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Social inequality in incidence of and survival from cancer in a population-based study in Denmark, 1994–2003: Summary of findings

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ABSTRACT

The purpose of this nationwide, population register-based study was to describe variations in cancer incidence and survival by social position in a social welfare state, Denmark, on the basis of a range of socioeconomic, demographic and health-related indicators. Our study population comprised all 3.22 million Danish residents born in 1925–1973 and aged ⩾30 years, who were followed up for cancer incidence in 1994–2003 and for survival in 1994–2006, yielding 147,973 cancers. The incidence increased with lower education and income, especially for tobacco- and other lifestyle-related cancers, although for cancers of the breast and prostate and malignant melanoma the association was inverse. Conversely there was a general increase in incidence among early retirement pensioners, persons living in rented housing and those living in the smallest dwellings. Also incidence rates were generally higher in persons living alone compared to those living with a partner and in the capital area compared to the rural areas. Social inequality in the prognosis of most cancers was observed, despite the equal access to health care in Denmark, with poorer relative survival related to fewer advantages, regardless of how they were measured, often most pronounced in the first year after diagnosis. Also living alone and having somatic or psychiatric comorbidity negatively impacted the relative survival after most cancers. Our study shows that inequalities in cancer incidence and survival must be addressed in all aspects of public health, with interventions both to reduce incidence and to prolong survival.

1. Background

Socioeconomic position is a commonly used concept in health research, and general inequalities in health reflect social inequalities. An extensive review from the late 1990s provided clear evidence that both cancer incidence and survival are related to social position, lower social position tending to be associated with higher cancer incidence and poorer cancer survival, even if the pattern differs by cancer site.[1] Although Denmark has an extensive welfare system and equal access to health care, social inequalities in both incidence of and survival from some cancers have been observed.[2–4]

Socioeconomic position is based on the social and economic factors that influence the positions individuals or

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groups hold in the structure of a society. Each indicator of socioeconomic position commonly used, such as education, income and occupation, measures a different but related aspect and may be more or less relevant to the outcome being studied. In addition to social gradients by education and income, there may be particularly vulnerable groups, who can be identified by other social or health-related indicators, such as early retirement pensioners, persons living in small apartments or peripheral rural areas or persons with comorbid conditions.

In this nationwide descriptive study, we systematically examined variations in the incidence of and survival from cancer in Denmark on the basis of a range of socioeconomic, demographic and health-related indicators, with the aim of addressing the following questions:What is the effect of indicators of social position on the incidence of cancer? To what extent do these socioeconomic indicators affect survival after cancer? Are some indicators of social position associated with a low incidence of cancer and good chances for survival after cancers at specific sites? Are there, conversely, indicators of social position that are markers for a high incidence of cancer and a worse prognosis?

The purpose of this paper is to summarise the findings from the analyses of cancers at specific sites, highlight patterns of social inequality in incidence and survival and direct attention to groups who bear a disproportionately heavy burden of cancer in Danish society today. The results of this study are important for other industrialised societies, because they mirror a society characterised by a high level of public social security. In general, Danes, although a small population, have organised a society that in many respects is seen as a model of the modern social welfare state.

2. Material and methods

The material and methods are described elsewhere.[5] Briefly, the study population comprised all 3.22 million Danish residents born between 1925 and 1973, and who entered the cohort at age 30 without a previous cancer (see Fig. 1 in [5]) Information on socioeconomic, demographic and health-related indicators was obtained from various Danish registers based on administrative data. The indicators were level of education, disposable income, affiliation to the work market, social class, housing tenure, size of dwelling, cohabitation status, type of district, ethnicity, Charlson comorbidity index, depression and schizophrenia measured at the individual level on an annual basis (see Table 1 in [5] for definition of the variables). Crude, age-specific and age-standardised incidence rates were calculated for 21 cancers at selected sites (see Table 4 in [5]) and for all cancers combined, 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.[6] Further, we used log-linear Poisson regression to model incidence rate ratios (IRRs), first adjusted for period (in 5-year periods) and age (as two continuous variables: age and age^2 in years) and secondly by adding education and disposable income to the models.

The study is based on 3,218,440 persons and 25,764,811 person–years of follow-up for cancer. A total of 147,973 cancers were diagnosed in the cohort, which, due to the age range of the cohort, represents 58% of all cancers diagnosed in Denmark during that period. For each level of each indicator, we conducted relative survival analyses, adjusting for level-specific population mortality amongst the incident cancer cases in 1994–2003 with follow-up through 2006.[5] 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.[5]

In this paper, we present selected estimated IRRs for the cancer sites included and for all cancers in relation to levels of the socioeconomic, demographic and health-related indicators for 1-year and 5-year relative survival. We thus provide an overview of the findings for both incidence and survival for the cancers at the sites investigated and evaluate patterns of social inequality and indications of groups who are vulnerable to cancer or to a worse prognosis. More detailed information on the IRRs and relative survival estimates for each cancer site is provided in separate papers in this supplement to The European Journal of Cancer.[7–17]

3. Social inequality in the incidence of cancer

Table 1 provides a summary of the associations between educational level and disposable income and the incidence rates of cancer, by site. We show the estimated IRRs for persons with basic or high-school education as compared with higher education and with low income (1st quartile) as compared with middle income (2nd and 3rd quartiles), each adjusted for each other. A consistent increase in the incidence rates was observed with shorter education and lower income for cancers of the mouth and pharynx, larynx, oesophagus, stomach, lung, kidney and cervix, all of which are related to tobacco smoking, whereas inverse associations were found for breast cancer, prostate cancer and malignant melanoma, with increasing incidences with longer education and higher income. For pancreas and bladder cancer, associations were found with education but not with income. For the remaining cancers sites, such as colon and rectum cancer, brain or central nervous system cancer and haematological cancers in both sexes and with corpus and ovary cancer in women and testicular cancer in men, no clear associations were found between incidence and socioeconomic position. The incidence of all cancers showed a small but statistically significant excess amongst men, but not women, with low social position (Table 1).

Table 2 provides an overview of the associations between indicators that are markers for possibly disadvantaged or vulnerable groups in regard to cancer incidence. A general pattern in regard to cancer incidence was seen for early retirement pensioners, persons living in rented housing and those living in the smallest dwellings. The first group had a particularly high incidence rate of lung cancer. Further, higher IRR estimates were observed for divorced persons than those who were married, and a similar pattern was seen for single persons and widows and widowers (data not shown). An urban–rural gradient in the incidence rates of most cancers was found, with the highest rates in the capital area and lower rates amongst persons living in peripheral rural areas (Table 2). As the group of immigrants and their descendants was small and heterogeneous, we did not include them

Table 1 – Incidence rate ratios by cancer site for indicators of low social position, basic school or high-school education and low income in persons born in 1925–1973 and aged ⩾30 years in Denmark between 1994 and 2003

Cancer site	Basic or high-school education (adjusted IRR)		Low income (adjusted IRR)		Overall association with low social status
	Men	Women	Men	Women	
Mouth and pharynx	1.43*	1.25	1.74*	1.25*	↑
Larynx	1.67*	3.23*	1.23*	1.18*	↑
Oesophagus	1.30*	0.87	1.16*	1.14	↑
Stomach	1.37*	1.23*	1.20*	1.03	↑
Pancreas	1.20*	1.22*	0.98	0.94	↑/→
Colon	0.93	1.02	0.99	0.95	→
Rectum	1.02	1.12	1.04	1.04	→
Lung	1.53*	1.85*	1.21*	1.06*	↑
Breast		0.80*		0.95*	↓
Cervix		1.33*		1.13*	↑
Corpus		0.98		0.94	→
Ovary		0.97		0.98	→
Prostate	0.81*		0.92*		↓
Testis	1.00		0.91		→
Kidney	1.22*	1.54*	1.13*	1.10	↑
Bladder	1.15*	1.37*	0.97	0.95	↑/→
Malignant melanoma	0.65*	0.69*	0.88*	0.96	↓
Brain and central nervous system	1.04	0.92	1.02	1.05	→
Non-Hodgkin lymphoma	1.10	1.14	1.01	0.98	→
Hodgkin lymphoma	1.05	1.16	1.24	0.92	→
Leukaemias	0.96	1.10	1.04	1.01	→
All cancers	1.10*	1.02	1.07*	1.00	

Adjusted IRR, incidence rate ratios adjusted for age, period, level of education and disposable income; basic or high-school education compared with higher education, and low income compared with middle income.
*95% confidence interval excludes 1.
↑ indicates increased incidence rate ratio with level of indicator in question; ↓ indicates reduced incidence rate ratio with level of indicator in question; → indicates no change in incidence rate ratio with level of indicator in question; / indicates that education and income have different patterns.

in the tables; however, those from non-western countries appeared to have lower incidence rates for most cancers than the total group of Danes, except for stomach cancer,[8] for which the incidence rates were increased in the former group.

Health-related indicators, such as the Charlson comorbidity index, depression and schizophrenia, were included in the study in order to obtain estimates of cancer incidence in persons with major health problems (Table 3). Having chronic somatic disorders, as measured by the Charlson comorbidity index, resulted in increased incidence rates for smoking-related cancers (cancers of the mouth and pharynx, larynx, lung, oesophagus, stomach, pancreas, kidney and bladder) and for haematological cancers (Table 3). Having been hospitalised for depression was associated with increased incidence rates for some smoking-related cancers, i.e. cancers of the mouth and pharynx, larynx and lung in men and women and oesophagus cancer in women. The incidence rates of breast cancer and brain cancer were also increased in women with depression. In persons with schizophrenia, the incidence rates of lung, breast and cervix cancer were increased and the incidence rate of prostate cancer was reduced (Table 3).

4. Social inequality in survival after cancer

Tables 4–7 show the estimates of relative survival (in %) for the levels of each indicator corresponding to the lowest and highest socioeconomic positions, for example, we compared the relative survival of persons with basic or high-school education with that of persons with higher education. Table 4 shows that for most cancers there were marked differences in relative survival by the level of education and disposable income, both 1 and 5 years after cancer diagnosis, persons with the least education and the lowest income having poorer relative survival. Sometimes persons with vocational education had the best survival, after 1 year for lung cancer,[10] after 5 years for colon cancer amongst women,[9] and after 1 year for non-Hodgkin lymphoma.[17]

For all cancers together, an approximately 10% difference was already apparent after 1 year; the difference was only 1–2% greater after 5 years. This overall 10% difference was greater than for most individual cancer sites, as it is a combined effect of more cancers with an overall poor prognosis and poorer relative survival in persons with low social position.

For some cancers, including those at sites with poorer survival, such as cancers of the oesophagus and lung, but also cancers with better prognosis, such as cancers of the ovary and rectum and leukaemia, most of the differences in relative survival between social groups were observed after 1 year, with less difference or none in long-term relative survival.

Early retirement pensioners were identified as having poorer relative survival in both the short and the long term

Table 2 – Incidence rate ratios by cancer site for indicators of disadvantaged groups in persons born in 1925–1973 and aged ⩾30 years in Denmark between 1994 and 2003, by sex and cancer site

Cancer site	Early retirement pensioners (adjusted IRR)		Rented housing (adjusted IRR)		Dwelling < 50 m^2 (adjusted IRR)		Divorced (adjusted IRR)		Peripheral rural area (adjusted IRR)	
	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women
Mouth and pharynx	4.52*	3.50*	2.83*	2.19*	4.08*	2.76*	3.13*	2.14*	0.52*	0.48*
Larynx	2.75*	2.15*	2.27*	2.02*	2.57*	0.81	2.41*	1.96*	0.62*	0.78
Oesophagus	2.43*	2.62*	1.90*	1.54*	2.26*	1.97*	1.95*	1.39*	0.59*	0.53*
Stomach	1.28*	1.43*	1.19*	1.21*	1.28	0.92	1.05	1.56*	0.87	0.77
Pancreas	1.65*	1.34*	1.40*	1.33*	1.51*	1.08	1.35*	1.35*	0.82	0.80*
Colon	1.18*	1.02	1.19*	0.98	1.22*	0.91	1.14*	0.94	0.90	0.92
Rectum	1.18*	1.08	1.17*	1.04	1.10	0.97	1.14*	0.94	0.83*	1.03
Lung	8.56*	4.52*	1.67*	1.57*	2.12*	2.95*	1.72*	1.79*	1.05	1.02
Breast		1.03*		1.04*		1.02		1.04		0.89*
Cervix		1.31*		1.51*		1.55*		1.90*		0.75*
Corpus		0.93		0.94		0.83		0.78*		0.97
Ovary		0.95		1.05		0.98		0.99		1.04
Prostate	0.87*		0.98		0.88		0.97		0.86*	
Testis	1.10		1.10		0.80		1.04		0.89	
Kidney	1.16	1.29*	1.20*	1.17*	1.19	0.81	1.24*	0.96	0.91	1.03
Bladder	1.24*	1.36*	1.21*	1.34*	1.16*	1.00	1.01	1.34*	0.83*	0.76*
Malignant melanoma	0.60*	0.67*	0.88*	0.85*	0.68*	0.75	0.82*	0.84*	0.95	1.03
Brain and central nervous system	1.05	1.10	0.99	1.05	0.72*	0.76	0.91	0.96	0.85	0.87
Non-Hodgkin lymphoma	1.14	1.31*	1.06	1.11*	0.96	0.86	1.03	1.04	0.91	0.90
Hodgkin lymphoma	1.26	1.10	1.29*	1.00	1.06	1.41	0.89	0.96	0.80	1.07
Leukaemias	1.17	0.99	0.97	0.93	1.26	0.86	0.93	0.98	0.83	0.95
All cancers	5.28*	2.57*	1.31*	1.14*	1.53*	1.37*	1.32*	1.16*	0.87*	0.93*
Overall pattern	↑	↑	↑	↑	↑	→/↑?	↑	↑	↓	↓

Adjusted IRR, incidence rate ratios adjusted for age, period, level of education and disposable income; early retirement pensioners compared with persons at work; rented housing compared with owner-occupied housing; dwelling < 50 m^2 compared with dwelling 100–149 m^2; divorced compared with married; peripheral rural area compared with capital area.

*95% confidence interval excludes 1.

↑ indicates increased incidence rate ratio with level of indicator in question; ↓ indicates reduced incidence rate ratio with level of indicator in question; → indicates no change in incidence rate ratio with level of indicator in question.

Table 3 – Incidence rate ratios by cancer site for health-related indicators in persons born in 1925–1973 and aged ⩾30 years in Denmark between 1994 and 2003, by sex

Cancer site	Charlson ⩾ 2 (adjusted IRR)		Depression (adjusted IRR)		Schizophrenia (adjusted IRR)	
	Men	Women	Men	Women	Men	Women
Mouth and pharynx	2.17*	2.75*	1.64*	1.55*	1.09	0.87
Larynx	1.74*	2.76*	1.32	1.50	1.01	0.73
Oesophagus	1.53*	2.03*	1.09	2.06*	1.50	1.41
Stomach	1.35*	1.54*	1.16	1.03	1.32	1.32
Pancreas	1.44*	1.55*	0.84	1.27	0.88	0.88
Colon	1.24*	1.10	1.01	0.92	0.95	0.92
Rectum	1.04	1.00	0.90	0.97	0.70	1.04
Lung	2.01*	2.69*	2.15*	2.01*	3.03*	2.51*
Breast		1.01		1.10*		1.18*
Cervix		1.08		1.00		1.35*
Corpus		0.82*		0.71*		0.87
Ovary		0.94		0.94		0.98
Prostate	1.03		0.93		0.59*	
Testis	1.27		0.78		0.80	
Kidney	1.57*	1.54*	0.91	1.25	1.35	1.31
Bladder	1.44*	1.63*	1.09	1.21	0.87	0.83
Malignant melanoma	0.92	0.87	1.01	0.95	0.86	0.81
Brain and central nervous system	1.20*	1.13	1.10	1.27*	0.78	0.89
Non-Hodgkin lymphoma	1.63*	1.94*	0.99	0.75	1.21	1.13
Hodgkin lymphoma	2.16*	2.41*	0.99	1.08	0.96	1.69
Leukaemias	1.24*	1.14	1.10	0.77	1.05	1.19
All cancers	1.47*	1.39*	1.29*	1.21*	1.47*	1.40*
Overall pattern	↑	↑	(↑)	(↑)	(↑)	(↑)

Adjusted IRR, incidence rate ratios adjusted for age, period, level of education and disposable income; Charlson ⩾ 2 compared with Charlson 0; depression compared with no depression; schizophrenia compared with no schizophrenia.
*95% confidence interval excludes 1.
↑ indicates increased incidence rate ratio with level of indicator in question; ↓ indicates reduced incidence rate ratio with level of indicator in question; → indicates no change in incidence rate ratio with level of indicator in question; (↑) indicates incidence rate ratios not increased for most sites but overall increase due to increases for major sites.

(Table 5). For all cancers together, the difference in relative survival between early retirement pensioners and persons active in the work market was almost 20%, again with a combined effect of more cancers with a poor prognosis and poorer relative survival from cancers at most sites. Relative survival was also poorer amongst persons living in rented rather than owned housing and for those who lived in smaller rather than larger housing (Table 5).

With respect to demographic indicators for short-term survival, being married was generally associated with longer relative survival, although most of the confidence intervals overlapped (Table 6). The difference was more pronounced for men than for women with colon and rectum cancer and some of the smoking-related cancers, such as of the mouth and pharynx, larynx, kidney and urinary bladder. Divorced persons (Table 6), widows and widowers and single persons had poorer relative survival than married people from cancers at many sites (data not shown). No general pattern in relative survival from any cancer could be discerned by type of district (Table 6). The relative survival of immigrants or their descendants from non-western countries seemed to be, if anything, better than that of the combined group of Danes; however, the estimates for these heterogeneous groups must be interpreted cautiously (data not shown).

Having somatic or psychiatric comorbidity appeared to be associated with poorer relative survival than for patients without, but the confidence intervals overlapped for most sites (Table 7). For cancers such as those of the larynx and urinary bladder cancer and malignant melanoma and non-Hodgkin lymphoma, men with a score of 2 or more on the Charlson comorbidity index had significantly poorer 5-year relative survival than men with a score of 0 (Table 7). The relative survival of cancer patients with depression or schizophrenia was significantly worse for only a few sites, i.e. for men with stomach cancer (1-year relative survival), for breast, ovary and rectum cancer in women (1-year relative survival) and for cervical cancer both 1 and 5 years after diagnosis.

5. Comment

In this paper, we have summarised the findings of a nationwide population-based study of the effects of socioeconomic, demographic and health-related indicators and on the incidence of and survival from cancers diagnosed between 1994 and 2003 in Denmark. Access to complete nationwide data sources based on data collected for administrative purposes and covering the entire Danish population and use of the unique personal identification numbers ensured a design that is virtually free of information or selection bias and essentially eliminates loss to follow-up. The outcome studied was obtained from the oldest cancer register in the world, established in 1943.[18] We were able to obtain individual information on social and economic status, demography and health at a level of detail that is unique, as access to

Table 4 – Indicators of social position and relative 1-year and 5-year survival (in %), by cancer site, in persons born in 1925–1973 and aged ⩾30 years in Denmark between 1994 and 2006

Cancer site	Level of education				Disposable income			
	Basic or high-school/higher				Low/high			
	Men		Women		Men		Women	
	1-year RS	5-year RS	1-year RS	5-year RS	1-year RS	5-year RS	1-year RS	5-year RS
Mouth and pharynx	66/78*	30/39	76/73	44/47	66/80*	25/46*	68/73	42/43
Larynx	85/89	52/59	81/76	54/65	81/94*	45/63*	77/90	50/71
Oesophagus	27/36*	5/7	30/52*	6/16	25/34	4/7	31/29	5/8
Stomach	39/41	13/10	38/38	16/15	37/41	12/13	37/42	15/18
Pancreas	14/16	2/3	16/15	2/2	17/20	3/3	15/16	1/3
Colon	69/75*	42/46	73/77	46/49	67/77*	40/46*	73/79*	45/55*
Rectum	77/84*	44/50	81/88*	51/57	75/84*	41/51*	82/87	49/58
Lung	28/34*	7/10*	33/34	9/10	27/33*	7/8*	32/36	9/10
Breast			95/98*	77/84*			95/97*	75/83*
Cervix			88/94*	68/78*			87/92*	68/73
Corpus			93/95	79/81			92/96*	77/83*
Ovary			74/81*	37/36			73/82*	36/39
Prostate	88/92*	47/59*			88/93*	47/56*		
Testis	98/99	93/97			97/99	93/97		
Kidney	62/68	38/41	61/74*	42/49	62/68	37/44	60/70	38/50
Bladder	86/93*	68/75*	81/89*	62/70	85/93*	65/74*	81/86	60/66
Malignant melanoma	93/97*	75/81*	97/98	86/92*	91/96*	73/82*	97/98*	87/92*
Brain and central nervous system	60/69*	39/47*	72/79*	58/66*	60/67	42/43	72/76	58/65
Non-Hodgkin lymphoma	73/79	48/58	80/85	58/65	72/79	46/56*	83/83	59/68
Hodgkin lymphoma	90/93	82/76	90/97	78/90	91/91	78/78	93/94	81/87
Leukaemias	72/80*	46/54	71/78	46/52	72/78	45/56*	73/79	49/57
All cancers	62/73*	37/48*	72/82*	50/62*	60/73*	34/48*	72/82*	49/62*

RS, cumulative level-specific relative survival in %.
Basic or high-school compared with higher education, and low income compared with high income.
*95% confidence intervals non-overlapping between levels of indicator.

Table 5 – Indicators of social position and relative 1-year and 5-year survival (in %), by cancer site, in persons born in 1925–1973 and aged ⩾30 years in Denmark between 1994 and 2006

Cancer site	Affiliation to work market				Housing tenure				Dwelling size (m^2)			
	Early retirement pensioner/working				Rental/owner-occupied				0–49/> 150			
	Men		Women		Men		Women		Men		Women	
	1-year RS	5-year RS	1-year RS	5-year RS	1-year RS	5-year RS	1-year RS	5-year RS	1-year RS	5-year RS	1-year RS	5-year RS
Mouth and pharynx	64/82*	27/46*	63/85*	35/55*	64/78*	30/38*	72/76	41/45	56/78*	21/42*	81/77	29/50
Larynx	80/90*	40/59*	70/91*	38/70*	81/90*	48/60*	82/79	54/57	79/93*	38/65*	102/90*	55/68
Oesophagus	24/36*	4/8	26/43	4/13	30/30	6/7	31/33	6/9	19/33	3/5	32/35	0/9
Stomach	35/44	12/15	34/43	15/20	39/40	14/12	34/39	10/18	38/42	16/15	17/42	9/20
Pancreas	19/11	3/3	16/22	2/4	12/18*	2/3	16/16	2/2	14/19	7/2	12/16	9/3
Colon	60/77*	35/48*	66/80*	39/52*	66/75*	39/46*	72/76	47/49	62/77*	36/49	53/78*	37/51
Rectum	79/84	44/51	84/88	51/57	77/80	43/48*	81/83	50/55	71/82	41/48	78/86	29/59*
Lung	23/37*	8/10	35/41*	10/11	28/31*	7/8	33/34	9/9	18/33*	4/9*	25/37*	6/11
Breast			94/98*	76/83*			95/97	77/80*			94/97*	73/81*
Cervix			78/94*	55/79*			87/91*	68/73*			69/91*	56/73*
Corpus			93/96	86/87			92/94	78/81			93/96	82/83
Ovary			71/88*	35/48*			76/78	38/46			64/81	34/39
Prostate	91/91	44/50			87/91*	51/52			80/92*	38/55*		
Testis	94/99	84/96			97/98	92/96*			98/97	85/94		
Kidney	56/72*	35/49*	57/79*	49/58	57/67*	37/41	64/66	43/44	55/68	40/42	83/66	76/43*
Bladder	88/93*	69/81*	80/93*	65/80*	85/90*	66/70*	79/85*	60/67*	75/91*	53/71*	92/86	65/70
Malignant melanoma	97/97	78/84	95/98*	93/92	94/95	77/80	97/98	88/89	91/95	67/81	99/97	94/90
Brain and central nervous system	59/73*	39/50	75/83	64/69	59/64	39/42	74/75	60/62	51/66	39/45	62/76	56/63
Non-Hodgkin lymphoma	68/85*	43/64*	75/90*	57/76*	72/79*	45/56*	82/82	58/62	67/81	48/57	57/86*	49/66
Hodgkin lymphoma	82/95	86/87	72/98	64/91	87/92	74/81	89/95	77/85	94/92	89/79	100/97	101/89
Leukaemias	72/81	44/58	64/81*	43/58	71/76	44/51*	69/74	45/49	69/76	34/52	85/75	69/47
All cancers	53/74*	31/52*	70/87*	50/68*	59/68*	35/43*	72/77*	50/56*	52/61*	29/46*	65/80*	45/59*

RS, cumulative level-specific relative survival in %.

Early retirement pensioners compared with being at work, rented housing compared with owner-occupied housing and small dwellings (0–49 m^2) compared with large dwellings (⩾m^2).

*95% confidence intervals non-overlapping between levels of indicator.

Table 6 – Demographic indicators of social position and relative 1-year and 5-year survival (in %), by cancer site, in persons born in 1925 and 1973 and aged ⩾30 years in Denmark between 1994 and 2006

Cancer site	Cohabitation status				Type of district			
	Divorced/married				Peripheral rural area/capital area			
	Men		Women		Men		Women	
	1-year RS	5-year RS	1-year RS	5-year RS	1-year RS	5-year RS	1-year RS	5-year RS
Mouth and pharynx	64/76*	27/40*	69/78	39/46	69/79	29/31	86/69*	61/40
Larynx	77/90*	37/61*	78/82	41/56	85/83	55/50	75/77	49/53
Oesophagus	23/32*	4/7	23/36	2/11	17/30	3/5	46/33	10/5
Stomach	33/41	9/14	31/39	11/17	37/40	12/12	48/35	24/12
Pancreas	13/16	2/3	15/16	1/3	21/14	5/3	12/14	0/2
Colon	67/74*	40/46	75/75	46/49*	73/72	41/43	72/75	50/50
Rectum	73/81*	35/49*	79/83	48/55	81/80	50/46	80/81	48/52
Lung	24/32*	6/8*	34/34	8/9*	32/29	8/7	35/33	11/9
Breast			96/97	78/80*			97/96	79/80
Cervix			86/91	66/72			87/90	68/71
Corpus			93/94	79/81			95/94	83/80
Ovary			74/80	32/38			77/79	41/35
Prostate	87/91*	48/53			88/91	43/57*		
Testis	97/98	91/95			99/98	99/95		
Kidney	52/67*	28/42*	62/68	42/46	60/61	37/39	66/68	50/49
Bladder	84/90*	63/70*	82/84	62/66	87/87	66/69	81/84	63/65
Malignant melanoma	92/95	77/80	96/98	89/90	93/96	81/82	100/97*	92/89
Brain and central nervous system	57/63	38/41	70/74	54/61	63/61	40/39	70/75	57/61
Non-Hodgkin lymphoma	71/81*	49/56	86/84	60/63	76/77	56/51	78/82	48/62
Hodgkin lymphoma	81/92	64/79	88/96	88/86	75/83	58/71	100/94	68/85
Leukaemias	72/75	49/52	70/73	48/49	64/76	34/52*	66/77	43/55
All cancers	56/68*	31/43*	71/77*	48/56*	64/65	38/41*	75/76	54/55

RS, cumulative level-specific relative survival in %.
Divorced compared with married and peripheral rural areas compared with capital area.
*95% confidence intervals non-overlapping between levels of indicator.

Table 7 – Indicators of health and relative 1-year and 5-year survival (in %), by cancer site, in persons born in 1925–1973 and aged ⩾30 years in Denmark between 1994 and 2006

Cancer site	Charlson comorbidity index				Depression				Schizophrenia or other psychosis			
	⩾2/0				Yes/no				Yes/no			
	Men		Women		Men		Women		Men		Women	
	1-year RS	5-year RS	1-year RS	5-year RS	1-year RS	5-year RS	1-year RS	5-year RS	1-year RS	5-year RS	1-year RS	5-year RS
Mouth and pharynx	58/73*	27/35*	64/78*	29/46	70/70	31/33	72/74	37/42	66/70	7/33	64/74	69/42*
Larynx	73/88*	38/56*	75/79	61/58	86/85	52/54	77/81	57/56	95/85	77/53	104/80	121/55
Oesophagus	25/31	7/6	22/34	5/8	17/30	5/7	38/32	13/7	31/30	0/7	19/33	15/8
Stomach	32/40	7/13	35/36	9/15	16/40*	8/13	17/38	0/15	32/40	0/13	8/38	0/15
Pancreas	11/16	2/3	8/16	2/2	8/16	0/3	17/16	2/2	0/16	0/3	14/16	0/2
Colon	66/73*	41/45	70/75	46/48	67/72	40/44	77/74	50/48	58/72	28/44	76/74	47/48
Rectum	75/80	42/47	78/83	51/52	79/79	45/46	86/82	51/53	51/79*	27/46	60/83*	34/53
Lung	27/30	7/8	31/34	7/9	29/30	6/8	34/34	10/9	21/30*	5/8	29/34	6/9
Breast			95/96	76/79			96/96	78/79			93/96*	74/79
Cervix			81/90	58/72			80/89	60/71			66/90*	46/71*
Corpus			90/94	76/79			93/94	80/80			81/94	64/80
Ovary			63/79*	32/38			76/77	33/37			58/77*	22/37
Prostate	89/90	51/52			88/90	54/52			80/90	40/52		
Testis	95/98	94/95			89/98	92/95			101/98*	98/95		
Kidney	64/65	34/40	57/66	40/43	61/64	35/39	61/65	41/44	44/64	38/39	69/65	58/44
Bladder	83/89*	59/71*	73/84*	46/66*	85/88	70/69	75/83	64/64	80/88	68/69	75/83	63/64
Malignant melanoma	85/95*	58/79*	96/98	88/89	97/95	66/79	97/98	85/89	100/95	84/79	98/98	70/89
Brain and central nervous system	62/63	38/42	73/75	55/62	70/62	53/41	74/74	63/61	48/62	28/41	76/74	63/61
Non-Hodgkin lymphoma	57/79*	39/54*	75/84	51/63*	87/77	57/53	83/82	61/61	66/77	39/53	74/82	57/61
Hodgkin lymphoma	83/90	83/78	79/96	81/85	101/90	58/78	77/93	60/83	101/90	107/78	100/93	102/82
Leukaemias	61/76*	34/51*	69/74	38/49	80/74	49/49	53/73	41/48	45/74	36/49	46/73	38/48
All cancers	56/67*	32/42*	64/77*	43/56*	60/65*	35/40*	70/75*	48/54*	48/65*	28/40*	66/75*	44/54*

RS, cumulative level-specific relative survival in %.

Charlson comorbidity index score ⩾2 compared with score 0, depression compared with no depression and schizophrenia or other psychosis compared with no schizophrenia or other psychosis.

*95% confidence intervals non-overlapping between levels of indicator.

national statistics for scientific purposes is possible in only a few countries in the world.

The age limits for the cohort were defined to cover persons of working age and those who had recently left the labour market. This was partly because the reliability and availability of data on socioeconomic status in Danish registers are poorer for the oldest section of the population. As we aimed to include the most recent population data, we analysed cancer incidence over a rather short period, some 10 years. Although this limitation precludes analyses of trends over time, we obtained an updated 'snapshot' of the importance of different indicators of social position for the incidence of and survival from cancer in Danish society today.

We saw relatively clear patterns of social inequality in the incidence rates of especially the smoking-related cancers (cancers of the mouth and pharynx, larynx, oesophagus, pancreas, lung, kidney, cervix and urinary bladder).[19] There was thus a stepwise increase in the incidence rates with decreasing social position, measured as both level of education and disposable income. Even after adjustment for these two factors, however, an effect was still seen for poorer affiliation to the labour market and living in small housing, as shown in more detail in the site-specific papers. Early retirement pensioners in particular had higher incidence rates of many cancers, particularly lung cancer. Although some 30% of the person–years were accumulated by persons living in rented housing, this factor still resulted in increased incidence rates for many cancer sites after adjustment for education and income, suggesting that housing tenure, which is a measure of material aspects of socioeconomic circumstances,[20] is associated with aspects of social position other than education and income. For breast cancer, prostate cancer and malignant melanoma, the situation was generally reversed, with increasing incidence rates associated with higher social position.[11,13,15] In addition, there was a slight but significantly higher (5%) incidence rate of breast cancer amongst women receiving early retirement pension, which might partly reflect the higher IRR for breast cancer observed in women with either depression or schizophrenia.[11]

The incidence rate differences calculated by level of education provide an overall estimate of the potential for prevention, which is large for many cancer sites at a population level. We estimated that the incidence rates of most smoking-related cancers could be reduced by 25–50% in the group with basic or high-school education if they have the same risk factor profile as persons with higher education, and this applies to both men and women.[7,8,10,14] Likewise, the incidence rates of breast cancer, prostate cancer and malignant melanoma in the group with higher education could be reduced by 20–40% if they have the same risk factor profile as the group with basic or high-school education.[11,13,15]

Many of the risk factors for cancer, such as smoking, alcohol intake, unhealthy diet and a sedentary lifestyle, are concentrated in less advantaged groups.[21–23] It is therefore not surprising that most of the cancers for which relatively large incidence rate differences were seen were cancers with a strong lifestyle component, such as smoking-related cancers. The magnitude of the differences observed not only indicates a large potential for prevention but also poses challenges, as some of the lifestyle factors that probably play a role in the social gradients observed in this study might be distributed even more unevenly amongst social groups in the future, as lifestyle is closely linked to the material and cultural resources that make up socioeconomic position. Nevertheless, prevention initiatives targeted at socially disadvantaged groups might have a strong effect on public health. Cancers that occur at higher incidence amongst affluent persons than those with lower social status represent another area for preventive policies. There is currently no scientific evidence to explain why prostate cancer occurs in excess amongst men of high social status. Most studies have identified reproductive factors as the explanation for the high incidence of breast cancer in affluent women. Likewise, financial ease is probably the explanation for the fact that persons of high socioeconomic status travel more, which might explain their higher incidence of melanoma. There is clear preventive potential for this cancer.

The pattern of social inequality in relative survival from cancer is more uniform across sites with survival being reduced in disadvantaged groups or no differences amongst groups. For some cancers, mainly those with poorer survival such as of the oesophagus and lung but also cancers of the ovary and kidney, differences amongst social groups were observed only for the short term. For other cancers, the inequalities remained throughout the 5 years of observation, including cancers of the colon, breast, cervix, prostate and urinary bladder, and malignant melanoma and non-Hodgkin lymphoma. Information on tumour stage was not available; however, cancer patients of higher socioeconomic position might have benefitted from, e.g. earlier diagnosis, which would result in differential stage distribution by socioeconomic position and might explain some of the differences in short-term survival from some cancers. Other explanations might be differences in peri-operative mortality and in access to state-of-art treatment,[24–27] by social position. Some socioeconomic factors, such as affiliation to the work market and educational level, did in fact predict a delay in cancer diagnosis in a Danish population-based cohort study of cancer patients and their general practitioners.[28] This is similar to the findings from a UK population-based study that showed that delay of diagnosis and treatment was longer in lower socioeconomic groups than in higher socioeconomic groups.[29]

Comorbidity was a marker for worse relative survival from cancers at many sites. In the previous studies also, comorbidity had been found to be related to stage of and survival from cancers of the breast, ovary and prostate in Denmark.[3,30–32] Presence of concurrent disease at the time of cancer diagnosis might lead to incomplete staging and less tolerance for the necessary cancer treatment, and thus possibly influence therapeutic decision making. We were unable to examine whether comorbidity had differential prognostic impact by socioeconomic position, but our finding that comorbidity influenced survival after most cancers is compatible with other population-based studies, i.e. based on the Eindhoven Cancer Registry where an independent prognostic effect of comorbidity for several cancers was observed.[33–35] Improved access to or compliance with treatment of comorbid disorders must be a priority in cancer patients of all socioeconomic groups.

The number of cancer cases for which there is social inequality in long-term survival is relatively large. Cancers of the colon, breast and prostate, and malignant melanoma and non-Hodgkin lymphoma constitute roughly one-third of all cancer cases in Denmark, and interventions must therefore target social inequality in the management of these cancers. We had no information on access to or compliance with treatment regimens or information from clinical monitoring of outpatients. Therefore, the observed differences in relative survival might be due to differences in access to treatment, including second-line or experimental treatment, and to differences in stage distribution, despite the supposedly equal access to treatment and care in Denmark.

Further, it is likely that social inequalities in health in general,[36,37] play a role in the long-term differences in survival from cancer. In the Eurocare studies, cancer patients in Denmark consistently had the poorest survival of all the countries in northern Europe, the survival estimates being closer to the average of countries in western Europe and close to estimates in England and Scotland, although better than those for eastern Europe.[38–40] For cancers of the stomach, colon, rectum, lung, breast, prostate and all sites combined, the Danish 5-year relative survival rate is below the European average; only the rates for survival from cancers of the cervix and testis and malignant melanoma are above the European average.[38] These findings, especially in comparison with other northern European countries, contributed importantly to the formulation of the national action plan against cancer. Two of the strongest measures of social position, level of education and disposable income, indicate clearly that survival from cancers of the lung, colon, rectum, breast, prostate and cervix amongst groups with higher social status is equal to or even better than the survival observed in the other countries of northern Europe.[38] The high incidence of and poor survival from smoking-related cancers show clearly that the very high prevalence of smoking in Denmark over the past several decades has played an important role.

Tobacco use is, however, not the only explanation, as Danish patients with cancers not related to smoking (breast, melanoma, prostate) also had poorer survival compared to those in northern Europe, although socially advantaged groups had better survival.[11,13,15] For cancer of the prostate, the survival of persons of high social status was similar to that seen in the other Nordic countries, where testing for prostate-specific antigen (PSA) is common and the incidence rates are high, which may indicate inequality in the use of health care. There is no formal screening programme for prostate cancer in Denmark, and the extent of PSA screening amongst Danish men has been limited.[41,42] It is likely that men of higher social status are better informed and, consequently, more aware of the symptoms and the possibility of asymptomatic (latent) prostate cancer. They would therefore be more likely to ask for a PSA test. As a result, differential 'grey zone' screening might influence not only the incidence but also the survival pattern by social group.

Our findings for relative survival from cervix cancer are interesting in this context. In the Eurocare project, the rates in Denmark are better than the average[38]; however, when only Danish patients of higher social position are considered,[12] the survival estimates exceed even those of Iceland, which has the best survival rates in Europe.[38] Compliance with the screening programme for cervix cancer in Denmark is fairly good but is likely to be influenced by social status, as reflected in both short- and long-term inequalities. Well-organised programmes for early detection with high compliance might limit social differences in cancer care. Thus, the challenge is to increase participation in or procedures for early detection and to improve treatment for all social groups.

This study covers an entire nation, which for historical and cultural reasons has striven to ensure equality in all aspects of life. This political and administrative goal covers all facets of public social support and preventive public health interventions; however, our study shows that, even in an egalitarian developed country, social inequality has not been completely banished from public health. The results show that, even in the incidence of and survival from cancer, socioeconomic position plays a role. Our results are relevant for all societies in which health interventions are established in accordance with the goal of equal access to public services. The results show that consideration must be given to how inequalities in cancer incidence and survival can be addressed in public health interventions and indicate that further research into the underlying mechanisms is required.

Conflict of interest statement

None declared.

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