# Social inequality and incidence of and survival from cancers of the colon and rectum in a population-based study in Denmark, 1994–2003

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## ARTICLE INFO

## ABSTRACT

We investigated the effects of socioeconomic indicators, demographic indicators and health-related indicators on the incidence of and survival from colon cancer and rectal cancer diagnosed in 1994–2003 with follow-up through 2006 in Denmark using information from nationwide registers. The analyses were based on data on 9958 patients with colon cancer and 7411 patients with rectal cancer in a cohort of 3.22 million people born between 1925 and 1973 and aged ⩾30 years. Higher incidences of colon and rectal cancers were associated with greater social disadvantage, predominantly amongst men, in regard to cohabiting status, housing tenure, dwelling size and affiliation to the work market. Comorbidity was associated with a higher incidence of colon cancer in both sexes. Short- and long-term relative survival from both colon and rectal cancers decreased with poorer education, disposable income, affiliation to the work market, housing tenure, dwelling size and cohabiting status.

## 1. Introduction

The incidence and mortality rates of colon and rectal cancers in Denmark are high: in 2003, 2244 cases of colon cancer and 1423 cases of rectal cancer were diagnosed. Colon cancer was the fifth most frequent cancer type diagnosed amongst men and the fourth amongst women, whilst rectal cancer ranked sixth and seventh amongst men and women, respectively.[1] In 2001, colon cancer was the third commonest cause of death from cancer amongst both men and women, whilst mortality from rectal cancer ranked fifth amongst men and sixth amongst women.[1]

Evidence of increasing inequality in the incidence of and mortality from colon and rectal cancers by socioeconomic position has emerged.[2–17] In a review in 1997, high social stratum was associated with a high risk for colon cancer but not rectal cancer.[3] In more recent studies based on data from other European countries, higher risks for colon and rectal cancers were associated with a higher level of education,[7,10,12] higher social class[4,7] and professional or white-collar occupation,[10,11] the associations being stronger for colon than for rectal cancer.[4,7,10] A positive social gradient has not, however, been observed in all studies,[13–15] in particular in the United States, where most studies have shown higher incidences of cancers at both sites in socially disadvantaged groups.[17] The findings with regard to socioeconomic position and survival after a diagnosis of colon or rectal cancer have been relatively consistent, most studies demonstrating poorer survival with decreasing socioeconomic position.[2,3,5,6,8,9,16]

Although the influence of marital status on survival after colon or rectal cancer in Denmark has been studied,[18] the effects of other socioeconomic indicators, demographic

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indicators and health-related indicators have not been addressed. The aim of this study was to investigate social inequality in the incidence of and survival from colon cancer and rectal cancer in Denmark, as part of a comprehensive, rigorous analysis of the role of socioeconomic position in cancer incidence and survival.
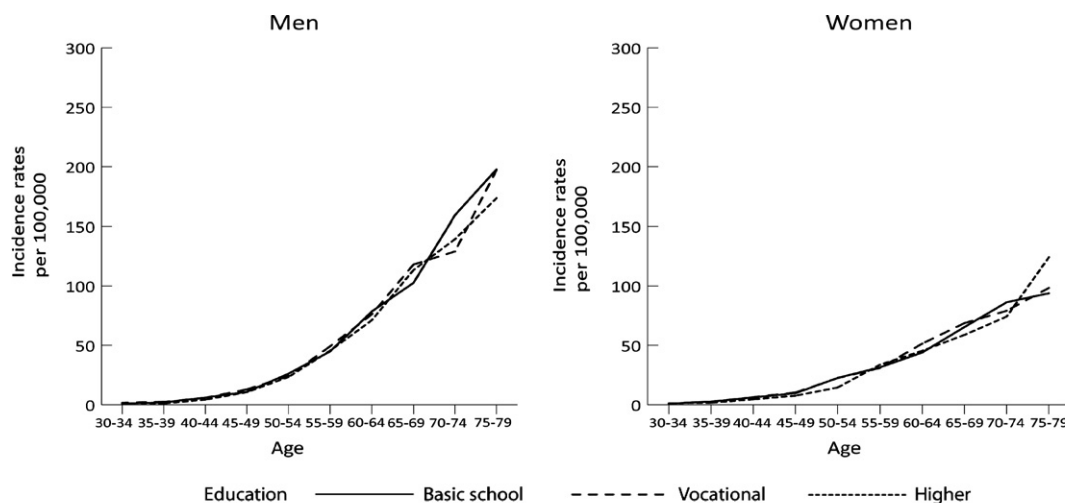
## 2. Materials and methods

The materials and methods are described elsewhere.[19] Briefly, the study population comprised all 3.22 million Danish residents born between 1925 and 1973 without a previous cancer and who entered the cohort at age 30 (see Fig. 1 in[19]). Information on socioeconomic indicators, demographic indicators and health-related indicators was obtained from various Danish registers based on administrative data.[19] Crude, age-specific and age-standardised incidence rates are presented for colon cancer (ICD-10 C18) and rectal cancer (ICD-10 C19–21) diagnosed in the cohort in 1994–2003. The incidence rates were standardised by age (in 5-year age groups) and period (in two 5-year periods), with the total study population as the standard.[20] Further, we used log-linear Poisson regression to model incidence rate ratios (IRRs), first by adjusting for period (in 5-year periods) and age (as two continuous variables: age and age[2] in years) and second by adding education and disposable income to the models. For each level of each indicator, we conducted relative survival analyses, adjusting for population mortality amongst the incident cancer cases in 1994–2003 with follow-up through 2006.[19] Population mortality rates were stratified by age, period and the respective indicator. Except for the analyses of ethnicity, all analyses included only residents born in Denmark to at least one Danish-born parent with Danish citizenship.[19]

## 3. Results

We included 9958 persons with colon cancer and 7411 persons with rectal cancer, constituting 47% and 54% of all cases of cancers at the two sites, respectively, diagnosed in Denmark during the period 1994–2003. Amongst Danish persons, the male:female ratio for colon cancer was 0.9, and the age- and period-standardised incidence rates were 39 and 37 per 100,000 person-years for men and women, respectively. The age- and period-standardised incidence rates for rectal cancer among Danish persons were 34 per 100,000 person-years for men and 23 per 100,000 person-years for women, with a male:female ratio of 1.5.



| Incidence rate | Men | | | Women | | |
|---|---|---|---|---|---|---|
| | Basic school | Vocational | Higher | Basic school | Vocational | Higher |
| | (n =1831 ) | (n =1681 ) | (n =694 ) | (n =1641 ) | (n =846) | (n =381 ) |
| Crude | 41 | 31 | 27 | 30 | 21 | 14 |
| Standardised | 35 | 35 | 33 | 23 | 24 | 21 |
| Difference | 2 | 2 | 0 | 2 | 3 | 0 |

Persons with unknown level of education not included

Fig. 1 – Age-specific incidence rates per 100,000 person-years for colon cancer by education amongst persons born in 1925–1973 in Denmark between 1994 and 2003. Supplementary table shows the crude incidence rate and the incidence rate standardised by age (5-year age groups) and period (two 5-year periods) with the total study population as the standard and the incidence rate difference, with basic school as the reference.

**Table 1 – Incidence rate ratios (IRRs) with 95% confidence intervals (95% CIs) for colon cancer in Danish persons born in 1925–1973 and aged ⩾30 years, by socioeconomic variables, demographic variables and health-related variables in Denmark, between 1994 and 2003**

| | Men | | | Women | | |
|---|---|---|---|---|---|---|
| | Obs | IRR[a] (95% CI) | Adjusted IRR[b] (95% CI) | Obs | IRR[a] (95% CI) | Adjusted IRR[b] (95% CI) |
| *Level of education* | | | | | | |
| Basic or high school | 2058 | 1.00 | 1.00 | 2735 | 1.00 | 1.00 |
| Vocational education | 1985 | 1.10 (1.03–1.17) | 1.10 (1.03–1.17) | 1262 | 1.00 (0.94–1.07) | 0.99 (0.93–1.06) |
| Higher education | 851 | 1.08 (0.99–1.17) | 1.07 (0.99–1.17) | 639 | 1.00 (0.91–1.09) | 0.98 (0.89–1.07) |
| Unknown | 75 | 1.10 (0.87–1.38) | 1.10 (0.87–1.38) | 48 | 1.02 (0.77–1.36) | 1.02 (0.77–1.36) |
| *Disposable income[c]* | | | | | | |
| Lowest (1st quartile) | 1674 | 0.98 (0.92–1.05) | 0.99 (0.93–1.06) | 1629 | 0.95 (0.89–1.02) | 0.95 (0.89–1.02) |
| Middle (2nd–3rd quartile) | 2118 | 1.00 | 1.00 | 2073 | 1.00 | 1.00 |
| Highest (4th quartile) | 1177 | 1.01 (0.94–1.09) | 1.00 (0.93–1.08) | 982 | 1.01 (0.93–1.09) | 1.01 (0.94–1.10) |
| *Affiliation to work market[d]* | | | | | | |
| Working | 2532 | 1.00 | 1.00 | 1864 | 1.00 | 1.00 |
| Unemployed or other | 557 | 1.20 (1.09–1.32) | 1.21 (1.10–1.34) | 757 | 1.11 (1.02–1.21) | 1.13 (1.03–1.23) |
| Early retirement pensioner | 387 | 1.14 (1.02–1.27) | 1.18 (1.05–1.31) | 619 | 1.00 (0.91–1.10) | 1.02 (0.92–1.12) |
| *Social class[e]* | | | | | | |
| Creative core | 264 | 1.00 (0.88–1.13) | 1.01 (0.87–1.17) | 72 | 1.13 (0.88–1.45) | 1.15 (0.88–1.50) |
| Creative professional | 857 | 1.08 (1.00–1.17) | 1.09 (0.99–1.19) | 364 | 1.00 (0.87–1.16) | 1.02 (0.87–1.19) |
| Bohemian | 25 | 1.01 (0.68–1.49) | 1.02 (0.68–1.51) | 9 | 0.91 (0.47–1.75) | 0.92 (0.47–1.78) |
| Service | 1151 | 0.99 (0.92–1.07) | 0.99 (0.92–1.07) | 2301 | 0.90 (0.81–1.00) | 0.89 (0.80–0.99) |
| Manual | 1986 | 1.00 | 1.00 | 409 | 1.00 | 1.00 |
| Agricultural | 220 | 0.70 (0.61–0.80) | 0.71 (0.62–0.82) | 101 | 0.92 (0.74–1.14) | 0.92 (0.74–1.15) |
| Unknown | 466 | 1.02 (0.92–1.13) | 1.03 (0.93–1.14) | 1428 | 0.96 (0.86–1.07) | 0.96 (0.86–1.07) |
| *Housing tenure* | | | | | | |
| Owner-occupied | 3324 | 1.00 | 1.00 | 2957 | 1.00 | 1.00 |
| Rental | 1565 | 1.18 (1.11–1.25) | 1.19 (1.12–1.26) | 1685 | 0.98 (0.93–1.04) | 0.98 (0.93–1.05) |
| Unknown | 80 | 1.46 (1.17–1.83) | 1.48 (1.19–1.85) | 42 | 0.91 (0.67–1.23) | 0.91 (0.67–1.23) |
| *Size of dwelling (m²)* | | | | | | |
| 0–49 | 159 | 1.18 (1.01–1.39) | 1.22 (1.03–1.43) | 61 | 0.91 (0.70–1.17) | 0.91 (0.71–1.18) |
| 50–99 | 1739 | 1.10 (1.03–1.18) | 1.12 (1.05–1.19) | 1933 | 1.02 (0.96–1.09) | 1.02 (0.96–1.10) |
| 100–149 | 1921 | 1.00 | 1.00 | 1692 | 1.00 | 1.00 |
| ⩾150 | 1150 | 0.95 (0.88–1.02) | 0.94 (0.87–1.01) | 998 | 1.06 (0.98–1.15) | 1.06 (0.98–1.14) |
| *Cohabiting status* | | | | | | |
| Married | 3615 | 1.00 | 1.00 | 2982 | 1.00 | 1.00 |
| Cohabiting | 291 | 1.02 (0.90–1.15) | 1.03 (0.91–1.16) | 218 | 0.94 (0.82–1.08) | 0.94 (0.82–1.08) |
| Single | 378 | 1.00 (0.90–1.11) | 1.02 (0.92–1.14) | 231 | 0.98 (0.86–1.12) | 0.99 (0.86–1.13) |
| Widow or widower | 247 | 1.06 (0.93–1.21) | 1.07 (0.94–1.22) | 802 | 1.01 (0.93–1.10) | 1.02 (0.94–1.10) |
| Divorced | 438 | 1.13 (1.02–1.25) | 1.14 (1.03–1.26) | 451 | 0.94 (0.85–1.03) | 0.94 (0.85–1.04) |
| *Type of district* | | | | | | |
| Capital area | 1605 | 1.00 | 1.00 | 1469 | 1.00 | 1.00 |
| Provincial city | 2476 | 0.89 (0.83–0.95) | 0.89 (0.84–0.95) | 2422 | 1.00 (0.93–1.06) | 1.00 (0.94–1.07) |
| Rural area | 606 | 0.89 (0.81–0.98) | 0.90 (0.82–0.99) | 558 | 1.02 (0.93–1.12) | 1.03 (0.93–1.13) |
| Peripheral rural area[f] | 282 | 0.89 (0.78–1.01) | 0.90 (0.79–1.02) | 235 | 0.91 (0.80–1.05) | 0.92 (0.80–1.06) |
| *Ethnicity[g]* | | | | | | |
| Danish | 4969 | 1.00 | 1.00 | 4684 | 1.00 | 1.00 |
| Immigrant or descendant from western country | 86 | 0.95 (0.77–1.18) | 0.95 (0.76–1.17) | 87 | 0.73 (0.59–0.90) | 0.73 (0.59–0.91) |
| Immigrant or descendant from non-western country | 70 | 0.68 (0.54–0.86) | 0.69 (0.54–0.89) | 62 | 0.68 (0.53–0.87) | 0.71 (0.54–0.93) |
| *Charlson comorbidity index[h]* | | | | | | |
| None | 3792 | 1.00 | 1.00 | 3884 | 1.00 | 1.00 |
| 1 | 747 | 1.10 (1.02–1.20) | 1.11 (1.02–1.20) | 504 | 1.09 (0.99–1.19) | 1.09 (0.99–1.20) |
| ⩾2 | 430 | 1.23 (1.11–1.36) | 1.24 (1.12–1.37) | 296 | 1.10 (0.98–1.24) | 1.10 (0.98–1.24) |
| *Depression* | | | | | | |
| No | 4877 | 1.00 | 1.00 | 4537 | 1.00 | 1.00 |
| Yes | 92 | 1.01 (0.82–1.24) | 1.01 (0.82–1.24) | 147 | 0.92 (0.78–1.09) | 0.92 (0.78–1.09) |
| *Schizophrenia or other psychosis* | | | | | | |
| No | 4930 | 1.00 | 1.00 | 4632 | 1.00 | 1.00 |
| Yes | 39 | 0.93 (0.68–1.28) | 0.95 (0.69–1.30) | 52 | 0.92 (0.70–1.21) | 0.92 (0.70–1.21) |

a Adjusted for calendar period (in 5-year intervals) and age modelled as age and age² in years.

b Adjusted for calendar period and age (as above) and additionally for level of education and disposable income.

c Household income after taxation and interest, adjusted for number of persons in household; categorised by gender-specific distribution of household disposable income per person.

d For pensioners, work market affiliation before pension date was assigned and followed up to age 69.

e Based on theory of creative class[35]: the creative core (e.g. researchers, designers, architects), creative professionals (e.g. managers, business and finance, lawyers, doctors), bohemians (e.g. artists, models), the service class (e.g. nurses, hairdressers, caterers), the manual class (e.g. construction workers, transport and production workers) and the agricultural class (e.g. farmers, fishermen).

f More than 40 km to a local centre with adequate possibilities for employment and not sharing a border with a centre municipality.

g Included as a separate indicator, but ethnic groups were excluded from the study population in all other analyses presented in Table 1, e.g. education and income.

h The presence of disorders, as defined in the Charlson index, was defined as an in- or outpatient contact with one of the diagnoses listed in Table 1 in[19] between 1978 and 2 years before the cancer diagnosis. Grouped according to the accumulated sum of scores.

**Table 2 – 1-year and 5-year relative survival[a] (%) with 95% confidence interval (95% CI) by socioeconomic variables, demographic variables and health-related variables in patients aged ⩾30 years born in 1925–1973, with colon cancer diagnosed in Denmark between 1994 and 2003 and followed through 2006**

| | Men | | | | | Women | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1-year survival | | | 5-year survival | | 1-year survival | | | 5-year survival | |
| | No. | % | 95% CI | % | 95% CI | No. | % | 95% CI | % | 95% CI |
| *Level of education* | | | | | | | | | | |
| Basic or high school | 2043 | 69 | 67–72 | 42 | 39–44 | 2715 | 73 | 71–74 | 46 | 44–48 |
| Vocational education | 1974 | 73 | 71–75 | 45 | 42–47 | 1251 | 77 | 75–80 | 52 | 49–55 |
| Higher education | 849 | 75 | 72–78 | 46 | 43–50 | 636 | 77 | 74–81 | 49 | 45–54 |
| Unknown | 74 | 62 | 52–75 | 38 | 28–53 | 48 | 78 | 67–91 | 50 | 37–69 |
| *Disposable income[b]* | | | | | | | | | | |
| Lowest (1st quartile) | 1660 | 67 | 64–70 | 40 | 37–43 | 1619 | 73 | 70–75 | 45 | 42–48 |
| Middle (2nd–3rd quartile) | 2109 | 72 | 71–75 | 45 | 43–48 | 2050 | 74 | 73–76 | 48 | 46–51 |
| Highest (4th quartile) | 1171 | 77 | 74–80 | 46 | 43–49 | 981 | 79 | 76–82 | 55 | 51–59 |
| *Affiliation to work market[c]* | | | | | | | | | | |
| Working | 2520 | 77 | 75–78 | 48 | 46–50 | 1858 | 80 | 78–82 | 52 | 50–54 |
| Unemployed or other | 552 | 66 | 61–72 | 41 | 36–48 | 754 | 82 | 78–85 | 53 | 49–57 |
| Early retirement pensioner | 381 | 60 | 54–67 | 35 | 29–43 | 607 | 66 | 61–72 | 39 | 33–45 |
| *Social class[d]* | | | | | | | | | | |
| Creative core | 263 | 74 | 69–80 | 48 | 42–55 | 72 | 75 | 64–88 | 45 | 33–61 |
| Creative professional | 855 | 75 | 73–78 | 48 | 44–52 | 362 | 78 | 74–83 | 51 | 46–58 |
| Bohemian | 25 | 77 | 62–96 | 60 | 42–86 | 9 | 83 | 71–99 | 41 | 18–95 |
| Service | 1146 | 73 | 71–76 | 43 | 40–46 | 2283 | 76 | 74–78 | 51 | 48–53 |
| Manual | 1973 | 71 | 69–73 | 43 | 41–46 | 402 | 73 | 69–77 | 47 | 42–52 |
| Agricultural | 218 | 73 | 67–79 | 49 | 42–56 | 100 | 74 | 66–84 | 42 | 33–54 |
| Unknown | 460 | 64 | 59–69 | 36 | 31–42 | 1422 | 72 | 69–74 | 45 | 42–48 |
| *Housing tenure* | | | | | | | | | | |
| Owner-occupied | 3312 | 75 | 73–76 | 46 | 44–48 | 2944 | 76 | 74–77 | 49 | 47–51 |
| Rental | 1550 | 66 | 64–68 | 39 | 36–42 | 1664 | 72 | 70–75 | 47 | 44–50 |
| Unknown | 78 | 72 | 62–84 | 48 | 36–64 | 42 | 73 | 60–89 | 49 | 35–69 |
| *Size of dwelling (m²)* | | | | | | | | | | |
| 0–49 | 153 | 62 | 54–70 | 36 | 28–47 | 61 | 53 | 42–68 | 37 | 26–52 |
| 50–99 | 1725 | 68 | 66–71 | 39 | 37–42 | 1913 | 73 | 71–75 | 47 | 45–50 |
| 100–149 | 1915 | 73 | 71–75 | 46 | 44–49 | 1679 | 75 | 73–77 | 49 | 46–51 |
| ⩾150 | 1147 | 77 | 75–80 | 49 | 46–52 | 997 | 78 | 75–81 | 51 | 48–55 |
| *Cohabiting status* | | | | | | | | | | |
| Married | 3602 | 74 | 73–76 | 46 | 44–48 | 2964 | 75 | 74–77 | 49 | 47–51 |
| Cohabiting | 291 | 71 | 65–77 | 41 | 35–49 | 214 | 73 | 67–81 | 48 | 40–57 |
| Single | 369 | 64 | 59–70 | 35 | 29–41 | 228 | 77 | 72–83 | 51 | 44–60 |
| Widow/widower | 246 | 67 | 60–76 | 41 | 33–52 | 795 | 69 | 65–74 | 46 | 41–52 |
| Divorced | 432 | 67 | 62–72 | 40 | 35–46 | 449 | 75 | 71–80 | 46 | 41–51 |
| *Type of district* | | | | | | | | | | |
| Capital area | 1593 | 72 | 70–74 | 43 | 40–46 | 1457 | 75 | 73–77 | 50 | 47–53 |
| Provincial city | 2461 | 72 | 70–74 | 45 | 43–47 | 2405 | 74 | 72–75 | 48 | 46–50 |
| Rural area | 604 | 72 | 69–75 | 43 | 39–48 | 556 | 77 | 74–81 | 45 | 41–49 |
| Peripheral rural area[e] | 282 | 73 | 68–78 | 41 | 35–48 | 232 | 72 | 66–78 | 50 | 44–58 |
| *Ethnicity[f]* | | | | | | | | | | |
| Danish | 4940 | 72 | 71–73 | 44 | 42–46 | 4650 | 74 | 73–76 | 48 | 47–50 |
| Immigrant or descendant from western country | 86 | 75 | 66–85 | 49 | 39–62 | 85 | 77 | 68–86 | 50 | 39–63 |
| Immigrant or descendant from non-western country | 70 | 79 | 69–91 | 64 | 51–80 | 62 | 86 | 77–95 | 55 | 42–73 |
| *Charlson comorbidity index[g]* | | | | | | | | | | |
| None | 3771 | 73 | 72–75 | 45 | 43–47 | 3865 | 75 | 74–76 | 48 | 47–50 |
| 1 | 742 | 70 | 67–74 | 41 | 37–45 | 497 | 73 | 69–77 | 51 | 46–56 |
| ⩾2 | 427 | 66 | 61–72 | 41 | 34–48 | 288 | 70 | 65–76 | 46 | 40–54 |
| *Depression* | | | | | | | | | | |
| No | 4850 | 72 | 71–73 | 44 | 43–46 | 4504 | 74 | 73–76 | 48 | 47–50 |
| Yes | 90 | 67 | 58–78 | 40 | 30–52 | 146 | 77 | 70–84 | 50 | 42–60 |
| *Schizophrenia or other psychosis* | | | | | | | | | | |
| No | 4901 | 72 | 71–73 | 44 | 43–46 | 4598 | 74 | 73–76 | 48 | 47–50 |
| Yes | 39 | 58 | 42–79 | 28 | 15–51 | 52 | 76 | 65–89 | 47 | 35–65 |

a  Ratio of observed survival of cancer patients and survival that would have been expected if the patients had had the same socioeconomic mortality, demographic mortality, or age-, period-, or health-related indicator-specific mortality as the total study population; for 'social class' and 'ethnicity', expected survival is adjusted only for age, not for period, because of low power.

b  Household income after taxation and interest, adjusted for number of persons in household; categorised by gender-specific distribution of household disposable income per person.

c  For pensioners, work market affiliation before pension date was assigned and followed up to age 69.

d  Based on the theory of creative class[35]: the creative core (e.g. researchers, designers, architects), creative professionals (e.g. managers, business and finance, lawyers, doctors), bohemians (e.g. artists, models), the service class (e.g. nurses, hairdressers, caterers), the manual class (e.g. construction workers, transport and production workers) and the agricultural class (e.g. farmers, fishermen).

e  More than 40 km to a local centre with adequate possibilities for employment and not sharing a border with a centre municipality.

f  Excluded from the study population in all other analyses presented in Table 2.

g  The presence of disorders, as defined in the Charlson index, was defined as an in- or outpatient contact with one of the diagnoses listed in Table 1 in[19] between 1978 and 2 years before the cancer diagnosis. Grouped according to the accumulated sum of scores.

### 3.1. Colon cancer

The stepwise age- and period-standardised incidence rates of colon cancer did not change with increasing length of education for either men or women (Fig. 1).

Table 1 shows that, amongst men, vocational education, unemployment or early retirement and living in small rented housing were associated with an increased IRR for colon cancer, whereas living in a larger dwelling was associated with a decreased IRR. The IRR of colon cancer amongst men in the creative professional class was higher than that of men in the manual class, and that of men in the agricultural class was lower. Divorced men had a higher IRR of colon cancer then those who were married, whilst living in more rural areas was associated with a lower IRR. Amongst women, unemployment was associated with an increased IRR of colon cancer, as was the presence of one or more comorbid conditions, but the effect was less marked than amongst men.

The 1-year relative survival of patients in whom colon cancer was diagnosed during 1994–2003 was 72% for men and 74% for women. The 5-year relative survival was 44% for men and 48% for women.

As shown in Table 2, basic or high-school education, early retirement and living in small rented housing were associated with shorter 1- and 5-year relative survival from colon cancer in both men and women. The poorest relative survival was seen amongst men with low income and amongst women with low or middle income. With regard to occupational status, relative survival was poorest amongst men and women in the manual class after 1 year, whereas after 5 years the lowest relative survival was observed in men in the service and manual classes and women in the agricultural class, when the small group of bohemians is disregarded. Single men experienced the poorest 1- and 5-year relative survival, whilst widows had the lowest 1-year relative survival. After 5 years, the poorest relative survival was that of divorced women and widows. A higher comorbidity score was associated with shorter 1- and 5-year survival.

Fig. 2 shows the age-standardised relative survival and corresponding excess mortality rates for colon cancer according
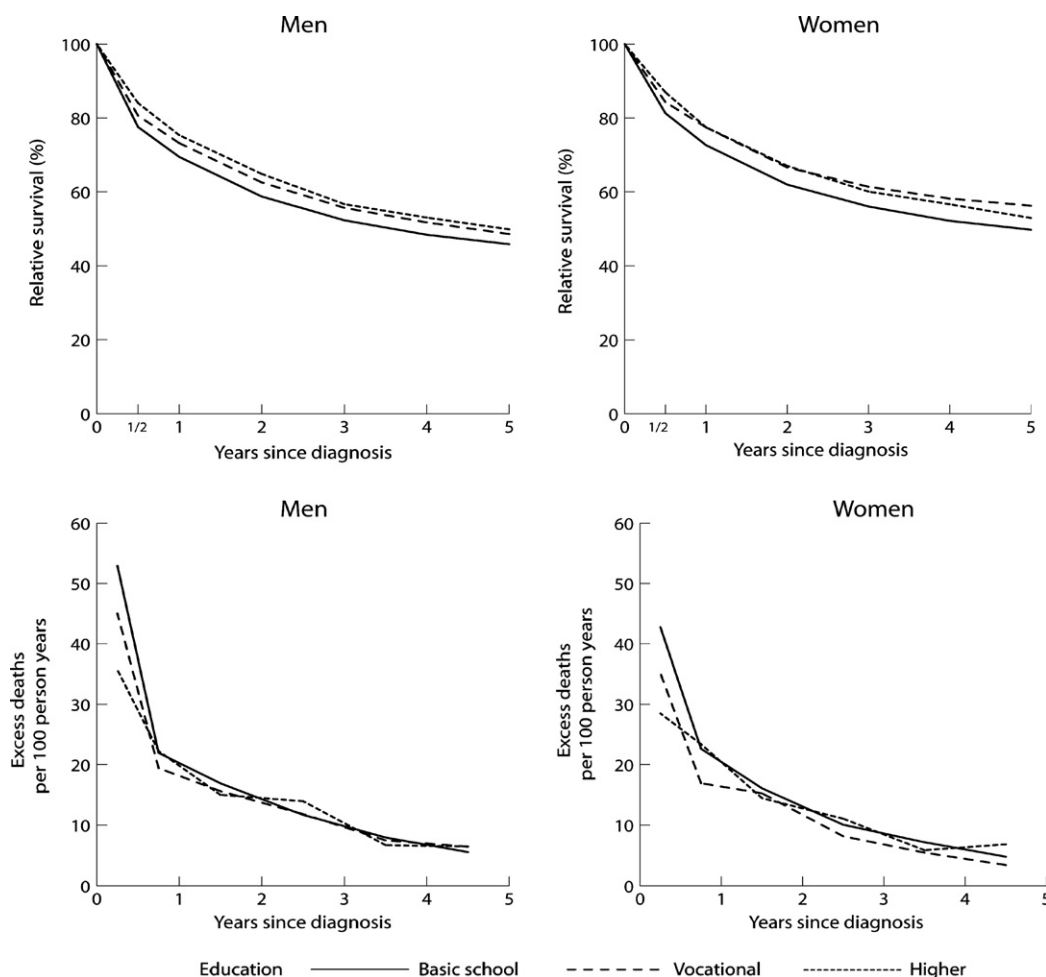


Fig. 2 – Age-standardised relative survival and excess mortality rates per 100 person-years by level of education in patients born in 1925–1973, with colon cancer diagnosed in Denmark between 1994 and 2003 and followed through 2006. Relative survival is the ratio of the observed survival of the cancer patients and the survival that would have been expected if the patients had had the same age-, period- and education-specific mortality as the total study population. Excess mortality is excess to the same population mortality and estimated in intervals since diagnosis. Estimates were standardised for age on the basis of the age distribution of all patients with colon cancer in the study cohort.

to educational level. Within the first 6 months after diagnosis, no difference was found in survival by educational level, whereas thereafter survival was slightly worse in both men and women with only basic schooling. Men with higher education had lower excess mortality rates up to 9 months, but no difference by education was seen thereafter. Amongst women, no clear difference in excess mortality rates by education was seen during the 5 years of follow-up.
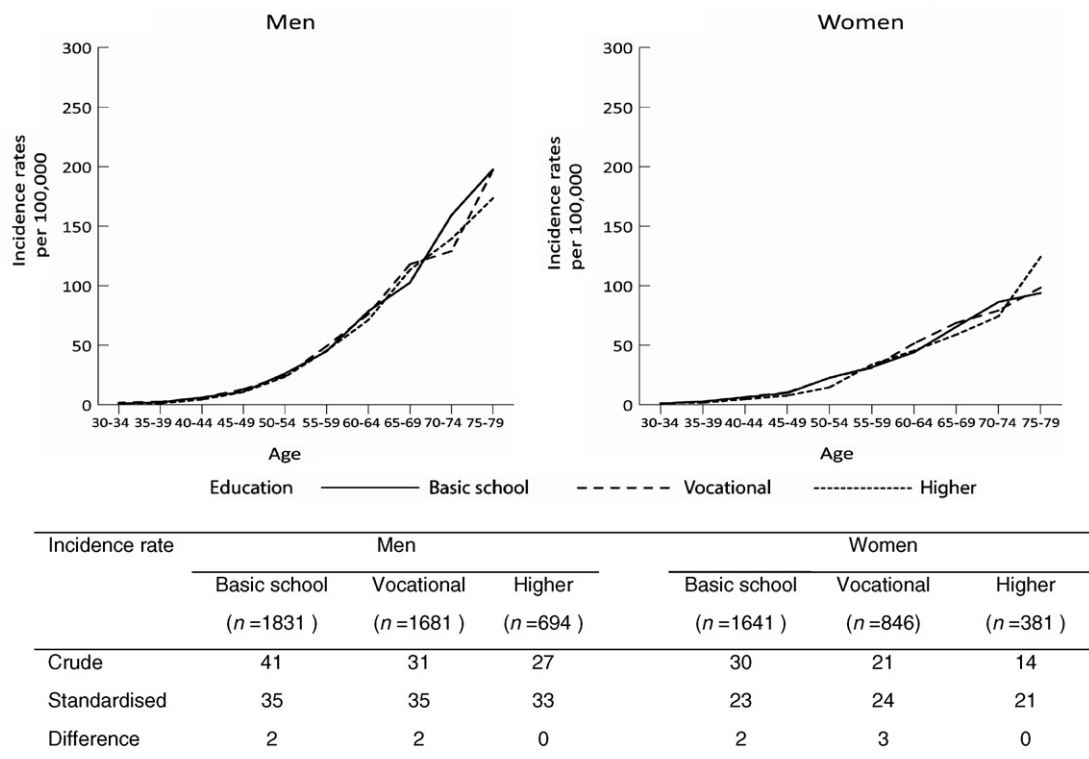
### 3.2.   Rectal cancer

The stepwise age- and period-standardised incidence rates of rectal cancer did not change with increasing length of education for either men or women (Fig. 3).

Table 3 shows that for men, unemployment and early retirement and living in smaller rented housing were associated with an increased IRR of rectal cancer. Men in the creative professional class, the service class and the agricultural class had lower IRRs than men in the manual class. Additionally, men living in more rural areas had a lower IRR than those living in capital areas. Amongst women, a higher level of education tended to be associated with a decreased IRR of rectal cancer, although the association was not significant. Men living with a partner or who were single or divorced had a higher IRR of rectal cancer than married men, whereas amongst women a higher IRR was seen only for those who were single. No

clear associations with health-related factors were seen for either sex.

The 1-year relative survival of patients in whom rectal cancer was diagnosed during 1994–2003 was 79% for men and 82% for women. The 5-year relative survival was 46% for men and 53% for women.

As shown in Table 4, basic or vocational education, low or middle income, being unemployed or taking early retirement and living in small rented housing were associated with the lowest 1- and 5-year relative survival from rectal cancer in both men and women. The lowest 1- and 5-year relative survival was seen amongst men in the manual class and women in the manual and service classes, when the small group of bohemians is disregarded. Compared to living with a partner, lower 1-year relative survival was seen for men who were single, widowers or divorced. The lowest 5-year relative survival was seen for single and divorced men. Divorced women had the lowest 1-year relative survival, whilst after 5 years the lowest relative survival was seen for single women. When short- and long-term relative survival were examined by type of district, they tended to be the best in men living in peripheral rural areas and the lowest in women living in peripheral rural areas. A comorbidity score of 1 or higher tended to be associated with lower 1-year relative survival. This pattern persisted amongst men 5 years after diagnosis, whereas it was seen only amongst women with a score of 2 or higher.



| Incidence rate | Men | | | Women | | |
|---|---|---|---|---|---|---|
| | Basic school (n =1831) | Vocational (n =1681) | Higher (n =694) | Basic school (n =1641) | Vocational (n =846) | Higher (n =381) |
| Crude | 41 | 31 | 27 | 30 | 21 | 14 |
| Standardised | 35 | 35 | 33 | 23 | 24 | 21 |
| Difference | 2 | 2 | 0 | 2 | 3 | 0 |

Persons with unknown level of education not included

**Fig. 3 – Age-specific incidence rates per 100,000 person-years for rectal cancer by education amongst persons born in 1925–1973 in Denmark between 1994 and 2003. Supplementary table shows the crude incidence rate and the incidence rate standardised by age (5-year age groups) and period (two 5-year periods) with the total study population as the standard and the incidence rate difference, with higher education as the reference.**

**Table 3 – Incidence rate ratios (IRRs) with 95% confidence intervals (95% CIs) for rectal cancer in Danish persons born in 1925–1973 and aged ⩾30 years by socioeconomic variables, demographic variables and health-related variables in Denmark between 1994 and 2003**

| | Men | | | Women | | |
|---|---|---|---|---|---|---|
| | Obs | IRR[a] (95% CI) | Adjusted IRR[b] (95% CI) | Obs | IRR[a] (95% CI) | Adjusted IRR[b] (95% CI) |
| *Level of education* | | | | | | |
| Basic or high school | 1831 | 1.00 | 1.00 | 1641 | 1.00 | 1.00 |
| Vocational education | 1681 | 1.01 (0.95–1.09) | 1.02 (0.96–1.09) | 846 | 1.04 (0.96–1.14) | 1.04 (0.96–1.14) |
| Higher education | 694 | 0.95 (0.87–1.04) | 0.98 (0.89–1.08) | 381 | 0.90 (0.80–1.00) | 0.89 (0.79–1.00) |
| Unknown | 70 | 1.11 (0.87–1.41) | 1.12 (0.88–1.42) | 33 | 1.11 (0.78–1.56) | 1.10 (0.78–1.56) |
| *Disposable income[c]* | | | | | | |
| Lowest (1st quartile) | 1427 | 1.04 (0.97–1.12) | 1.04 (0.96–1.12) | 973 | 1.04 (0.96–1.14) | 1.04 (0.95–1.14) |
| Middle (2nd–3rd quartile) | 1849 | 1.00 | 1.00 | 1268 | 1.00 | 1.00 |
| Highest (4th quartile) | 1000 | 0.95 (0.88–1.02) | 0.95 (0.88–1.03) | 660 | 1.03 (0.94–1.13) | 1.05 (0.95–1.16) |
| *Affiliation to work market[d]* | | | | | | |
| Working | 2299 | 1.00 | 1.00 | 1283 | 1.00 | 1.00 |
| Unemployed or other | 458 | 1.13 (1.02–1.25) | 1.11 (1.00–1.24) | 445 | 1.03 (0.92–1.15) | 1.02 (0.91–1.15) |
| Early retirement pensioner | 356 | 1.18 (1.05–1.32) | 1.18 (1.05–1.32) | 413 | 1.08 (0.96–1.21) | 1.08 (0.96–1.22) |
| *Social class[e]* | | | | | | |
| Creative core | 219 | 0.87 (0.76–1.00) | 0.88 (0.75–1.04) | 36 | 0.86 (0.61–1.22) | 0.95 (0.66–1.37) |
| Creative professional | 652 | 0.87 (0.79–0.95) | 0.88 (0.80–0.97) | 218 | 0.94 (0.79–1.13) | 1.02 (0.83–1.24) |
| Bohemian | 15 | 0.64 (0.38–1.06) | 0.65 (0.39–1.08) | 6 | 0.96 (0.43–2.15) | 1.03 (0.46–2.32) |
| Service | 961 | 0.88 (0.81–0.95) | 0.89 (0.82–0.96) | 1574 | 0.99 (0.87–1.13) | 1.00 (0.87–1.15) |
| Manual | 1857 | 1.00 | 1.00 | 247 | 1.00 | 1.00 |
| Agricultural | 214 | 0.73 (0.64–0.85) | 0.73 (0.64–0.85) | 56 | 0.87 (0.65–1.16) | 0.87 (0.65–1.17) |
| Unknown | 358 | 0.88 (0.78–0.98) | 0.87 (0.78–0.98) | 764 | 0.92 (0.80–1.07) | 0.92 (0.80–1.07) |
| *Housing tenure* | | | | | | |
| Owner-occupied | 2896 | 1.00 | 1.00 | 1823 | 1.00 | 1.00 |
| Rental | 1342 | 1.18 (1.11–1.26) | 1.17 (1.10–1.25) | 1043 | 1.04 (0.96–1.13) | 1.04 (0.96–1.13) |
| Unknown | 38 | 0.80 (0.58–1.10) | 0.79 (0.57–1.09) | 35 | 1.23 (0.88–1.72) | 1.23 (0.88–1.72) |
| *Size of dwelling ($m^2$)* | | | | | | |
| 0–49 | 127 | 1.11 (0.93–1.33) | 1.10 (0.92–1.32) | 41 | 0.96 (0.70–1.32) | 0.97 (0.71–1.32) |
| 50–99 | 1527 | 1.17 (1.09–1.25) | 1.16 (1.09–1.25) | 1178 | 1.01 (0.93–1.10) | 1.01 (0.93–1.10) |
| 100–149 | 1627 | 1.00 | 1.00 | 1103 | 1.00 | 1.00 |
| ⩾150 | 995 | 0.95 (0.88–1.03) | 0.95 (0.88–1.03) | 579 | 0.91 (0.82–1.01) | 0.91 (0.82–1.01) |
| *Cohabiting status* | | | | | | |
| Married | 3049 | 1.00 | 1.00 | 1852 | 1.00 | 1.00 |
| Cohabiting | 282 | 1.16 (1.03–1.31) | 1.16 (1.03–1.31) | 167 | 1.11 (0.95–1.30) | 1.11 (0.95–1.31) |
| Single | 367 | 1.15 (1.03–1.28) | 1.14 (1.02–1.27) | 169 | 1.16 (0.99–1.36) | 1.18 (1.01–1.39) |
| Widow or widower | 193 | 1.06 (0.92–1.23) | 1.06 (0.91–1.22) | 433 | 1.02 (0.91–1.13) | 1.02 (0.91–1.14) |
| Divorced | 385 | 1.15 (1.04–1.28) | 1.14 (1.02–1.27) | 280 | 0.94 (0.83–1.06) | 0.94 (0.83–1.07) |
| *Type of district* | | | | | | |
| Capital area | 1360 | 1.00 | 1.00 | 930 | 1.00 | 1.00 |
| Provincial city | 2149 | 0.91 (0.85–0.98) | 0.90 (0.84–0.97) | 1475 | 0.96 (0.89–1.04) | 0.96 (0.88–1.04) |
| Rural area | 542 | 0.94 (0.85–1.04) | 0.93 (0.84–1.03) | 330 | 0.95 (0.84–1.08) | 0.95 (0.84–1.08) |
| Peripheral rural area[f] | 225 | 0.85 (0.73–0.97) | 0.83 (0.72–0.96) | 166 | 1.03 (0.88–1.22) | 1.03 (0.87–1.22) |
| *Ethnicity[g]* | | | | | | |
| Danish | 4276 | 1.00 | 1.00 | 2901 | 1.00 | 1.00 |
| Immigrant or descendant from western country | 81 | 1.02 (0.82–1.27) | 1.02 (0.82–1.28) | 64 | 0.87 (0.68–1.12) | 0.87 (0.68–1.12) |
| Immigrant or descendant from non-western country | 49 | 0.54 (0.41–0.72) | 0.53 (0.40–0.71) | 40 | 0.68 (0.49–0.92) | 0.66 (0.47–0.92) |
| *Charlson comorbidity index[h]* | | | | | | |
| None | 3375 | 1.00 | 1.00 | 2463 | 1.00 | 1.00 |
| 1 | 592 | 1.02 (0.93–1.11) | 1.01 (0.93–1.11) | 282 | 1.03 (0.91–1.17) | 1.03 (0.91–1.17) |
| ⩾2 | 309 | 1.05 (0.93–1.18) | 1.04 (0.92–1.17) | 156 | 1.00 (0.85–1.18) | 1.00 (0.85–1.18) |
| *Depression* | | | | | | |
| No | 4205 | 1.00 | 1.00 | 2809 | 1.00 | 1.00 |
| Yes | 71 | 0.91 (0.72–1.15) | 0.90 (0.71–1.14) | 92 | 0.96 (0.78–1.18) | 0.97 (0.78–1.19) |
| *Schizophrenia or other psychosis* | | | | | | |
| No | 4250 | 1.00 | 1.00 | 2865 | 1.00 | 1.00 |
| Yes | 26 | 0.71 (0.48–1.04) | 0.70 (0.47–1.03) | 36 | 1.03 (0.74–1.43) | 1.04 (0.75–1.44) |

a Adjusted for calendar period (in 5-year intervals) and age modelled as age and $age^2$ in years.

b Adjusted for calendar period and age (as above) and additionally for level of education and disposable income.

c Household income after taxation and interest, adjusted for number of persons in household; categorised by gender-specific distribution of household disposable income per person.

d For pensioners, work market affiliation before pension date was assigned and followed up to age 69.

e Based on theory of creative class[35]: the creative core (e.g. researchers, designers, architects), creative professionals (e.g. managers, business and finance, lawyers, doctors), bohemians (e.g. artists, models), the service class (e.g. nurses, hairdressers, caterers), the manual class (e.g. construction workers, transport and production workers) and the agricultural class (e.g. farmers, fishermen).

f More than 40 km to a local centre with adequate possibilities for employment and not sharing a border with a centre municipality.

g Included as a separate indicator, but ethnic groups were excluded from the study population in all other analyses presented in Table 1, e.g. education and income.

h The presence of disorders, as defined in the Charlson index, was defined as an in- or outpatient contact with one of the diagnoses listed in Table 1 in[19] between 1978 and 2 years before the cancer diagnosis. Grouped according to the accumulated sum of scores.

**Table 4 – 1-year and 5-year relative survival [a] (%) with 95% confidence interval (95% CI) by socioeconomic variables, demographic variables and health-related variables in patients aged ⩾30 years born in 1925–1973, with rectal cancer diagnosed in Denmark between 1994 and 2003 and followed through 2006**

| | Men | | | | | Women | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | 1-year survival | | | 5-year survival | | | 1-year survival | | | 5-year survival | |
| | No. | % | 95% CI | % | 95% CI | No. | % | 95% CI | % | 95% CI |
| *Level of education* | | | | | | | | | | |
| Basic or high school | 1818 | 77 | 75–79 | 44 | 42–47 | 1637 | 81 | 79–83 | 51 | 48–54 |
| Vocational education | 1672 | 78 | 76–80 | 47 | 44–49 | 844 | 82 | 80–85 | 54 | 50–58 |
| Higher education | 687 | 84 | 81–87 | 50 | 46–55 | 381 | 88 | 84–91 | 57 | 51–63 |
| Unknown | 70 | 80 | 70–91 | 41 | 31–55 | 33 | 86 | 74–100 | 68 | 52–89 |
| *Disposable income[b]* | | | | | | | | | | |
| Lowest (1st quartile) | 1416 | 75 | 73–78 | 41 | 38–44 | 970 | 82 | 80–85 | 49 | 46–54 |
| Middle (2nd–3rd quartile) | 1836 | 80 | 78–81 | 47 | 45–50 | 1265 | 81 | 79–83 | 54 | 51–57 |
| Highest (4th quartile) | 995 | 84 | 81–86 | 51 | 47–55 | 660 | 87 | 83–90 | 58 | 53–64 |
| *Affiliation to work market[c]* | | | | | | | | | | |
| Working | 2295 | 84 | 82–85 | 51 | 48–53 | 1282 | 88 | 86–89 | 57 | 55–60 |
| Unemployed or other | 449 | 77 | 73–82 | 45 | 39–51 | 444 | 85 | 82–89 | 49 | 44–55 |
| Early retirement pensioner | 352 | 79 | 74–85 | 44 | 37–52 | 413 | 84 | 79–89 | 51 | 44–58 |
| *Social class[d]* | | | | | | | | | | |
| Creative core | 218 | 84 | 79–90 | 56 | 49–63 | 36 | 86 | 74–99 | 72 | 58–90 |
| Creative professional | 646 | 83 | 81–86 | 49 | 45–53 | 218 | 87 | 82–92 | 56 | 49–65 |
| Bohemian | 15 | 84 | 70–101 | 61 | 45–82 | 6 | 84 | 70–100 | 46 | 29–74 |
| Service | 955 | 79 | 76–82 | 48 | 45–52 | 1569 | 83 | 81–85 | 53 | 50–56 |
| Manual | 1846 | 76 | 75–78 | 42 | 40–45 | 247 | 81 | 76–86 | 51 | 45–59 |
| Agricultural | 213 | 78 | 72–84 | 46 | 39–54 | 56 | 92 | 85–99 | 68 | 57–82 |
| Unknown | 354 | 83 | 79–87 | 49 | 43–55 | 763 | 81 | 78–84 | 50 | 46–55 |
| *Housing tenure* | | | | | | | | | | |
| Owner-occupied | 2882 | 80 | 79–82 | 48 | 46–50 | 1820 | 83 | 82–85 | 55 | 52–57 |
| Rental | 1327 | 77 | 74–79 | 43 | 40–46 | 1040 | 81 | 79–84 | 50 | 47–54 |
| Unknown | 38 | 70 | 56–88 | 34 | 21–57 | 35 | 60 | 45–79 | 32 | 19–53 |
| *Size of dwelling (m²)* | | | | | | | | | | |
| 0–49 | 121 | 71 | 63–80 | 41 | 32–53 | 41 | 78 | 68–91 | 29 | 18–47 |
| 50–99 | 1515 | 75 | 73–78 | 41 | 38–44 | 1175 | 81 | 79–84 | 50 | 47–53 |
| 100–149 | 1619 | 82 | 80–84 | 50 | 47–52 | 1100 | 82 | 79–84 | 54 | 51–57 |
| ⩾150 | 992 | 82 | 79–84 | 48 | 45–52 | 579 | 86 | 83–89 | 59 | 54–63 |
| *Cohabiting status* | | | | | | | | | | |
| Married | 3032 | 81 | 80–82 | 49 | 48–51 | 1849 | 83 | 81–85 | 55 | 52–57 |
| Cohabiting | 281 | 81 | 76–86 | 41 | 35–49 | 167 | 83 | 76–90 | 49 | 40–59 |
| Single | 367 | 73 | 68–78 | 34 | 29–40 | 169 | 81 | 75–88 | 46 | 38–56 |
| Widow/widower | 190 | 69 | 60–79 | 42 | 32–54 | 432 | 82 | 77–86 | 48 | 42–55 |
| Divorced | 377 | 73 | 69–78 | 35 | 30–41 | 278 | 79 | 74–84 | 48 | 42–55 |
| *Type of district* | | | | | | | | | | |
| Capital area | 1346 | 80 | 77–82 | 46 | 43–49 | 925 | 81 | 79–84 | 52 | 49–56 |
| Provincial city | 2138 | 79 | 77–81 | 46 | 43–48 | 1474 | 83 | 81–85 | 53 | 50–56 |
| Rural area | 539 | 78 | 75–82 | 46 | 42–51 | 330 | 82 | 78–87 | 53 | 47–59 |
| Peripheral rural area[e] | 224 | 81 | 76–86 | 50 | 44–58 | 166 | 80 | 73–86 | 48 | 41–57 |
| *Ethnicity[f]* | | | | | | | | | | |
| Danish | 4247 | 79 | 78–80 | 46 | 45–48 | 2895 | 82 | 81–84 | 53 | 51–55 |
| Immigrant or descendant from western country | 81 | 82 | 74–91 | 52 | 41–66 | 64 | 82 | 73–93 | 48 | 37–63 |
| Immigrant or descendant from non-western country | 49 | 74 | 62–89 | 58 | 44–77 | 40 | 83 | 71–97 | 57 | 42–79 |
| *Charlson comorbidity index[g]* | | | | | | | | | | |
| None | 3351 | 80 | 79–81 | 47 | 45–49 | 2461 | 83 | 81–84 | 52 | 50–55 |
| 1 | 588 | 76 | 72–80 | 42 | 38–47 | 279 | 79 | 74–85 | 53 | 46–60 |
| ⩾2 | 308 | 75 | 70–81 | 42 | 35–50 | 155 | 78 | 71–85 | 51 | 41–62 |
| *Depression* | | | | | | | | | | |
| No | 4178 | 79 | 78–80 | 46 | 45–48 | 2804 | 82 | 81–84 | 53 | 51–55 |
| Yes | 69 | 79 | 70–90 | 45 | 34–59 | 91 | 86 | 79–94 | 51 | 40–65 |
| *Schizophrenia or other psychosis* | | | | | | | | | | |
| No | 4221 | 79 | 78–80 | 46 | 45–48 | 2859 | 83 | 81–84 | 53 | 51–55 |
| Yes | 26 | 51 | 36–72 | 27 | 16–46 | 36 | 60 | 46–77 | 34 | 21–52 |

a Ratio of observed survival of cancer patients and survival that would have been expected if the patients had had the same socioeconomic mortality, demographic mortality or age-, period-, health-related indicator-specific mortality as the total study population; for 'social class' and 'ethnicity', expected survival is adjusted only for age, not period, because of low power.

b Household income after taxation and interest, adjusted for number of persons in household; categorised by gender-specific distribution of household disposable income per person.

c For pensioners, work market affiliation before pension date was assigned and followed up to age 69.

d Based on the theory of creative class[35]: the creative core (e.g. researchers, designers, architects), creative professionals (e.g. managers, business and finance, lawyers, doctors), bohemians (e.g. artists, models), the service class (e.g. nurses, hairdressers, caterers), the manual class (e.g. construction workers, transport and production workers) and the agricultural class (e.g. farmers, fishermen).

e More than 40 km to a local centre with adequate possibilities for employment and not sharing a border with a centre municipality.

f Excluded from the study population in all other analyses presented in Table 2.

g The presence of disorders, as defined in the Charlson index, was defined as an in- or outpatient contact with one of the diagnoses listed in Table 1 in[19] between 1978 and 2 years before the cancer diagnosis. Grouped according to the accumulated sum of scores.
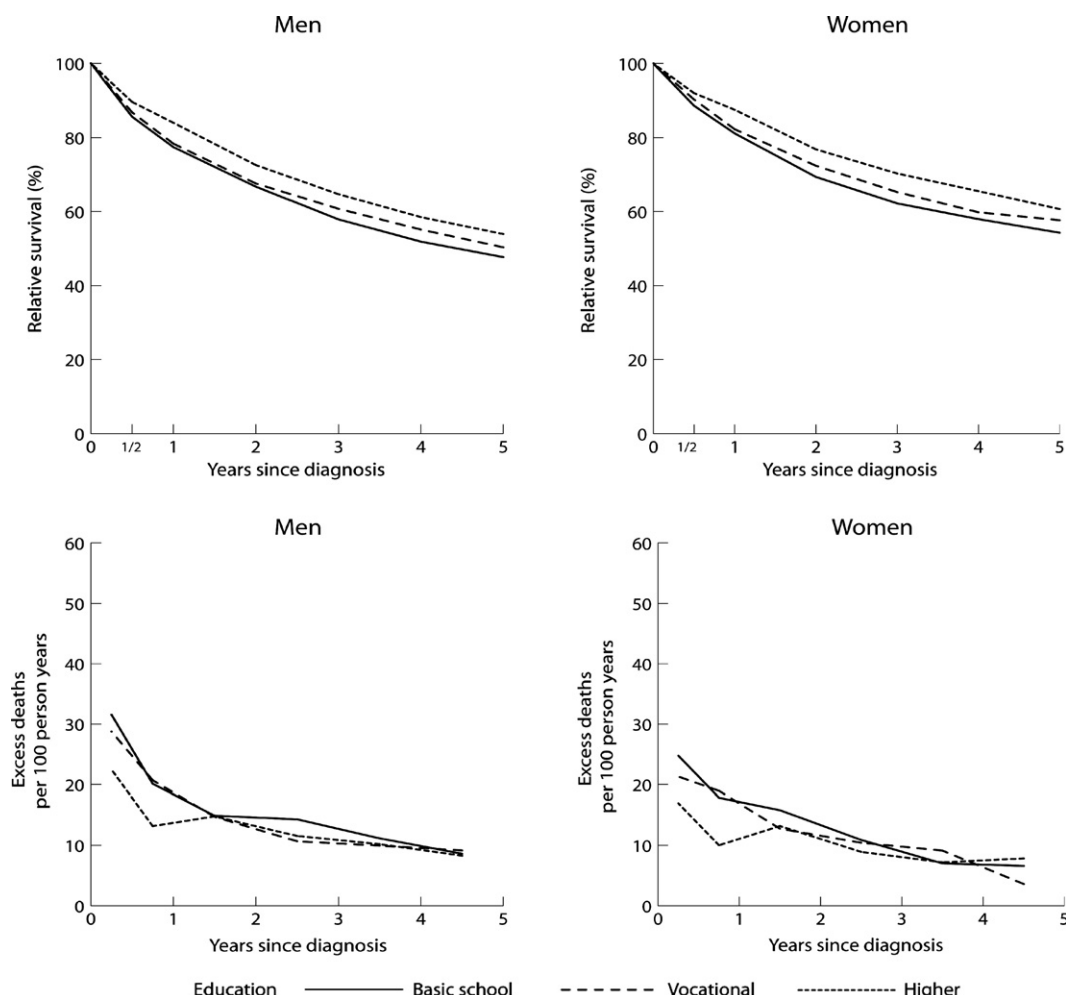
**Fig. 4 – Age-standardised relative survival and excess mortality rates per 100 person-years by level of education in patients born in 1925–1973, with rectal cancer diagnosed in Denmark between 1994 and 2003 and followed through 2006. Relative survival is the ratio of the observed survival of the cancer patients and the survival that would have been expected if the patients had had the same age-, period- and education-specific mortality as the total study population. Excess mortality is excess to the same population mortality and estimated in intervals since diagnosis. Estimates were standardised for age on the basis of the age distribution of all patients with rectal cancer in the study cohort.**

Fig. 4 shows the age-standardised relative survival and the corresponding excess mortality rates for rectal cancers according to education. The relative survival was slightly worse in men and women with basic schooling than in the other levels of education throughout the study period. Both women and men with higher education had lower excess mortality rates during the first 9 months after diagnosis; subsequently, the differences in excess mortality rates by education levelled out, and no difference was seen after 5 years.

## 4. Discussion

In this population- and register-based study, social gradients in the incidences of colon and rectal cancers were observed, predominantly in men. The IRRs of both cancers increased with greater social disadvantage, as measured by affiliation to the work market, housing tenure, dwelling size and cohabiting status. Living in more rural rather than capital areas tended to be associated with lower IRRs of both colon and rec-

tal cancer. The pattern with regard to education as a marker of socioeconomic position was less clear. The presence of comorbid conditions resulted in increased IRRs of colon cancer in both sexes.

Although increased risks for both colon and rectal cancers have been associated with high socioeconomic position in various European populations,[3,4,7,10–12] our results do not support a positive social gradient. Rather, they are similar to findings from studies in the United States, where higher incidences of both cancers have been reported in socially disadvantaged groups.[17]

Physical inactivity and obesity are considered to be potential risk factors for colorectal cancer[21] and may explain some of the social inequality in incidence, as less physical activity and a higher frequency of obesity have been reported in persons of low socioeconomic position.[22] In a recent Danish study, people with a higher level of education reported dietary habits that were more closely in accordance with national dietary guidelines than people with only basic schooling;[23]

thus, differences in dietary habits by socioeconomic position might also explain some of the differences in colon and rectal cancers incidence. Other studies, however, have indicated that diet and other health behaviours alone do not explain all the social gradient in the incidences of the two cancers.[7,24]

The estimated 1- and 5-year relative survival from colon and rectal cancers in Denmark were similar to those observed previously.[25,26] Although the relative survival has improved,[25] Denmark still has poorer survival from both cancers than other Nordic and European countries.[1,27] This study indicates a social gradient in the pattern of survival from colon and rectal cancers. The 1-year relative survival decreased with decreasing social advantage, as measured by the level of education, disposable income, affiliation to the work market, housing tenure, dwelling size and cohabiting status. Even 5 years after diagnosis, there appeared to be a social gradient in survival from either cancer. These findings are in agreement with those of other studies, in which poorer survival from colon and rectal cancers was found amongst persons of low socioeconomic position.[2,3,5,6,8,9,16] The reasons are not well understood, but differences in stage of diagnosis[28] and treatment received[29] have been proposed. The differential distribution of physical activity, obesity and dietary patterns might further explain the social gradient in survival. High levels of physical activity have been shown to reduce the risk for colon cancer recurrence and mortality, whereas a western dietary pattern and a body mass index greater than 35.0 at diagnosis have been associated with higher risks for recurrence and death from colon cancer.[30–32] Some evidence suggests that social support improves overall survival from cancer[33], and this was also indicated in this study, married or cohabiting persons having better survival from both colon and rectal cancer than persons living alone. As participation in colorectal cancer screening has been associated with indicators of high socioeconomic position[34], this has also been suggested to contribute to social inequality in survival from colon and rectal cancers. In Denmark, only pilot screening programmes for colorectal cancer have been conducted, and so this cannot explain the social inequality observed.

In conclusion, this study suggests that the incidences of colon cancer and rectal cancer vary by socioeconomic position, predominantly for Danish men. Although survival from both cancers in Denmark has improved, social inequalities in survival remain.

## Conflict of interest statement

None declared.

## Acknowledgement

REFERENCES

1. Engholm G, Storm H, Ferlay J, et al. NORDCAN: cancer incidence, mortality and prevalence in the Nordic countries, version 3.1. Association of Nordic Cancer Registries, Danish Cancer Society; 2008. <http://www.ancr.nu>.

2. Menvielle G, Luce D, Geoffroy-Perez B, Chastang JF, Leclerc A. Social inequalities and cancer mortality in France 1975–1990. *Cancer Causes Contr* 2005;**16**:501–13.

3. Faggiano F, Partanen T, Kogevinas M, Boffetta P. Socioeconomic differences in cancer incidence and mortality. In: Kogevinas M, Pearce N, Susser M, Boffetta P, editors. *Social inequalities and cancer.* Lyon, International Agency for Research on Cancer: IARC Scientific Publications No. 138; 1997. p. 65–176.

4. Weiderpass E, Pukkala E. Time trends in socioeconomic differences in incidence rates of cancers of gastro-intestinal tract in Finland. *BMC Gastroenterol* 2006;**6**:41.

5. Wrigley H, Roderick P, George S, Smith J, Mullee M, Goddard J. Inequalities in survival from colorectal cancer: a comparison of the impact of deprivation, treatment, and host factors on observed and cause specific survival. *J Epidemiol Community Health* 2003;**57**:301–9.

6. Shaw C, Blakely T, Sarfati D, Fawcett J, Peace J. Trends in colorectal cancer mortality by ethnicity and socio-economic position in New Zealand, 1981–99: one country, many stories. *Aust N Z J Public Health* 2006;**30**:64–70.

7. Tavani A, Fioretti F, Franceschi S, et al. Education, socioeconomic status and risk of cancer of the colon and rectum. *Int J Epidemiol* 1999;**28**:380–5.

8. Sloggett A, Young H, Grundy E. The association of cancer survival with four socioeconomic indicators: a longitudinal study of the older population of England and Wales 1981–2000. *BMC Cancer* 2007;**7**:20.

9. Coleman MP, Babb P, Sloggett A, Quinn M, De Stavola B. Socioeconomic inequalities in cancer survival in England and Wales. *Cancer* 2001;**91**:208–16.

10. Pisa FE, Barbone F, Montella M, Talamini R, La Vecchia C, Franceschi S. Migration, socio-economic status and the risk of colorectal cancer in Italy. *Eur J Cancer Prev* 2000;**9**: 409–16.

11. Hemminki K, Zhang H, Czene K. Socioeconomic factors in cancer in Sweden. *Int J Cancer* 2003;**105**:692–700.

12. Hemminki K, Li X. Level of education and the risk of cancer in Sweden. *Cancer Epidemiol Biomark Prev* 2003;**12**: 796–802.

13. Rosengren A, Wilhelmsen L. Cancer incidence, mortality from cancer and survival in men of different occupational classes. *Eur J Epidemiol* 2004;**19**:533–40.

14. Vidarsdottir H, Gunnarsdottir HK, Olafsdottir EJ, Olafsdottir E, Pukkala E, Tryggvadottir L. Cancer risk by education in Iceland; a census-based cohort study. *Acta Oncol* 2008;**47**:385–90.

15. Braaten T, Weiderpass E, Kumle M, Lund E. Explaining the socioeconomic variation in cancer risk in the Norwegian Women and Cancer Study. *Cancer Epidemiol Biomark Prev* 2005;**14**:2591–7.

16. Hussain SK, Lenner P, Sundquist J, Hemminki K. Influence of education level on cancer survival in Sweden. *Ann Oncol* 2008;**19**:156–62.

17. Palmer RC, Schneider EC. Social disparities across the continuum of colorectal cancer: a systematic review. *Cancer Causes Contr* 2005;**16**:55–61.

18. Johansen C, Schou G, Soll-Johanning H, Mellemgaard A, Lynge E. Influence of marital status on survival from colon and rectal cancer in Denmark. *Br J Cancer* 1996;**74**:985–8.

19. Dalton SO, Steding-Jessen M, Gislum M, et al. Social inequality and incidence of and survival from cancer in a population-based study in Denmark, 1994–2003: Background, aims, material and methods. *Eur J Cancer* 2008;**44**:1938–49.

20. Boyle P, Parkin DM. Statistical methods for registries. In: Jensen OM, Parkin DM, MacLennan R, Muir CS, Skeet RG,

editors. *Cancer registration: principles and methods*. Lyon, International Agency for Research on Cancer: IARC Scientific Publication No. 95. p. 126–58.

21. World Cancer Research Fund, American Institute for Cancer Research. Food, nutrition, physical activity and the prevention of Cancer: a global perspective. Washington DC: American Institute for Cancer Research; 2007.

22. Schnohr C, Hojbjerre L, Riegels M, et al. Does educational level influence the effects of smoking, alcohol, physical activity, and obesity on mortality? A prospective population study. *Scand J Public Health* 2004;**32**:250–6.

23. Groth MV, Fagt S, Brondsted L. Social determinants of dietary habits in Denmark. *Eur J Clin Nutr* 2001;**55**:959–66.

24. Goy J, Rosenberg MW, King WD. Health risk behaviors: examining social inequalities in bladder and colorectal cancers. *Annu Epidemiol* 2008;**18**:156–62.

25. Iversen LH, Pedersen L, Riis A, Friis S, Laurberg S, Sorensen HT. Population-based study of short- and long-term survival from colorectal cancer in Denmark, 1977–1999. *Br J Surg* 2005;**92**:873–80.

26. Engholm G, Kejs AM, Brewster DH, et al. Colorectal cancer survival in the Nordic countries and the United Kingdom: excess mortality risk analysis of 5 year relative period survival in the period 1999 to 2000. *Int J Cancer* 2007;**121**:1115–22.

27. Berrino F, De Angelis R, Sant M, et al. Survival for eight major cancers and all cancers combined for European adults diagnosed in 1995–99: results of the EUROCARE-4 study. *Lancet Oncol* 2007;**8**:773–83.

28. Frederiksen BL, Osler M, Harling H, Jorgensen T. Social inequalities in stage at diagnosis of rectal but not in colonic cancer: a nationwide study. *Br J Cancer* 2008;**98**:668–73.

29. Lemmens VE, van Halteren AH, Janssen-Heijnen ML, Vreugdenhil G, Repelaer van Driel OJ, Coebergh JW. Adjuvant treatment for elderly patients with stage III colon cancer in the southern Netherlands is affected by socioeconomic status, gender, and comorbidity. *Annu Oncol* 2005;**16**:767–72.

30. Meyerhardt JA, Heseltine D, Niedzwiecki D, et al. Impact of physical activity on cancer recurrence and survival in patients with stage III colon cancer: findings from CALGB 89803. *J Clin Oncol* 2006;**24**:3535–41.

31. Meyerhardt JA, Niedzwiecki D, Hollis D, et al. Association of dietary patterns with cancer recurrence and survival in patients with stage III colon cancer. *JAMA* 2007;**298**:754–64.

32. Dignam JJ, Polite BN, Yothers G, et al. Body mass index and outcomes in patients who receive adjuvant chemotherapy for colon cancer. *J Natl Cancer Inst* 2006;**98**:1647–54.

33. Woods LM, Rachet B. Origins of socio-economic inequalities in cancer survival: a review. *Annu Oncol* 2006;**17**:5–19.

34. Blom J, Yin L, Liden A, et al. Toward understanding nonparticipation in sigmoidoscopy screening for colorectal cancer. *Int J Cancer* 2008;**122**:1618–23.

35. Florida R. *The rise of the creative class*. New York: Basic Books; 2002.