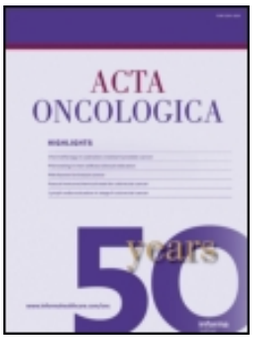

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ORIGINAL ARTICLE

Survival of patients diagnosed with cancer in the Nordic countries up to 1999–2003 followed to the end of 2006. A critical overview of the results

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Abstract

Differences in Nordic cancer patient survival observed today originate from the 1970s, but were first identified in a mortality prediction from 1995. This paper provides timely comparisons of survival using NORDCAN, a database with comparable information from the Nordic cancer registries. Elucidation of the differences is important when monitoring cancer care generally and evaluating the impact of cancer plans. *Material and methods*. The NORDCAN database 1964–2003 with follow-up for death through 2006, was used to analyse incidence, mortality, and survival for all NORDCAN cancer sites. We analysed 5-year relative survival and excess mortality rates in the first three months and 2–5 years after diagnosis. *Results*. The time trends in survival 1989–2003 were largely similar between the Nordic countries with increases in 14 sites among men and 16 among women. In all countries the excess mortality rates were highest in the first three months after diagnosis, but decreased to similar levels across all countries 2–5 years after diagnosis. Comparing countries excess mortality was highest in Denmark irrespective of follow-up period. Lower survival was observed for Danish cancer patients in 23 of the 33 cancer sites in men and 26 of 35 sites in women. Low and similar levels of survival were observed for cancers of the oesophagus, lung, liver and pancreas, while an 8–10 percentage point difference in survival was found between countries for colorectal cancer. *Conclusion*. The notable differences in Nordic cancer patient survival can be linked to national variations in risk factors, co-morbidity, and the implementation of screening. Improved treatment and primary prevention, in particular the targeting of tobacco and alcohol use, is required to improve cancer control. The recently-initiated cancer plans in Denmark and Norway are yet to show an observable effect on the corresponding cancer survival.

Survival differences among Nordic cancer patients have been reported in several publications [1–6]. The first comprehensive account of differences across all primary sites, published in 1964, reported a lower survival in Finland compared to the other Nordic countries [1]. In contrast, the most recent Nordic analysis from 1995 [2] showed Danish patients to have the lowest survival. Part of the data were re-analysed in a European setting by the EUROCARE group, which confirmed the findings and demonstrated that the Nordic countries, except Denmark, had the highest cancer survival in Europe [7,8].

The repeated observation of a lower survival in Denmark pointed to the need for a comprehensive cancer control plan in Denmark, of which the first was launched in the year 2000, and a follow-up plan in 2004 [9,10]. The Cancer Society and other professional societies in oncology and diagnostics initiated working groups some years prior to the launch of the plan, leading to a partial implementation of the recommendations ahead of the official launch. When launched, the plan lead to a fast renewal and expansion of radiotherapy equipment, a boost in modern imaging techniques, implementation of new chemotherapeutic regimes, and a substantial financial commitment from the government for cancer care. The second plan included organisation of surgery and screening and packages

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securing a fast track of patients and minimal waiting times.

The Finnish government appointed in April 1952 a committee commissioned "to make a proposal for intensification of the control of malignant diseases". In the summary of the committee's report the following was stated: "There exists as yet no reliable preventive method for the control of malignant diseases". Therefore, the committee recommended intensification of early diagnosis, an increase in therapeutic facilities and a promotion of research [11]. A cancer control plan for preventing cancer was then subsequently formulated in Finland already in 1984, highlighting the need for health education, research, tobacco and alcohol control, better nutrition, and protection against environmental cancer risks [11], and a comprehensive plan adding diagnostics and therapy to the previous was launched in March 2010. In Norway, a government-backed comprehensive cancer plan with 20 specific tasks in the domains of prevention, early diagnosis and screening, through to improved care and better organisation of care, education, financial matters, and research was published in 1997 [12]. While in Sweden, the regional and national cancer care programmes based on clinical guidelines have since the 1970s been lead, updated, and followed by the various health regions. This is a first very important step in a cancer plan, and should become part of a comprehensive approach, from prevention and early diagnosis through to rehabilitation and palliation. Further, sufficient funding and government support are required to ensure the goals of a WHO cancer plan strategy are reached. Cancer was given limited focus in Iceland in the second health plan implemented in 2001.

To assess the impact of the plans it is necessary to follow both the care and quality of life of the patients and the outcomes of a comprehensive approach to cancer, for which incidence, mortality, and survival are essential measures. However, it is insufficient to judge these in national settings, and international benchmarking is needed [13], and may be assessed within a reasonably short period of follow-up. Hence a comparable dataset is paramount, and for this purpose the NORDCAN database [14,15] was established to serve as a basis for research and a tool for monitoring cancer in the Nordic countries. The aim of this study is to give an overview of Nordic cancer patient survival across cancer sites and to study the current trends in survival some 10 years after the last comprehensive review [2]. The present paper summarises the most recent survival results from a series of site-specific papers [16–27] with a view to assessing the impact on survival of a shifting focus on cancer control in the Nordic countries during the last decade.

Material and methods

We compiled the results for the time period 1999–2003 followed through 2006 as analysed in the series of papers studying survival trends for cancer patients in the Nordic countries 1964–2003 [16–27]. A uniform set of methods was used in these reports, as explained in detail in Engholm et al. [16]. In brief, we used the NORDCAN database, and hence the data have been checked and converted to well-defined entities. We included all cancer patients diagnosed with malignant neoplasms (ICD 10: C00-C95+D09.0+D41.4+D32-33+D42-43) excluding non-melanoma skin cancer (ICD10: C44+C46.0) 1999–2003 in Denmark, Finland, Iceland, Norway, and Sweden, and supplemented the cancer records with individual follow-up for death and emigration up to the end of 2006. All sites combined (excluding non-melanoma skin cancer) were analysed in three ways, with and without adjustment for case-mix, and with another case-mix adjustment which excluded breast and prostate cancer for women and men, respectively [16,27]. We used a hybrid analysis combining period and cohort survival [28] for the period 1999–2003. Country-specific life tables were used to calculate the expected survival. Age-standardisation was performed using the standard weight distributions for cancers (ICSS standards) as in the EUROCARE-4 analysis [29]. Patients were followed until death, emigration or loss to follow-up, or to the end of 2006. Excess mortality rates were stratified into short intervals after diagnosis: the first month, the first three months, 1–3 months, 4–12 months and yearly intervals thereafter.

In order to evaluate if 5-year relative survival ratios could be predicted by excess mortality rates in the first three months following diagnosis across sites, we plotted the age-standardised 5-year relative survival ratio against the excess mortality rate in the first three months for the 15 largest cancer sites 1999–2003 for each sex after breast and prostate cancer were excluded. This was applied for each combination of country and sex. For each plot a LOESS curve [30] was fitted and the sex-specific LOESS-curves for the five countries were compared. The comparisons were made in figures with the excess mortality rates on a logarithmic axis.

The trends in survival were assessed by comparing the 5-year relative survival ratios in 1999–2003 with the two preceding periods 1989–93 and 1994–98. We present 5-year age-standardised relative survival ratios (RS) for 1999–2003 and a graphical symbol (arrows) of time trends. Further tables are presented describing the highest and lowest 5-year age-standardised relative survival ratios by country, site and sex, and tables on excess mortality rates for the follow-up periods, the first three months and 2–5 years following diagnosis.

Results

Tables I and II for men and women respectively, present an overview of the 5-year age-standardised relative survival ratios in the Nordic countries by site for the most recent period 1999–2003, and the trends in survival observed during the three calendar periods 1989–1993, 1994–1998, 1999–2003, with the direction of the trend indicated by arrows. Due to the small numbers of cancer cases in Iceland it was often difficult to assess the temporal development.

For cancers of the oesophagus, colon, rectum, prostate, kidney, and Hodgkin lymphoma among men, survival has increased in all countries since 1989, as also seen for other haematological malignancies, cancers of the brain, tongue, pharynx, and melanoma of the skin. Cancer survival in women has increased in all countries since 1989 for Hodgkin lymphoma, and cancers of the breast, corpus uteri and brain, and increased in most countries for cancers of the stomach, colon, rectum, lung, ovary, kidney, bladder, as well as other haematological malignancies and melanoma of the skin.

In general, the 5-year age-standardised survival ratios for cancers in lip, oral cavity and pharynx in men and women were lowest in Denmark with the exception of pharyngeal cancer in Norway. The Danish deficit relative to the other countries was statistically significant for cancers of the tongue and mouth, with the exception of Finland (males). The same pattern, with lower survival in Denmark, was seen for cancers of the digestive tract with the exception of cancers of the gallbladder and extrahepatic biliary ducts and pancreas in both sexes, with equally poor survival in all countries, and for cancer of the liver in women. For cancers of the respiratory tract, survival was fairly

Table I. Five-year age-standardised relative survival (%) (RS) with 95% confidence intervals (CI) by site and country for patients diagnosed 1999–2003 and trends in survival 1989–2003. Nordic cancer survival study: Men.

	Denmark		Finland		Iceland		Norway		Sweden		Survival trend
Site	RS	CI	RS	CI	RS	CI	RS	CI	RS	CI	1989–2003
Lip	89	84–94	91	87–95	*	*	91	86–97	91	88–95	↔
Tongue	35	30–40	50	42–59	*	*	45	39–51	46	41–51	↑↔
Salivary glands	56	48–66	58	49–68	*	*	57	49–66	64	58–70	↔
Mouth	41	36–46	43	38–49	*	*	48	42–55	50	46–54	↔
Pharynx	34	30–38	38	33–44	*	*	33	29–37	36	34–39	↑↔
Oesophagus	6	5–7	9	7–11	12	7–21	8	6–11	11	10–13	↑
Stomach	14	12–15	26	24–27	22	16–31	20	18–22	20	18–21	↔↕
Small intestine	35	28–44	54	47–61	*	*	48	42–55	52	48–56	
Colon	49	47–50	59	57–61	55	49–62	55	54–57	56	55–57	↑
Rectum and anus	49	48–51	57	55–59	65	55–76	57	56–59	57	56–58	↑
Liver	3	2–4	8	6–10	7	3–21	5	4–8	7	6–8	↔
Gallbladder and ducts	10	8–14	13	10–17	17	8–38	14	11–19	13	11–16	↔
Pancreas	3	2–3	3	2–4	3	1–9	3	3–5	4	4–5	↔
Nose and sinuses	54	47–62	44	36–54	*	*	49	40–59	52	45–59	↔
Larynx	60	57–64	61	56–66	73	59–91	66	62–71	66	63–69	↔
Lung	8	7–9	8	8–9	11	9–15	10	9–10	11	10–12	↔
Pleura	4	2–6	6	4–9	*	*	2	1–4	4	3–6	↔
Prostate	53	51–55	86	84–87	81	78–85	78	77–79	81	80–82	↑
Testis	93	89–97	88	83–94	*	*	92	88–97	94	90–97	↔
Penis and other genital	74	67–81	62	51–74	*	*	80	73–88	70	65–75	↔
Kidney	40	38–43	57	54–59	60	51–70	51	49–54	52	50–54	↑
Bladder	71	69–72	74	73–76	76	70–82	73	72–75	74	73–75	↔↑
Skin melanoma	80	78–82	82	80–85	93	89–98	78	77–80	86	85–88	↑↔
Eye	69	61–78	83	74–93	*	*	76	68–85	77	71–84	↔
Brain	46	44–48	52	50–54	40	34–48	45	43–47	48	47–50	↑↔
Thyroid	68	63–74	81	77–85	85	74–96	82	76–87	81	77–85	↔
Bone	55	47–66	62	54–71	*	*	54	45–65	64	58–71	↔↑
Soft tissues	61	57–66	65	61–70	*	*	66	62–71	62	59–66	↔
Non-Hodgkin lymphoma	50	48–53	53	51–55	56	47–67	51	48–53	54	53–56	↑↔
Hodgkin lymphoma	80	77–84	85	81–88	*	*	84	81–88	84	81–86	↑
Multiple myeloma	28	25–31	34	31–37	29	19–42	36	33–39	37	35–39	↑↔
Acute Leukaemia	41	38–45	42	38–46	*	*	38	33–43	43	40–46	↑↔
Other leukaemia	63	60–65	55	52–58	71	59–85	58	55–61	68	66–70	↑↔

↑ Increasing trend; ↔ Level trend; ↕ Increasing and decreasing trends; (if more arrows are presented for a cancer site the first indicate the dominating trend in the Nordic countries and the second most often the trend in Iceland).
*Too few cases to calculate survival.

Table II. Five-year age-standardised relative survival (%) (RS) with 95% confidence intervals (CI) by site and country for patients diagnosed 1999–2003 and trends in survival 1989–2003. Nordic cancer survival study: Women.

	Denmark		Finland		Iceland		Norway		Sweden		Survival trend
Site	RS	CI	RS	CI	RS	CI	RS	CI	RS	CI	1989–2003
Lip	87	81–95	97	92–101	*	*	94	87–101	94	90–98	↔
Tongue	46	40–53	67	61–74	*	*	59	51–67	58	53–64	↔
Salivary glands	66	58–76	65	58–74	*	*	66	57–76	73	67–79	↔
Mouth	49	44–54	69	63–75	56	40–79	61	55–68	60	56–64	↔
Pharynx	34	29–39	51	43–61	*	*	30	25–36	45	41–50	↔
Oesophagus	7	5–10	20	16–25	9	3–25	9	6–13	14	11–17	↔↑
Stomach	14	12–16	30	28–33	43	33–56	24	22–27	24	22–26	↑↔
Small intestine	35	28–43	49	43–56	*	*	55	49–61	51	47–55	↔↑
Colon	52	51–53	62	61–64	58	51–65	59	57–60	60	59–61	↑↔
Rectum incl. anus	53	51–54	60	58–62	52	43–64	63	61–65	62	61–64	↑↔
Liver	5	3–7	8	6–11	*	*	11	8–16	8	6–9	↔
Gallbladder and ducts	11	8–16	12	10–14	29	17–48	12	9–16	10	9–12	↔
Pancreas	3	3–4	4	3–5	1	0–5	4	3–5	5	4–6	↔
Nose and sinuses	55	48–63	52	43–63	*	*	57	47–69	61	54–69	↔
Larynx	52	46–59	56	45–70	*	*	65	56–75	61	54–68	↔
Lung	9	8–9	13	12–14	15	12–19	13	12–14	15	15–16	↑↔
Pleura	8	5–14	7	3–15	*	*	7	3–17	14	9–24	↔
Breast	79	78–80	86	85–87	87	84–91	83	82–84	85	85–86	↑
Cervix uteri	64	62–66	67	65–70	64	54–76	68	66–70	65	64–67	↔↑
Corpus uteri	79	78–81	83	82–85	75	68–84	81	79–82	83	82–84	↑
Ovary and tubes	33	31–34	44	42–45	34	28–42	41	39–42	43	42–45	↑↔
Other genital organs	57	53–60	55	51–59	64	48–85	63	59–67	57	54–60	↔↑
Kidney	41	38–43	62	60–64	52	43–63	55	52–58	57	55–59	↑↔
Bladder	62	60–64	72	69–75	71	62–81	68	66–70	68	67–70	↑↔
Skin melanoma	90	89–91	89	87–90	91	85–97	88	87–90	92	91–93	↑↔
Eye	70	63–77	78	71–86	*	*	77	70–84	74	69–80	↔
Brain	61	59–63	67	65–69	60	52–69	67	65–69	68	66–69	↑
Thyroid	77	73–80	90	88–91	93	87–99	86	83–89	86	84–88	↔
Bone	57	48–67	66	57–76	*	*	58	49–68	68	61–76	↔
Soft tissues	64	59–68	67	63–71	*	*	71	66–76	63	59–66	↔
Non-Hodgkin lymphoma	55	53–57	58	56–60	57	48–68	57	55–59	60	58–61	↑↔
Hodgkin lymphoma	84	81–88	84	81–88	*	*	85	82–89	84	81–87	↑
Multiple myeloma	33	30–36	33	31–36	29	18–48	38	35–42	41	38–43	↑↔
Acute leukaemia	42	38–46	49	45–53	40	30–53	44	40–50	46	43–49	↑↔
Other leukaemia	68	65–71	60	56–64	68	54–86	64	61–68	70	68–73	↑↔

↑ Increasing trend; ↔ Level trend; (if more arrows are presented for a cancer site the first indicate the dominating trend in the Nordic countries and the second most often the trend in Iceland).

*Too few cases to calculate survival.

similar across countries although the poor survival associated with lung cancer was higher in Norway, Iceland and Sweden for both sexes, and in Finnish women. Ovarian cancer among the sex-specific cancers and female breast cancer reflect a general pattern of lower survival in Denmark. In men, survival after testicular cancer was high in all countries (RS: 88–94%), whereas Denmark had a lower survival ratio for prostate cancer (RS: 53%) compared to the other countries (RS: 78–86%). Kidney cancer survival was considerably lower in Denmark (40–41%) compared to the other countries (51–62%). Bladder cancers were observed to have the same pattern with lower survival among Danish men (RS: 71%) and women (RS: 62%) whereas the survival in the other countries with few exceptions was rather homogenous (RS-men: 73–76%; RS-women 68–72%). Survival after diagnoses of melanoma of the skin was a little lower in Norway, but the survival was high generally, around 90% in women, and a little lower in men. A similar pattern between countries was seen for cancers of the eye, thyroid, and bone, with a somewhat lower survival in Denmark, most evident among women, with smaller differences in survival following diagnoses of cancers of the brain and soft tissues. The haematological malignancies however demonstrated a much more uniform 5-year survival for non-Hodgkin lymphoma in both sexes and in men for Hodgkin lymphoma and multiple myeloma.

Of the 33 cancer sites examined in men, Denmark had the lowest 5-year relative survival for 23 sites, Finland in six, and Norway in seven. Sweden did not rank lowest for any cancer (Table III) and had the highest survival for 16 cancer sites followed by

Table III. Lowest and highest 5-year age-standardised relative survival ratio (RS) 1999–2003 in the Nordic countries* and percentage point difference. Nordic cancer survival study: Men.

Site	Lowest 5-year RS		Highest 5-year RS		Percentage point difference high–low
	Country	RS	Country	RS	
Lip	Denmark	89	Fin/Nor/Swe	91	2
Tongue	Denmark	35	Finland	50	15
Salivary glands	Denmark	56	Sweden	64	8
Mouth	Denmark	41	Sweden	50	9
Pharynx	Norway	34	Finland	38	5
Oesophagus	Denmark	6	Sweden	11	5
Stomach	Denmark	14	Finland	26	12
Small intestine	Denmark	35	Finland	54	19
Colon	Denmark	49	Finland	59	10
Rectum and anus	Denmark	49	Fin/Nor/Swe	57	8
Liver	Denmark	3	Finland	8	5
Gallbladder and ducts	Denmark	10	Norway	14	4
Pancreas	Den/Nor/Swe	3	Sweden	4	1
Nose and sinuses	Finlandland	44	Denmark	54	10
Larynx	Denmark	60	Norway/Sweden	66	6
Lung	Denmark/Finland	8	Sweden	11	3
Pleura	Norway	2	Finland	6	4
Prostate	Denmark	53	Finland	86	33
Testis	Finland	88	Sweden	94	6
Penis and other genital	Finland	62	Norway	80	18
Kidney	Denmark	40	Finland	57	17
Bladder	Denmark	71	Finland/Sweden	74	3
Skin melanoma	Norway	78	Sweden	86	8
Eye	Denmark	69	Finland	83	14
Brain	Norway	45	Finland	52	7
Thyroid	Denmark	68	Norway	82	14
Bone	Norway	54	Sweden	64	10
Soft tissues	Denmark	61	Norway	66	5
Non-Hodgkin lymphoma	Denmark	50	Sweden	54	4
Hodgkin lymphoma	Denmark	80	Finland	85	5
Multiple myeloma	Denmark	28	Sweden	37	9
Acute leukaemia	Norway	38	Sweden	43	5
Other leukaemia	Finland	55	Sweden	68	13

*Iceland excluded due to small numbers and large random variation.

Finland (15), Norway (7) and Denmark (1). For 12 of the 33 sites, the percentage point differences in 5-year relative survival were 10 or greater, including cancers of the prostate, small intestine, penis and other genital organs, kidney, tongue, eye, thyroid, stomach, bone, colon as well as other leukaemia, and to a lesser extent for common cancers such as lung and bladder, as well as melanoma and most haematological malignancies. For women, the pattern was similar, with Denmark ranking lowest for 26 of 35 sites (Table IV). For 16 sites, the percentage point differences were 10 or higher, and as for men, included cancers of the tongue, kidney, stomach, small intestine, colon, thyroid, bone and other leukaemia, as well as cancers of the neoplasms of the lip, mouth, pharynx, rectum, larynx, bladder, and ovary. Comparing the highest 5-year age-standardised survival ratios in the Nordic countries between sexes, large differences – from 13 to 19 percentage points – were observed for cancers of the tongue, mouth, pharynx, and brain. Differences between sexes of 6 to 9 percentage points were seen for cancers of the lip, salivary glands, oesophagus, rectum, nose, pleura, melanoma, eye, thyroid, non-Hodgkin, and acute leukemia. For the remaining 16 sites, survival differences were 5 percentage points or less for frequent cancers such as lung, bladder, kidney, and colon. Iceland is not included in any of these comparisons because of the rather unstable estimates for most cancers. However, on considering the five most frequent cancer sites – for which the estimates are most stable – the Icelandic survival ratios tended to be on the higher side. Male survival ranked first for cancers of the lung (along with Swedish males), kidney and bladder, while no survival ranked lowest among the sites under consideration. Icelandic females had the highest survival for breast cancer among the Nordic countries, and the lowest survival following cancer of the corpus uteri.

Tables V and VI present the excess mortality rates 1999–2003 in follow-up intervals spanning the first three months and 2–5 years after diagnosis. The rates during the first three months after diagnosis reflect the overall observed pattern for the

Table IV. Lowest and highest 5-year age-standardised relative survival ratio (RS) 1999–2003 in the Nordic countries* and percentage point difference. Nordic cancer survival study: Women.

Site	Lowest 5-year RS		Highest 5-year RS		Percentage point difference high–low
	Country	RS	Country	RS	
Lip	Denmark	87	Finland	97	10
Tongue	Denmark	46	Finland	67	21
Salivary glands	Finland	65	Sweden	73	8
Mouth	Denmark	69	Finland	69	20
Pharynx	Norway	30	Finland	51	21
Oesophagus	Denmark	7	Finland	20	13
Stomach	Denmark	14	Finland	30	16
Small intestine	Denmark	35	Norway	55	20
Colon	Denmark	52	Finland	62	10
Rectum and anus	Denmark	53	Norway	63	10
Liver	Denmark	5	Norway	11	6
Gallbladder and ducts	Sweden	10	Finland/Norway	12	2
Pancreas	Denmark	3	Sweden	5	2
Nose and sinuses	Finland	52	Sweden	61	9
Larynx	Denmark	52	Norway	65	13
Lung	Denmark	9	Sweden	15	6
Pleura	Norway/Finland	8	Sweden	14	7
Breast	Denmark	79	Finland	86	7
Cervix uteri	Denmark	64	Norway	68	4
Corpus uteri	Denmark	79	Finland/Sweden	83	4
Ovary and tubes	Denmark	33	Finland	44	11
Other female genital	Finland	55	Norway	63	8
Kidney	Denmark	41	Finland	62	21
Bladder	Denmark	62	Finland	72	10
Skin melanoma	Norway	88	Sweden	92	4
Eye	Denmark	70	Finland	78	8
Brain	Denmark	61	Sweden	68	7
Thyroid	Denmark	77	Finland	90	13
Bone	Denmark	57	Sweden	68	11
Soft tissues	Sweden	63	Norway	71	8
Non-Hodgkin lymphoma	Denmark	55	Sweden	60	5
Hodgkin lymphoma	Den/Nor/Swe	84	Norway	85	1
Multiple myeloma	Denmark/Finland	33	Sweden	41	8
Acute leukaemia	Denmark	42	Finland	49	7
Other leukaemia	Finland	60	Sweden	70	10

*Iceland excluded due to small numbers and large random variation.

relative survival, inasmuch that Danish men and women have higher excess mortality rates than their Nordic neighbours generally, and the male-female differences in survival are most evident in the excess mortality early in the follow-up (Table V). The absolute differences appear to have largely disappeared 2–5 years after the diagnosis, but the relative differences remain or increase slightly for the more frequent cancers of the colon, rectum, lung, breast (females) and melanoma (Table VI). A few cancer sites, including cancers of the oesophagus, liver, gallbladder and biliary tract, pancreas, lung, pleura, and multiple myeloma, are notable for still – contrary to remaining sites – to have high absolute excess mortality rates after two years.

Figure 1 presents the 5-year relative survival ratios plotted against the excess mortality rates in the first three months for the 15 most frequent cancer sites excluding prostate and female breast cancer for each combination of country and sex, with the fitted curves compared between countries separately for each sex in Figure 2, with excess mortality on a logarithmic scale. The shapes of the curves are rather similar between countries. Differences were smallest for cancer sites associated with low survival (and high excess mortality). Using weights from the case-mix adjustment in the curve-fitting did not alter the curves substantially (not shown).

Discussion

We have compiled the survival and excess mortality data from a series of papers evaluating the cancer incidence, mortality, relative survival and excess mortality from 1964–2003 in the Nordic countries [16–27]. We studied 1999–2003 to limit the analysis to timely and comparable incidence data on cancer available from each of the Nordic countries with a

Table V. Excess mortality rates 1999–2003 per 100 person years; Follow-up interval first three months. Nordic cancer survival study.

	Men					Women				
Site	Denmark	Finland	Iceland	Norway	Sweden	Denmark	Finland	Iceland	Norway	Sweden
Lip	2	8	0	1	4	3	0	35	0	0
Tongue	63	37	0	43	40	50	17	0	20	19
Salivary glands	29	26	0	26	17	14	31	0	17	15
Mouth	27	22	21	31	32	35	19	0	16	18
Pharynx	48	41	14	54	42	42	38	59	46	51
Oesophagus	138	139	95	116	104	141	96	79	109	85
Stomach	139	116	143	122	114	160	105	72	101	109
Small intestine	138	84	195	83	72	117	75	32	54	61
Colon	80	54	51	56	41	63	47	29	44	33
Rectum and anus	47	44	46	33	25	42	30	30	28	18
Liver	397	234	212	330	315	337	277	219	278	291
Gallbladder and ducts	197	196	117	207	180	206	178	202	181	194
Pancreas	299	279	248	281	257	253	232	177	229	214
Nose and sinuses	27	5	0	21	21	14	18	89	16	18
Larynx	18	26	0	16	16	40	30	0	8	22
Lung	188	165	132	174	140	176	143	130	168	117
Pleura	99	118	277	120	95	142	87	0	121	90
Breast						12	8	8	7	5
Cervix uteri						25	20	30	16	17
Corpus uteri						15	13	10	9	8
Ovary and tubes						79	71	60	66	44
Other female genital						36	50	0	23	21
Prostate	17	5	5	8	4					
Testis	8	8	0	19	3					
Penis and other genital	17	18	26	17	13					
Kidney	91	67	40	72	64	95	57	54	63	49
Bladder	19	20	8	17	15	38	25	32	30	23
Skin melanoma	8	6	0	7	1	3	4	0	2	1
Eye	2	12	20	5	5	17	5	0	2	3
Brain	73	69	71	63	62	57	57	27	43	37
Thyroid	47	35	10	40	27	44	24	0	28	30
Bone	64	34	0	40	22	42	32	0	46	22
Soft tissue	34	36	16	26	23	30	24	0	16	28
Non-Hodgkin lymphoma	66	69	36	59	42	52	64	58	48	38
Hodgkin lymphoma	20	15	50	11	16	23	16	0	17	7
Multiple myeloma	64	87	50	63	44	56	82	59	46	32
Acute leukaemia	110	103	56	147	76	119	97	111	133	73
Other leukaemia	31	66	31	49	20	30	65	32	37	20
All, case-mix adjusted	81	67	52	68	58	70	58	46	56	47
All excl prostate and breast cancer, case-mix adjusted	109	94	74	96	82	95	80	63	78	66

follow-up of the patients until the end of 2006. Our aim is to provide an overview and a summary of findings, inasmuch that such a Nordic comparison is most relevant for the study of the potential impact of established cancer control plans and the implementation of new treatment modalities at the end of the last century and the beginning of the current one. It must be stressed however, that comparisons of national relative survival ratios and excess mortality rates must also consider the cancer incidence and the case-mix [27]. This is particularly important when studying all cancer sites combined, and for specific cancers where screening (breast, cervix) or other early diagnostic measures like PSA (prostate) or Haemoccult for blood in the stools (colorectal) are implemented on a population basis, be it part of an organised activity or otherwise. It must also be noted that from a clinical point of view, our data are comparable only at a rather crude level. Cancer registry data are usually unable to record new diagnostic innovations at the time they are implemented, and thus subgroups of cancers within an ICD category for which successful treatments exist, are often underemphasised. Perhaps more importantly in survival comparisons, staging is rarely recorded and reported in a uniform and comprehensive way. Hence we could not include stage and histology in the present analysis. However, the Nordic cancer registry data and its compilation into the NORDCAN database [15] are renowned for their high quality and com-

Table VI. Excess mortality rates 1999–2003 per 100 person years; Follow-up 2–5 years. Nordic cancer survival study.

	Men					Women				
Site	Denmark	Finland	Iceland	Norway	Sweden	Denmark	Finland	Iceland	Norway	Sweden
Lip	3	2		3	2	2	0		2	1
Tongue	16	7		12	8	8	3		6	6
Salivary glands	8	5		10	5	6	3		6	5
Mouth	11	19		8	7	8	3	18	7	6
Pharynx	10	14		19	14	18	9		18	12
Oesophagus	35	21	20	22	20	33	17	44	19	20
Stomach	18	9	16	15	13	15	9	7	11	11
Small intestine	9	7		8	6	9	8		6	9
Colon	7	4	7	6	7	6	4	6	6	6
Rectum and anus	10	7	6	8	8	8	6	8	6	7
Liver	41	26	23	21	26	40	22		74	23
Gallbladder and ducts	28	18	31	22	18	18	19	7	20	17
Pancreas	26	30	10	31	26	22	36	44	26	31
Nose and sinuses	8	15	3	12	12	10	8		10	6
Larynx	7	6	8	5	5	7	5		6	8
Lung	21	25	22	24	20	22	19	29	17	16
Pleura	51	43		61	49	30	46		30	28
Breast						4	2	2	3	3
Cervix uteri						6	4	6	5	6
Corpus uteri						2	2	4	3	2
Ovary and tubes						15	11	22	14	14
Other female genital						7	4	12	6	6
Prostate	11	3	4	5	4					
Testis	0	1		0	1					
Penis and other genital	3	7		1	3					
Kidney	10	5	7	6	6	8	4	8	5	5
Bladder	4	3	4	4	3	4	3	6	3	4
Skin melanoma	4	2	2	5	3	2	2	1	2	2
Eye	7	5		6	6	7	3		6	8
Brain	4	4	8	5	3	3	2	1	2	2
Thyroid	5	2	2	0	2	2	0	1	1	1
Bone	6	8		5	6	9	2		7	5
Soft tissue	6	5		5	6	5	4		3	6
Non-Hodgkin lymphoma	8	7	9	9	8	8	5	7	8	6
Hodgkin lymphoma	3	3		3	3	2	2		3	3
Multiple myeloma	27	23	27	22	23	24	24	22	20	21
Acute leukaemia	11	8		18	11	12	8	18	12	12
Other leukaemia	8	9	7	8	7	7	7	7	7	6
All, case-mix adjusted	11	8	9	9	8	8	6	9	7	7
All excl prostate and breast cancer, case-mix adjusted	12	10	78	11	10	10	8	12	8	9

pleteness, with excellent register-based follow-up of all cancer patients, and are thus ideally suited to the study the effect of cancer control planning. The registry data provides an unbiased population-based perspective of the survival of cancer patients, and one that is vital for the planning and monitoring of health care, serving the clinical specialties as they look beyond clinical trials to population interventions.

A large number of clinical publications have shown the relevance of short-term survival, especially following surgical interventions. The measure is also highly relevant in the study of the impact of national cancer plans [13] and for cancers where surgical interventions are commonly not undertaken. Co-morbidity may be a factor capable of explaining some of the survival differences in Denmark for colorectal, prostate and ovarian cancer patients [31–33] as well as diabetics with heart diseases [34], and in terms of shared risk factors, the effect of tobacco and alcohol consumption, as discussed in the cancer-specific papers on survival [17–27]. Quitting alcohol and tobacco use before elective surgery has been shown to lead to lower peri-operative morbidity and better recovery in a review paper [35], while a Dutch study concluded that co-morbidity might lead to less invasive and less optimal cancer treatment being used [36]. The level of smoking in Denmark has from the 1970s been higher than in the other Nordic countries, except among Norwegian women in 2000–2004 (Figure 3) and the Icelandic population in the 1960s [37–39]. Before the 1980s, the average tobacco consumption per capita was highest in

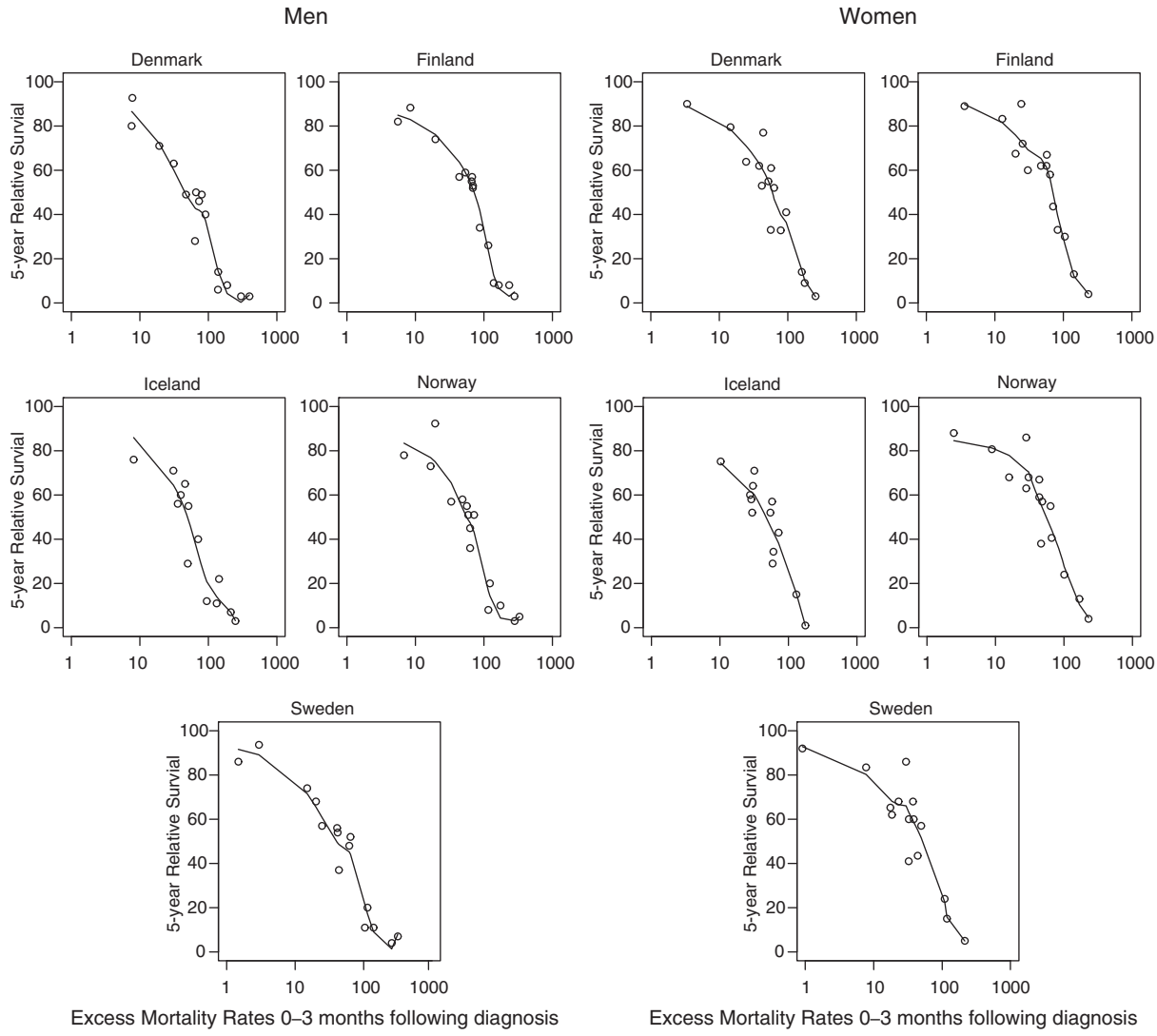

Figure 1. Five-year relative survival plotted against excess mortality rates in the first three months following diagnoses in 1999–2003 for cancer patients by country and sex with LOESS curves for the 15 most common cancer sites excluding prostate and breast cancer. Nordic cancer survival study.

Denmark, with Finland and Norway close behind, but with very differing smoking patterns seen between countries. A large part of the Danish consumption patterns could at that time be attributed to pipe, cigars and cigarillos, while Finns mostly smoked strong Russian-type cigarettes and Norwegians, hand-rolled cigarettes. In Sweden, the consumption of smokeless tobacco has been historically high [38,40]. The Swedish snus has been described as an interesting but controversial experience amongst believers in harm reduction, and reducing exposure to tobacco [41]. However this avenue to tobacco control has been carefully assessed and warned against by Swedish public health researchers [42,43]. Cigarette smoking in Finland was high already in the 1920s [40], but from the mid-1960s anti-smoking legislation and campaigns started in Finland [44]. In more recent years cigarette smoking has become the key mode of tobacco consumption in the Nordic countries, making the OECD registrations of daily tobacco smokers (in Figure 3) a more comparable measure of risk assessment.

Trends in average alcohol consumption indicate that Danish consumption has been double that estimated in the other countries (except Finland) (Figure 4) [37,45]. Although not the only contributing factors, the patterns of tobacco and alcohol consumption are in accordance with trends in life expectancy [16], as well as the observed patterns of cancer incidence and survival, and probably play an independent role in explaining some of the survival variations observed between the countries.

The excess mortality rate for the first months after diagnosis has been demonstrated to be a good indicator of the level and ranking of the 5-year age-standardised survival rates in our Nordic study

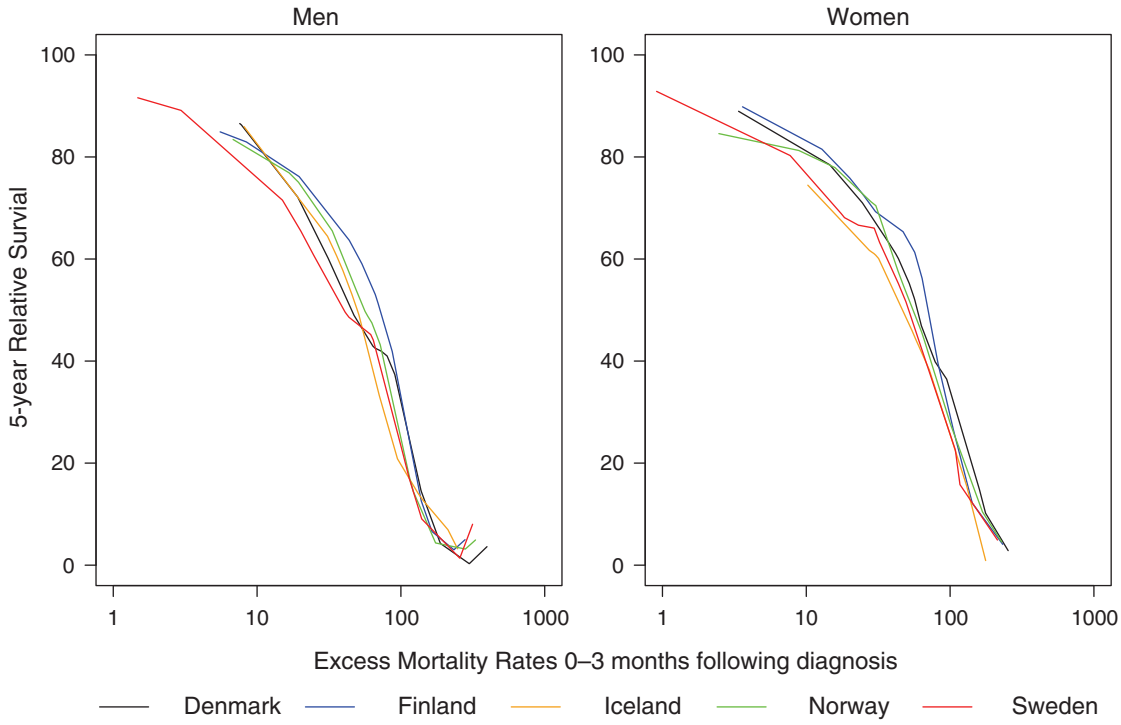

Figure 2. Country-specific fitted LOESS curves to plots of 5-year relative survival against excess mortality rates in the first three months following diagnosis in 1999–2003 for male and female cancer patients of the 15 most common cancer sites excluding prostate and breast. Nordic cancer survival study.

[13,46]. The excess mortality was much higher in the 1960s through to the late-1980s in the first month after diagnosis, with the difference between the first and the following two months after a cancer diagnosis becoming rather minor. Hence the excess mortality for the first three months after a diagnosis in the 1990s and thereafter will be more informative and stable to study.

The LOESS curves fitted to plots of 5-year relative survival by excess mortality 0–3 months after diagnosis for the 15 most common cancer sites (excluding breast and prostate cancer) (Figures 1 and 2), show a remarkably similar shape between countries for both sexes. The variation in 5-year relative survival at an excess mortality ratio of around 10 is only around 5 percentage points

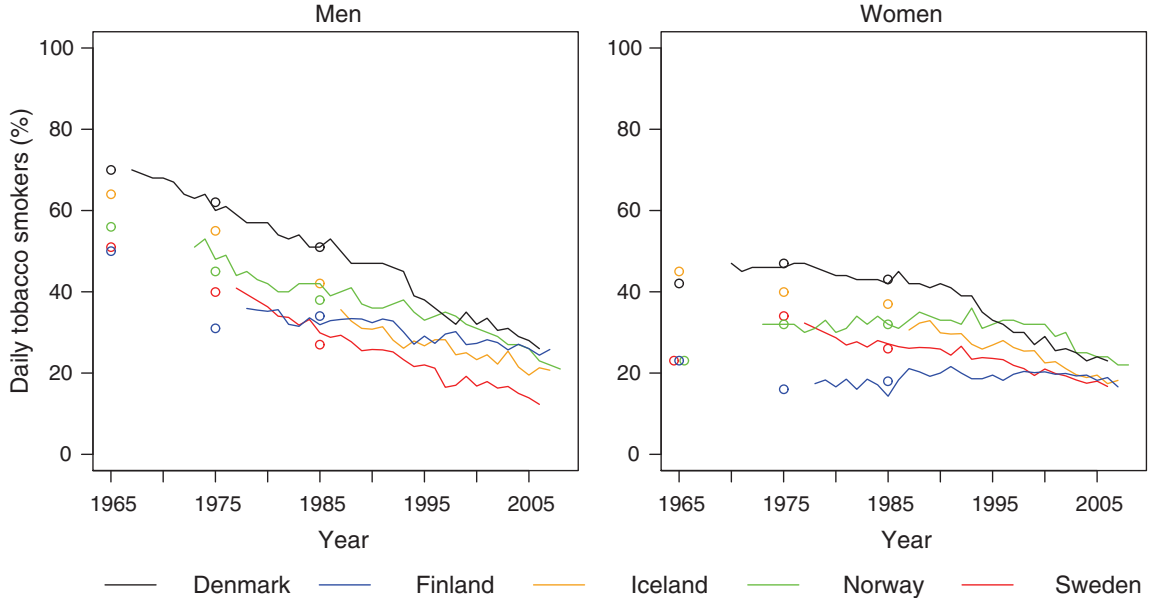

Figure 3.Trends in the proportion of daily smokers in the Nordic countries by sex. (Sources: lines depict data from OECD (reference [36]) while the circles represent data from reference [38]).

between countries, whereas the differences for an excess death ratio of 50 are larger, particularly among men. The largest differences relate to colorectal and kidney cancers. The similar pattern and shape of the curves between countries and by sex, advocate for the use of excess mortality 0–3 month as an early indicator of the impact of new actions designed to improve cancer control. The curves for Sweden are consistently lower and shifted a little to the left relative to the other countries, an effect likely related to missing death certificate initiated cancers.

The correlation between the early mortality and the 5-year relative survival is an important observation for the monitoring of the impact of the implementation of cancer plans, with the reservation that the impact of prevention and health promotion is likely to be observable only after several decades, and only for those actions that have a large impact on the general population, such as smoking cessation. Although a general observation is that Danish cancer patients fare worse than their Nordic counterparts, it is noted that the time trends in survival by country – with a few exceptions such as prostate and breast cancer – are rather parallel after an initial period of approximately 6–12 months after diagnosis. It thus seems that, other than the initial survival deficit, the health care system in Denmark is able to deliver treatment and care, and to capitalise on new developments in diagnosis and treatment, as in the other countries.

Our study highlights both the similarities and the differences in survival among cancer patients in the Nordic countries. Where findings are consistent between the sexes and countries, they most likely reflect what is achievable at a population level today, considering the wealth of the Nordic countries and the organisation of health care. Apart from prostate and breast cancer [20,22], where the survival was high but heavily influenced by screening and diagnostic activities, it is noteworthy that patients diagnosed with melanoma of skin, Hodgkin lymphoma and cancers of the testis, thyroid and lip all have 5-year relative survival ratios over 80%. Only a few cancer patient groups – specifically those diagnosed with cancers of the oesophagus, gallbladder and biliary ducts, lung, pleura, liver, and pancreas – present with survival ratios below 20%, while diagnoses of acute leukaemia, multiple myeloma, stomach, and ovary are associated with levels of survival below 50%. Such observations are helpful when making prioritised decisions regarding the strategies for tackling the cancer problem. For cancers associated with very poor prognosis, it is necessary to focus more on prevention and research into modifiable risk factors that may

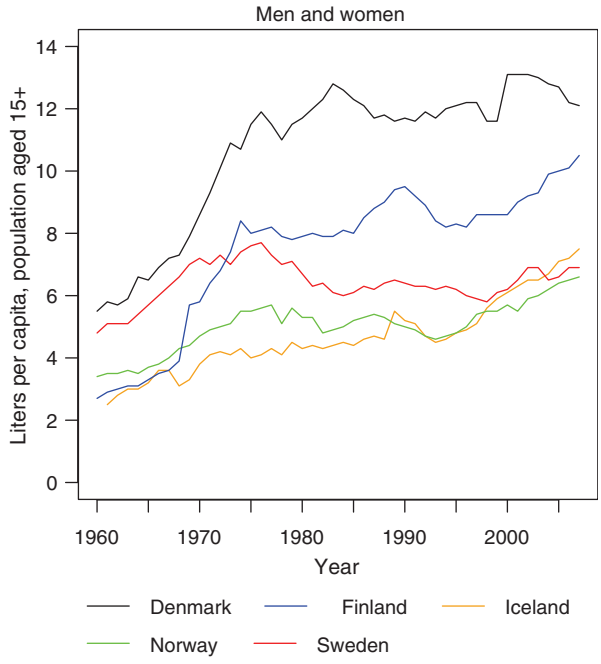

Figure 4. Trends in alcohol consumption in the Nordic countries (Source: reference [36]).

prevent the disease. The case for further tobacco and alcohol control is obvious for those cancer types with the lowest survival. With the general survival pattern in mind, prevention, especially a healthier life style with less tobacco and alcohol, would seem a strategy necessary to enforce as part of cancer control planning [47], in particular in Denmark, where survival is lowest and excess mortality highest. There is room for improvement of the survival for colon and rectal cancer in all countries, but most evidently in Denmark. Screening and early diagnosis are obvious possibilities for these cancers [18,48,49], combined with improved surgery.

Survival is an important measure of early diagnosis, treatment and the quality of care of cancer patients; however it is not sufficient for the evaluation of cancer control. Survival only partially explains results pertaining to treatment after the initial diagnosis. From the perspective of the individual, it is much more important *not* to develop the disease, that is, either to be cured following treatment of a precancerous lesion or to avoid contracting cancer at all. Hence, if a cancer control plan is to be shown effective, we should expect a decline in incidence and mortality, and an increase in survival. However, with success in avoiding cancers at an early age, coupled with global demographic changes (increases in life expectancy, population ageing), both the future numbers of new cancer cases and deaths may increase if the current age-specific incidence and mortality remain unchanged [50], even if we manage to better control known risk factors for cancer, as

described in the site-specific papers [17–27]. It is on the other hand quite plausible that the results of effective preventive interventions will lead to a better general health [47], and thus less co-morbidity for those contracting cancer, and subsequently, higher success rates in terms of therapy and supportive care during the initial treatment and beyond.

We initiated this study to provide a comprehensive overview of the survival of Nordic cancer patients, with a view to be able to study the effects of cancer control. Despite cancer plans formulated and put in action in both Denmark and Norway, we cannot as yet see a direct impact on incidence, mortality, or survival. It may be too early to see the results compared to Sweden and Finland. The cancer care plans in Sweden that improved the quality of cancer care, and the Finnish prevention plan that led to an improved general health, were instigated several decades ago. In terms of observable changes in cancer incidence and mortality, prevention activities usually surface many years or several decades after initiation, whilst new effective therapies will show up rather rapidly, if applied to the majority of patients. We noted that the survival trends seem to be parallel for most sites with country differences driven by the excess mortality right after diagnosis. In the early years this was especially high during the first month of follow-up, but in the most recent periods the excess mortality in the first month is of a similar order of magnitude to that observed in the following two months, although still highest in Denmark for the majority of cancer sites. In summary, the differences in survival between the Nordic countries likely relate to a range of host and institutional determinants. They include a varying prevalence of exposure to key risk factors such as tobacco and alcohol, and resultant differences in co-morbidity, as well as differences in the stage at presentation at diagnosis, and in the treatment and management of the disease.

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