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Education, socioeconomic status and risk of cancer of the colon and rectum

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Background Socioeconomic correlates of cancer of the large bowel differ in various countries and calendar periods and may differ for the colon and rectum. Thus, the relationship between education and social class and risk of cancers of the colon and rectum was considered.

Methods Combination of two hospital-based case-control studies conducted in six Italian centres between 1985 and 1996. Cases were 3533 patients aged <79, with histologically confirmed cancer of the colon (n = 2180) or rectum (n = 1353), and controls were 7062 patients admitted to hospital for a wide spectrum of acute, non-neoplastic, non-digestive tract diseases.

Results Compared to individuals with <7 years of education the multivariate odds ratios (OR) of colon cancer for those with ⩾16 years were 2.45 (95% confidence interval [CI] : 1.87–3.23) in men and 1.29 (95% CI : 0.88–1.90) in women, with significant trends in risk. No significant association emerged between education and risk of rectal cancer, with OR of 1.18 (95% CI : 0.83–1.70) and 1.01 (95% CI : 0.61–1.67) respectively for men and women in the highest educational category compared to the lowest. Social class was also related to colon cancer risk: the OR were 2.30 (95% CI : 1.82–2.90) in men and 1.33 (95% CI : 1.03–1.73) in women in the highest versus the lowest social class. No association was found between social class and rectal cancer risk, with OR of 1.18 for either men or women in the highest as compared to the lowest social class. No significant heterogeneity was found for the association between education and colon cancer risk in either sex across strata of age at diagnosis, coffee, alcohol and vegetable intake, family history of the disease, and in anatomical subsites within the colon.

Conclusion This study, based on a uniquely large dataset, indicates that there are different social class correlates for colon and rectal cancer. Consequently the two sites should not be combined in studies considering lifestyle factors in the aetiology of these neoplasms.

Keywords Case-control studies, colorectal cancer, education, risk factors, socioeconomic status

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Indirect observations that colorectal cancer might be related to affluence derive from descriptive epidemiology, since colorectal cancer incidence rates vary approximately 20-fold around the world, the rates being highest in the developed countries of North America and western Europe.[1] However, within each country colorectal cancer incidence and mortality show less clear patterns with reference to various social class indicators.[2] The social class gradient, moreover, tends to become weaker over recent calendar periods, and is generally more evident for colon than for rectal cancer.[2,3]

Some record linkage cross-sectional studies found an increased risk of colorectal cancer for people in the highest social class or with the highest levels of education,[4,5] which was stronger for men than for women.[5] However, other studies found no association with socioeconomic status,[6] or education,[7] and a study based on electoral registries from Northern Ireland

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found a positive association between colorectal cancer incidence and the highest levels of community deprivation.[8] Most studies, however, combined colon and rectal cancer, and only recently it has been suggested that the socioeconomic correlates of colon and rectal cancer may differ.

When colon and rectal cancer have been considered separately, an excess of risk of colon cancer was observed for occupations of higher socioeconomic status in a large multicentric US case-control study.[9] Socioeconomic status and education were positively associated with colon, but not rectal cancer incidence in the Finnish cancer register database[10] while in a cohort study from The Netherlands the positive association of colon cancer risk with socioeconomic status was restricted to men.[11] However, no significant association of socioeconomic status with either colon or rectal cancer was found in a study combining data from the Whitehall study of London civil servants, the OPCS Longitudinal study and the Registrar General's Decennials Supplement,[12] and in a study of cancer incidence in Blacks and Whites from the National Cancer Institute's Surveillance, Epidemiology, and End Results (SEER) Program.[13]

Thus, it is difficult to define and quantify the importance of various lifestyle correlates of socioeconomic status on subsequent colon and rectal cancer risk. Nonetheless, further reports on this issue are of general interest, since the socioeconomic determinants of colon and rectal cancer risk are known to differ in different subsites (colon and rectum), across countries and time periods, and the prevalence of other risk factors or cofactors can vary substantially in various populations. We, therefore, analysed the relationship of education and social class with risk of cancers of colon and rectum, using combined data from two case-control studies conducted in Italy between 1985 and 1996 on a total of over 3500 cases.[14] The large dataset and the availability of information on several covariates make this study of specific interest.

Subjects and Methods

As previously described,[14] the data were derived from two case-control studies of colorectal cancer, the first conducted between January 1985 and May 1991 in the greater Milan area,[15] and the second between June 1991 and June 1996 in six Italian areas: greater Milan, the province of Pordenone, the urban area of Genoa and the province of Forlì, in northern Italy; the province of Latina, in central Italy; and the urban area of Naples, in southern Italy.[16] The interviewers were centrally trained and the structured questionnaires were tested for reproducibility.[17]

Cases were 3533 patients, aged 19–79 years (median age 62) with incident (i.e. diagnosed within the year before interview), histologically confirmed cancer of the colon (2180 cases) or rectum (1353 cases), admitted to the major teaching and general hospitals in the areas under surveillance. Cancer of colon and rectum and their anatomical subsites were defined according to the International Classification of Diseases, Ninth Edition (ICD-9). Colon cancer corresponded to ICD-9 153; ascending colon included ICD-9 153.0, 153.4, 153.5 and 153.6; transverse and descending colon ICD-9 153.1, 153.2 and 153.7; sigmoid colon corresponded to ICD-9 153.3. Rectal cancer corresponded to ICD-9 154: rectosigmoid junction corresponded to ICD-9 154.0 and rectum to ICD-9 154.1.

Controls were 7062 patients, aged 19–79 years (median age 57), residing in the same geographical areas and admitted to the same network of hospitals where cases had been identified, for a wide spectrum of acute conditions unrelated to known or potential risk factors for colorectal cancer. Of these, 30% had traumatic conditions (mostly fractures and sprains), 25% non-traumatic orthopaedic disorders (mostly low back pain and disc disorders), 21% were admitted for acute surgical conditions (mostly abdominal, such as acute appendicitis or strangulated hernia), and 24% for miscellaneous other illnesses, such as eye, ear, nose and throat and dental disorders. All interviews for cases and controls were conducted in hospital, and less than 4% of cases and controls approached refused the interview.

Both questionnaires included information on personal characteristics and habits, anthropometric variables, education and other socioeconomic factors, general lifestyle habits, such as smoking, alcohol, coffee and tea consumption, related medical history, and history of intake of selected drugs. Information on education and other socioeconomic factors included the subject's and spouse's years of education, longest lifetime occupation and marital status. Social class was based on the level of the head of household's occupation, defined according to the British Registrar General's Classification,[18,19] and grouped in three levels: high including social classes I and II, intermediate including social class III, and low including social classes IV and V, plus 'Others', including unemployed, housewives with unspecified husband's occupations, farmers, all members of armed forces, clergy and students.

Data analysis

Odds ratios (OR) of colon and rectal cancers, and the corresponding 95% CI were derived from unconditional multiple logistic regression models, fitted by the method of maximum likelihood.[20] Two models were considered, the first one (A) including terms for study/centre (geographical area), age and sex, and the second (B) including further terms for smoking, alcohol, coffee and vegetable intake.

Results

Table 1 shows the distribution of colon and rectal cancer cases and of the comparison group according to sex and selected covariates. Colon and rectal cancer cases were older than controls, and colon cancer patients were more educated and more often belonged to the highest social class.

Table 2 shows the multivariate OR according to education and social class. Compared to patients with <7 years of education, the OR of colon cancer were 2.45 for men and 1.29 for women in the highest level of education, with a significant trend in risk. No association between rectal cancer and education emerged, since the OR for the highest level of education compared to the lowest one were 1.18 and 1.01 for men and women, respectively. Men and women in the intermediate and in the highest social class had a significantly elevated risk of colon cancer than those in the lowest, with OR respectively of 2.30 and 1.33 for men and women in the highest social class. No association with colon cancer risk emerged for subjects in the 'Others' category. The association with social class was weaker for rectal cancer, and the corresponding OR for men and women in the highest social class were 1.18.

Table 1 Distribution of 2180 cases of colon, 1353 cases of rectal cancer and 7062 controls according to age and other variables. Italy, 1985–1996

	Colon cancer				Rectal cancer				Controls			
	Men		Women		Men		Women		Men		Women	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Age (years)												
<50	165	14	168	17	93	11	84	16	1141	29	871	28
50–64	571	48	461	46	398	49	250	46	1839	47	1422	46
⩾65	450	38	365	37	320	39	208	38	972	25	817	26
Education (years)												
<7	531	45	603	61	463	57	354	65	2037	52	1836	59
7–9	283	24	188	19	174	21	104	19	960	24	638	21
10–15	264	22	161	16	128	16	64	12	756	19	508	16
⩾16	108	9	42	4	46	6	20	4	199	5	128	4
Social class[a]												
Low (IV–V)	460	39	372	37	360	44	205	38	1941	49	1258	40
Intermediate (III)	432	36	374	38	260	32	193	36	1230	31	1148	37
High (I–II)	159	13	106	11	64	8	54	10	280	7	310	10
Others	124	10	128	13	119	15	85	16	478	12	361	12
Missing	11	1	14	1	8	1	5	1	23	1	33	1
Coffee intake (cups/day)[b,c]												
⩽1	417	35	412	41	290	36	208	38	1186	30	1103	35
>1 to ⩽2	342	29	290	29	241	30	156	29	1119	28	841	27
>2	426	36	292	29	279	34	178	33	1644	42	1165	37
Smoking habit[b]												
Never smokers	316	27	752	76	228	28	411	76	970	25	2154	69
Current smokers	375	32	162	16	270	33	78	14	1596	40	682	22
Ex-smokers	495	42	80	8	313	39	52	10	1384	35	271	9
Alcohol intake (drinks/day)[b,c]												
0	118	10	321	32	90	11	179	33	404	10	1194	38
>0 to <2.3	377	32	550	55	250	31	299	55	1096	28	1595	51
⩾2.3	690	58	121	12	469	58	64	12	2445	62	319	10
Vegetable intake (portions/week)[b,c]												
⩽7	611	52	470	47	405	50	246	45	1635	41	986	32
>7 to ⩽13	323	27	301	30	221	27	156	29	1177	30	964	31
>13	251	21	223	22	184	23	140	26	1138	29	1157	37
Family history of colorectal cancer in first-degree relatives												
No	1087	92	906	91	770	95	510	94	3847	97	3034	98
Yes	99	8	88	9	41	5	32	6	105	3	76	2

[a] Based on the British Registrar's General Classification.

[b] The sum does not add up to the total because of some missing values.

[c] Approximate tertiles of intake.

The relationship between education and colon cancer in separate strata of selected covariates is considered in Table 3. No heterogeneity was found across strata of age at diagnosis, coffee, alcohol, vegetable intake and family history of the disease, but the risk of a high educational level was apparently stronger for ex-smokers. Analyses in various strata of selected covariates were made also for men and women separately. Although most associations were stronger for men, the overall pattern was consistent in either sex. Thus, the OR for the highest level of education were 3.76 for men <50 years, 2.63 for those aged 50–64 and 1.58 for men aged ⩾65 years. Corresponding values for women were 1.25, 1.49 and 1.11. In subjects with no family history of colorectal cancer the OR for the highest level of education were 2.45 and 1.26 for men and women, respectively. In several strata, however, the logistic model did not fit due to a low number of subjects in certain subgroup analyses.

Table 4 shows the OR of cancer at various anatomical subsites of the colon and rectum according to educational level and social class. The risk of cancer appeared consistently increased in all the subsites of colon considered, but no association emerged in the rectosigmoid junction or the rectum.

Discussion

Our results, based on a uniquely large dataset, show a positive association of colon cancer with education and social class,

Table 2 Odds ratios and 95% CI of colon and rectal cancer according to selected socioeconomic factors. Italy, 1985–1996

	Odds ratios (95% CI)[a]					
	Colon cancer			Rectal cancer		
	Men	Women	All	Men	Women	All
Education (years)						
<7	1[b]	1[b]	1[b]	1[b]	1[b]	1[b]
7–9	1.40 (1.17–1.66)	1.14 (0.93–1.39)	1.25 (1.10–1.43)	1.02 (0.84–1.26)	1.08 (0.83–1.39)	1.03 (0.88–1.20)
10–15	1.74 (1.44–2.09)	1.37 (1.09–1.71)	1.54 (1.34–1.78)	0.97 (0.77–1.22)	0.90 (0.66–1.22)	0.94 (0.79–1.13)
⩾16	2.45 (1.87–3.23)	1.29 (0.88–1.90)	1.93 (1.55–2.40)	1.18 (0.83–1.70)	1.01 (0.61–1.67)	1.13 (0.85–1.51)
χ^2, trend	60.23 ($P < 0.001$)	7.63 ($P = 0.006$)	59.38 ($P < 0.001$)	0.17 ($P = 0.680$)	0.10 ($P = 0.750$)	0.01 ($P = 0.907$)
Social class						
Low (IV–V)	1[b]	1[b]	1[b]	1[b]	1[b]	1[b]
Intermediate (III)	1.47 (1.26–1.72)	1.30 (1.10–1.55)	1.39 (1.24–1.56)	1.09 (0.90–1.31)	1.17 (0.94–1.46)	1.13 (0.98–1.30)
High (I–II)	2.30 (1.82–2.90)	1.33 (1.03–1.73)	1.78 (1.50–2.11)	1.18 (0.86–1.60)	1.18 (0.84–1.65)	1.18 (0.95–1.48)
Others	0.97 (0.77–1.22)	1.05 (0.82–1.34)	1.03 (0.87–1.22)	1.21 (0.95–1.53)	1.32 (0.99–1.77)	1.28 (1.06–1.53)
χ^2, trend	57.15 ($P < 0.001$)	9.23 ($P = 0.002$)	57.31 ($P < 0.001$)	1.58 ($P = 0.209$)	1.63 ($P = 0.202$)	3.90 ($P = 0.048$)

[a] Estimates from multiple logistic regression equations, including terms for study/centre, age, coffee intake, smoking, alcohol and vegetable intake. Estimates of risk for men and women together were further allowed for sex.

[b] Reference category.

Table 3 Odds ratios and 95% CI of colon cancer according to education and social class in strata of selected covariates. Italy, 1985–1996

	Odds ratios (95% CI)[a]					
	Education (years)[b]			Social class[c]		
	7–9	10–15	⩾16	intermediate (III)	high (I–I)	others
Age (years)						
<50	1.37 (1.00–1.88)	1.54 (1.11–2.13)	2.27 (1.47–3.51)	1.56 (1.19–2.06)	2.09 (1.43–3.05)	1.73 (1.08–2.78)
50–64	1.25 (1.04–1.51)	1.70 (1.39–2.07)	2.12 (1.52–2.97)	1.38 (1.17–1.63)	1.90 (1.47–2.46)	1.07 (0.84–1.38)
⩾65	1.16 (0.92–1.47)	1.39 (1.08–1.80)	1.40 (0.94–2.08)	1.35 (1.10–1.65)	1.63 (1.21–2.19)	0.94 (0.73–1.22)
Coffee intake (cups/day)[d]						
⩽1	1.12 (0.90–1.40)	1.47 (1.15–1.87)	1.65 (1.14–2.38)	1.23 (1.01–1.50)	1.51 (1.12–2.04)	1.00 (0.77–1.30)
>1 to ⩽2	1.25 (0.98–1.60)	1.52 (1.17–1.98)	2.11 (1.39–3.21)	1.45 (1.17–1.80)	2.31 (1.67–3.21)	1.02 (0.75–1.38)
>2	1.40 (1.13–1.74)	1.68 (1.34–2.12)	2.01 (1.41–2.88)	1.60 (1.32–1.95)	1.92 (1.45–2.55)	1.19 (0.87–1.63)
Smoking habit						
Never smokers	1.33 (1.10–1.61)	1.30 (1.04–1.61)	1.62 (1.17–2.24)	1.38 (1.16–1.63)	1.76 (1.37–2.26)	1.03 (0.81–1.30)
Current smokers	1.34 (1.05–1.71)	1.55 (1.19–2.01)	1.72 (1.11–2.65)	1.18 (0.95–1.47)	1.59 (1.12–2.26)	0.98 (0.69–1.40)
Ex-smokers	1.07 (0.82–1.39)	1.96 (1.51–2.54)	2.71 (1.79–4.10)	1.76 (1.39–2.23)	2.36 (1.69–3.31)	1.18 (0.85–1.63)
Alcohol intake (drinks/day)[d]						
0	1.12 (0.84–1.50)	1.28 (0.94–1.74)	1.58 (0.99–2.52)	1.33 (1.03–1.71)	1.58 (1.08–2.31)	1.08 (0.73–1.58)
>0 to <2.3	1.16 (0.94–1.42)	1.46 (1.18–1.82)	2.02 (1.46–2.81)	1.34 (1.12–1.60)	1.80 (1.39–2.32)	1.00 (0.77–1.30)
⩾2.3	1.46 (1.18–1.81)	1.82 (1.44–2.29)	2.05 (1.40–3.00)	1.52 (1.25–1.83)	2.21 (1.62–3.00)	1.04 (0.80–1.35)
Vegetable intake (portions/week)[d]						
⩽7	1.25 (1.04–1.51)	1.47 (1.19–1.81)	1.49 (1.07–2.07)	1.39 (1.17–1.64)	1.65 (1.27–2.16)	0.91 (0.70–1.18)
>7 to ⩽13	1.47 (1.16–1.88)	1.61 (1.24–2.08)	2.98 (1.98–4.48)	1.34 (1.07–1.67)	2.26 (1.66–3.09)	1.22 (0.92–1.62)
>13	1.04 (0.78–1.37)	1.65 (1.24–2.19)	2.09 (1.37–3.20)	1.55 (1.22–1.97)	1.94 (1.38–2.74)	1.14 (0.81–1.60)
Family history of colorectal cancer in first-degree relatives						
No	1.27 (1.11–1.45)	1.51 (1.31–1.75)	1.93 (1.54–2.42)	1.39 (1.23–1.56)	1.79 (1.49–2.14)	1.02 (0.86–1.22)
Yes	0.93 (0.51–1.70)	1.41 (0.75–2.66)	1.45 (0.56–3.72)	1.37 (0.79–2.39)	1.85 (0.87–3.97)	1.16 (0.55–2.43)

[a] Estimates from multiple logistic regression equations, including terms for study/centre, age, sex, coffee intake, smoking, alcohol and vegetable intake.

[b] Reference category was subjects with <7 years of education in each stratum.

[c] Reference category was subjects with the lowest social class in each stratum.

[d] Approximate tertile of intake.

Table 4 Distribution of anatomical subsites of colon and rectal cancer cases, and corresponding odds ratios[a] (OR) with 95% CI according to education and social class. Italy, 1985–1996

	Ascending colon		Transverse and descending colon		Sigmoid colon		Rectosigmoid junction		Rectum	
	No.	OR (95% CI)	No.	OR (95% CI)	No.	OR (95% CI)	No.	OR (95% CI)	No.	OR (95% CI)
Education (years)										
<7	165	1[b]	145	1[b]	400	1[b]	146	1[b]	657	1[b]
7–9	52	0.93 (0.67–1.30)	53	1.11 (0.80–1.55)	172	1.28 (1.05–1.56)	41	0.84 (0.58–1.21)	229	1.03 (0.87–1.22)
10–15	42	0.98 (0.68–1.42)	62	1.69 (1.23–2.34)	173	1.78 (1.45–2.18)	25	0.69 (0.44–1.07)	165	0.98 (0.81–1.19)
⩾16	16	1.40 (0.81–2.40)	17	1.74 (1.02–2.96)	50	1.77 (1.27–2.46)	14	1.46 (082–2.60)	51	1.02 (0.74–1.41)
χ^2, trend		0.32 ($P = 0.571$)		10.97 ($P = 0.001$)		33.71 ($P < 0.001$)		0.25 ($P = 0.615$)		0.00 ($P = 0.995$)
Social class										
Low (IV and V)	110	1[b]	116	1[b]	289	1[b]	86	1[b]	467	1[b]
Intermediate (III)	92	1.17 (0.88–1.56)	97	1.19 (0.90–1.58)	313	1.52 (1.27–1.81)	72	1.16 (0.84–1.61)	376	1.13 (0.97–1.32)
High (I and II)	33	1.72 (1.14–2.60)	36	1.81 (1.22–2.70)	93	1.75 (1.35–2.27)	22	1.43 (0.88–2.33)	94	1.16 (0.91–1.49)
χ^2, trend		6.08 ($P = 0.014$)		8.51 ($P = 0.004$)		28.65 ($P < 0.001$)		2.30 ($P = 0.129$)		3.06 ($P = 0.080$)

[a] Estimates from multiple logistic regression equations, including terms for study/centre, age, sex, coffee intake, smoking, alcohol and vegetable intake. The information on anatomical subsites was missing for 833 cases of colon and 25 cases of rectal cancer.

[b] Reference category.

mostly in males, but no association emerged with rectal cancer. Thus, these data confirm that colon and rectal cancer have different socioeconomic correlates.

Our findings can be partly explained in terms of known risk factors for colon cancer. They are, in fact, consistent with the increased risk of colon cancer in individuals with low occupational physical activity,[21–23] which tends to be a correlate of higher education and social class. A possible link with physical activity is also consistent with the stronger association in men than women and restricted to colon cancer, since physical activity is not consistently associated with rectal cancer risk.[22,24] However, in this study allowance for the level of physical activity at work (available for the more recent dataset only) did not lower the OR, which were 2.71 for men and 1.75 for women in the highest educational level, indicating that this cannot by itself explain the association.

Other potential factors mediating the risk of colon cancer in the higher socioeconomic groups include diet and a complex mixture of lifestyle factors. In Italy, individuals in the higher social classes reported higher intakes of meat and eggs (reportedly risk factors), but also of vegetables, fruit and coffee (reportedly protective factors).[25,26] Thus, the influence of diet as a correlate of the association between high socioeconomic level and colon cancer risk remains open to debate. Moreover, although we were able to allow in the analysis for a few selected lifestyle and dietary habits and the multivariate OR were not appreciably different from the unadjusted ones, it is conceivable that a complex combination of these and other correlates may contribute to the increased risk of colon cancer in subjects of higher socioeconomic level.

This study has the limitations and strengths of hospital-based case-control investigations.[20] It was not population-based, but cases and controls were identified in the major teaching and general hospitals of the area under surveillance, where most patients with severe and acute conditions requiring hospitalization are admitted, and the catchment areas of cases and controls were comparable. The participation of cases and controls was almost complete and we excluded from the control group all patients admitted to hospital for chronic conditions, or selective hospital admissions which may be influenced by social class. The different results for colon and rectum and, to some extent, for men and women also weigh against any systematic selection in the comparison group.

The variables investigated were unlikely to be appreciably influenced by recall bias, and information on education was satisfactorily reproducible.[27] The results were similar in the two studies, and the potential confounding effect of several covariates was allowed for in the analysis, but no appreciable interaction or modifying effect was observed. Finally, the large number of patients allowed meaningful analysis in subgroups. However, no significant heterogeneity emerged across strata of selected covariates, except for sex and smoking.

These findings have important implications, since they indicate that lifestyle correlates of colon and rectal cancer differ, at least to some extent. Thus, the two sites should not be combined in aetiological studies.[28] It is also of interest that, at least in Italy, colon cancer remains one of the few neoplasms with positive social class correlates.[3,5]

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