Explaining the Socioeconomic Variation in Cancer Risk in the Norwegian Women and Cancer Study

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Abstract

Associations between level of education and cancer risk is well supported by scientific evidence, but previous studies could only partly adjust for relevant confounding factors. In this article, we examined how risk of cancer varies with level of education and identified factors that explain this variation using data from a prospective cohort study, including 93,638 Norwegian women who responded to an extensive questionnaire in 1991/1992 or 1996/1997. A total of 3,259 incident primary invasive cancer cases were diagnosed during follow-up, which ended in December 2001. We used Cox proportional hazards model to calculate relative risks (RR) with 95% confidence intervals (95% CI). Besides a similar overall risk of female cancers by level of education, we observed differing risks between educational groups for cancers of the lung, breast, cervix, kidney, and skin melanoma. Women with >16 years of education had an increased risk of breast cancer (RR, 1.46; 95% CI, 1.19-1.79) and a decreased risk of lung cancer (RR, 0.30; 95% CI, 0.13-0.70) and cervical cancer (RR, 0.38; 95% CI, 0.17-0.85) compared with the lowest educated women (7-9 years). The middle educated (13-16 years) had the lowest risk of kidney cancer (RR, 0.24; 95% CI, 0.08-0.71), whereas the risk of skin melanoma was highest among women with 10 to 12 years of education (RR, 1.53; 95% CI, 1.05-2.24) compared with the lowest educated women. After multivariate adjustment for potential confounders related to level of education, the variation in cancer risk according to educational levels declined into nonsignificance for all these sites. (Cancer Epidemiol Biomarkers Prev 2005;14(11):2591–7)

Introduction

Variation in cancer risk by socioeconomic status (SES) has been considered by several epidemiologic studies during the last decades. Among women, the socioeconomic gradient in risk tends to be negative (i.e., poorer women are more affected than richer ones) for lung, stomach, esophagus, and cervical cancer, whereas a positive association (richer women are more affected than poorer ones) has been observed for skin melanoma and cancers of the colon, breast, and ovaries (1). A variety of measures of SES have been applied in different studies, but the associations seem to be relatively consistent in Western countries with income (2-9), socioeconomic group (8, 10-19), and level of education (2-4, 7-10, 19-21). Several of these studies are large ecological or record linkage studies that have given convincing evidence of the associations between SES and cancer risk, but their lack of individual information on exposures impairs an examination of underlying causal factors related to SES in cancer causation. A few sample surveys indicated that the differences in cancer risk associated with SES reflect differences in exposures to carcinogens or lifestyles that determine cancer risk. One case-control study has investigated the effect of tobacco and alcohol consumption (known carcinogens) on 35 cancer sites (4), whereas another case-control study has considered the role of physical activity (potentially cancer preventive) on 15 sites (15). Other case-control studies have been able to control for several potential confounders in the analyses of selected cancers (7, 8, 22). However, prospective studies addressing the effect of SES on cancer risk are scarce. One prospective cohort study of colon cancer did not find any association between SES and cancer incidence (23), whereas three studies of breast cancer show contradictory results (11, 24, 25).

We present here results from a large, prospective cohort study carried out in Norway, with comprehensive information on behavior and lifestyle characteristics that might affect cancer risk among women. Our aim was to assess how risk for different cancer sites varies with level of education and to identify the underlying causal factors leading to this variation.

Materials and Methods

The Norwegian Women and Cancer Study. The present investigation is based on data from the Norwegian Women and Cancer Study (NOWAC), a prospective cohort study described in detail previously (ref. 26; see also http://www.ism.uit.no/kk/e/). A total of 179,388 women ages 30 to 69 years were randomly selected from the Central Population Register according to year of birth. This registry records the addresses of all persons alive and residing in the country and the dates of death or migration to or from Norway since 1960. Each person is identified by an individual national registration number; the first six digits encode information on date of birth and the last five digits are based on an algorithm that ensures a unique number, including information on gender (27).

A letter of invitation to participate in the study and a health survey questionnaire were mailed to 24 subgroups of women at irregular intervals between 1991 and 1997. The length of the questionnaire varied between two and eight pages, with a core set of questions, including reproductive history, height and weight, smoking history, use of oral contraceptives and hormone replacement therapy (HRT), alcohol consumption, family history of breast cancer, participation in mammography screening, physical activity, and years of education. In total, 102,433 women returned the questionnaire, giving a crude response rate of 57.1%.

Follow-up. Follow-up was achieved through linkages of the cohort data set to national registers. The cancer data were

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provided by the National Cancer Registry, and information on death and emigration was collected from the Central Population Register of Norway. These registers are considered to be almost complete. Four women with missing information on death/emigration together with 28 women who were dead or had emigrated before the start of follow-up were excluded from the cohort. Another 3,118 women with a prevalent cancer diagnosis at study enrollment were also excluded, as were 5,645 women who did not state educational length in the questionnaire. Hence, the initial study population comprised 93,638 subjects. From each site-specific analysis, we further excluded women with missing information on covariates included in the respective multivariate model. The follow-up ended on December 31, 2001 or at emigration, death, or primary cancer diagnosis, whichever occurred first.

Classification of Education. In the questionnaire, women were asked to give the total number of years they attended school. The choice of classification is related to levels in the educational system in Norway; hence, the term educational level will be used in the following. Compulsory school attendance increased from 7 to 9 years about 1965. Thus, 7 to 9 years of education means primary school with at most 2 years of additional education. Women with 10 to 12 years of education may have completed secondary school or up to 5 years of professional training. Education lasting 13 to 16 years corresponds to a university bachelor degree or, in some instances, several professional training sessions at a lower level. The highest category comprises women with >16 years of education, which mainly corresponds to a university master level.

Statistical Analysis. We applied the Cox proportional hazards model to perform the statistical analyses using the SAS Software Package (version 8.2) to calculate hazard ratios with corresponding 95% confidence intervals (95% CI). The hazard ratios are interpreted as estimates of relative risks (RR).

The relationship between years of education and cancer incidence was first examined in age-adjusted analyses. Subsequently, other explanatory variables were added stepwise to the models whenever they tended to confound the association of interest, which was defined as a change in the RR of at least 1%. To make the estimates comparable, only subjects included in the multivariate analyses were left in the corresponding age-adjusted analyses. Smoking status and history, total alcohol consumption (0, <4, 4-10, >10 g/d on average), change in body mass index (BMI; weight in kilos divided by height squared) since age 18 years, participation in cervical cancer screening (never, more or less often than every third year), number of sunburns, age at first birth (<21, 22-24, 25-29, ≥30 years), and parity (0, 1, 2, ≥3 children) were included as sets of indicator variables, whereas perceived health, total intake of fat (<50, ≥50 g/d), ever use of oral contraceptives, current use of HRT, menopausal status at entry, and region of residence were considered dichotomous. Age at start of follow-up, BMI, and height were treated as continuous variables. Participation in mammography screening was included in the analysis of breast cancer as a time-varying variable, combining information from the questionnaire with time of introduction of the national screening program in each county. Information on menopausal status was obtained from the questionnaire. Only women who reported natural menopause or a bilateral oophorectomy at cohort enrollment were considered postmenopausal, regardless of hysterectomy or use of HRT.

Tests for linear trend were carried out by the introduction of an ordinal variable obtained by assigning consecutive integers to the categories of education. The relative contribution of each confounding variable was calculated as follows: The variables were added stepwise to the model by decreasing influence, evaluated at each step. For each variable (or set of variables) included, let A be the model before inclusion and B be the model after inclusion. The relative contribution of this variable is then [RR (model A) − RR (model B)] / [RR (age-adjusted model) − 1], where RR refers to the RR for the highest educated women. RRs < 1 have to be inverted before calculation. The *P* of each confounding variable is derived from the analysis of the respective full model. When categorical variables were considered, the *P* of the most significant category is reported.

Only cancer sites counting >40 incident cases are included in the analyses.

The National Data Inspectorate and the Regional Ethical Committee for Medical Research approved the study design, and all women gave an informed consent to participate in the study.

Results

Table 1 shows characteristics by education of the study population from the NOWAC. Well-educated women were on average younger, had fewer children, and had a later age at first birth. They were also taller, had a lower BMI, and had a lower increase in weight since age 18 years. The less educated were more likely to be smokers, started smoking at a younger age, and had a higher number of pack-years. They also reported a poorer self-perceived health. Alcohol consumption increased with educational level, as did both use of oral contraceptives and HRT and participation in cancer screening programs. The average number of sunburns yearly also increased by level of education, which is an indicator of vacation trips to southern countries, popular among middle and high SES people in Norway. The proportion of well-educated women was highest in the southern part of Norway. Table 2 gives the age-adjusted RRs of developing cancer by site and level of education. Besides a similar overall risk of female cancers by level of education, we observed differing risks between educational groups for cancers of the lung, breast, cervix, kidney, and skin melanoma. After multivariate adjustment for potential confounders related to level of education, the variation in risk declined into nonsignificance for all these sites (Table 3).

Positive Associations with Education. The risk of breast cancer showed a steadily increasing positive association with level of education (age-adjusted *P* for linear trend < 0.0001). When we added age at first birth and number of children to the model, the magnitude of the association decreased considerably. Low BMI accounted for a modest increase in risk. The slight variation still left was almost completely explained by use of oral contraceptives and HRT, consumption of alcohol, height, menopausal status at entry, and participation in mammography screening (multivariate-adjusted *P* for trend = 0.29). For skin melanoma, we did not observe any linear trend (age-adjusted *P* for trend = 0.48), only an increased risk among the middle educated women. After adjustment for number of sunburns and region of living in Norway, the RR turned into nonsignificance.

Negative Associations with Education. The risk of lung cancer was strongly related to education and, as expected, was mostly explained by differences in smoking habits. Total intake of fat and perceived health acted as minor confounders of the association (age-adjusted *P* for trend < 0.0001, multivariate-adjusted *P* = 0.06). The negative gradient in risk of kidney cancer was also partly related to the effect of smoking. Consumption of alcohol (a habit of relatively wealthy women in Norway) seemed to be a protecting factor of kidney cancer, contributing to the decrease in risk among the highly educated women (age-adjusted *P* = 0.004, multivariate-adjusted *P* = 0.07). The variation in risk of cervical cancer

Table 1. Characteristics by level of education, the NOWAC study, 1991-2001

	n	Education (y)			
		7-9 (%)	10-12 (%)	13-16 (%)	≥17 (%)
Total	96,485	28.8	34.7	25.3	11.2
Age at entry into the cohort (y)					
30-39	26,017	14.8	28.5	35.1	35.2
40-49	45,056	42.3	48.8	48.0	48.6
50-59	15,265	21.7	14.8	11.9	12.8
60-69	10,147	21.2	7.9	5.0	3.4
Mean (SD) age at cohort enrollment (y)		50.0 (9.7)	45.1 (8.3)	43.5 (7.7)	43.3 (7.2)
Smoking status					
Current	38,350	46.0	44.5	34.2	26.2
Former	23,191	24.0	23.8	24.6	26.4
Never	33,681	30.0	31.7	41.2	47.5
Age at start smoking (y)					
<20	36,412	61.8	63.6	56.6	50.0
≥20	24,084	38.2	36.4	43.4	50.0
No. pack-years smoked					
1-19	87,200	89.5	92.0	95.1	95.8
≥20	7,074	10.5	7.8	4.9	4.2
Perceived health					
Poor or very poor	7,381	14.1	7.6	5.1	4.8
Good or very good	78,083	85.9	92.4	94.9	95.2
Total intake of fat (g/d)					
<50	60,404	69.1	77.7	79.6	78.0
≥50	19,506	30.9	22.3	20.4	22.0
Age at first birth (y)					
<20	11,871	23.3	14.5	5.2	2.9
20-24	42,331	54.8	54.0	42.1	26.7
25-29	24,202	16.8	23.9	39.3	44.7
≥30	8,825	5.1	7.6	13.4	25.7
Mean (SD) age at first birth		22.3 (3.8)	23.3 (4.0)	25.2 (4.1)	26.9 (4.4)
Parity at entry					
Nulliparous	9,222	7.1	8.0	11.0	17.5
1 child	11,540	9.7	12.2	12.7	15.3
2 children	39,414	34.3	44.3	44.0	39.8
≥3 children	36,307	49.0	35.4	32.3	27.4
Mean (SD) no. children		2.6 (1.4)	2.2 (1.1)	2.1 (1.1)	1.8 (1.2)
BMI (kg/m^2)					
<18.5	2,571	2.4	2.7	3.0	3.1
18.5-24.5	64,620	59.2	69.5	74.5	77.5
25-29.5	21,106	29.2	22.1	18.3	15.7
≥30	5,763	9.2	5.8	4.2	3.6
Mean (SD) BMI		24.6 (4.1)	23.6 (3.6)	23.1 (3.4)	22.8 (3.3)
Change in BMI since age 18 y (units)					
<0	17,302	18.5	18.3	21.1	22.6
0-4	44,714	43.0	51.2	55.0	56.8
>4	26,384	38.5	30.6	23.9	20.6
Mean (SD) height (cm)		165.1 (5.6)	166.2 (5.5)	166.9 (5.6)	167.5 (5.6)
Use of oral contraceptives					
Ever used	52,316	41.2	57.7	64.0	67.0
Never used	41,549	58.8	42.3	36.0	33.0
Ever use of HRT among women ages ≥50 y at entry					
Yes	9,390	30.6	40.7	43.6	48.0
No	16,022	69.4	59.3	56.4	52.0
Menopausal status at entry					
Premenopausal	72,670	59.0	78.2	84.8	87.1
Postmenopausal	23,815	41.0	21.8	15.2	12.9
Daily consumption of alcohol (g)					
Teetotaller	26,133	38.4	27.3	24.3	20.7
0.1-3.9	43,609	48.4	50.6	47.4	43.2
4.0-9.9	15,732	10.3	17.1	21.9	26.0
≥10	4,814	2.9	5.0	6.4	10.1
Mean (SD) alcohol consumption		1.9 (5.0)	2.8 (5.5)	3.2 (4.9)	4.0 (5.7)
Frequency of cytologic screening					
Never	3,058	5.4	3.2	2.9	3.5
Less often than every third year	21,834	31.1	24.9	25.1	28.1
Every third year or more often	55,521	63.4	71.9	72.0	68.4
Participation in mammography screening before entry among women ages ≥50 y					
Yes	9,676	31.9	43.0	45.0	42.5
No	15,736	68.1	57.0	55.0	57.5
No. sunburns yearly					
0	10,145	21.2	12.3	9.1	6.8
1	55,036	67.7	73.0	72.8	72.3
≥2	11,804	11.0	14.6	18.1	20.9
Region of living					
South or middle of Norway	75,164	65.7	81.2	85.0	83.0
Northern Norway	21,321	34.3	18.8	15.0	17.0

was explained by smoking status, change in BMI since age 18 years, age at first birth, and frequency of participation in cervical cancer screening programs (age-adjusted P = 0.004, multivariate-adjusted P = 0.10).

Discussion

Our study showed a similar overall risk of female cancers across social strata, which is consistent with most (13, 16, 17) but not all (2, 10) previous studies. However, the lack of a socioeconomic gradient in overall risk covered contradictory associations between SES and cancer incidence in the site-specific analyses.

Our initial finding (before multiple adjustment) of a positive association between SES and risk for breast cancer and skin melanoma is well confirmed, as is the negative social gradient for cancers of the lung and cervix (1). For kidney cancer, the evidence is less convincing, but some studies have found an increased risk among low educated women (28, 29) as observed in our study. Moreover, our hypothesis that socioeconomic variation in cancer risk can be explained by known risk factors was supported.

Tobacco. Differing smoking habits accounted for ~64% of the increase in risk of lung cancer among the lowest category of education compared with the highest, whereas the corresponding proportions for both cervical and kidney cancer were 32%.

Diet. Consumption of alcohol seemed to have contrary effects on cancer of the breast and kidney, respectively, and contributed to extend the variation in risk for both sites. The effect of alcohol amounted to 23% of difference in risk of breast cancer after controlling for parity and age at first birth. Total intake of fat showed a minor confounding effect on the association between education and lung cancer, as a lower intake among the well educated decreased their RR.

Anthropometric Measures. BMI did also show contrary effects between cancer sites. The higher prevalence of overweight and obesity among the less educated increased their risk of lung cancer slightly but decreased their breast cancer risk. The inverse association between BMI and breast cancer risk is considered expected, as the majority of the women were premenopausal at cohort entry. Height was positively associated with breast cancer risk, yielding a further increased RR in the well educated. Increase in BMI since age 18 years was most prevalent among the less educated and showed a negative effect on risk of cervical cancer. Its effect on socioeconomic differences in risk was slight and only involving the middle and lower educated women.

Reproductive Factors. Differences in parity and age at first birth contributed to 26% of the variation in breast cancer risk between the highest and the lowest educational groups. A young age at first birth showed a minor influence on risk of cervical cancer, probably serving as a proxy of age at first intercourse.

Participation in Screening Programs. Highly educated women were more likely to participate in mammography screening, which revealed cases that otherwise would remain undiagnosed or diagnosed at a later time. On the contrary, regular participation in cytologic screening programs reduced the risk of developing invasive cervical cancer, in favor of the well-educated women.

Hormones. Use of both oral contraceptives and HRT contributed slightly to an increasing risk of breast cancer by level of education.

Other Factors. Differences in perceived health increased the variation in lung cancer risk slightly, which may result from residual confounding of smoking or perhaps a weakened immune system. The effect on variation in breast cancer risk by menopausal status increased after controlling for HRT use, BMI, and screening participation. Number of sunburns affected difference in risk of skin melanoma, as the lowest educated women reported a lower frequency than the others. Region of living did also alter risk of skin melanoma. Women in northern Norway are on average lower educated than in the rest of the country as confirmed by national figures (30).

The strengths of our study include its prospective design, large size, and complete follow-up. Our data offer sufficient variability in years of education as well as in related exposures to exhibit any differential in risk.

The use of self-reported information on education may represent a weakness of the study. Self-reported education often exceeds the number of years recorded in official statistics because the participants are likely to state both incomplete and informal training sessions. Moreover, as frequently observed in studies with volunteers, an overrepresentation of highly educated women compared with the source population is likely. Possible selection bias by education has been assessed in a part of our cohort by comparing the educational level among those who responded the questionnaire with the total population invited to participate using information from the national register of education. Of the 9,237 women who responded the questionnaire, 26% had completed ≥13 years of education compared with 22% in the invited sample of 15,000 women (26). This excess of highly educated women may increase breast cancer rates by 5 cases per 100,000 at most, assuming that the relationship between risk behaviors and education does not vary according to response to the

Table 2. Age-adjusted RRs with 95% CIs of developing cancer in relation to years of education, the NOWAC study, 1991-2001

	No. cases	Education (y)				P for linear trend
		7-9	10-12	13-16	≥17	
All	3,259	1.00 (reference)	1.01 (0.93-1.10)	1.03 (0.94-1.14)	1.05 (0.92-1.19)	0.41
Colon	205	1.00 (reference)	0.86 (0.61-1.20)	0.95 (0.65-1.39)	0.81 (0.46-1.42)	0.52
Rectum	112	1.00 (reference)	1.37 (0.88-2.14)	0.80 (0.44-1.45)	1.58 (0.83-3.02)	0.60
Lung	150	1.00 (reference)	0.70 (0.48-1.00)	0.40 (0.24-0.67)	0.30 (0.13-0.70)	<0.0001
Breast	1,093	1.00 (reference)	1.13 (0.96-1.32)	1.29 (1.09-1.53)	1.46 (1.19-1.79)	<0.0001
Cervix uteri	125	1.00 (reference)	0.94 (0.62-1.43)	0.61 (0.37-1.02)	0.38 (0.17-0.85)	0.004
Corpus uteri	179	1.00 (reference)	0.89 (0.61-1.29)	1.35 (0.92-1.99)	1.06 (0.61-1.86)	0.27
Ovary	251	1.00 (reference)	1.06 (0.77-1.44)	1.13 (0.80-1.59)	0.76 (0.46-1.27)	0.73
Kidney	46	1.00 (reference)	0.61 (0.32-1.19)	0.24 (0.08-0.71)	0.29 (0.07-1.25)	0.004
Melanoma of skin	201	1.00 (reference)	1.53 (1.05-2.24)	1.42 (0.94-2.14)	1.13 (0.66-1.94)	0.48
Brain	46	1.00 (reference)	0.87 (0.43-1.78)	0.61 (0.26-1.47)	1.08 (0.41-2.83)	0.67
Thyroid gland	52	1.00 (reference)	0.99 (0.47-2.09)	1.15 (0.53-2.49)	1.41 (0.57-3.50)	0.43

Table 3. Multivariate-adjusted RRs with 95% CIs of developing cancer in relation to years of education, the *P*s, the confounding variables, and their relative contribution by stepwise inclusion, the NOWAC study, 1991-2001

Cancer site	Adjustment	Relative contribution (%)	*P*	Education (y)				*P* for linear trend
				7-9	10-12	13-16	≥17	
Lung	Smoking status, age started smoking, no. pack-years	64.4	<0.0001	1.00 (reference)	0.85 (0.59-1.23)	0.66 (0.39-1.11)	0.58 (0.25-1.34)	0.06
	Perceived health	3.4	0.01					
	Total intake of fat	1.0	0.02					
Breast	No. children, age at first birth	26.3	0.005	1.00 (reference)	1.00 (0.85-1.18)	1.07 (0.89-1.27)	1.11 (0.89-1.38)	0.29
	Consumption of alcohol	23.3	0.0002					
	Ever use of oral contraceptives	7.4	0.004					
	Height	6.5	0.002					
	Current use of HRT	3.3	<0.0001					
	BMI	2.8	0.07					
	Participation in mammography screening	2.6	<0.0001					
	Menopausal status at entry	3.9	0.001					
Cervix uteri	Smoking status	31.6	0.0001	1.00 (reference)	1.05 (0.68-1.60)	0.77 (0.46-1.31)	0.51 (0.22-1.18)	0.10
	Participation in cytologic screening	3.3	<0.0001					
	Age at first birth	6.4	0.33					
	Change in BMI since age 18 y	0.0	0.03					
Kidney	Smoking status	32.4	0.001	1.00 (reference)	0.75 (0.38-1.46)	0.36 (0.12-1.08)	0.50 (0.11-2.21)	0.07
	Consumption of alcohol	26.8	0.02					
Melanoma of skin	No. sunburns	53.0	0.001	1.00 (reference)	1.43 (0.98-2.09)	1.29 (0.85-1.95)	1.02 (0.59-1.75)	0.82
	Latitude of residence	36.0	0.006					

questionnaire. Reassuringly, the NOWAC incidence rates of breast cancer and total cancer (26) coincide closely with national figures. Furthermore, the study of the external validity of NOWAC shows only modestly diverging distributions of important exposures as parity and age at first birth according to response to the questionnaire (26). We therefore believe that the respondents in our study have a similar cancer risk profile to equally educated nonrespondents and that substantial selection bias is unlikely.

The status of human papillomavirus was unknown among the cohort members. Because human papillomavirus plays a crucial role in the etiology of squamous cell carcinoma as well as adenocarcinoma of the cervix (31), our analysis of cervical cancer is limited.

All risk factors for cancer occurring in the present study have been described previously. The effect of smoking on lung and cervical cancer risk is well known (31), although we observed a stronger effect of smoking on kidney cancer than in previous studies (32, 33).

The protecting effect of alcohol consumption on kidney cancer observed in our study has been reported by a few others (28, 34), although the adverse effect of alcohol on breast cancer is well established (35, 36). The associations between reproductive pattern, anthropometric measures, and hormones on cancer risk is well evidenced (31), as is the association between screening rates and incidence of breast and cervical cancer (37-39).

The socioeconomic profile in health exposures varies not only by ethnicity and level of development (40, 41) but also between developed countries. Smoking follows a negative social gradient in most western countries, whereas a positive gradient is generally observed for consumption of alcohol and leisure time physical activity (42-45). Nevertheless, studies of a Mediterranean population show a higher proportion of smokers among highly educated but no socioeconomic differences in alcohol consumption (46, 47). In our study, we found no significant socioeconomic variation in level of total physical activity, which may result from an offsetting of contradictory associations for occupational and leisure time physical activity. Reports on SES and diet are inconsistent (48, 49). We observed certain disparities in dietary pattern, but the only alteration of cancer risk appeared by consumption of alcohol and slightly by total intake of fat. However, reproductive pattern, anthropometry, screening behavior, and use of oral contraceptives and HRT seem to be similarly related to SES in most western populations (24, 47, 50-56).

Besides the contemporary variation between populations, the socioeconomic distribution of health exposures has changed over time within populations, as the socioeconomic distribution itself has changed. The average level of education among women has increased considerably in Norway since the late 1960s as in other western countries (30, 57). Following the development of education, the lifestyle and behavior related to a certain level has changed over time and differ between birth cohorts (58-60). Dividing our cohort into two equally spaced birth cohorts revealed a wider socioeconomic distribution of anthropometry and fat and alcohol intake among the oldest, whereas the younger had a greater disparity in parity pattern, smoking, and oral contraceptive use (data not shown).

The relationship between SES and cancer incidence may also depend on how SES is operationalized, although studies using both income and level of education have provided almost similar estimates for the two measures (2-4, 7-9, 61). However, the advantages of choosing years of education as an indicator of SES are several; it applies to every adult individual, is more stable over one's lifetime than either occupation or income (62), and is easily obtainable and recordable (63).

We found a significant relationship between level of education and risk for cancers of the lung, kidney, cervix, breast, and skin melanoma. The association was negative for lung, kidney, and cervical cancer, whereas a positive association was observed for breast cancer and skin melanoma. After multivariate adjustment for potential confounders, all RRs turned into nonsignificance, which shows that socioeconomic variation in cancer risk can be explained by known risk factors. We believe that our ability to identify the confounders in the analyses of the NOWAC study is attributable to three aspects: the comprehensive information on exposures, a high quality of both the questionnaire information and the cancer data, and a close relationship between level of education and characteristics of a woman's life and behavior that might affect the risk of developing cancer.

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