91**	12.65	**0.00**	0.1
Melanoma	3,713	1.00	0.97	1.03	886	**1.89**	**1.76**	**2.02**	2,047.73	**0.00**	15.4
Skin (squamous cell)	4,010	1.00	0.97	1.03	623	**1.47**	**1.35**	**1.59**	396.67	**0.00**	3.1
Eye	409	1.00	0.91	1.10	41	0.92	0.66	1.25	20.44	**0.00**	18.3
Nervous system	3,738	1.00	0.97	1.03	493	**1.12**	**1.03**	**1.23**	28.48	**0.00**	15.5
Thyroid gland	624	1.00	0.92	1.08	75	1.15	0.91	1.44	26.04	**0.00**	9.5
Endocrine gland	1,574	1.00	0.95	1.05	212	1.12	0.97	1.28	1.78	0.18	0.9
Bone	231	1.00	0.88	1.14	18	0.65	0.38	1.02	2.96	0.09	55.7
Connective tissue	853	1.00	0.93	1.07	102	1.08	0.88	1.31	6.24	**0.01**	2.0
Non-Hodgkin's lymphoma	4,370	1.00	0.97	1.03	499	1.00	0.92	1.09	7.89	**0.00**	3.1
Hodgkin's disease	691	1.00	0.93	1.08	75	0.96	0.76	1.20	35.85	**0.00**	28.4
Myeloma	2,019	1.00	0.96	1.04	182	0.89	0.76	1.03	2.10	0.15	15.3
Leukemia	3,757	1.00	0.97	1.03	393	0.96	0.87	1.06	18.92	**0.00**	9.6
All	119,141	1.00	0.99	1.01	12,028	**0.93**	**0.92**	**0.95**	329.41	**0.00**	13.8[b]

[a] Bold type: 95% CI does not include 1.00, $P < 0.05$.
[b] Weighted PAF of all sites.

PAFs for cancer at the stomach, anus, and cervix were >50%. The overall weighted PAF for educational level was 16.7%. When socioeconomic status was introduced as an additional adjustment variable (data not shown), SIRs changed to a limited extent. SIR for melanoma among university educated showed the largest change from 1.57 to 1.41 (Table 3).

We divided the follow-up period into two to examine time trends in risks between educational groups. In Table 4, data are shown for men. Changes at most sites were small, with a few exceptions: among university graduates, male breast cancer was increased only in the latter period, whereas for testicular cancer the trend was opposite. Bone tumors and Hodgkin's disease were decreased among university graduates only in the latter period, but the significance of this finding remains unclear because it was not reproduced among female graduates (data not shown). The changes among most female sites such as the breast were also small, and we do not tabulate the results. However, among university graduates, the SIR for cervical cancer was 0.33 ($n = 77$; 95% CI, 0.26–0.41) in years 1970–1984 and 0.61 ($n = 85$; 95% CI, 0.40–0.76) in years 1985–1998. A similar trend was observed for other genital cancer, with SIRs of 0.44 and 0.64, respectively. An opposite development was noted for lung cancer: female graduates had an SIR of 0.58 ($n = 39$; 95% CI, 0.41–0.79) in the first period and 0.40 ($n = 134$; 95% CI, 0.33–0.47) in second period.

Fig. 1 illustrates the uniformity of the findings between men and women for university graduates. All sites were shown that were significant in either gender. Stars above the bars indicate that the SIR was significant. Breast and skin cancer and melanoma were increased for both genders, and upper aerodigestive tract, gastric, liver, lung, kidney, and bladder cancer were decreased for both genders. Among the least educated, the SIR did not correlate between men and women (Spearman correlation coefficient 0.11, when SIRs were calculated by using the whole population as reference). However, SIR correlated among university graduates (Spearman correlation coefficient 0.57, $P = 0.003$).

Discussion

This study was based on the Swedish Family-Cancer Database, which has a practically complete coverage of the Swedish population (11). The cancer data originate from the Swedish Cancer Registry and the educational data from the national census of year 1970, conducted by Statistics Sweden. Census forms are individually filled in, and they may contain minor inaccuracies regarding educational level, and these would bias the present results toward null. However, although we cannot exclude the presence of such a bias, the results between men and women showed such consistent patterns that a large bias was unlikely, although female data were adjusted for parity and age at first birth, which may reduce the comparability between genders. Even if any bias between men and women were nonrandom, it is inconceivable that the high correlation between gender SIRs for tumors such as lung cancer and melanoma in Fig. 1 were because of bias: population differences in exposure to the relevant risk factors are well documented. The trend test was significant for 27 of 29 male and 28 of 31 of

Table 3 SIR and trend for cancer in women in educational groups[a]

Cancer site	Less than 9 years			University educated			Trend		PAF (%)
	Observed	SIR	95% CI	Observed	SIR	95% CI	χ^2	*P*	
Upper aerodigestive tract	1,424	1.00	0.95 1.05	54	**0.69**	**0.51 0.89**	23.51	**0.00**	27.7
Salivary gland	339	1.00	0.90 1.11	15	0.84	0.47 1.39	4.07	**0.04**	11.1
Esophagus	518	1.00	0.92 1.09	18	0.80	0.47 1.26	20.50	**0.00**	13.5
Stomach	3,736	1.00	0.97 1.03	85	**0.57**	**0.45 0.70**	495.94	**0.00**	52.8
Small intestine	547	1.00	0.92 1.09	24	0.90	0.57 1.34	0.26	0.61	11.7
Colon	9,984	1.00	0.98 1.02	370	**0.90**	**0.81 0.99**	102.07	**0.00**	11.9
Rectum	4,926	1.00	0.97 1.03	194	0.92	0.80 1.06	64.99	**0.00**	9.8
Anus	405	1.00	0.90 1.10	9	**0.41**	**0.18 0.77**	100.80	**0.00**	56.1
Liver	4,566	1.00	0.97 1.03	93	**0.52**	**0.42 0.64**	468.80	**0.00**	47.2
Pancreas	3,730	1.00	0.97 1.03	99	**0.64**	**0.52 0.78**	113.47	**0.00**	10.2
Lung	6,733	1.00	0.98 1.02	173	**0.43**	**0.37 0.50**	1,379.10	**0.00**	32.8
Breast	35,397	1.00	0.99 1.01	2,972	**1.37**	**1.32 1.42**	1,805.33	**0.00**	9.6
Cervix	5,442	1.00	0.97 1.03	162	**0.43**	**0.37 0.51**	1,793.56	**0.00**	52.8
Endometrium	9,188	1.00	0.98 1.02	484	1.04	0.95 1.13	0.16	0.69	6.3
Uterus	986	1.00	0.94 1.06	45	0.80	0.59 1.08	20.19	**0.00**	10.1
Ovary	8,313	1.00	0.98 1.02	380	**0.82**	**0.74 0.90**	315.95	**0.00**	11.1
Other female genitals	1,171	1.00	0.94 1.06	32	**0.58**	**0.40 0.82**	216.32	**0.00**	10.1
Kidney	3,919	1.00	0.97 1.03	126	**0.75**	**0.62 0.89**	192.32	**0.00**	25.6
Urinary bladder	2,965	1.00	0.96 1.04	105	**0.80**	**0.65 0.97**	73.75	**0.00**	10.0
Melanoma	4,038	1.00	0.97 1.03	443	**1.57**	**1.42 1.72**	787.94	**0.00**	17.8
Skin (squamous cell)	2,727	1.00	0.96 1.04	132	**1.23**	**1.03 1.46**	106.13	**0.00**	3.8
Eye	398	1.00	0.90 1.10	22	1.04	0.65 1.57	5.43	**0.02**	15.3
Nervous system	4,623	1.00	0.97 1.03	294	1.06	0.95 1.19	12.05	**0.00**	12.0
Thyroid gland	1,783	1.00	0.95 1.05	87	**0.76**	**0.61 0.93**	123.16	**0.00**	29.8
Endocrine gland	4,249	1.00	0.97 1.03	181	**0.82**	**0.70 0.95**	106.31	**0.00**	14.0
Bone	178	1.00	0.86 1.16	16	1.54	0.88 2.51	3.61	0.06	40.6
Connective tissue	833	1.00	0.93 1.07	38	0.86	0.61 1.18	6.37	**0.01**	25.7
Non-Hodgkin's lymphoma	3,779	1.00	0.97 1.03	166	0.91	0.78 1.06	68.43	**0.00**	17.4
Hodgkin's disease	460	1.00	0.91 1.10	21	0.79	0.49 1.22	5.48	**0.02**	57.1
Myeloma	1,829	1.00	0.95 1.05	53	**0.76**	**0.57 0.99**	45.95	**0.00**	3.9
Leukemia	3,074	1.00	0.96 1.04	115	**0.81**	**0.67 0.97**	35.06	**0.00**	12.3
All	132,260	1.00	0.99 1.01	7,008	0.99	0.97 1.02	372.10	**0.00**	16.7[b]

[a] Bold type: 95% CI does not include 1.00, $P < 0.05$.
[b] Weighted PAF of all sites.

female cancer sites. Another technical point is that the data were adjusted for period and region. Moreover, because the study covered a large part of the Swedish population, sampling issues appear irrelevant.

The largest educational group, <9 years of school, comprised close to half of the population, and this group served as a reference. For university-educated men and women, tobacco-related sites were in excess, including the lung, upper aerodigestive tract, and for men only, esophagus, of which alcohol contributes to the latter two sites, interactively with tobacco smoking (16). The data are consistent with less than average frequency of tobacco smoking in the educated population (17–19). For women graduates, lung cancer risk was less in the period 1985–1998 than in period 1970–1984, suggesting that the health education has penetrated best the educated segment of the population. In university-educated men and women, stomach and liver cancers were also decreased, which follows the common socioeconomic gradient (5, 6, 20–22). A chronic infection by *Helicobacter pylori* has been identified as the main risk factor of gastric cancer (16). Dietary nitrite, salt, and smoked food are thought to be other risk factors for gastric cancer, and the intake of dietary antioxidants reduces its incidence (23–25). On the basis of previous studies, low socioeconomic status and large sibship sizes are known risk factors of gastric cancer (26–28). Cervical and other genital cancers were also decreased in university graduates, but the difference to the least educated decreased toward the end of the follow-up time, suggesting that the beneficial effects of whole population cervical cancer screening programs had equalized the educational differentials in risk (29, 30).

Male university graduates had an excess of cancers of the colon, breast, prostate, testis, nervous system, and skin, including melanoma. The highest SIR of the study was 1.89 for melanoma. Solar irradiation is a risk factor for melanoma and squamous cell skin cancer (31, 32). This is accordance with the known socioeconomic gradient (4). A previous study on socioeconomic factors from Sweden, covering years 1961–1970, found only small differences for melanoma. The present difference, close to 2.0 for men, is probably the result of increasing holiday taking in sunny southern countries (33, 34). For colon cancer, physical inactivity and diet rich in meat and poor of fiber may explain some of the difference in risk between educational backgrounds (35, 36). For prostate and testicular cancer, the absolute differences in SIRs were not large and they were in line with previous studies (4–6, 37). For prostate cancer, the effect of opportunistic testing cannot be excluded (37). Male and female breast cancer was increased among university graduates, and in men, the effect was limited to the last follow-up period. Much of the increase for women remains unexplained; yet, the data are in agreement with the previous literature (4, 38). Hormonal factors do not offer a simple explanation because endometrial and ovarian cancer did not follow the pattern (39–41). The low risk of ovarian cancer

Table 4 SIR for cancer in male educational groups in different periods

Cancer site	Period 1970–1984								Period 1985–1998							
	Less than 9 years				University educated				Less than 9 years				University educated			
	Observed	SIR	95%	CI	Observed	SIR	95%	CI	Observed	SIR	95%	CI	Observed	SIR	95%	CI
Upper aerodigestive tract	1,910	1.00	0.96	1.05	117	**0.59**	**0.49**	**0.70**	2,636	1.00	0.96	1.04	217	**0.61**	**0.53**	**0.70**
Salivary gland	131	1.00	0.84	1.19	19	1.40	0.84	2.20	154	1.00	0.85	1.17	16	0.83	0.48	1.36
Esophagus	445	1.00	0.91	1.10	21	**0.44**	**0.27**	**0.68**	1,020	1.00	0.94	1.06	75	**0.56**	**0.44**	**0.70**
Stomach	2,517	1.00	0.96	1.04	96	**0.44**	**0.36**	**0.54**	3,710	1.00	0.97	1.03	214	**0.54**	**0.47**	**0.62**
Small intestine	214	1.00	0.87	1.14	25	1.16	0.75	1.72	411	1.00	0.91	1.10	52	1.09	0.81	1.43
Colon	2,511	1.00	0.96	1.04	273	**1.22**	**1.08**	**1.37**	5,826	1.00	0.97	1.03	693	1.07	0.99	1.15
Rectum	1,854	1.00	0.95	1.05	132	**0.81**	**0.68**	**0.96**	4,268	1.00	0.97	1.03	404	**0.84**	**0.76**	**0.93**
Anus	49	1.00	0.74	1.32	3	0.52	0.10	1.54	92	1.00	0.81	1.23	11	0.92	0.45	1.65
Liver	929	1.00	0.94	1.07	69	**0.77**	**0.60**	**0.98**	2,269	1.00	0.96	1.04	1.65	**0.64**	**0.55**	**0.75**
Pancreas	1,427	1.00	0.95	1.05	103	**0.82**	**0.67**	**0.99**	2,289	1.00	0.96	1.04	222	**0.83**	**0.73**	**0.95**
Lung	4,942	1.00	0.97	1.03	240	**0.48**	**0.42**	**0.55**	9,265	1.00	0.98	1.02	554	**0.46**	**0.43**	**0.50**
Breast	55	1.00	0.75	1.30	6	1.05	0.38	2.30	113	1.00	0.82	1.20	24	**1.67**	**1.07**	**2.49**
Prostate	5,292	1.00	0.97	1.03	408	1.00	0.91	1.10	23,860	1.00	0.99	1.01	2,848	**1.16**	**1.12**	**1.21**
Testis	383	1.00	0.90	1.11	82	**1.54**	**1.22**	**1.91**	266	1.00	0.88	1.13	42	1.28	0.92	1.73
Other male genitals	163	1.00	0.85	1.17	15	0.85	0.47	1.40	281	1.00	0.89	1.12	22	0.68	0.43	1.03
Kidney	1,956	1.00	0.96	1.05	145	**0.77**	**0.65**	**0.90**	2,915	1.00	0.96	1.04	271	**0.80**	**0.71**	**0.90**
Urinary bladder	2,659	1.00	0.96	1.04	239	0.94	0.82	1.07	6,340	1.00	0.98	1.02	606	**0.82**	**0.75**	**0.88**
Melanoma	1,392	1.00	0.95	1.05	313	**1.88**	**1.68**	**2.10**	2,321	1.00	0.96	1.04	573	**1.89**	**1.74**	**2.05**
Skin (squamous cell)	739	1.00	0.93	1.07	102	**1.54**	**1.26**	**1.87**	3,271	1.00	0.97	1.03	521	**1.45**	**1.33**	**1.58**
Eye	178	1.00	0.86	1.16	17	1.02	0.59	1.64	231	1.00	0.88	1.14	24	0.86	0.55	1.29
Nervous system	1,648	1.00	0.95	1.05	206	**1.21**	**1.05**	**1.38**	2,090	1.00	0.96	1.04	287	1.07	0.95	1.20
Thyroid gland	297	1.00	0.89	1.12	39	1.35	0.96	1.85	327	1.00	0.89	1.11	36	0.99	0.70	1.38
Endocrine gland	672	1.00	0.93	1.08	80	1.08	0.86	1.35	902	1.00	0.94	1.07	132	1.14	0.95	1.35
Bone	129	1.00	0.83	1.19	13	0.89	0.47	1.52	102	1.00	0.82	1.21	5	**0.38**	**0.12**	**0.89**
Connective tissue	316	1.00	0.89	1.12	39	1.14	0.81	1.57	537	1.00	0.92	1.09	63	1.05	0.80	1.34
Non-Hodgkin's lymphoma	1,342	1.00	0.95	1.05	136	0.97	0.81	1.15	3,028	1.00	0.96	1.04	363	1.01	0.91	1.12
Hodgkin's disease	411	1.00	0.91	1.10	54	1.20	0.90	1.57	280	1.00	0.89	1.12	21	**0.63**	**0.39**	**0.97**
Myeloma	636	1.00	0.92	1.08	44	0.79	0.57	1.06	1,383	1.00	0.95	1.05	138	0.93	0.78	1.10
Leukemia	1,388	1.00	0.95	1.05	133	1.00	0.84	1.18	2,369	1.00	0.96	1.04	260	0.94	0.83	1.07
All	36,585	1.00	0.99	1.01	3,169	**0.91**	**0.88**	**0.94**	82,556	1.00	0.99	1.01	8,859	**0.94**	**0.92**	**0.96**

Bold type: 95% CI not include 1.00.

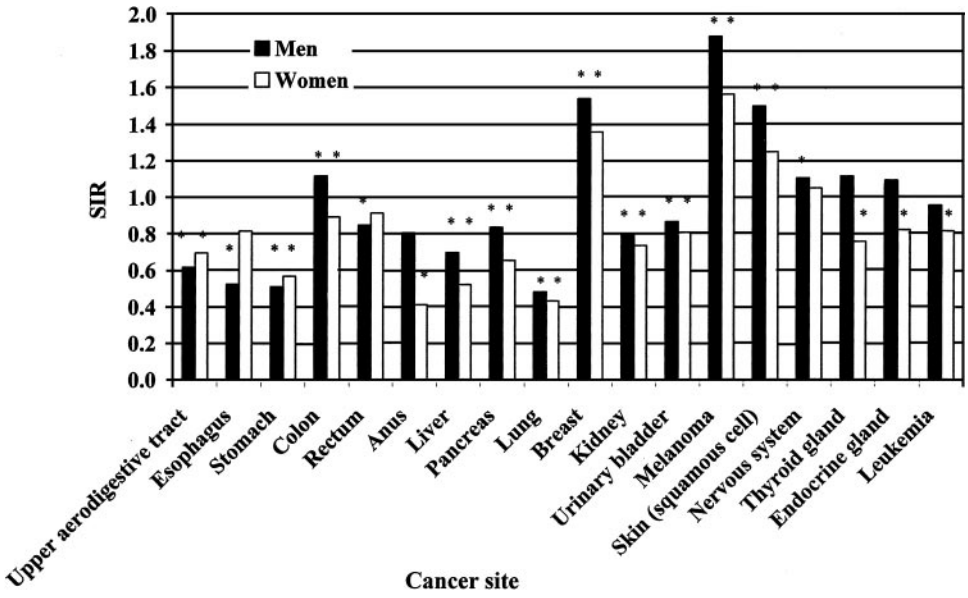

Fig. 1. SIR for cancer in male and female university graduates at sites for which the SIR in Tables 2 or 3 is significant for at least one gender. * shows that the 95% CIs for the SIR did not include 1.00.

among university-educated women may be partially because of the protective effects of oral contraceptives (42).

What are the reasons for these systematic differences in cancer risk between educational levels? Considering the earlier literature and the known population distribution of many of the implicated risk factors for cancer occurrence, it is likely that socioeconomic and lifestyle factors weigh heavily on the findings (1, 2). Thus, additional adjustment for socioeconomic

factors would appear *a priori* as an overadjustment. However, our attempt to adjust for socioeconomic factors gave a small overall effect, probably because the socioeconomic and educational classifications are not complementary. Even the narrowest educational group, university graduates, might not fit to a single socioeconomic category "professionals"; some may be classified among "self employed" and "agriculture." Despite such mixed classification, adjustment for socioeconomic factors reduced markedly some of the highest SIRs such as those for melanoma in the university educated population.

Overall, differences in cancer occurrence between educational groups showed a PAF of 13.8% for men and 16.7% for women. At individual sites, the PAF for stomach cancer was >50% for men and women. For men, tobacco-related sites, the upper aerodigestive tract, esophagus, pancreas, and lung showed PAFs between 20 and 40%, but for women, these sites weighted somewhat less. Prostate and testicular cancer showed PAFs of 3.3 and 38.6%, respectively. Female breast cancer showed a low PAF of 9.6%, but cervical and anal cancers exceeded 50%. At least some risk factors are known for all of the listed neoplasms, except that the variation in testicular cancers cannot be explained. The total PAFs of 13.8 and 16.7% for men and women are relatively large because it has been estimated that no more than 33 and 20% of all cancers arising in men and women in the Nordic populations can be accounted for by the known risk factors (43). In Sweden, smoking habits would account for less than half of these avoidable cases (44). Among other known causes, familial aggregation accounts for <5% of cancer at most sites, and it is highest, 9% for prostate cancer, for which we found a low PAF of 3.3% between educational groups (45, 46). We have carried out a similar exercise on PAFs for socioeconomic factors in the Family-Cancer Database, and some 17% of male and 11% of female cancers can be explained by them (47).

The results show that although the overall risk of cancer does not differ much between people with different educational backgrounds, site-specific risks do differ, largely in directions that can be predicted from the literature on socioeconomic gradients of cancer incidence. The consistency of the gradient suggests that the known and unknown risk factors also change in a uniform way. This should give a handle to resolve the underlying reasons, *e.g.*, why an educational background divides the population in two groups differing 2-fold in their stomach and 1.4-fold in breast cancer risk.

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Level of Education and the Risk of Cancer in Sweden

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