ISSN 0959–8278

EUROPEAN JOURNAL OF CANCER PREVENTION

The Official Journal of the
European Cancer Prevention Organisation (ECP)

Volume 11 Supplement 1 June 2002

www.eurjcancerprev.com

Prediction of cancer incidence in the Nordic countries up to the year 2020

Bjørn Møller, Harald Fekjær, Timo Hakulinen, Laufey Tryggvadóttir,
Hans H. Storm, Mats Talbäck and Tor Haldorsen

This supplement was sponsored by the Nordic Cancer Union

An Official Journal of the
International Association
of Cancer Registries

LIPPINCOTT WILLIAMS & WILKINS

EUROPEAN JOURNAL OF CANCER PREVENTION

The Official Journal of the European Cancer Prevention Organisation (ECP)

AIMS AND SCOPE

With its fast publication of the latest developments and discoveries in this important field of medicine, the European Journal of Cancer Prevention aims to promote an increased awareness of all aspects of cancer prevention and to stimulate new ideas and innovations. The journal has a wide-ranging scope, covering such aspects as descriptive and metabolic epidemiology, histopathology, genetics, biochemistry, molecular biology, microbiology, clinical medicine, intervention trials and public education, basic laboratory studies and special group studies.
European Journal of Cancer Prevention is the official journal of the European Cancer Prevention Organisation (ECP), which was formed in 1981 to exploit the wide range of cancer incidence, and exposure to numerous factors associated with increased cancer risk (eg diet, sunlight, exogenous hormones and cigarette smoking), within Europe in the study of the causation and prevention of human cancer.

European Journal of Cancer Prevention is covered in Current Contents/Clinical Medicine, CABS, Excerpta Medica/EMBASE and Index Medicus and MEDLINE on the MEDLARS system, and available on CD-ROM via ADONIS.

LIPPINCOTT WILLIAMS & WILKINS

This material is copyright the original publisher Unauthorised copying and distribution is prohibited

EUROPEAN JOURNAL OF CANCER PREVENTION

The Official Journal of the
European Cancer Prevention Organisation (ECP)

CONTENTS

Volume 11 Supplement 1 June 2002

EUROPEAN JOURNAL OF CANCER PREVENTION

The Official Journal of the European Cancer Prevention Organisation (ECP)

European Journal of Cancer Prevention (ISSN 0959-8278) is published bimonthly in 2001 (in February, April, June, August, October and December) by Lippincott Williams & Wilkins, 16522 Hunters Green Parkway, Hagerstown, MD 21740, USA.
Business offices are located at 530 Walnut Street, Philadelphia, PA 19106-3621, USA.
Correspondence should be addressed to the production office: *European Journal of Cancer Prevention*, Lippincott Williams & Wilkins, Third Floor, 241 Borough High Street, London SE1 1GB, UK.
Tel: +44 20 7940 7500
Fax: +44 20 7940 7575
Publisher: Phil Daly (pdaly@lww.co.uk)
Production Editor: Ranadi Johnston (rjohnsto@lww.co.uk)
Supplement Manager: Isabelle Rameau (irameau@lww.co.uk)
Project Co-ordinator: Bridie Selley (bselley@lww.co.uk)
Information for contributors: Copies of 'Instructions for authors' may be obtained free of charge from the publisher. Papers submitted for publication should be sent to Prof M Hill, ECP (UK) Headquarters, Nutrition Research Centre, South Bank University, 103 Borough Road, London SE1 0AA. Tel: +44 1256 880416; fax: +44 1256 882564.

We can also provide author's **offprints** of any article (minimum 100 copies, printed with the issue) and larger quantities of **reprints** to meet corporate requirements. Prices for offprints or reprints are available from the **Offprints Administrator** (e-mail: offprint@lww.co.uk) or the **Reprints Coordinator** (Special Sales Department, e-mail: eostime@ lww.co.uk), respectively.

European Journal of Cancer Prevention also publishes **supplements** (Special Sales Department, e-mail: eostime@lww.co.uk) on behalf of academic and corporate sponsors. Supplements are normally supplied to subscribers at no extra charge.

European Journal of Cancer Prevention is indexed and abstracted by Current Contents/Clinical Medicine, CABS, Excerpta Medica/EMBASE, and Index Medicus and MEDLINE on the MEDLARS system, and available on CD-ROM via ADONIS.

Typeset by Neil Morris, Lincolnshire. Printed by Hobbs the Printers Limited, Totton, UK on recyclable elemental chlorine free paper from sustainable forests meeting the requirements of ISO 9706 and EN ISO 14001. Cover design by Maria Grasso Design Associates, London, UK.

Address for subscription information, orders, or change of address: *(except Japan, India, Bangladesh, Sri Lanka, Nepal and Pakistan)* Lippincott Williams & Wilkins, 16522 Hunters Green Parkway, Hagerstown, MD 21740, USA. Tel: +1 301 223 2300 outside North America, or +1 800 638 3030 in USA, Canada and Mexico; fax: +1 301 223 2400; e-mail: customerservice@lww.com *In Japan:* Igaku-Shoin Ltd, 3-23-14 Hongo, Bunkyo-ku, Tokyo 113-0033, Japan, Tel: +81 3 5689 5400; fax: +81 3 5689 5402. *In India, Bangladesh, Sri Lanka, Nepal and Pakistan,* contact Globe Publications Pvt. Ltd. B-13, 3rd FL, A Block, Shopping Complex, Naraina Vihar, Ring Road, New Delhi 110028, India. Tel: +91 11 579 3211; fax: +91 11 579 8876.

Subscription prices for 2002: US$223 Individual, US$845 Institution. (The Canadian GST tax of 7% will be added to the subscription price of all orders shipped to Canada. Lippincott Williams & Wilkins' GST Identifcation Number is 130876246. Other sales taxes are added where applicable.)
Please add US$6 for air freight delivery outside the European Union. (Airfreight delivery usually occurs within 7 days to 21 days.)
Please add US$6 to all rates for handling.
Subscriptions outside USA must be prepaid. Payment must be in US funds drawn on a US bank.

Subscriptions at the personal rate must be paid by personal cheque or charge. Charges are accepted on VISA, MasterCard, American Express, Diners Card, or Discover cards. Please have the card number and expiration date available when calling. Prices subject to change without notice. Copies will be replaced without charge if the publisher receives a request within 90 days of the mailing date, both in the USA and worldwide.

Standard postage paid at Hagerstown, MD and at additional mailing offices. Airfreight and mailing in the USA by Mercury Airfreight International Ltd, 365 Blair Road, Avenal, NJ 07001, USA.

Members of the European Cancer Prevention Organisation (ECP) receive a subscription to the journal as part of their annual membership. For information on joining ECP, please contact the Editors.

Postmaster: send address corrections and back issue queries to *European Journal of Cancer Prevention*, P.O. Box 1550, Hagerstown, MD 21741, USA.

Visit the **Lippincott Williams & Wilkins** website at **http://www.lww.com** and the ***European Journal of Cancer Prevention*** website at **http://www.eurjcancerprev.com**

EUROPEAN JOURNAL
OF
CANCER PREVENTION

The Official Journal of the
European Cancer Prevention Organisation (ECP)

The Association of the Nordic Cancer Registries consists of:

Danish Cancer Registry
Amaliegade 13
Dk Copenhagen K
Denmark
Telephone: (+45) 33 91 16 01
Fax: (+45) 33 91 22 48

Finnish Cancer Registry
Liisankatu 21 B
FIN-00170 Helsinki
Finland
Telephone: (+35) 89 135 331
Fax: (+35) 89 135 5378

Icelandic Cancer Registry
P.O. Box 5420
IS-125 Reykjavik
Iceland
Telephone: (+35) 4 540 1900
Fax: (+35) 4 540 1910

Kreftregisteret
Institute of Population-Based Cancer Research
Montebello
N-0310 Oslo
Norway
Telephone: (+47) 22 45 13 00
Fax: (+47) 22 45 13 70

Centre for Epidemiology
The National Board of Health and Welfare
SE-106 30 Stockholm
Sweden
Telephone: (+46) 8 5555 30 00
Fax: (+46) 8 5555 33 27

The Nordic Cancer Union

Kræftens Bekæmpelse
Danish Cancer Society

Cancer Society of Finland

Icelandic Cancer Society

Den Norske Kreftforening

Cancerfonden
Swedish Cancer Society

European Journal of Cancer Prevention 2002, **11 (suppl 1)**, S1–S96

Prediction of cancer incidence in the Nordic countries up to the year 2020

Bjørn Møller[1], Harald Fekjær[1], Timo Hakulinen[2], Laufey Tryggvadóttir[3], Hans H. Storm[4], Mats Talbäck[5] and Tor Haldorsen[1]

Introduction

The five Nordic countries (Denmark, Finland, Iceland, Norway and Sweden) are geographically (Figure 1), historically, culturally and politically related, and their languages, except Finnish, belong to the same group. Political collaboration between the Nordic countries has a long history, and in 1989, a Nordic action plan was adopted by the Nordic Council of Ministers. The first part of this action plan was to acquire a complete description and analysis of cancer patterns in the Nordic countries, including predictions of cancer incidence up to the years 2000 and 2010. The Association of the Nordic Cancer Registries (ANCR) was requested to conduct this analysis, and in 1993, "Predictions of cancer incidence in the Nordic countries up to the years 2000 and 2010" by Engeland *et al*. (1993) was published, as the first in a series of publications about the cancer picture in the Nordic countries.

The predictions were based on observations up to 1987, and ten more years of observations are now available. The ANCR therefore initiated a project (i) to evaluate the previous predictions, (ii) to compare different prediction methods, (iii) to include information about etiological factors and screening activity, and (iv) to make new predictions up to the year 2020. The present publication covers the new predictions of cancer incidence up to the years 2005 and 2020. It is based on an evaluation of the previous predictions, and special attention has been given to cancers of the breast and prostate, in view of the issues of mammographic screening and prostate-specific antigen (PSA) testing.

Gerda Engholm has given valuable comments on drafts of this publication. The project is financed by the Nordic Cancer Union and the five Nordic cancer registries.

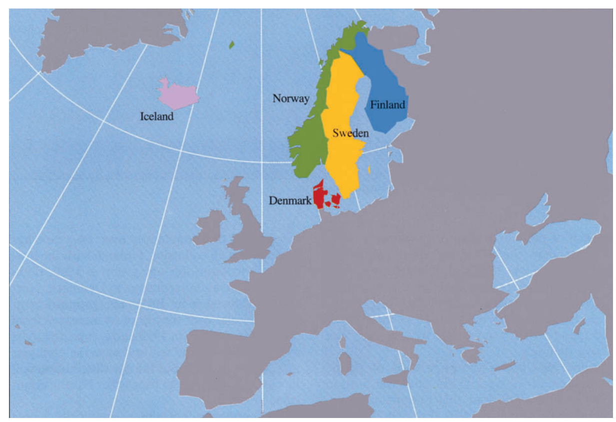


Figure 1. Map of Europe showing the five Nordic countries.

[1]*Kreftregisteret, Institute of Population-Based Cancer Research, Norway.* [2]*Finnish Cancer Registry, Finland.* [3]*Icelandic Cancer Registry, Iceland.* [4]*Danish Cancer Society, Denmark.* [5]*Centre for Epidemiology, The National Board of Health and Welfare, Sweden. Correspondence to: Bjørn Møller, Kreftregisteret, Institute of Population-based Cancer Research, Montebello, N-0310 Oslo, Norway. Tel: (+47) 23 33 39 13, Fax: (+47) 22 45 13 70. E-mail: bjorn.moller@kreftregisteret.no*

Cancer registration in the Nordic countries

Each of the Nordic countries has a population-based cancer registry. The Danish Registry is the oldest, having been founded in 1942. The Norwegian, Finnish and Icelandic registries were founded in 1952–1954 and the Swedish Registry in 1958.

The financial basis for each of the registries, except that of Sweden, was originally provided by the cancer society in the respective country. The registries in Finland and Iceland are now run by the cancer societies with support from governmental funds, while the Danish (since 1997), Norwegian (since 1979) and Swedish registries are administered by the state.

The Nordic cancer registries collaborate closely, and annual meetings are held to discuss standardization of registration and classification and to plan joint projects. A recent survey comparing the coding practices used in the Nordic countries (ANCR, 2001) concluded that there are only minor differences between the countries, and that their data can safely be used in descriptive comparative studies.

Notification is compulsory in all of the Nordic countries except Iceland, where a law proposal regarding notification is in preparation. Reporting became compulsory for private physicians in Sweden in 1983 and for all medical doctors in Denmark in 1987. Almost 100% coverage of incident cases is achieved in all of the registries, which rely on reporting from multiple sources, including physicians, hospitals, institutions with hospital beds, and pathological and cytological laboratories. Information is also collected from death certificates, except in Sweden.

In all of the Nordic countries, each inhabitant has a unique personal identification number, which makes identification simple and reliable. The registries collect a minimal set of data on each cancer patient, which is used for routine statistical reporting. The data are collected in different forms in the five countries, but the following items are registered for each cancer case in each registry: patient identification, place of residence, primary site of the tumour, date of diagnosis, verification of diagnosis, histological type and date and cause of death. For more details, see the survey of the Nordic cancer registries (ANCR, 2001).

Apart from routine production of statistics, the Finnish, Icelandic, Norwegian and Swedish registries employ research staff, who work mainly in the fields of epidemiology, clinical pathology, public health and biometry. The research staff at the registries also assist other scientists who wish to use registry data for their own projects. In Denmark, the corresponding research is conducted by scientists employed by the Danish Cancer Society. The national Swedish Cancer Registry has overall responsibility for combining and reporting all cancer cases registered in Sweden by six regional cancer registries. The regional registries are situated at the major oncological centres and are responsible for collecting and coding the Swedish data. In the other countries, the collection and coding is centralized.

Populations

Of the Nordic countries, Sweden has the largest population, 8.9 million inhabitants (Table 1). Denmark and Finland have similar population size, 5.3 and 5.2 millions, respectively. Norway is marginally less populated, with 4.5 million inhabitants and the population size in Iceland is much smaller, 280 000. Forecasts of population growth between now and 2018–2022, made by the central statistical offices in the Nordic countries, suggest that Iceland will experience the largest proportional increase, amounting to 18%. The populations in Denmark, Norway and Sweden are estimated to increase by 6–9%, while the Finnish population will increase by only 3%. The reason for this is that the Finnish forecasts assume a relatively low birth rate and low net immigration (Table 1). Sweden has at present the highest life expectancy of the Nordic countries, but also the lowest observed birth rate. In the Swedish forecasts, the birth rate is assumed to increase to the level in Norway and Denmark.

The population structures vary (Figures 2–13), but in each of the Nordic countries the population is older than the world standard population and is expected to grow even older over the coming decades. Sweden has the oldest and Iceland the youngest population. In all the countries, elevated birth rates following the second world war account for the higher numbers of persons in age groups 40–44 years and younger in 1993–1997. By 2018–2022, ageing of these large cohorts will imply large numbers of people around the age of 65 years.

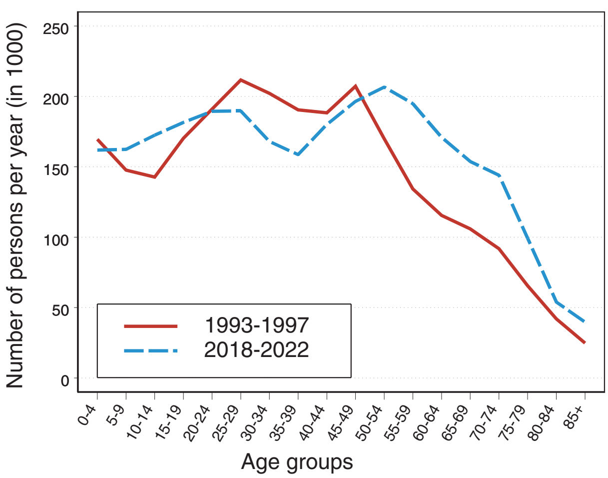


Figure 2. Age distribution of the Danish male population in 1993–1997 and 2018–2022 (thousands).

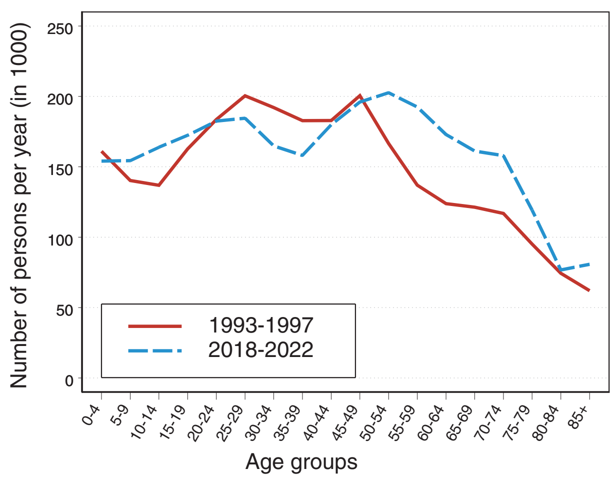


Figure 3. Age distribution of the Danish female population in 1993–1997 and 2018–2022 (thousands).

Table 1. Life expectancy, birth rate, net immigration per year and population size in 1998-2002 and in 2018-2022, by country.

Country	Life expectancy[a]		Birth rate	Net immigration	Population size (mill.)
	Males	Females			
Denmark					
1998-2002	74.3	79.0	1.8	10 000	5.3
2018-2022	76.2	81.1	1.9	17 000	5.7
Finland					
1998-2002	74.1	81.0	1.7	5 000	5.2
2018-2022	77.7	83.4	1.7	5 000	5.3
Iceland					
1998-2002	77.6	81.4	2.0	177	0.28
2018-2022	79.7	83.0	2.1	177	0.33
Norway					
1998-2002	75.5	81.2	1.8	14 000	4.5
2018-2022	77.3	82.5	1.8	10 000	4.9
Sweden					
1998-2002	77.1	82.1	1.5	18 000	8.9
2018-2022	79.5	84.1	1.8	15 000	9.4

[a]The population forecasts had different endpoints in each country, varying from 2030 to 2050. Life expectancy in 2018-2022 was calculated by linear interpolation between present life expectancy and life expectancy in the endpoint for each country.

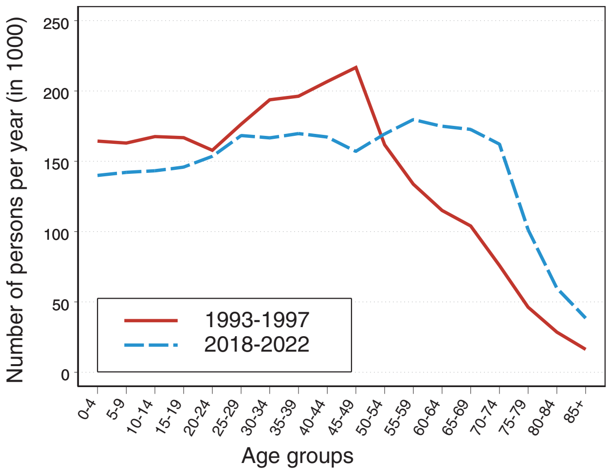


Figure 4. Age distribution of the Finnish male population in 1993–1997 and 2018–2022 (thousands).

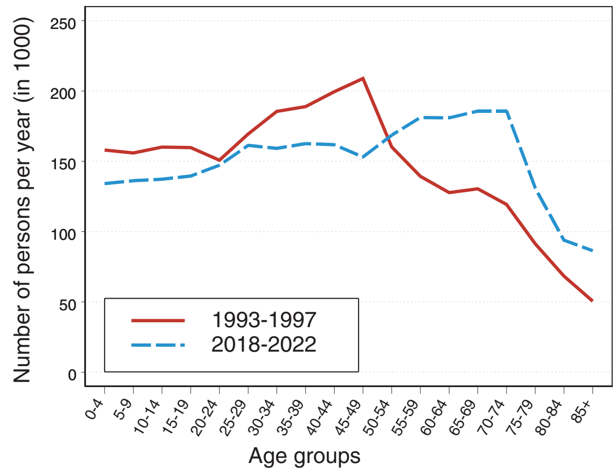


Figure 5. Age distribution of the Finnish female population in 1993–1997 and 2018–2022 (thousands).

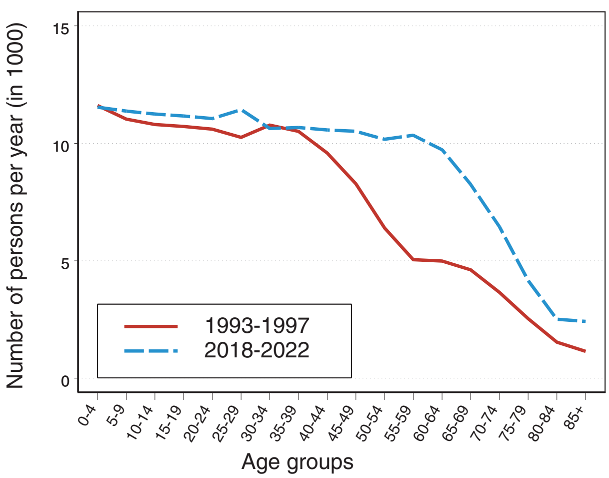


Figure 6. Age distribution of the Icelandic male population in 1993–1997 and 2018–2022 (thousands).

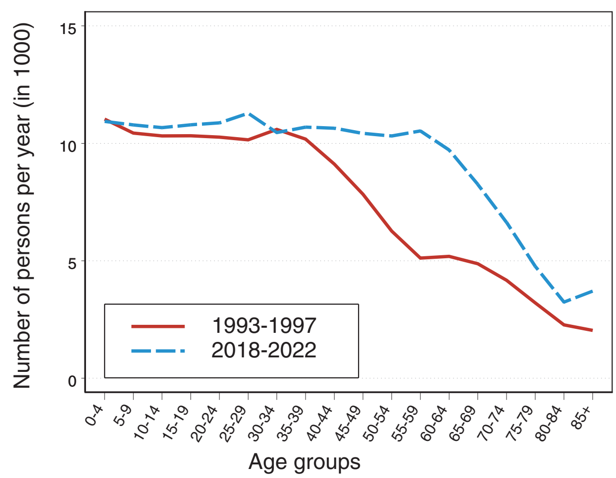


Figure 7. Age distribution of the Icelandic female population in 1993–1997 and 2018–2022 (thousands).

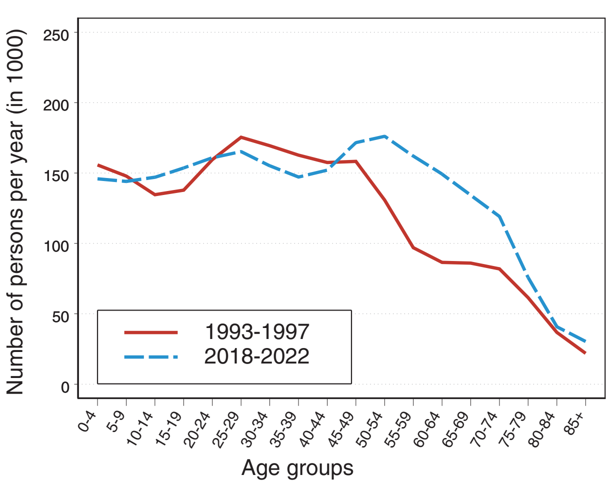


Figure 8. Age distribution of the Norwegian male population in 1993–1997 and 2018–2022 (thousands).

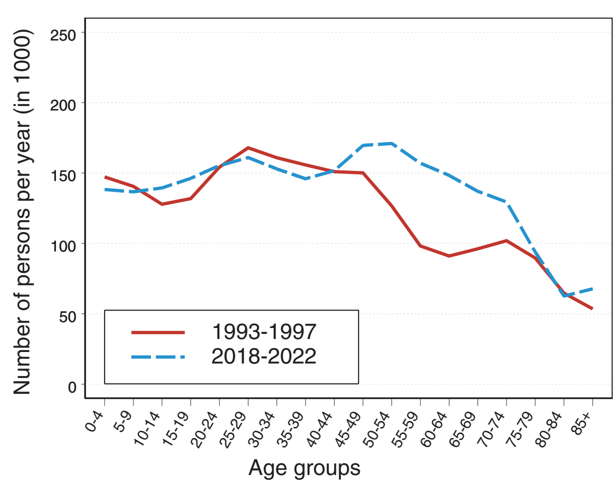


Figure 9. Age distribution of the Norwegian female population in 1993–1997 and 2018–2022 (thousands).

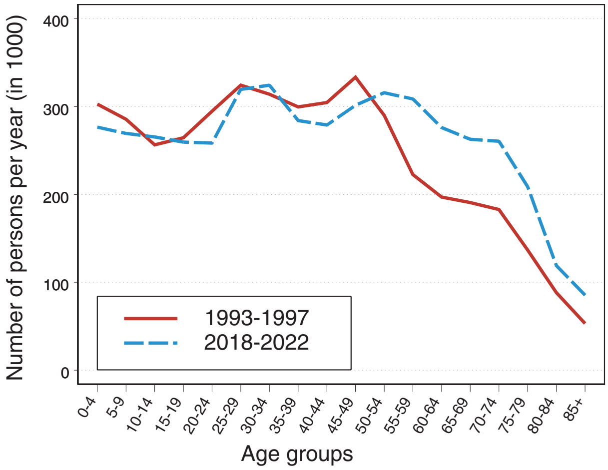


Figure 10. Age distribution of the Swedish male population in 1993–1997 and 2018–2022 (thousands).

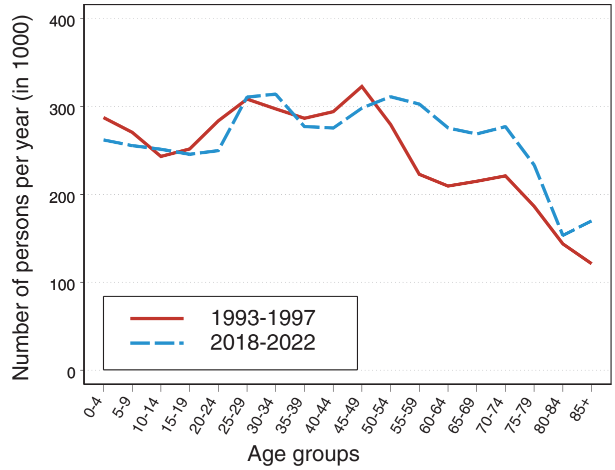


Figure 11. Age distribution of the Swedish female population in 1993–1997 and 2018–2022 (thousands).

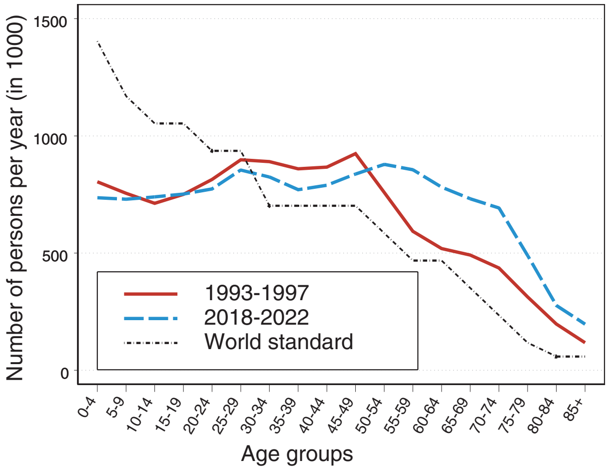


Figure 12. Age distribution of the Nordic male population in 1993–1997, 2018–2022 and the age distribution of the world standard population as applied to the Nordic population size of 1993–1997 (thousands).

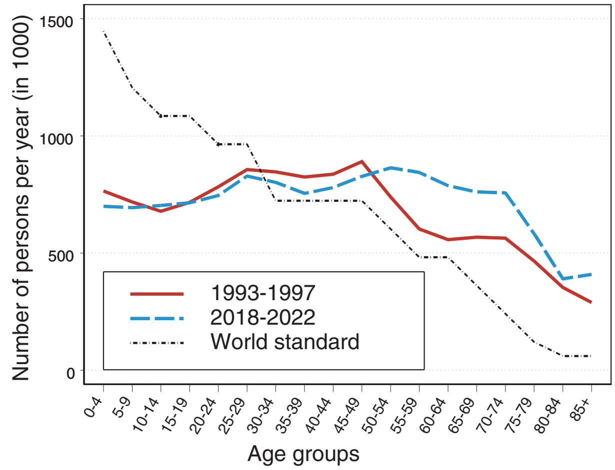


Figure 13. Age distribution of the Nordic female population in 1993–1997, 2018–2022 and the age distribution of the world standard population as applied to the Nordic population size of 1993–1997 (thousands).

Data and methods

Data

The basis for the predictions consists of data on new cancer cases diagnosed in the Nordic countries in 1958–1997, population figures for 1958–2000/2001 and the forecasts of population size and structure in 2001/2002–2022, produced by the central statistical offices in each country.

The new cancer cases were grouped into eight five-year calendar periods (1958–1962, 1963–1967, …, 1993–1997), five-year age groups (0–4, 5–9, …, 80–84, 85+ years) and 20 cancer types for each sex. The types of cancer in this study and their definitions are the same as those described by Engeland *et al*. (1993) and are listed in Table 2. Cancers of the lip and larynx are presented only for males because of the small number of female cases, and cancer of the breast is presented only for females because of the small number of male cases. For all types of cancer combined, predictions were made for people of each sex as the sum of the site-specific predictions (including "other sites"; see Table 2). "All types of cancer" is taken to mean all cancers except skin cancers other than melanoma (ICD-7 code 191).

Methods for prediction

The predicted numbers of cancer cases in the five periods 1998–2002, 2003–2007, 2008–2012, 2013–2017 and 2018–2022 were calculated by first predicting the incidence rates, based on observed rates up to 1997, then multiplying these rates by the population forecasts for the future periods. The method for predicting cancer incidence rates in Iceland is described separately, because the method that was used in the other countries had to be modified due to the small population in Iceland.

Denmark, Finland, Norway and Sweden

Incidence rates were modelled as a function of age, calendar period and birth cohort. Birth cohort was calculated as age subtracted from calendar period. Since the data are aggregated into five-year age groups and five-year calendar periods, the birth cohorts are synthetic, and people alternate between two birth cohorts during their lifetime.

Historically, the age–period–cohort (APC) model (Osmond, 1985) has been widely used for making cancer incidence predictions. The model can be written as:

$$R_{ap} = \exp\,(A_a + D \cdot p + P_p + C_c),$$

where R_{ap} is the incidence rate in age group a in calendar period p, D is the common drift parameter (Clayton and Schifflers, 1987), A_a is the age component for age group a, P_p is the non-linear period component of period p and C_c is the non-linear cohort component of cohort c. This Poisson regression model often gives a good fit when modelling cancer incidence rates. However, the multiplicative relationship between the rate and the covariates produces predictions in which the rates may grow exponentially with time. Another problem is that current trends extrapolate more reliably to the close future than to more distant periods. In the previous cancer incidence predictions for the Nordic countries by Engeland *et al.* (1993), these problems were handled in the following way:

(i) To level off the exponential growth in the multiplicative model, a power link was used instead of the log link.

(ii) Only half the linear trend was projected for the third and fourth five-year prediction periods, based on the belief that trends would eventually tend to flatten.

An empirical evaluation (Møller *et al*., article in preparation) shows that both these changes resulted in better predictions for the period 1993–1997. The power model used in the previous predictions (Engeland *et al.*, 1993) has therefore also been used for the present predictions:

$$R_{ap} = (A_a + D \cdot p + P_p + C_c)^5,$$

where R_{ap}, A_a, P_p and C_c are defined as in the multiplicative model.

A lower age limit was chosen such that the number of cases exceeds 10 in all observation periods for each country. For age groups below this limit, future rates were estimated using the average rates in the last two periods. When fitting the regression model, one or two age groups below the lower age limit were used, if possible, to improve the estimates for the youngest cohorts. The age limits are shown in Appendix B, Table B1.

The prediction base is the observation period used when fitting the statistical model. First, a model using the last six five-year periods was fitted. If the model was rejected by a goodness-of-fit test (5% level), a model using the five last periods was fitted. If this model also was rejected, only the last four periods were used. The number of periods in the prediction base (six, five or four) was chosen separately for each country. The periods included for each cancer type are shown in Appendix B, Table B1.

The predictions are based on the assumption that cohort-specific patterns will continue into the future. Due to the co-linearity of age, period and cohort, it is not possible to estimate the linear effect of period and cohort

Table 2. Types of cancer (and their definitions) included in the study (M, males only; F, females only).

ICD-7	Site
140(M)	**Lip**
141, 143-145	**Tongue, oral cavity and pharynx**
and 147-148	- Tumours of the salivary glands and those of the nasopharynx are excluded.
150	**Oesophagus**
	- Adenocarcinomas of the cardia are included under cancer of the stomach when it was not known whether oesophagus or stomach was the primary site.
	- Since 1978, all cancers for which cardia is mentioned have been grouped as stomach cancers in Denmark.
151	**Stomach**
	- See oesophagus.
153	**Colon**
	- Cancer of the rectosigmoid junction is included under colon cancer in Denmark, Finland (for the present study only) and Norway. In Iceland and Sweden it is included under rectal cancer.
	- Carcinoid tumours are included, irrespective of malignancy, in all the Nordic countries except Iceland, where only `malignant' carcinoids are registered.
	- Unspecified cancers of the intestinal tract are classified as colon cancer according to ICD7 practice.
154	**Rectum**
	- Cancer of the rectosigmoid junction is included under rectal cancer for Iceland and Sweden, but under colon cancer for Denmark, Finland (for the present study only) and Norway.
	- Tumours of the anal canal, anus and skin of the anus have been included for Finland only.
157	**Pancreas**
	- Insulomas are included, in Finland only malignant insulomas are included.
161(M)	**Larynx**
162-163	**Lung**
	- Both primary lung cancers and cancers of the lung unspecified as primary or secondary (ICD7: 163) are included.
	- Cancer of the trachea is included.
	- Cancer of the pleura and bronchial adenomas are excluded.
170(F)	**Breast**
	- Only the first malignant tumour diagnosed is included in all the countries except Denmark, where all malignant tumours with different morphological characteristics, have been included since 1978.
171	**Cervix uteri**
172	**Corpus uteri**
175.0	**Ovary**
	- Tumours of borderline malignancy, thecoma and benign Brenner tumours are excluded.
	- Benign granulosa-cell tumours are excluded in all the Nordic countries except Denmark.
177	**Prostate**
178	**Testis**
	- Leydig-cell tumours are excluded in all the countries except Denmark.
180	**Kidney**
	- Tumours of the ureter and papillomas of the renal pelvis and ureter are included.
181.0	**Urinary bladder**
	- Tumours of the urethra and papillomas are included.
190	**Melanoma of the skin**
	- Juvenile melanoma is excluded in all countries.
	- Lentigo maligna is excluded in all countries except Denmark (where it comprises 3 % of the cases).
194	**Thyroid**
200, 202	**Non-Hodgkin lymphomas**
	- Lymphomas arising in organs other than lymph nodes are included.
201	**Hodgkin disease**
203	**Multiple myeloma**
	- Waldenström's macroglobulinaemia is excluded.
	- Myelomatosis and solitary plasmocytoma are included.
204 AL	**Acute leukaemia**
-	**Other sites**
	- Skin cancer (ICD7: 191) is excluded.
	- Polycythaemia vera, myelofibrosis, all in situ lesions and other precancerous lesions, such as villous adenomas of the intestines and carcinoma incipiens of the breast, are excluded.
	- Benign lesions of the central nervous system are included.

Lymphomas arising in organs other than lymph nodes are included in non-Hodgkin lymphomas and all in-situ lesions are excluded.

separately, but only a common linear trend (D). It is, however, possible to estimate cohort-specific departures from this average trend. These non-linear cohort effects (C_c), which are contrasts between consecutive cohorts,

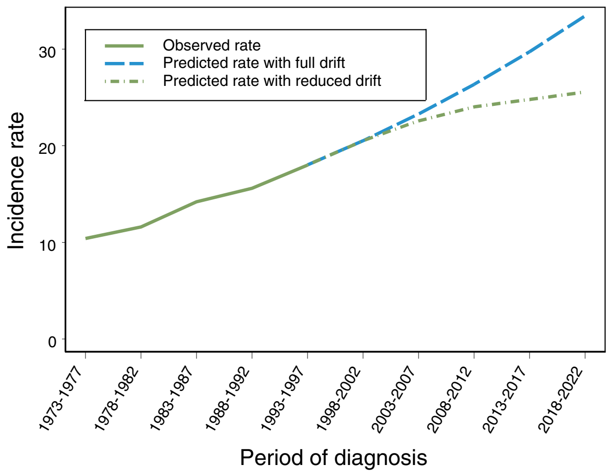


Figure 14. Comparison of full projection of drift with reduced projection of drift.

were assumed to continue to the same extent in the future. Future non-linear cohort and period effects were taken as equal to the last estimated effect in the model. The common linear drift (D) was also assumed to continue, but with some reduction in the later prediction periods. Based on an empirical comparison of different prediction methods (Møller *et al*., article in preparation), we found that reducing the drift gradually worked marginally better than halving the drift after the first two periods. Since this is also a more intuitive way of reducing the impact of current trends in the predictions, we added D, $0.75D$, $0.50D$, $0.25D$ and $0.25D$ to the five new periods. Figure 14 shows the effect of reducing the drift in a constructed data-set. It is important to bear this graph in mind when interpreting the predictions given in the results chapter. The levelling off in future rates is not based on observed trends, but on a belief that rates will not continue to increase forever. Construction of the predicted rates is shown in Appendix B Table B2.

Drift is the average linear increase in the observation period. One problem with projecting the drift is that it is influenced by older, perhaps less relevant trends. If the rates displayed significant curvature in the prediction base, the trend in the last 10 years was used as the drift component to be projected. If we have P periods, then the last slope is $D - P_P = D_{last}$, where D is the common drift and P_P is the last deviation from this. Technically, the choice between using an older secant (D) or a recent tangent (D_{last}) is based on the model $R_{ap} = (A_a + D \cdot p + S \cdot p^2 + C_c)^5$. If there was significant curvature in the trend over time, i.e. if the estimate of S was significant, D_{last} was used, otherwise we used D. Whether average (D) or recent (D_{last}) trend was used is shown in Appendix B, Table B1.

The method described above was used here for all cancer types except cancer of the breast and prostate. Information on mammographic screening was included in the model for breast cancer, and the method is described in the results chapter and in Appendix A. Regarding prostate cancer, the introduction of PSA testing has influenced the incidence rates. The modification of the method used for prediction of prostate cancer is included in the results chapter.

Iceland

Since in Iceland some cancer sites have relatively few cases, reasonable predictions cannot be obtained in the same way as for the other countries. The full age–period–cohort model described above can only be used for the most common types of cancer (stomach, colon, lung, breast, prostate, male bladder and "other sites"). The last six periods were used as the prediction base in all sites, with a few exceptions, which are described in the text. A lower age limit was chosen such that the number of cases exceeds five in all observation periods. For age groups below this limit, future rates were estimated using the average rates in the last three periods. If a limit of 10 had been used, as in the other countries, a larger number of age groups would have been based on the average rates. This would reduce the effect of current trends, so a lower limit of five was chosen as a trade-off between unbiased estimation of the underlying trend and a large estimation error. When fitting the regression model, one or two age groups below the lower age limit were used, if possible, to improve the estimates for the youngest cohorts.

For other types of cancer, the age–drift–period model $R_{ap} = (A_a + D \cdot p + P_p)^5$ was used. A lower age limit was chosen such that the number of cases exceeds 10 for all periods combined, and average rates in the last three periods were used for age groups below this limit.

The trend component was gradually reduced in Iceland, in the same way as for the other countries, but if the current trend in Iceland deviated from those in all the other Nordic countries, the drift was halved in the predictions, adding only $0.5D$, $0.375D$, $0.25D$, $0.125D$ and $0.125D$ in the five future periods. Predictions for cancer sites where this reduction of the drift was applied have been given a different dotted line in the graphs, with individual comments in the results chapter.

Presentation of results

All incidence rates are calculated per 100 000 person-years. For comparison between countries, the rates adjusted for age according to the world standard population (Breslow and Day, 1987) are presented. Age adjustment removes the effect of differences in age distribution on comparisons of rates.

For each type of cancer, a figure giving age-specific rates in the Nordic countries combined in 1993–1997 is included to show the cross-sectional age–incidence patterns. In addition, the median age at diagnosis has been calculated and is mentioned in the text. In order to illustrate time trends and differences between the countries, figures are given showing observed (1958–1997) and predicted (1998–2022) age-adjusted incidence rates in each country.

Tables for males and females give the observed (1993–1997) and predicted (2003–2007, 2018–2022) average annual numbers of cases, the crude incidence rate and world standardized rates. The latter should be used to compare the cancer risk in the different countries and the changes in risk over time. The crude rates are influenced by the age distribution, and should only be used to compare the relative cancer burden per 100 000 person-years between the countries. The predictions for each country are based on the last 4–6 five-year periods, and either the average trend or the trend in the last 10 years has been used as the drift component to be forecast (see 'Methods for predictions'). Which prediction base and drift component were used in each country are listed in Appendix B1. In addition to results for cancers of the colon and rectum separately, results for colorectal cancer are given as the sum of the predictions for the two sites. In the section on cancers of all sites, the results are the sum of the site-specific predictions.

A further section is devoted to predicted changes in the numbers of cancer cases due to changes in population structure and to changes in risk. The final section gives a summary of the results.

In this publication, the numbers of cases presented in the tables are annual average numbers and are divided into three age groups. In all the tables, the numbers were rounded separately, so the totals in the tables may differ from the sums of the age-specific numbers of cases.

Results

Cancer of the lip

Cancer of the lip is relatively rare. In 1993–1997, the annual number of new cases in males in the Nordic countries was 372, comprising only 0.7% of all male cancer cases (Table 3). Since cancer of the lip is three to five times less common among females than in males, incidence among females was not analysed.

The median age of patients in 1993–1997 was 72 years. The incidence rate increased consistently with age at diagnosis to 28 per 100 000 person-years in the oldest age group (Figure 15).

There has been a steady decrease in the incidence rates in all the Nordic countries in the period 1958–1997. Sweden had the lowest rates in the whole period (Figure 16). Finland, which has had the highest rates, also had the greatest decline in the rates, and the difference between the countries has decreased. If the decline in all the countries continues, the standardized rates for all the Nordic countries will drop from 1.9 in 1993–1997, to 0.9 in 2018–2022. The difference between the countries is predicted to further diminish, giving predicted standardized rates around 1 for each country. Even though the rates on average will decrease by more than 50%, the annual number of cases will fall by only 25%, due to the older age distribution in 2018–2022 (Table 3).

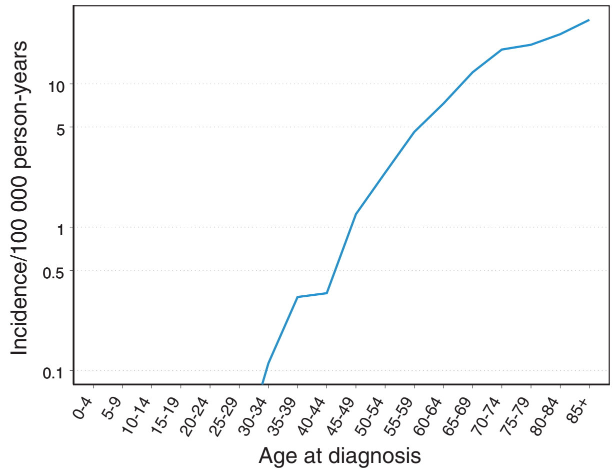


Figure 15. Age-specific incidence rates of lip cancer in males in the Nordic countries, 1993–1997.

Comments

The risk of lip cancer is high among males employed in outdoor occupations (Tomatis *et al.*, 1990). In 1960, the proportion of males employed in agriculture, forestry and fishing varied in the Nordic countries between 18% (Sweden) and 38% (Finland) (Nordic Council and Nordic Statistical Secretariat, 1986), whereas 25 years

Table 3. Observed and predicted average annual numbers of new cases by age, and crude and world-standardized rates in the five Nordic countries; cancer of the lip, males.

Males		DENMARK			FINLAND			ICELAND		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	10	9	8	7	6	4	0	0	0
Number	55-74	45	27	23	64	39	34	1	1	2
of cases	≥ 75	29	21	22	28	38	37	2	1	2
	Total	84	57	53	100	83	75	3	3	3
Crude rate[a]		3.3	2.1	1.9	4.0	3.2	2.9	2.2	1.9	2.1
World stand. rate		**2.0**	**1.2**	**0.9**	**2.7**	**1.7**	**1.1**	**1.5**	**1.2**	**1.0**
		NORWAY			SWEDEN			TOTAL		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	8	6	5	11	10	10	37	32	28
Number	55-74	34	18	17	55	44	49	200	130	125
of cases	≥ 75	21	16	13	55	51	53	135	127	127
	Total	63	40	36	122	105	112	372	288	280
Crude rate[a]		2.9	1.8	1.5	2.8	2.4	2.4	3.2	2.4	2.2
World stand. rate		**1.8**	**1.0**	**0.7**	**1.4**	**1.1**	**1.0**	**1.9**	**1.2**	**0.9**

[a]Crude rate should not be used to compare the risk of cancer in different countries, or the change of risk over time, since it is not adjusted for differences in age distribution. It can, however, be used to compare the relative cancer burden between countries.

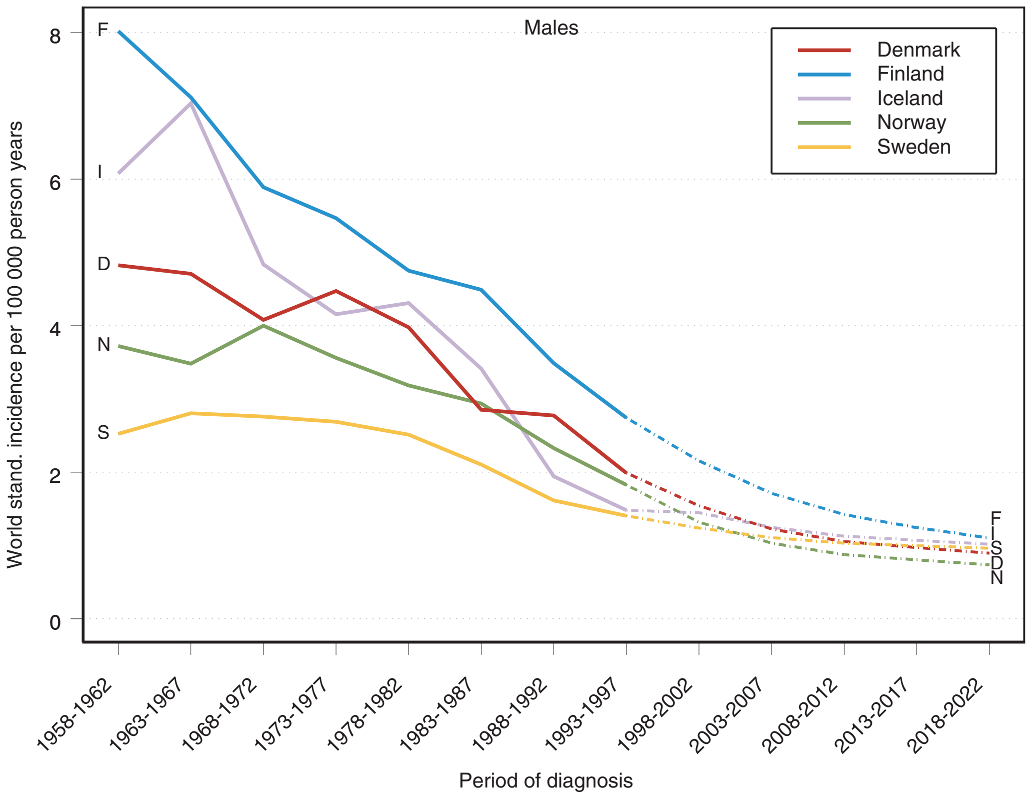


Figure 16. Observed and predicted age-adjusted incidence rates in the five Nordic countries: cancer of the lip, males.

later the range was from 7% (Sweden) to 13% (Finland) (Nordic Council and Nordic Statistical Secretariat, 1992). Lip cancer is one of a few cancer types for which incidence rates are highest in rural areas. The proportion of the population living in rural areas has decreased in all the Nordic countries. Thus, the range of observed and predicted rates, both between countries and over time, reflects the occupational and residential changes and differentials observed in the Nordic populations.

Cancers of the tongue, oral cavity and pharynx

In 1993–1997, the average annual numbers of new cases of cancers of the tongue, oral cavity and pharynx (ICD-7: 141, 143–145, 147–148) in the Nordic countries were 890 in males and 499 in females, comprising 1.7% and 1.0% of all male and female cancer cases, respectively (Table 4).

In the last observation period, the median ages of patients were 63 years for males and 69 years for females. The incidence rates increased with age at diagnosis to 26 (males) and 20 (females) per 100 000 person-years in the oldest age group (Figure 17).

Incidence rates have increased steadily since 1958–1962 in all countries, most markedly in Denmark (Figure 18). The increase has been less evident in Finland, but cohort-specific risks indicate a change towards higher risks for both males and females born around 1938 and later in Finland. In Denmark, Norway and Sweden, the cohort-specific risks started to increase twenty years earlier. There were too few cases for this group of sites in Iceland to study cohort-specific patterns.

In Denmark, the rates in males have doubled since 1978–1982, from 4 to 8 per 100 000 (Figure 18 top). In the prediction model, current trends were predicted to fade gradually after the first prediction period (see Figure 14).

Table 4. Observed and predicted average annual numbers of new cases by age, and crude and world-standardized rates in the five Nordic countries; cancer of the tongue, oral cavity and pharynx.

Males		DENMARK			FINLAND			ICELAND		
		1993	2003	2018	1993	2003	2018	1993	2003	2018
	Age	-1997	-2007	-2022	-1997	-2007	-2022	-1997	-2007	-2022
Annual	0-54	101	120	140	44	47	41	2	2	2
Number	55-74	152	291	433	60	108	173	2	3	5
of cases	≥ 75	37	57	127	18	25	53	1	2	3
	Total	290	468	699	122	181	267	5	7	10
Crude rate[a]		11.3	17.4	24.8	4.9	7.1	10.2	3.7	4.7	6.2
World stand. rate		**8.1**	**11.2**	**13.6**	**3.5**	**4.3**	**5.1**	**3.1**	**3.3**	**3.5**
		NORWAY			SWEDEN			TOTAL		
		1993	2003	2018	1993	2003	2018	1993	2003	2018
	Age	-1997	-2007	-2022	-1997	-2007	-2022	-1997	-2007	-2022
Annual	0-54	44	59	69	75	67	66	265	296	318
Number	55-74	92	138	240	164	223	288	470	762	1139
of cases	≥ 75	34	47	63	65	78	131	155	210	378
	Total	170	244	372	303	368	486	890	1267	1835
Crude rate[a]		7.9	10.7	15.3	7.0	8.3	10.4	7.6	10.5	14.4
World stand. rate		**5.6**	**7.1**	**8.5**	**4.5**	**4.8**	**5.1**	**5.3**	**6.5**	**7.6**

Females		DENMARK			FINLAND			ICELAND		
		1993	2003	2018	1993	2003	2018	1993	2003	2018
	Age	-1997	-2007	-2022	-1997	-2007	-2022	-1997	-2007	-2022
Annual	0-54	29	30	33	24	21	18	0	1	1
Number	55-74	66	97	134	40	51	71	3	4	7
of cases	≥ 75	40	52	83	32	42	59	3	4	6
	Total	136	180	250	96	114	148	6	9	14
Crude rate[a]		5.1	6.6	8.7	3.6	4.3	5.5	4.5	5.9	8.3
World stand. rate		**2.9**	**3.6**	**4.0**	**2.0**	**2.1**	**2.2**	**2.7**	**3.4**	**3.7**
		NORWAY			SWEDEN			TOTAL		
		1993	2003	2018	1993	2003	2018	1993	2003	2018
	Age	-1997	-2007	-2022	-1997	-2007	-2022	-1997	-2007	-2022
Annual	0-54	16	16	18	35	34	35	104	101	105
Number	55-74	38	45	59	76	105	139	223	302	410
of cases	≥ 75	33	41	49	65	82	121	173	222	318
	Total	87	103	126	175	221	295	499	626	833
Crude rate[a]		3.9	4.4	5.1	3.9	4.9	6.2	4.1	5.0	6.4
World stand. rate		**2.2**	**2.3**	**2.3**	**2.0**	**2.3**	**2.6**	**2.3**	**2.5**	**2.8**

[a]Crude rate should not be used to compare the risk of cancer in different countries, or the change of risk over time, since it is not adjusted for differences in age distribution. It can, however, be used to compare the relative cancer burden between countries.

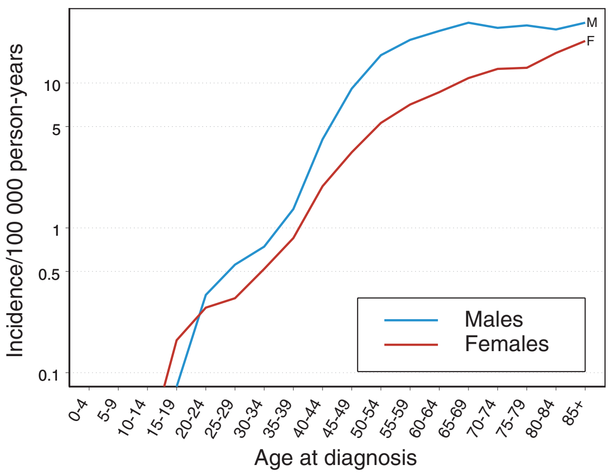


Figure 17. Age-specific incidence rates of cancer of the tongue, oral cavity and pharynx in the Nordic countries, 1993–1997.

Despite this, rates in males are predicted to increase by almost 70% by 2018–2022 to 13.6 per 100 000. Similarly, rates have increased for Danish females, but not as radically, and are predicted to increase by around 40% from 1993–1997 to 2018–2022 (Figure 18 bottom). The rates are also predicted to increase in all the other countries, but to a smaller extent than in Denmark. For all the Nordic countries combined, rates are predicted to increase from 5.3 (male) and 2.3 (female) in 1993–1997 to 7.6 and 2.8 in 2018–2022. The annual number of male cases will more than double, from around 900 to more than 1800, whereas the number of females will increase from around 500 to over 800 cases (Table 4).

Comments

Alcohol and tobacco smoking have been considered to be the main risk factors for this group of cancers (Tomatis *et al.*, 1990). The consumption of alcohol per inhabitant aged 15 years and over (in litres of 100% alcohol) increased in Denmark from 5.9 in 1963 to 11.4 in 1989, in Finland from 3.1 to 9.4, in Iceland from 3.0 to 5.5, in Norway from 3.6 to 5.0 and in Sweden from 5.1 to 6.6 (Nordic Council and Nordic Statistical Secretariat, 1973, 1992). The proportions of smokers have been decreasing since the 1960s in males in all the Nordic countries, but in females no such favourable change has been observed (Olsen *et al.*, 1997). The temporal and geographical variation of these risk factors is thus only partially reflected in the observed incidence rates. Changes in coding to ICD-O in 1978 may have created an artificial increase in the later years of observation in Denmark (Engeland *et al.*, 1993).

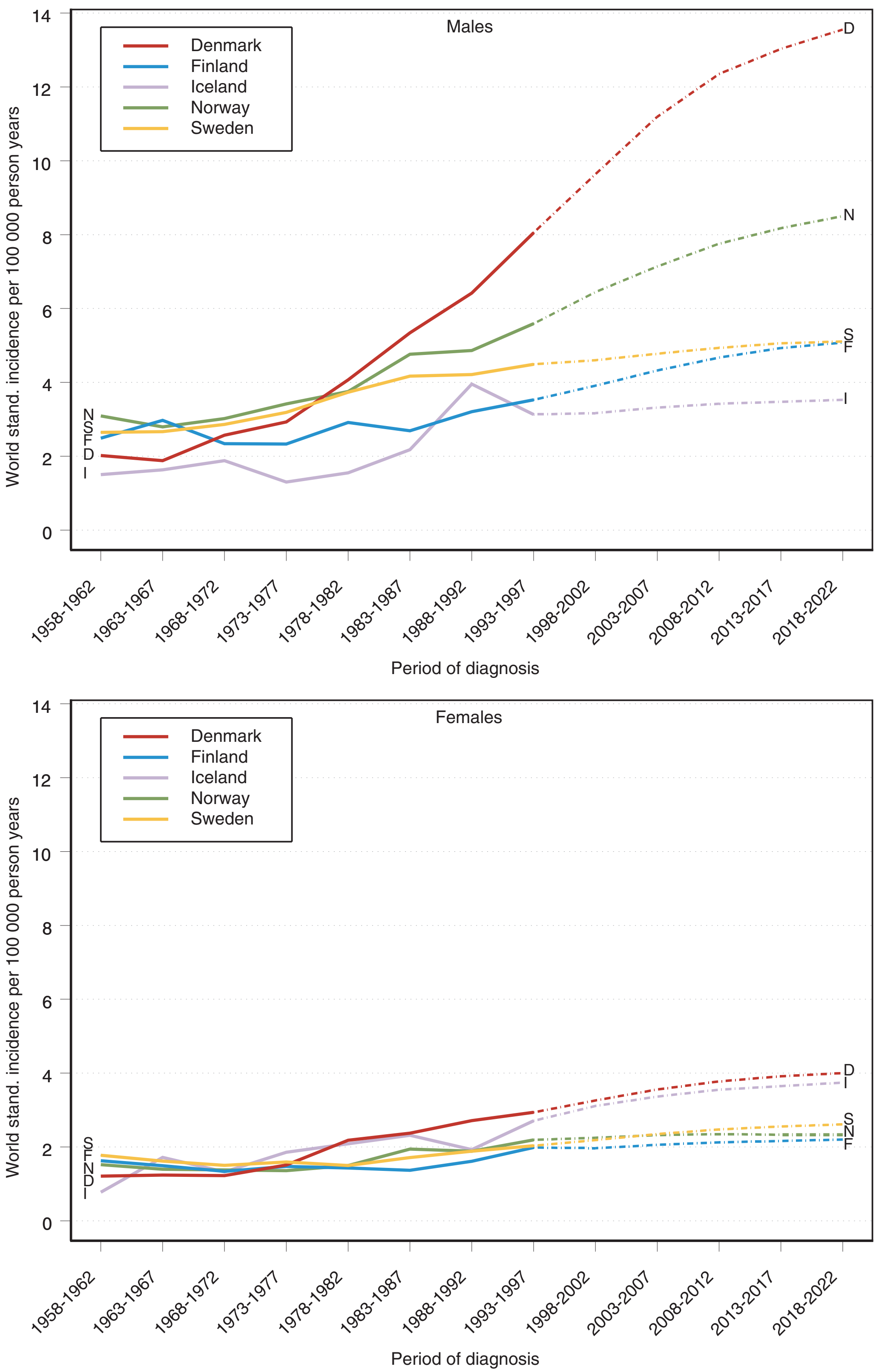


Figure 18. Observed and predicted age-adjusted incidence rates in the five Nordic countries: cancer of the tongue, oral cavity and pharynx.

Cancer of the oesophagus

In 1993–1997, the average annual numbers of new cases of cancer of the oesophagus in the Nordic countries were 706 in males and 337 in females, comprising 1.4% and 0.6% of all male and female cancer cases, respectively (Table 5).

The median ages of patients in the last observation period were 69 years for men and 75 years for women. The incidence rates increased with age at diagnosis to 32 per 100 000 person-years in males and 19 in females (Figure 19). The male:female ratio of rates decreased with age. In the age group 45–49 years, the rate in males was 5.5 times higher than that in females, whereas the ratio was 1.7 for ages over 84 years.

In the past, the Finnish and Icelandic rates were much higher than in those in the other Nordic countries (Figure 20). These rates have, however, steadily declined, and by 1993–1997, the rates for males in Finland had reached the level of Norway and Sweden. The rates in Danish males have shown the opposite trend, with a rapid increase since 1978–1982; some increase has also been observed for Danish females.

Extending the current trends into the future gives a predicted increase of 50% in the rates in Danish males in

Table 5. Observed and predicted average annual numbers of new cases by age, and crude and world-standardized rates in the five Nordic countries; cancer of the oesophagus.

Males		DENMARK			FINLAND			ICELAND		
		1993	2003	2018	1993	2003	2018	1993	2003	2018
	Age	-1997	-2007	-2022	-1997	-2007	-2022	-1997	-2007	-2022
Annual	0-54	39	45	53	18	16	13	0	1	1
Number	55-74	134	207	305	66	84	116	4	7	11
of cases	≥ 75	60	91	153	30	39	73	6	6	9
	Total	234	343	512	114	139	202	11	14	22
Crude rate[a]		9.1	12.8	18.1	4.6	5.4	7.7	7.9	9.4	13.3
World stand. rate		**5.8**	**7.5**	**8.7**	**3.2**	**3.1**	**3.2**	**5.2**	**6.4**	**6.6**
		NORWAY			SWEDEN			TOTAL		
		1993	2003	2018	1993	2003	2018	1993	2003	2018
	Age	-1997	-2007	-2022	-1997	-2007	-2022	-1997	-2007	-2022
Annual	0-54	14	16	18	26	23	23	97	101	108
Number	55-74	66	83	130	135	164	221	405	544	783
of cases	≥ 75	31	38	50	76	84	134	205	258	421
	Total	110	137	199	237	270	377	706	903	1312
Crude rate[a]		5.1	6.0	8.2	5.5	6.1	8.1	6.0	7.5	10.3
World stand. rate		**3.3**	**3.8**	**4.1**	**3.1**	**3.2**	**3.4**	**3.7**	**4.2**	**4.7**

Females		DENMARK			FINLAND			ICELAND		
		1993	2003	2018	1993	2003	2018	1993	2003	2018
	Age	-1997	-2007	-2022	-1997	-2007	-2022	-1997	-2007	-2022
Annual	0-54	9	8	9	5	6	5	0	0	0
Number	55-74	45	52	66	34	26	29	2	2	3
of cases	≥ 75	41	55	77	52	48	50	2	3	4
	Total	95	116	152	91	79	84	5	5	7
Crude rate[a]		3.6	4.2	5.3	3.5	3.0	3.1	3.6	3.6	4.3
World stand. rate		**1.7**	**1.9**	**1.9**	**1.4**	**1.1**	**0.9**	**2.0**	**1.9**	**1.8**
		NORWAY			SWEDEN			TOTAL		
		1993	2003	2018	1993	2003	2018	1993	2003	2018
	Age	-1997	-2007	-2022	-1997	-2007	-2022	-1997	-2007	-2022
Annual	0-54	3	4	4	5	7	7	22	24	25
Number	55-74	19	18	26	46	43	51	145	142	175
of cases	≥ 75	21	27	30	53	64	73	170	197	233
	Total	43	49	60	104	114	131	337	364	434
Crude rate[a]		1.9	2.1	2.4	2.3	2.5	2.8	2.8	2.9	3.4
World stand. rate		**0.8**	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**	**1.2**	**1.2**	**1.1**

[a]Crude rate should not be used to compare the risk of cancer in different countries, or the change of risk over time, since it is not adjusted for differences in age distribution. It can, however, be used to compare the relative cancer burden between countries.

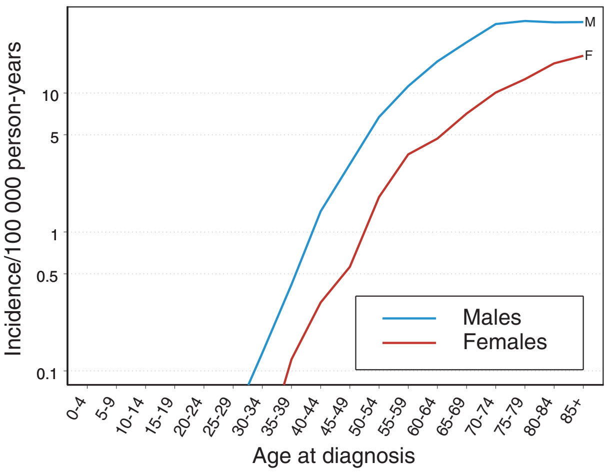


Figure 19. Age-specific incidence rates of oesophageal cancer in the Nordic countries, 1993–1997.

2018–2022. For males, Finland together with Sweden will have the lowest rates in the next 20 years. For women, the standardized rates will be around 2 in Denmark and Iceland, and around 1 in the other countries. The annual number of male cases will almost double, from about 700 in 1993–1997 to about 1300 in 2018–2022, whereas the annual number of female cases will increase by approximately 100 cases to about 430 cases per year in 2018–2022 (Table 5).

Comments

The rates in males in Denmark are predicted to increase by 50%, which is a result of the steep increase in the rates over the last 20 years. Even though the Danish rates are predicted to be two or three times higher than in the other Nordic countries by 2018–2022, several European countries, such as the United Kingdom, France and Russia, already have rates above this high level. However, the predictions for Denmark may be too high.

Tobacco smoking and alcohol consumption are considered to be the main risk factors for this type of cancer (Olsen *et al.*, 1997). About 55% (males) and 44% (females) of oesophageal cancers could be avoided if smoking were eliminated, and 40% and 30% for males and females, respectively, if alcohol drinking were eliminated. From 1965 to 1985, the consumption of alcohol generally increased in all the Nordic countries, among both males and females. Over the same period, the proportion of smokers has declined in males but increased in females. Since both alcohol consumption and smoking have increased in women, an increase in the incidence rates would have been expected, but they have been stable.

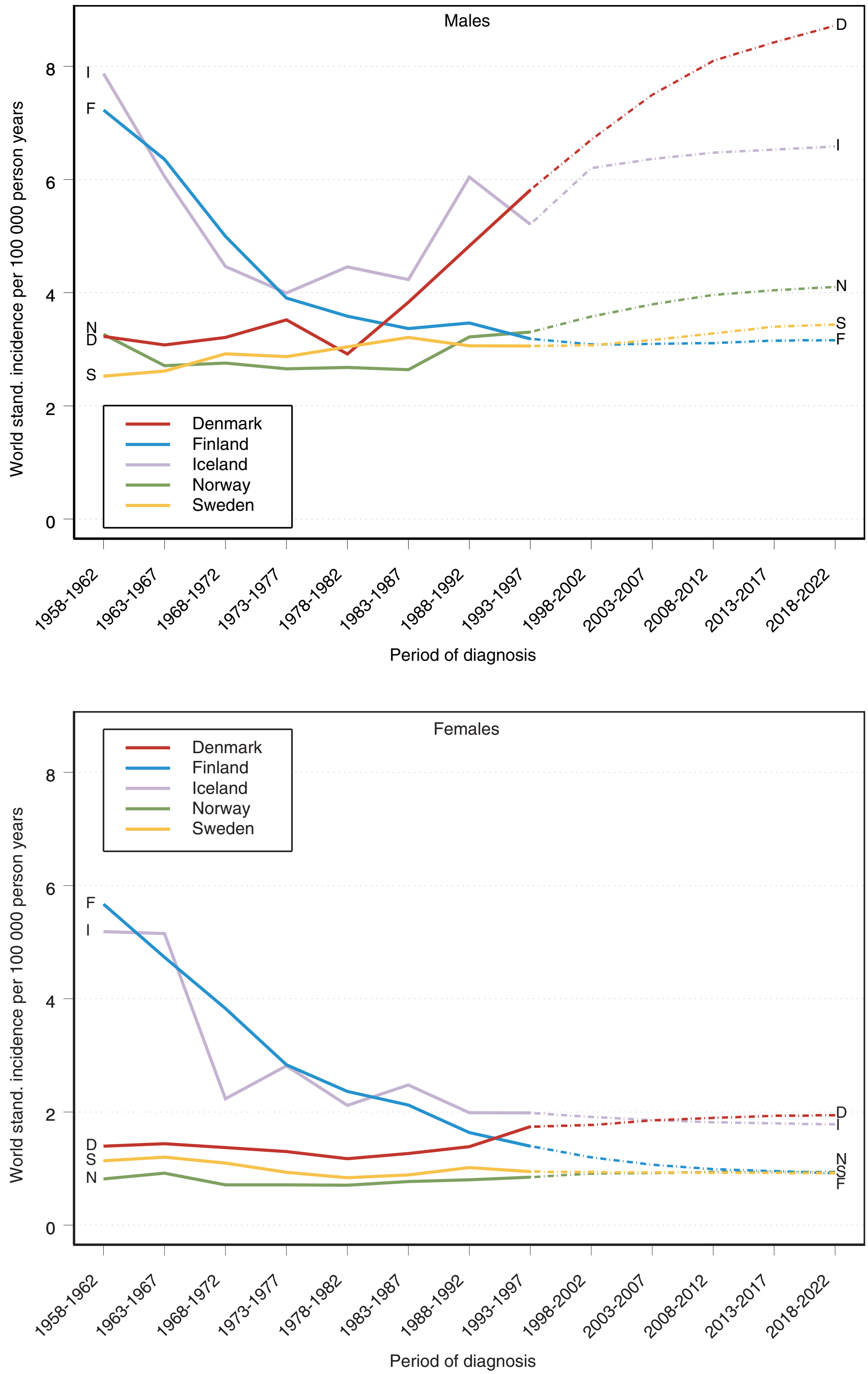


Figure 20. Observed and predicted age-adjusted incidence rates in the five Nordic countries: cancer of the oesophagus.

Cancer of the stomach

In 1993–1997, the average annual numbers of new cases of cancer of the stomach in the Nordic countries were 2039 in males and 1418 in females, comprising 4.0% and 2.7% of all male and female cancer cases, respectively (Table 6).

The median ages of patients in the last observation period were 73 years for men and 76 years for women. The incidence rates increased with age at diagnosis to 155 per 100 000 person-years in males and 82 in females (Figure 21). The age-specific rates in males and females were almost the same in age groups below 40 years, but the male:female ratio of the rates was around 1.5–2 in age groups above 50 years.

The incidence of stomach cancer has decreased more markedly than that of any other cancer type during the observation period (Figure 22). The reduction in rates has been similar in all the Nordic countries, and the internal ranking is the same for men and women, with the highest rates in Finland and Iceland, and the lowest in Denmark and Sweden. Analysis of cohort-specific risks indicates that risk is declining for both sexes in all countries, except for males in Denmark, where there is no decline for males born since around 1943.

Table 6. Observed and predicted average annual numbers of new cases by age, and crude and world-standardized rates in the five Nordic countries; cancer of the stomach.

Males		DENMARK			FINLAND			ICELAND		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	50	47	44	68	57	41	2	5	5
Number	55-74	177	189	277	236	223	303	13	14	20
of cases	≥ 75	126	113	170	166	155	194	12	10	14
	Total	352	350	491	470	435	538	28	29	39
Crude rate[a]		13.7	13.0	17.4	18.9	17.0	20.6	20.9	19.5	24.0
World stand. rate		**8.3**	**7.5**	**8.2**	**12.7**	**9.4**	**8.6**	**15.7**	**13.9**	**13.1**
		NORWAY			SWEDEN			TOTAL		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	42	37	34	64	44	37	226	190	161
Number	55-74	208	164	229	335	258	333	970	848	1162
of cases	≥ 75	189	167	158	350	269	312	843	715	848
	Total	439	368	421	749	571	682	2039	1753	2172
Crude rate[a]		20.3	16.2	17.3	17.3	12.8	14.6	17.4	14.5	17.1
World stand. rate		**11.6**	**9.0**	**8.2**	**8.6**	**6.0**	**5.7**	**9.9**	**7.7**	**7.4**

Females		DENMARK			FINLAND			ICELAND		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	23	18	13	49	32	22	1	3	3
Number	55-74	83	69	90	161	128	162	7	5	6
of cases	≥ 75	106	76	94	201	169	200	7	6	7
	Total	212	163	197	411	329	383	14	14	16
Crude rate[a]		8.0	5.9	6.9	15.7	12.3	14.2	10.8	9.3	9.7
World stand. rate		**3.6**	**2.7**	**2.6**	**7.0**	**5.0**	**4.5**	**6.4**	**5.4**	**4.8**
		NORWAY			SWEDEN			TOTAL		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	24	20	18	48	31	24	145	104	79
Number	55-74	103	84	105	175	128	152	530	415	516
of cases	≥ 75	165	138	129	264	208	219	743	596	649
	Total	292	242	252	488	367	395	1418	1115	1243
Crude rate[a]		13.2	10.5	10.2	11.0	8.1	8.3	11.8	9.0	9.6
World stand. rate		**5.5**	**4.4**	**3.9**	**4.4**	**3.1**	**2.8**	**5.0**	**3.7**	**3.4**

[a]Crude rate should not be used to compare the risk of cancer in different countries, or the change of risk over time, since it is not adjusted for differences in age distribution. It can, however, be used to compare the relative cancer burden between countries.

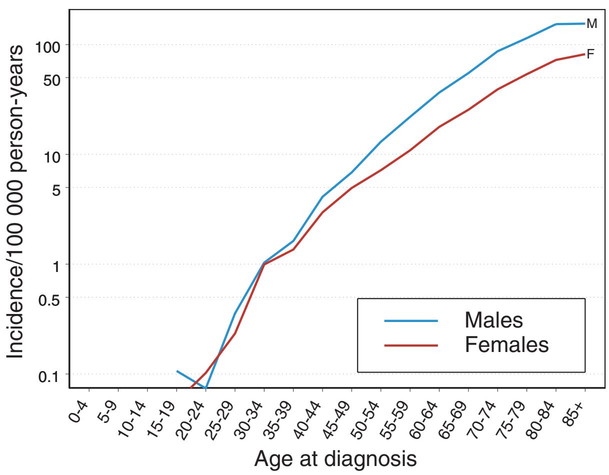


Figure 21. Age-specific incidence rates of stomach cancer in the Nordic countries, 1993–1997.

For Danish males, there is no decline in the predicted rates. For Danish females, and for males and females in all the other countries, the rates will continue to decline. For all countries combined, the rates are predicted to decrease by 25% and 32% from 1993–1997 to 2018–2022 for males and females respectively. Despite this, due to the ageing of the population, the annual number of cases will increase by more than 100 cases for men, to around 2170. For women, the annual number of cases will decrease from around 1400 in 1993–1997 to around 1250 in 2018–2022 (Table 6).

Comments

The large, highly stable decrease in stomach cancer incidence observed over more than 40 years is thought to be related to changes in dietary habits (Olsen *et al.*, 1997) and a decrease in prevalence of infection with *Helicobacter pylori* bacteria. If the latter was eliminated, it is estimated that about 58% of the stomach cancer cases could be avoided.

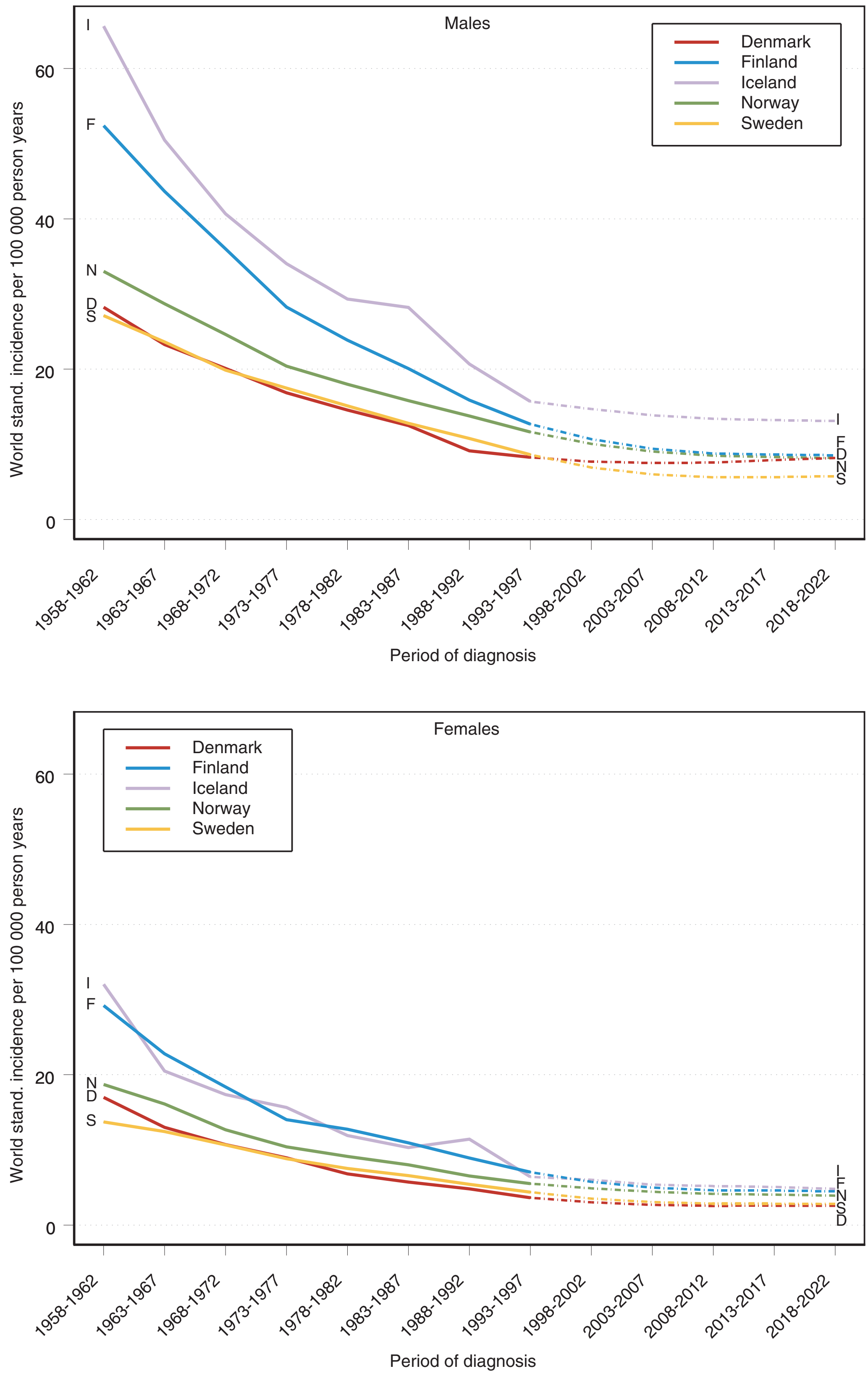


Figure 22. Observed and predicted age-adjusted incidence rates in the five Nordic countries: cancer of the stomach.

Cancer of the colon

For all the Nordic countries combined, annual numbers of new cases in 1993–1997 were 4024 in males and 4460 in females, comprising 7.9% and 9.0% of all male and female cancer cases, respectively (Table 7). This makes cancer of the colon the second most frequent cancer among females in 1993–1997, after breast cancer. In males, only cancers of the prostate and lung were more frequent.

The median ages of patients in the last observation period were 72 years for men and 75 years for women. The incidence rates increased with age at diagnosis to 288 per 100 000 person-years in males and 225 in females (Figure 23). The rates were higher in females than in males under the age of 60 years, but higher in males than females over that age.

In the period 1958–1997, the trends in the rates for males and females have been similar in each country (Figure 24), but with great differences between the countries. Most remarkable is the rapid increase in incidence in both sexes in Norway. Since 1960 and up to the last observed period, the Norwegian rates have overtaken both the Swedish and the Danish rates, and are now the highest in the Nordic countries. The predictions for Norway indicate that this increase will

Table 7. Observed and predicted average annual numbers of new cases by age, and crude and world-standardized rates in the five Nordic countries; cancer of the colon.

Males		DENMARK			FINLAND			ICELAND		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	104	101	102	87	90	84	3	5	5
Number	55-74	518	598	744	312	422	559	18	22	34
of cases	≥ 75	385	438	619	186	315	533	17	24	32
	Total	1007	1138	1465	586	827	1177	39	51	72
Crude rate[a]		39.2	42.4	51.9	23.5	32.3	45.1	28.8	34.8	43.6
World stand. rate		**23.2**	**23.4**	**22.7**	**16.1**	**17.9**	**17.7**	**21.0**	**22.6**	**22.2**

Males		NORWAY			SWEDEN			TOTAL		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	83	92	86	129	109	102	407	397	380
Number	55-74	451	479	616	678	713	798	1978	2234	2752
of cases	≥ 75	381	491	559	671	779	1013	1640	2047	2756
	Total	915	1062	1261	1478	1600	1912	4024	4678	5887
Crude rate[a]		42.3	46.7	51.9	34.0	35.9	40.9	34.4	38.6	46.3
World stand. rate		**24.8**	**26.0**	**23.6**	**17.4**	**16.6**	**15.1**	**19.8**	**20.0**	**18.9**

Females		DENMARK			FINLAND			ICELAND		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	102	86	80	96	93	86	5	5	6
Number	55-74	517	518	574	302	354	486	13	16	24
of cases	≥ 75	578	600	739	331	443	600	16	20	28
	Total	1197	1204	1393	729	890	1172	34	41	58
Crude rate[a]		45.3	44.0	48.5	27.8	33.3	43.3	25.3	28.2	35.0
World stand. rate		**20.4**	**19.0**	**17.4**	**13.1**	**13.9**	**14.5**	**15.6**	**16.2**	**16.2**

Females		NORWAY			SWEDEN			TOTAL		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	99	113	125	138	124	118	439	421	416
Number	55-74	459	480	583	657	622	682	1948	1991	2348
of cases	≥ 75	535	703	738	813	882	1017	2273	2648	3121
	Total	1093	1296	1446	1607	1629	1817	4660	5060	5886
Crude rate[a]		49.5	56.0	58.7	36.1	35.9	38.4	38.7	40.8	45.5
World stand. rate		**22.7**	**24.4**	**22.9**	**15.1**	**13.9**	**13.0**	**17.1**	**16.8**	**16.1**

[a]Crude rate should not be used to compare the risk of cancer in different countries, or the change of risk over time, since it is not adjusted for differences in age distribution. It can, however, be used to compare the relative cancer burden between countries.

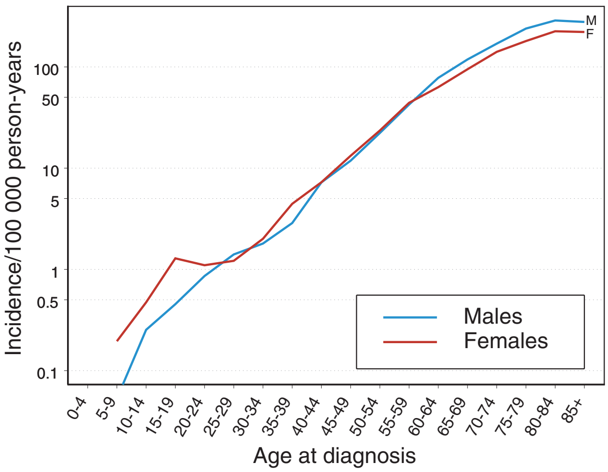


Figure 23. Age-specific incidence rates of colon cancer in the Nordic countries, 1993–1997.

diminish and that the rates will start to decline after the period 2003–2007. This is because cohorts born around 1943 and later have a lower risk of colon cancer than earlier cohorts. Denmark, Finland and Iceland have also experienced a steady increase in rates, which are predicted to stabilize, and even decline for Danish females. The increase in Sweden is less than in the other Nordic countries. In the last observation period, there was a slight decrease in the rates, which is predicted to continue.

For all the Nordic countries combined, the rates have more than doubled for both males and females from 1958–1962 to 1993–1997. According to the predictions, the rates will stabilize and even start to decline. Despite this, due to the ageing population, the numbers of cases are predicted to increase by 46% for males and 26% for females up to 2018–2022 (Table 7).

Comments

Rectosigmoid junction is included with colon cancer in Denmark, Finland and Norway, and constitutes less than 5% of the cases. In Iceland and Sweden, it is classified as rectum cancer.

Diet is regarded as the most important risk factor for colon cancer. Consumption of fruits and vegetables is preventive, while consumption of total and saturated fats, animal and total proteins and total energy may increase the risk (Olsen *et al.*, 1997). It is, however, difficult to explain the differences in the incidence rates between the countries on the bases of these risk factors.

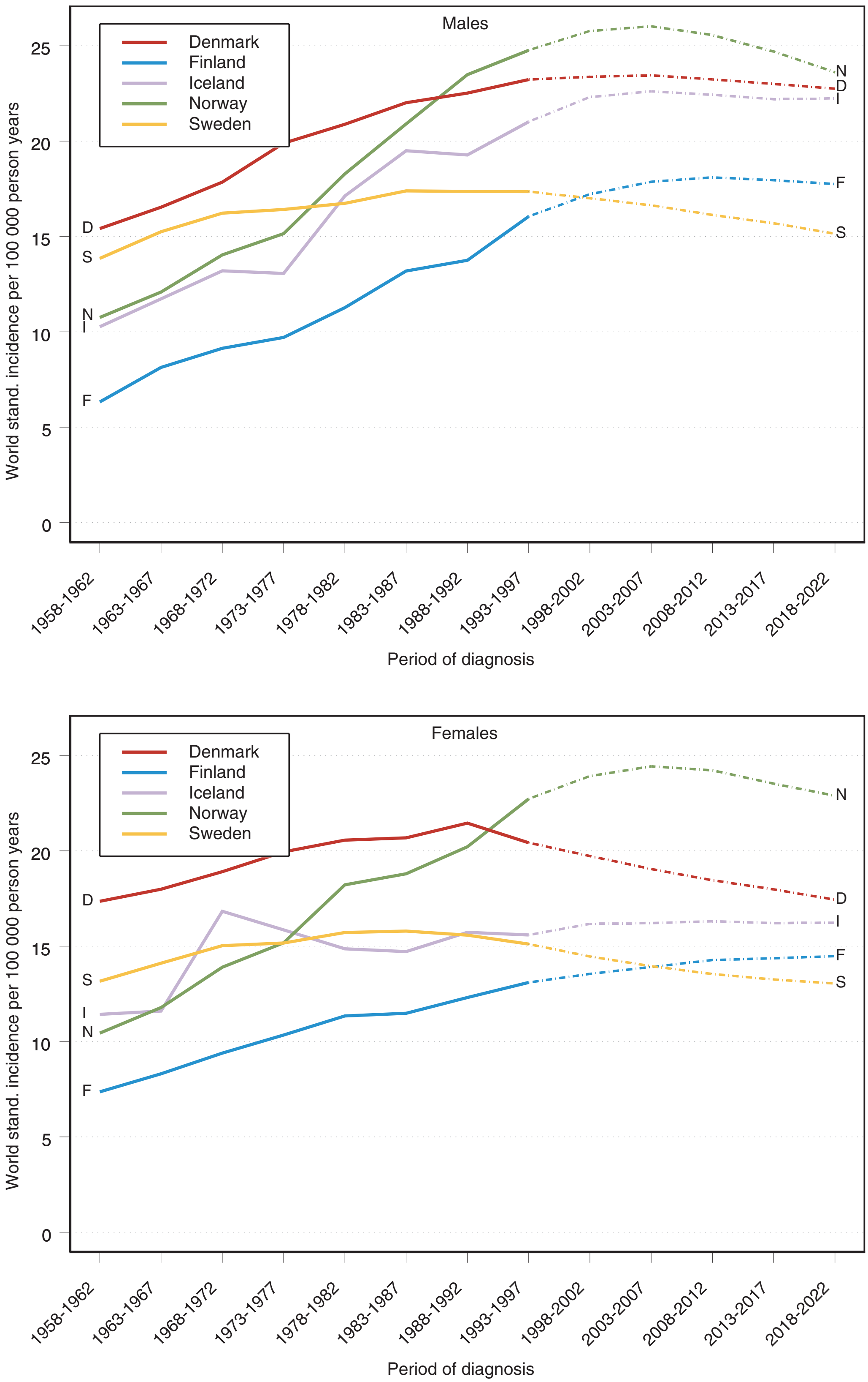


Figure 24. Observed and predicted age-adjusted incidence rates in the five Nordic countries: cancer of the colon.

Cancer of the rectum

In 1993–1997, the annual numbers of new cases of rectum cancer for all the Nordic countries combined were 2511 in males and 2012 in females, comprising 4.9% and 3.9% of all male and female cancer cases, respectively (Table 8).

The median ages of patients in the last observation period were 71 years for men and 73 years for women. The incidence rates increased with age at diagnosis to 152 per 100 000 person-years in males and 85 in females (Figure 25). The age-specific rates in males and females were almost the same in age groups below 55 years. Above this age, the male:female ratio increased with age to 1.8.

There are similarities in the observed trends for cancers of the colon and rectum. In each country, rates were similar in males and females. Only Norway had a striking increase in the incidence rates (Figure 26). In Finland, Iceland and Sweden, the rates have been stable or slightly increasing, whereas the Danish rates have decreased throughout the period.

For males, the predictions indicate that the rates of cancer of the rectum will stabilize in all the countries. For females, incidence is predicted to marginally decrease in Denmark and Sweden, with the opposite

Table 8. Observed and predicted average annual numbers of new cases by age, and crude and world-standardized rates in the five Nordic countries; cancer of the rectum.

Males		DENMARK			FINLAND			ICELAND		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	67	71	71	44	50	43	1	1	1
Number	55-74	352	390	513	203	240	345	7	7	11
of cases	≥ 75	221	242	339	99	136	210	3	5	7
	Total	640	703	923	345	426	598	12	14	19
Crude rate[a]		24.9	26.2	32.7	13.9	16.6	22.9	8.7	9.2	11.8
World stand. rate		**15.1**	**14.8**	**15.0**	**9.5**	**9.3**	**9.5**	**6.8**	**6.4**	**6.3**

		NORWAY			SWEDEN			TOTAL		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	52	56	59	93	90	93	257	267	266
Number	55-74	285	291	403	511	581	709	1358	1509	1981
of cases	≥ 75	188	232	272	386	465	642	897	1080	1470
	Total	525	579	733	989	1135	1444	2511	2856	3717
Crude rate[a]		24.3	25.4	30.2	22.8	25.5	30.9	21.5	23.6	29.3
World stand. rate		**14.8**	**14.8**	**14.4**	**12.2**	**12.5**	**12.4**	**12.7**	**12.6**	**12.6**

Females		DENMARK			FINLAND			ICELAND		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	51	47	47	45	48	41	2	2	2
Number	55-74	226	232	271	154	174	250	4	5	8
of cases	≥ 75	205	209	246	142	179	243	5	5	7
	Total	481	488	565	341	401	534	11	12	17
Crude rate[a]		18.2	17.8	19.7	13.0	15.0	19.7	8.1	8.5	10.4
World stand. rate		**8.8**	**8.3**	**7.9**	**6.3**	**6.5**	**6.9**	**5.2**	**5.2**	**5.2**

		NORWAY			SWEDEN			TOTAL		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	48	55	61	72	70	73	217	223	224
Number	55-74	187	193	268	344	353	390	915	956	1187
of cases	≥ 75	188	222	235	340	395	455	880	1010	1186
	Total	423	469	563	757	818	917	2012	2188	2597
Crude rate[a]		19.1	20.3	22.9	17.0	18.0	19.4	16.7	17.6	20.1
World stand. rate		**9.5**	**9.7**	**9.8**	**7.6**	**7.4**	**7.0**	**7.9**	**7.8**	**7.7**

[a]Crude rate should not be used to compare the risk of cancer in different countries, or the change of risk over time, since it is not adjusted for differences in age distribution. It can, however, be used to compare the relative cancer burden between countries.

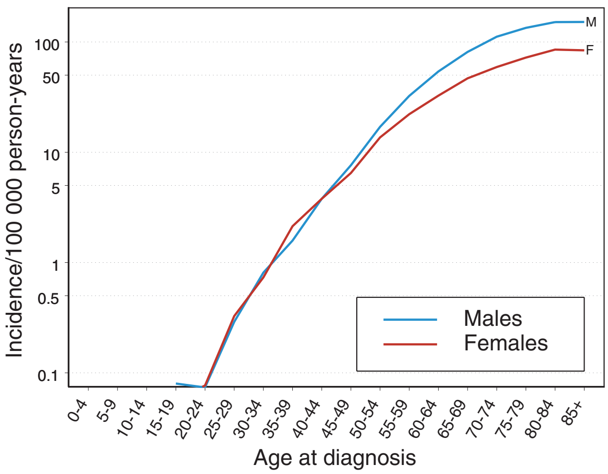


Figure 25. Age-specific incidence rates of rectum cancer in the Nordic countries, 1993-1997.

pattern in Norway and Finland. For all the Nordic countries combined, rates are predicted to remain approximately unchanged from 1993–1997 to 2018–2022 for both sexes. Because of the older age distribution, the annual numbers of cases will increase by 49% and 29% to around 3700 and 2600 cases for males and females, respectively (Table 8).

Comments

As mentioned for cancer of the colon, Sweden and Iceland classify rectosigmoid junction with rectum cancer, while the other countries include it with colon cancer. The aetiologies of cancers of the colon and rectum are generally assumed to be similar (Olsen *et al.*, 1997), namely that consumption of fruits and vegetables is preventive, while consumption of total and saturated fats, animal and total proteins and total energy may increase the risk.

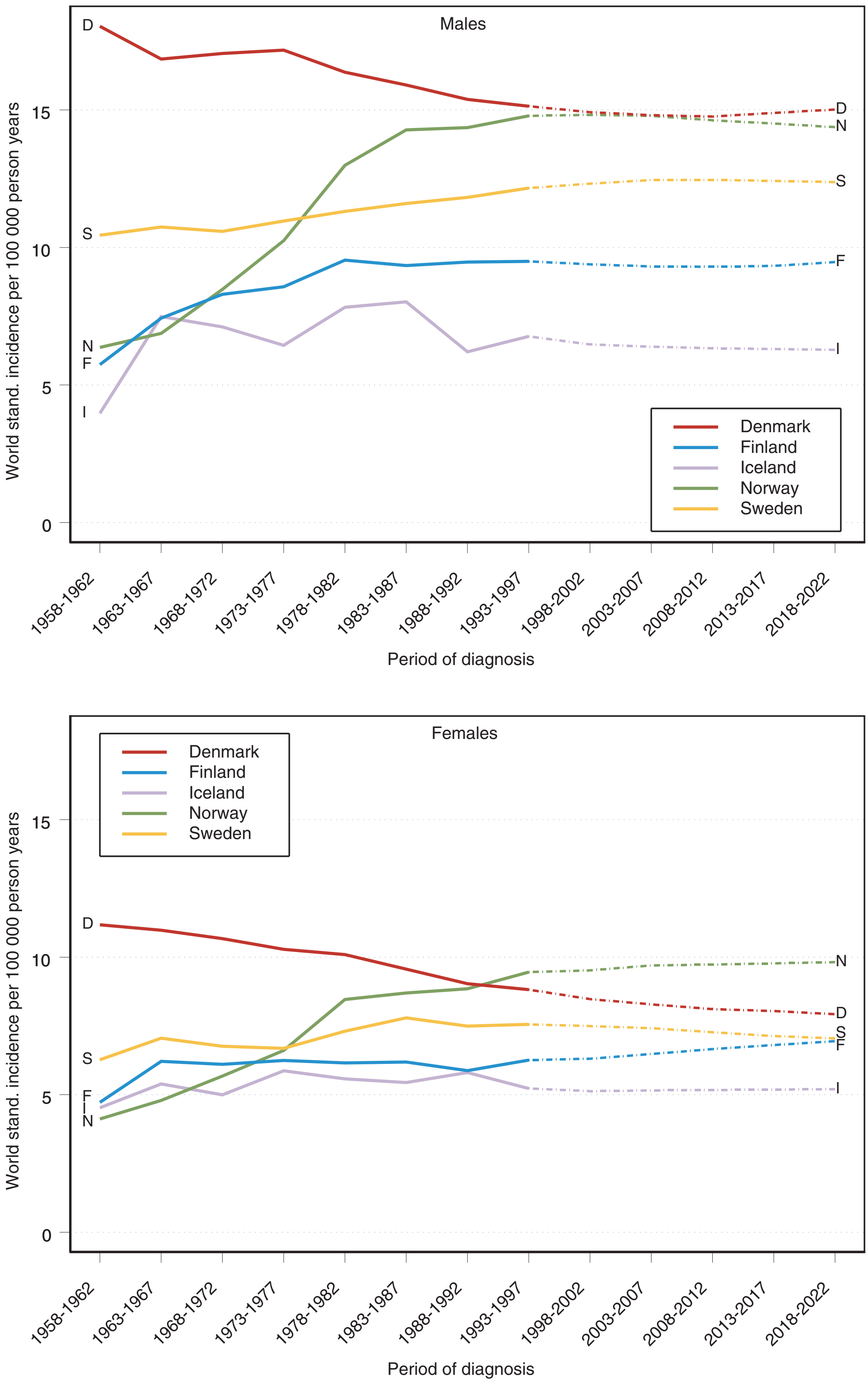


Figure 26. Observed and predicted age-adjusted incidence rates in the five Nordic countries: cancer of the rectum.

Cancers of the colon and rectum

In addition to separate analyses of cancers of the colon and rectum, combined figures and tables are presented for colorectal cancer. The average annual numbers of new cases of colorectal cancer in 1993–1997 in the Nordic countries were 6536 in males and 6672 in females, amounting to 12.8% and 12.9% of all male and female cancer cases, respectively (Table 9).

The median ages of patients in the last observation period were 72 years for men and 74 years for women. The incidence rates increased with age at diagnosis to 439 per 100 000 person-years in males and 310 in females (Figure 27).

Incidence rates have increased for males in all the Nordic countries in the period 1958–1962 to 1993–1997 (Figure 28 top). For women, only Finland and Norway have had a consistent increase over the whole period, whereas the rates in Denmark, Sweden and Iceland have been stable since around 1968–1972 (Figure 28 bottom).

The increase in the Norwegian rates has been dramatic for both males and females, but because of a decline in the risk for younger cohorts, the rates are predicted to peak around 2003–2007, and decrease towards

Table 9. Observed and predicted average annual numbers of new cases by age, and crude and world-standardized rates in the five Nordic countries; colorectal cancer.

Males		DENMARK			FINLAND			ICELAND		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	171	172	173	131	140	127	4	7	7
Number	55-74	870	988	1257	515	662	904	26	29	45
of cases	≥ 75	606	680	958	285	451	743	20	29	39
	Total	1647	1840	2388	931	1253	1775	50	65	91
Crude rate[a]		64.1	68.6	84.6	37.4	49.0	67.9	37.4	44.0	55.4
World stand. rate		**38.4**	**38.3**	**37.8**	**25.5**	**27.2**	**27.2**	**27.8**	**29.0**	**28.5**
		NORWAY			SWEDEN			TOTAL		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	135	147	145	222	198	194	663	664	646
Number	55-74	736	770	1019	1189	1294	1507	3335	3743	4732
of cases	≥ 75	569	723	831	1056	1244	1655	2537	3127	4226
	Total	1440	1640	1995	2467	2736	3356	6536	7534	9604
Crude rate[a]		66.6	72.1	82.1	56.8	61.4	71.8	55.9	62.2	75.6
World stand. rate		**39.5**	**40.8**	**38.0**	**29.5**	**29.1**	**27.5**	**32.5**	**32.7**	**31.5**

Females		DENMARK			FINLAND			ICELAND		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	152	133	128	141	142	127	7	7	8
Number	55-74	742	750	845	456	528	736	17	21	32
of cases	≥ 75	783	809	985	473	622	843	20	25	35
	Total	1678	1692	1958	1070	1291	1706	45	54	75
Crude rate[a]		63.6	61.8	68.1	40.8	48.3	63.1	33.4	36.7	45.4
World stand. rate		**29.2**	**27.3**	**25.4**	**19.4**	**20.4**	**21.4**	**20.8**	**21.4**	**21.4**
		NORWAY			SWEDEN			TOTAL		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	147	167	186	210	194	191	656	644	640
Number	55-74	646	673	851	1001	975	1071	2862	2947	3535
of cases	≥ 75	724	925	972	1153	1277	1472	3153	3657	4307
	Total	1516	1765	2009	2364	2447	2734	6672	7249	8482
Crude rate[a]		68.6	76.2	81.6	53.2	53.9	57.8	55.4	58.4	65.6
World stand. rate		**32.2**	**34.1**	**32.7**	**22.7**	**21.4**	**20.1**	**25.0**	**24.6**	**23.8**

[a]Crude rate should not be used to compare the risk of cancer in different countries, or the change of risk over time, since it is not adjusted for differences in age distribution. It can, however, be used to compare the relative cancer burden between countries.

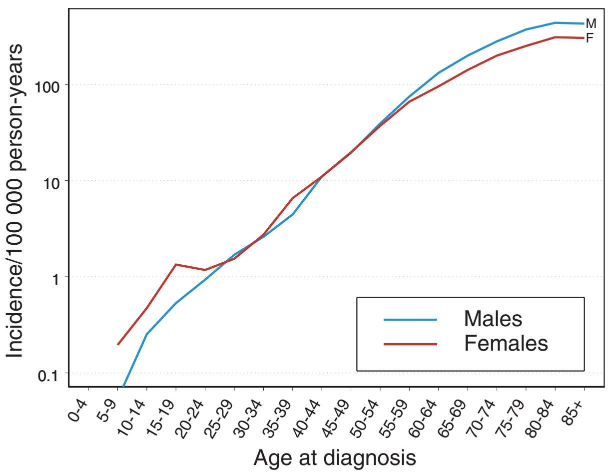


Figure 27. Age-specific incidence rates of colorectal cancer in the Nordic countries, 1993–1997.

2018–2022. For both sexes, the rates will decline in Denmark and Sweden, and slightly increase in Finland and Iceland. For all the Nordic countries combined, the rates will remain approximately unchanged, but due to the ageing of the population, the annual numbers of cases will increase by 47% (males) and 27% (females), to around 9600 male cases and about 8500 female cases per year (Table 9).

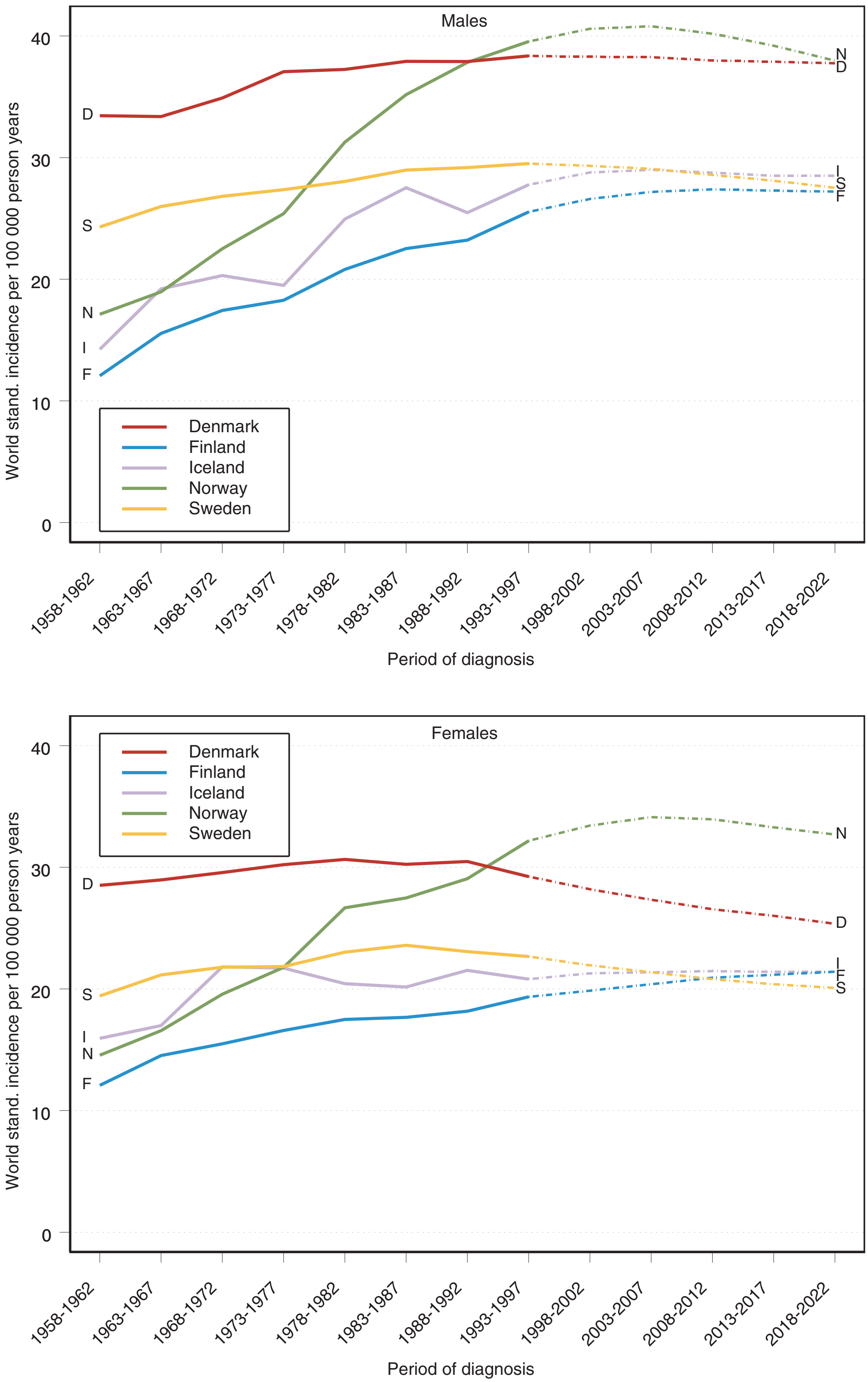


Figure 28. Observed and predicted age-adjusted incidence rates in the five Nordic countries: colorectal cancer.

Cancer of the pancreas

The average annual numbers of new cases of cancer of the pancreas in 1993–1997 in the Nordic countries were 1409 in males and 1575 in females, comprising 2.8% and 3.0% of all male and female cancer cases, respectively (Table 10).

The median ages of patients in the last observation period were 71 years for men and 75 years for women. The incidence rates increased with age at diagnosis to 82 per 100 000 person-years in males and 76 in females (Figure 29). The ratio between male and female rates was close to 1.3 for all ages.

The time trends for cancer of the pancreas are similar for all the Nordic countries (Figure 30). For males, the rates increased until around 1973–1977, and since then decreased markedly. The same pattern is seen in the female rates, except that the curves peaked some years later. For Norwegian women, the rates have stabilized.

The predictions of pancreatic cancer are based on the trends in the last 10 years. This gives a decline in the rates for both sexes in all countries up to 2018–2022, except in Norwegian women, where the rates are predicted to be stable. For all countries combined, the rates for both males and females will decrease by 15–20% from 1993–1997 to 2018–2022. Despite the reduction in

Table 10. Observed and predicted average annual numbers of new cases by age, and crude and world-standardized rates in the five Nordic countries; cancer of the pancreas.

Males		DENMARK			FINLAND			ICELAND		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	45	35	32	44	42	33	2	2	2
Number	55-74	162	188	258	180	204	277	5	5	9
of cases	≥ 75	99	87	125	95	121	176	4	5	7
	Total	306	310	415	319	367	486	11	12	17
Crude rate[a]		11.9	11.5	14.7	12.8	14.3	18.6	8.1	8.3	10.6
World stand. rate		**7.3**	**6.7**	**6.9**	**8.8**	**8.0**	**7.6**	**6.2**	**5.7**	**5.5**
		NORWAY			SWEDEN			TOTAL		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	27	19	20	52	39	33	169	137	120
Number	55-74	138	134	168	263	265	326	749	796	1037
of cases	≥ 75	115	111	106	178	154	221	491	478	635
	Total	279	264	294	494	458	580	1409	1411	1793
Crude rate[a]		12.9	11.6	12.1	11.4	10.3	12.4	12.0	11.6	14.1
World stand. rate		**7.6**	**6.6**	**5.6**	**6.3**	**5.3**	**5.1**	**7.2**	**6.4**	**6.1**

Females		DENMARK			FINLAND			ICELAND		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	32	25	22	28	24	18	1	1	1
Number	55-74	148	135	169	156	142	197	5	5	8
of cases	≥ 75	155	131	149	198	204	227	5	6	7
	Total	334	291	340	382	370	442	11	12	17
Crude rate[a]		12.6	10.6	11.8	14.6	13.8	16.3	8.4	8.4	10.1
World stand. rate		**5.9**	**4.8**	**4.6**	**6.3**	**5.3**	**5.1**	**5.3**	**4.9**	**4.8**
		NORWAY			SWEDEN			TOTAL		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	21	23	27	40	29	25	122	103	93
Number	55-74	120	122	165	247	218	239	676	622	777
of cases	≥ 75	161	180	177	258	222	269	776	742	830
	Total	302	325	369	546	469	533	1575	1467	1701
Crude rate[a]		13.7	14.0	15.0	12.3	10.3	11.3	13.1	11.8	13.1
World stand. rate		**5.9**	**6.0**	**5.9**	**5.3**	**4.2**	**3.9**	**5.7**	**4.9**	**4.7**

[a]Crude rate should not be used to compare the risk of cancer in different countries, or the change of risk over time, since it is not adjusted for differences in age distribution. It can, however, be used to compare the relative cancer burden between countries.

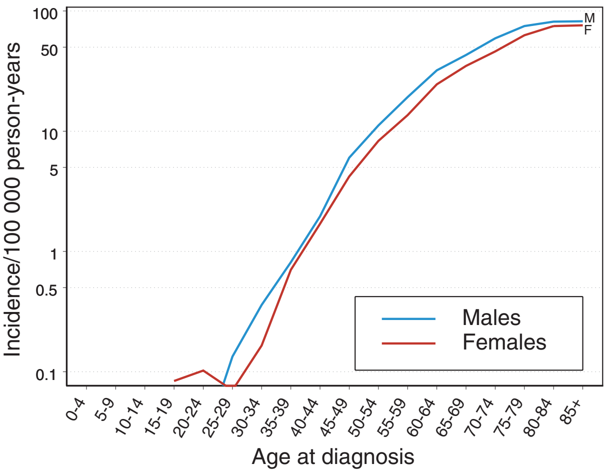


Figure 29. Age-specific incidence rates of pancreatic cancer in the Nordic countries, 1993–1997.

risk of pancreatic cancer in the future, the annual number of male cases will increase from around 1400 to around 1800 over the period, due to the ageing of the Nordic population (Table 10 top). For females, the annual number of new cases will increase by more than one hundred, to about 1700 cases per year (Table 10 bottom).

Comments

Tobacco smoking is the main known risk factor for this type of cancer, but smoking is not as strongly associated with pancreatic cancer as with cancer of the lung and larynx. Only about 17% of the male and 12% of the female cases could be avoided if tobacco smoking was eliminated (Olsen *et al.*, 1997).

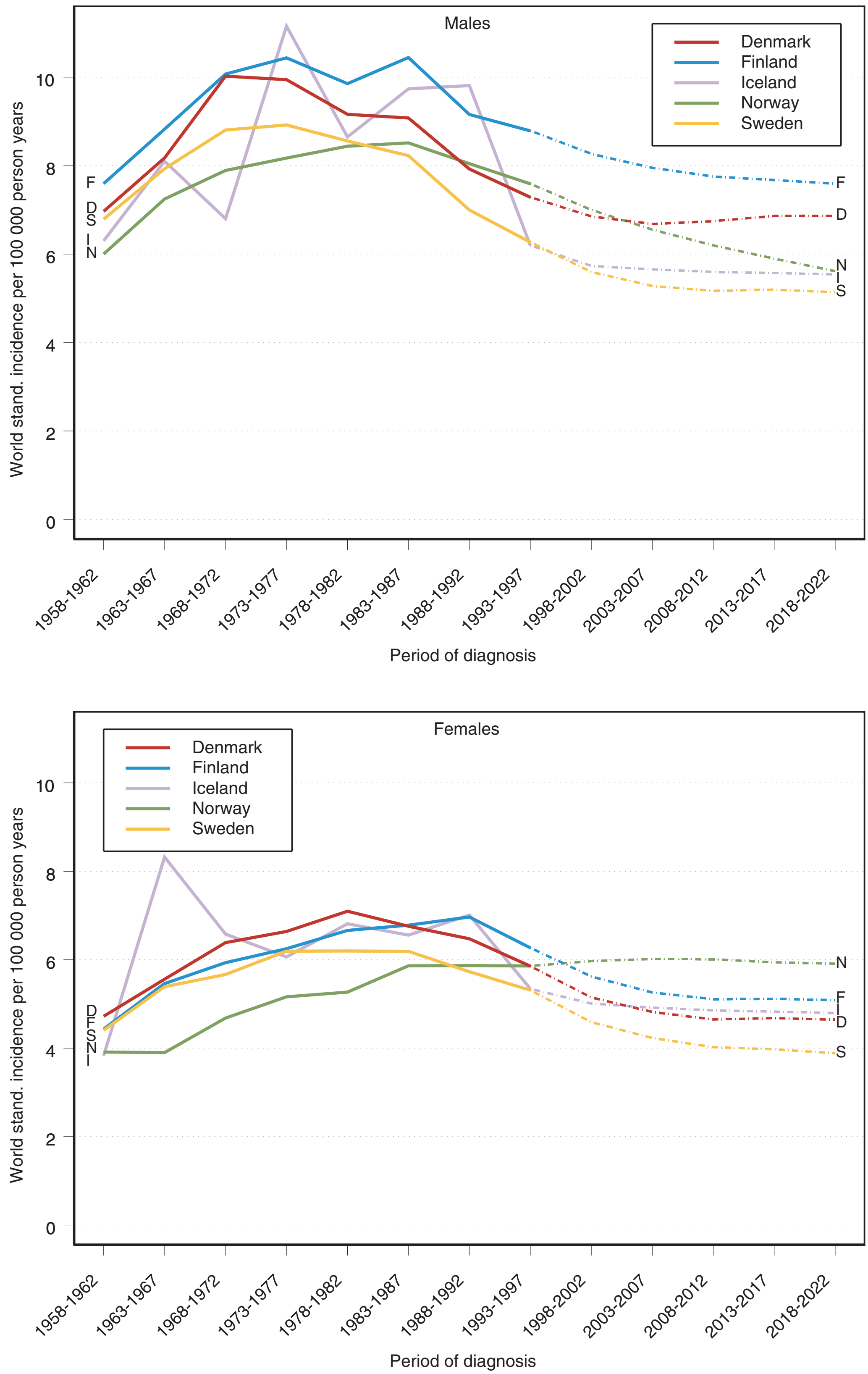


Figure 30. Observed and predicted age-adjusted incidence rates in the five Nordic countries: cancer of the pancreas.

Cancer of the larynx

Cancer of the larynx is relatively rare. In 1993–1997, the average annual number of new male cases was 599, comprising 1.2% of all male cancer cases (Table 11). Since cancer of the larynx is five to ten times less common among females than in males in the Nordic countries, incidence among females has been not analysed.

The median age of male patients in 1993–1997 was 67 years. The incidence rate increased with age at diagnosis to 24 per 100 000 person-years for the age group 70–74 years, followed by a slight decline in the age-specific rates (Figure 31).

The rates in Finland were much higher than those in the other countries up to 1973–1977, when a striking decline in the rates began (Figure 32). This decline continued up to 1993–1997. Cohort-specific risks decreased for all consecutive birth cohorts, but the reduction escalated for men born around 1928 and later. The rates in Denmark and Norway steadily increased until 1978–1982, after which they stabilized. The increase in the rates was most pronounced in Denmark, and by 1993–1997, Danish males had much higher rates of laryngeal cancer than males in the other Nordic countries. Sweden has the lowest rates among the Nordic countries, and the rates have been declining since 1973–1977.

Sweden is predicted to continue to have the lowest rates of laryngeal cancer, four times lower than Denmark, and half the rate of Finland, Iceland and Norway. For all the Nordic countries combined, the incidence rate is predicted to decline by 15% from 1993–1997 to 2018–2022. The annual number of cases will nevertheless increase by around 140 cases, to 740 per year, due to changes in the population structure (Table 11).

Comments

The link between tobacco smoking and alcohol consumption and risk of laryngeal cancer is well established (Tomatis *et al.*, 1990). The risk is especially elevated when these two factors are combined (Saracci, 1987). Tobacco smoking is the strongest risk factor, accounting for about 70% of the cases (Olsen *et al.*, 1997), and one would expect patterns of incidence of larynx cancer to mirror those of lung cancer. This is clearly the case for Finnish men, but not for Danish. Since alcohol consumption is estimated to account for 30% of laryngeal cancers in men and 25% in the combined Nordic population (Olsen *et al.*, 1997), the combined effect of these two risk factors may explain the deviations from the lung cancer pattern. Alcohol consumption per capita in Denmark is 50% higher than in Finland and twice as high

Table 11. Observed and predicted average annual numbers of new cases by age, and crude and world-standardized rates in the five Nordic countries; cancer of the larynx, males.

Males		DENMARK			FINLAND			ICELAND		
	Age	1993-1997	2003-2007	2018-2022	1993-1997	2003-2007	2018-2022	1993-1997	2003-2007	2018-2022
Annual	0-54	45	43	43	21	25	22	1	1	1
Number	55-74	137	159	199	69	70	96	2	3	4
of cases	≥ 75	33	42	61	20	26	24	1	1	1
	Total	215	244	303	110	121	142	4	5	6
Crude rate[a]		8.3	9.1	10.7	4.4	4.7	5.4	3.1	3.3	3.9
World stand. rate		**5.7**	**5.6**	**5.6**	**3.1**	**2.8**	**2.7**	**2.5**	**2.5**	**2.4**
		NORWAY			SWEDEN			TOTAL		
	Age	1993-1997	2003-2007	2018-2022	1993-1997	2003-2007	2018-2022	1993-1997	2003-2007	2018-2022
Annual	0-54	17	16	18	23	16	15	108	101	98
Number	55-74	66	73	94	94	84	82	367	389	474
of cases	≥ 75	24	30	36	45	40	44	124	139	166
	Total	108	120	147	162	140	140	599	629	739
Crude rate[a]		5.0	5.3	6.1	3.7	3.1	3.0	5.1	5.2	5.8
World stand. rate		**3.4**	**3.4**	**3.1**	**2.2**	**1.7**	**1.4**	**3.4**	**3.1**	**2.9**

[a]Crude rate should not be used to compare the risk of cancer in different countries, or the change of risk over time, since it is not adjusted for differences in age distribution. It can, however, be used to compare the relative cancer burden between countries.

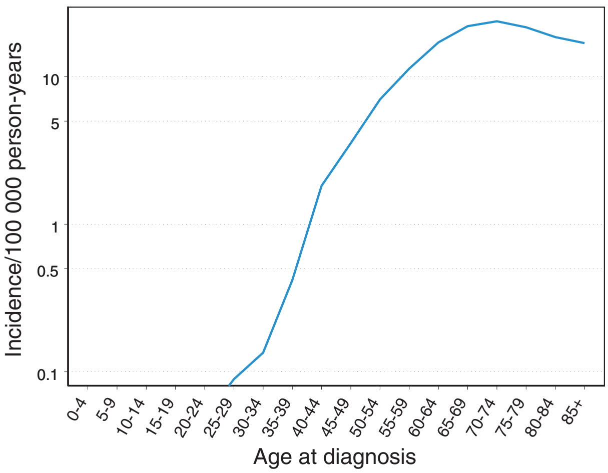


Figure 31. Age-specific incidence rates of laryngeal cancer in males in the Nordic countries, 1993–1997.

as in the other Nordic countries. Since alcohol consumption has tended to increase in Denmark and been rather stable in the other Nordic countries, the Danish predictions may come true even if tobacco consumption declines in Denmark.

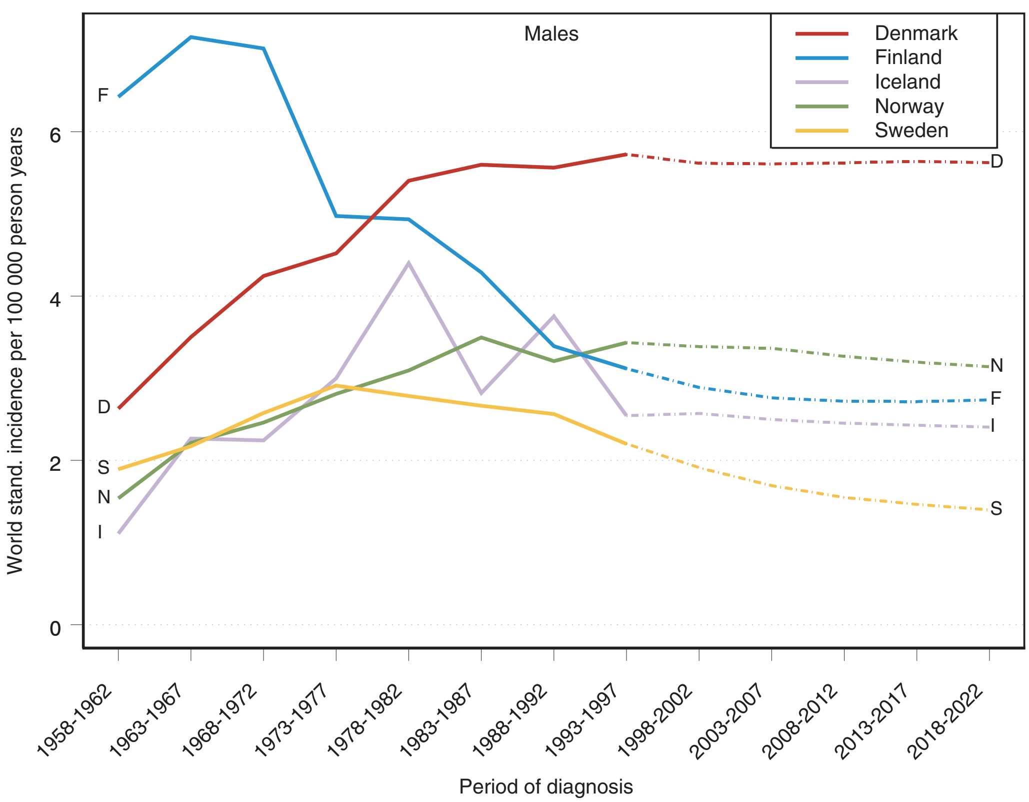


Figure 32. Observed and predicted age-adjusted incidence rates in the five Nordic countries: cancer of the larynx, males.

Cancer of the lung

For all the Nordic countries combined, the average annual numbers of new cases in 1993–1997 were 6702 for males and 3495 for females, comprising 13.2% and 6.7% of all male and female cancer cases, respectively (Table 12). This makes lung cancer the third most common cancer for women and second for men.

The median ages of patients in the last observation period were 70 years for men and 68 years for women. The incidence rates increased with age at diagnosis to 348 per 100 000 person-years in males (75–79 years of age) and 112 in females (70–74 years of age) (Figure 33). Up to the age of 50 years, males and females had similar rates. After this, the male:female ratio of rates increased with age, to about 4.0.

The trends in lung cancer have changed dramatically during the last 35 years, in both males and females, although the patterns have differed. In general, rates in males have peaked for all countries but Norway (Figure 34 top). Underlying cohort-specific risks in each country reveal further details of the picture. In 1968–1972, Finland was the first of the Nordic countries to reach its historical peak. Cohort-specific risks increased for cohorts born up to around 1903, and have decreased for all subsequent cohorts. In Sweden, the peak in incidence

Table 12. Observed and predicted average annual numbers of new cases by age, and crude and world-standardized rates in the five Nordic countries; cancer of the lung.

Males		DENMARK			FINLAND			ICELAND		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	211	209	217	148	124	100	8	8	10
Number	55-74	1253	1271	1622	1051	872	1098	36	36	48
of cases	≥ 75	570	552	655	435	475	468	15	25	25
	Total	2033	2031	2494	1633	1471	1667	59	69	82
Crude rate[a]		79.1	75.7	88.4	65.6	57.5	63.8	44.0	47.0	49.9
World stand. rate		**49.5**	**44.1**	**42.9**	**44.7**	**31.6**	**27.1**	**35.0**	**33.0**	**28.0**
		NORWAY			SWEDEN			TOTAL		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	129	128	121	169	114	97	665	584	545
Number	55-74	746	776	908	1024	945	997	4110	3899	4673
of cases	≥ 75	369	451	431	538	531	673	1927	2033	2251
	Total	1245	1355	1459	1732	1590	1767	6702	6516	7469
Crude rate[a]		57.6	59.5	60.1	39.9	35.7	37.8	57.3	53.8	58.8
World stand. rate		**36.4**	**36.0**	**29.1**	**22.4**	**18.3**	**15.6**	**35.1**	**29.8**	**26.6**

Females		DENMARK			FINLAND			ICELAND		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	202	239	275	56	58	52	8	12	14
Number	55-74	835	1042	1289	223	260	367	27	36	56
of cases	≥ 75	304	501	716	167	243	298	15	22	30
	Total	1341	1782	2281	446	562	716	50	70	100
Crude rate[a]		50.8	65.1	79.4	17.0	21.0	26.5	37.5	47.7	60.7
World stand. rate		**30.0**	**34.8**	**36.5**	**8.5**	**9.1**	**9.4**	**27.6**	**31.5**	**32.8**
		NORWAY			SWEDEN			TOTAL		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	96	120	151	183	184	198	545	613	690
Number	55-74	348	466	678	597	801	1000	2030	2604	3389
of cases	≥ 75	153	284	374	279	414	649	919	1465	2067
	Total	597	870	1203	1059	1399	1847	3494	4682	6147
Crude rate[a]		27.0	37.5	48.8	23.8	30.8	39.0	29.0	37.7	47.5
World stand. rate		**16.4**	**20.9**	**22.9**	**13.2**	**15.6**	**16.8**	**16.4**	**19.3**	**20.7**

[a]Crude rate should not be used to compare the risk of cancer in different countries, or the change of risk over time, since it is not adjusted for differences in age distribution. It can, however, be used to compare the relative cancer burden between countries.

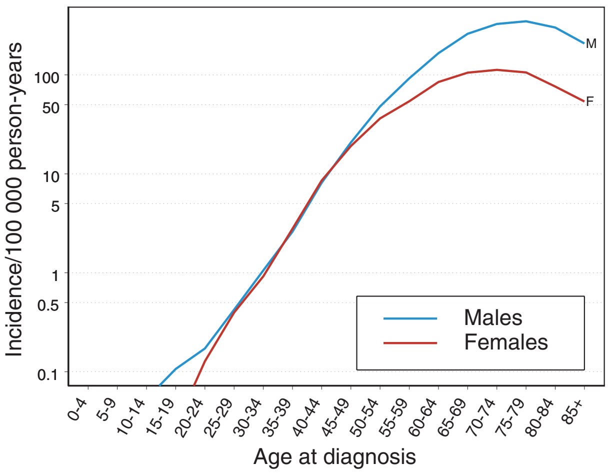


Figure 33. Age-specific incidence rates of lung cancer in the Nordic countries, 1993–1997.

was reached in 1978–1982. Cohort-specific rates went both up and down for different cohorts born before 1928, but risks have steadily decreased for subsequent cohorts. The Danish and Icelandic patterns are similar to the Swedish. The highest incidence rates were observed in 1983–1987, and cohort-specific risks started to decline for cohorts born around 1928 in Denmark and around 1932 in Iceland. The cohort-specific decline was less pronounced for Iceland. The Norwegian rates have not yet turned downwards, but are predicted to peak in the period 1998–2002. The cohort-specific pattern in Norway is different from those in the other countries. Risks steadily increased for cohorts born up to 1928, but instead of starting to decrease for cohorts born after this point, they have stabilized.

Lung cancer incidence rates for males in all the Nordic countries are predicted to decrease. The rate among Finnish males is already lower than in Danish males, and is predicted to be lower than both the Icelandic and the Norwegian rates by 2003–2007. For all the Nordic countries combined, the rates will decrease by 24% from 1993–1997 to 2018–2022. The number of new cases will decrease from around 6700 annual cases in 1993–1997 to around 6500 in 2003–2007 (Table 12 top). By 2018–2022, the annual number of cases is predicted to be nearly 7500 per year, due to the ageing of the population.

For females, the incidence rates have increased in all the countries (Figure 34 bottom). The highest levels are seen in Denmark and Iceland, and the most rapid increases have occurred in Denmark and Norway. The cohort-specific risks have steadily increased for all countries, so the predicted levelling off of the rates after 2010 is a result of the assumption in the model that current trends will fade over time. For all the Nordic countries combined, the rates will increase by 26% from 1993–1997 to 2018–2022, whereas the annual number of new cases will increase from around 3500 to more than 6100 in the same period (Table 12 bottom).

The male:female ratio of standardized rates has decreased from 6.7 to 2.1 in the observation period. This ratio will further decrease to 1.5 in 2003–2007 and to 1.3 in 2018–2022. In this last period, world standardized rates for Swedish and Icelandic women are predicted to overtake the male rates for the respective country.

Comments

Cigarette smoking is the predominant risk factor for lung cancer (Tomatis *et al.*, 1990), accounting for about 85% of all incident cases among men and 80% in women in the Nordic countries (Olsen *et al.*, 1997). A much more minor risk factor is indoor radon, estimated to produce 180 cases annually in the Nordic countries after adjustment for smoking. Occupational exposures may account for as many as one fifth of cases in men (up to 1000 cases). However, smoking habits clearly drive the predicted and observed trends (Engeland *et al.*, 1993). The prevalence of smokers in Finland halved from the early 1960s to the 1980s, in parallel with a change in types of tobacco smoked. In Denmark, the prevalence of smoking in men dropped continuously from about 80% daily smokers in the early 1950s to 30% in 2001, while among females, smoking reached a maximum of 47% in 1970, after which the prevalence decreased in parallel with that in men to reach 30% in 2001. The resulting trend in lung cancer incidence was not well estimated by Engeland et al. (1993), so that the number of cases predicted was too high. The present predictions also seem to fail to allow for the effects of recent trends in smoking prevalence, particularly among women. Nevertheless, the patterns of smoking habits tabulated by Olsen et al. (1997) explain the differences and trends in incidence that are being observed. With one third of the population still smoking in Denmark, there is clearly scope for further prevention of smoking.

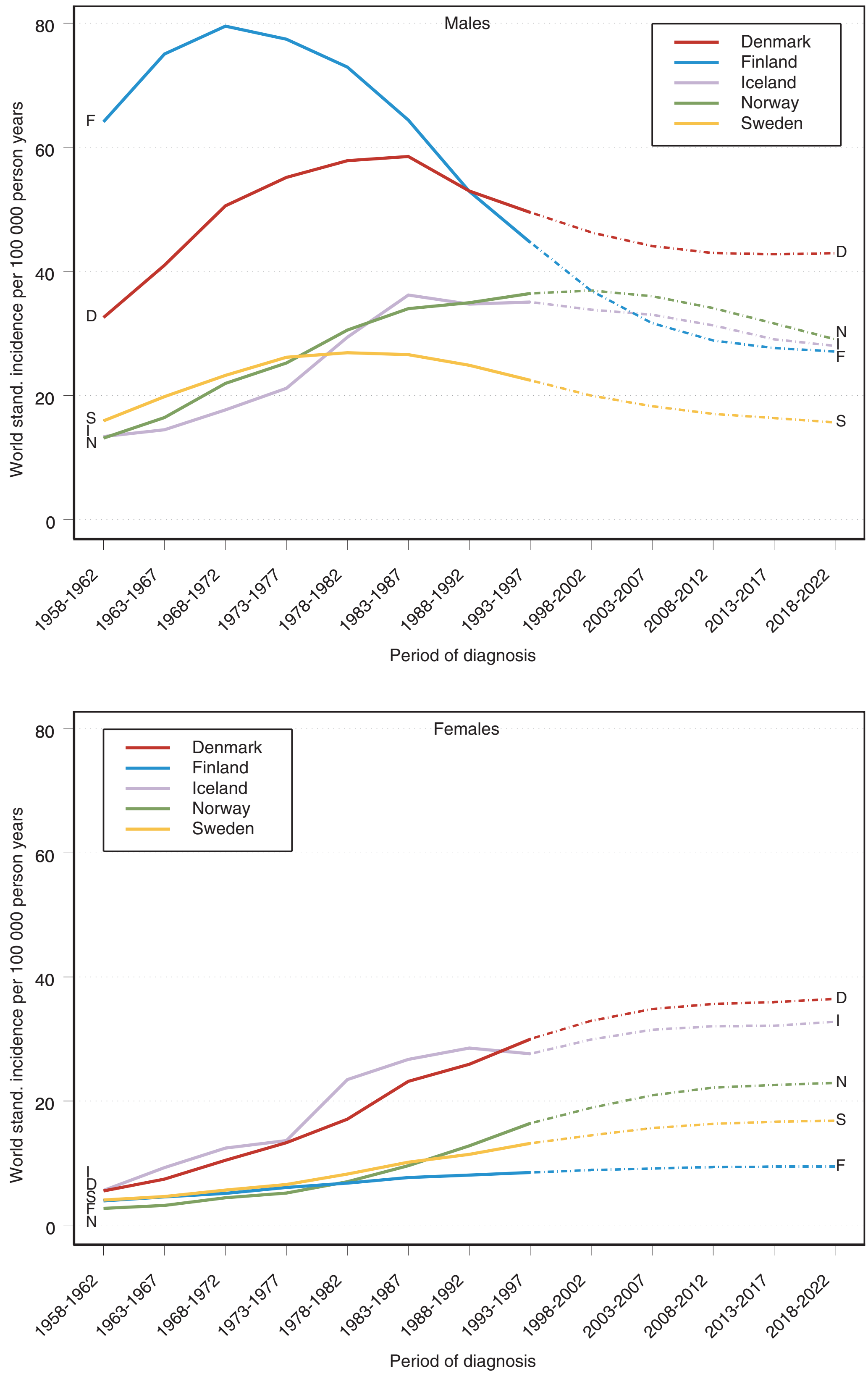


Figure 34. Observed and predicted age-adjusted incidence rates in the five Nordic countries: cancer of the lung.

Cancer of the breast

Model considerations

Breast cancer incidence is greatly influenced by the introduction of mammographic screening. In the Nordic countries, screening programmes have been introduced at different points in time. Sweden started in 1974, Iceland and Finland in 1987, Denmark in 1991 and Norway in 1996. In addition to the different starting points, screening has been introduced in counties or birth cohorts at different time points within the countries. Contrasts within each country can be used to quantify the effect that screening has had on the incidence of breast cancer.

The effects of screening can be divided into three main components: (i) the effect of the initial round of screening, with detection of new cases from the prevalent pool of undiagnosed cancers, (ii) the effect of subsequent rounds, due to the facts that cancers are detected earlier by screening, and that incidence increases strongly with age, and (iii) the post-screening effect, that is, the drop in incidence expected after the final screening round because some of the potential future cancer cases have already been diagnosed in an earlier screening round.

Variables characterizing these three effects are defined as $screen_1$, $screen_2$ and $screen_3$ in Appendix A. The variables can be described as the proportions of person-years, in each five-year age group and calendar period, who are screened for the first time, who continue to be screened, and who have stopped being screened, respectively. Tables of the observed values of these variables, together with assumed values for the future, are also given in Appendix A.

The predictions have been made in the following way. First, the effects of the three screening variables were estimated in each country. These effects were assumed to remain valid in the future, and the values of the screening variables from the scheduled screening practice in each country were used in the prediction model. Since Norway did not start until 1996, the Swedish estimates for the effect of subsequent screening and post-screening were used.

Results

Cancer of the breast is the most common cancer among females, with 14 143 new cancer cases annually in 1993–1997 for all the Nordic countries combined (Table 13), comprising 27.3% of all female cancer cases. Due to the very small number of male breast cancer cases, incidence among males has been not analysed.

The median age of patients in 1993–1997 was 62 years. The incidence rate increased strongly with age at diagnosis to 276 per 100 000 person-years for the age group 50–54 years, with a less pronounced increase at ages above 70 years (Figure 35).

The standardized rates increased steadily in all the Nordic countries during the period 1958–1997 (Figure 36). Until around 1978–1982, the rise was

Table 13. Observed and predicted average annual numbers of new cases by age, and crude and world-standardized rates in the five Nordic countries; cancer of the breast, females.

Females		DENMARK			FINLAND			ICELAND		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	1149	1151	1189	1243	1402	1151	44	56	63
Number	55-74	1545	2014	2274	1297	2090	2812	49	58	77
of cases	≥ 75	726	883	1334	584	872	1479	24	32	40
	Total	3419	4047	4797	3125	4364	5442	118	146	181
Crude rate[a]		129.5	147.9	166.9	119.1	163.4	201.2	88.5	99.7	109.7
World stand. rate		**82.1**	**87.4**	**87.0**	**75.9**	**93.3**	**97.5**	**72.2**	**72.9**	**70.0**

		NORWAY			SWEDEN			TOTAL		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	760	990	1116	1689	1666	1701	4885	5265	5220
Number	55-74	906	1119	1652	2265	2801	3242	6062	8082	10058
of cases	≥ 75	575	653	721	1287	1385	1789	3196	3824	5362
	Total	2241	2762	3489	5240	5851	6732	14143	17171	20640
Crude rate[a]		101.4	119.3	141.6	117.9	128.9	142.2	117.3	138.4	159.5
World stand. rate		**65.6**	**75.8**	**82.5**	**71.6**	**74.2**	**75.7**	**73.9**	**81.8**	**84.2**

[a]Crude rate should not be used to compare the risk of cancer in different countries, or the change of risk over time, since it is not adjusted for differences in age distribution. It can, however, be used to compare the relative cancer burden between countries.

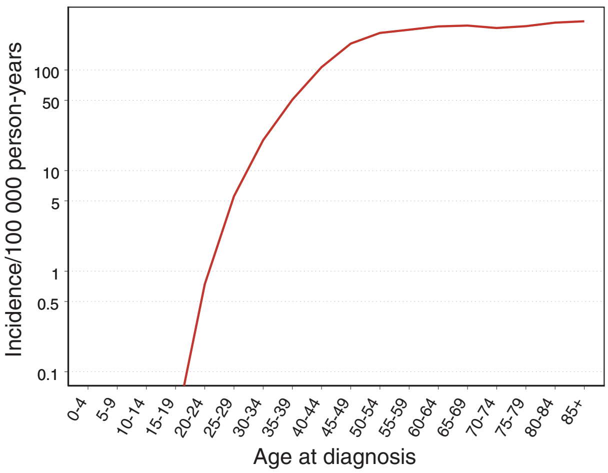


Figure 35. Age-specific incidence rates of breast cancer in females in the Nordic countries, 1993–1997.

similar in all countries, but at different levels. As a result of screening activities, different trends have occurred in recent decades. When screening activity is controlled for in the analysis, the Nordic countries display great differences in cohort-specific risks. In the prediction of breast cancer, Finland has the largest increase in incidence. Risks increased in successive cohorts born up to around 1958 and then seem to have stabilized for the younger cohorts. In Denmark, risks increased in cohorts born up to around 1943, with a steady decrease of risk for cohorts born after that time. These women were aged 50 years and above in 1993–1997, and their declining risk causes a downward trend in the Danish rates after 2010. A similar pattern, although less pronounced, is seen in Iceland; risks increased for women born up to around 1923, and stabilized in the following birth cohorts. The cohort-specific risks in Sweden were rather different. Risks declined for cohorts born up to around 1918, then started to increase in women born up to around 1948, after which the risks levelled out. In Norway, each birth cohort had higher risk than the preceding cohort. This, combined with the increasing screening activity in Norway, is predicted to lead to higher rates in Norway than in Iceland and Sweden by 2003–2007.

For all the Nordic countries combined, the standardized incidence rates will increase by 13% from 1993–1997 to 2018–2022. In the same period, the annual number of cases will increase by about 6500, to more than 20 600 cases (Table 13).

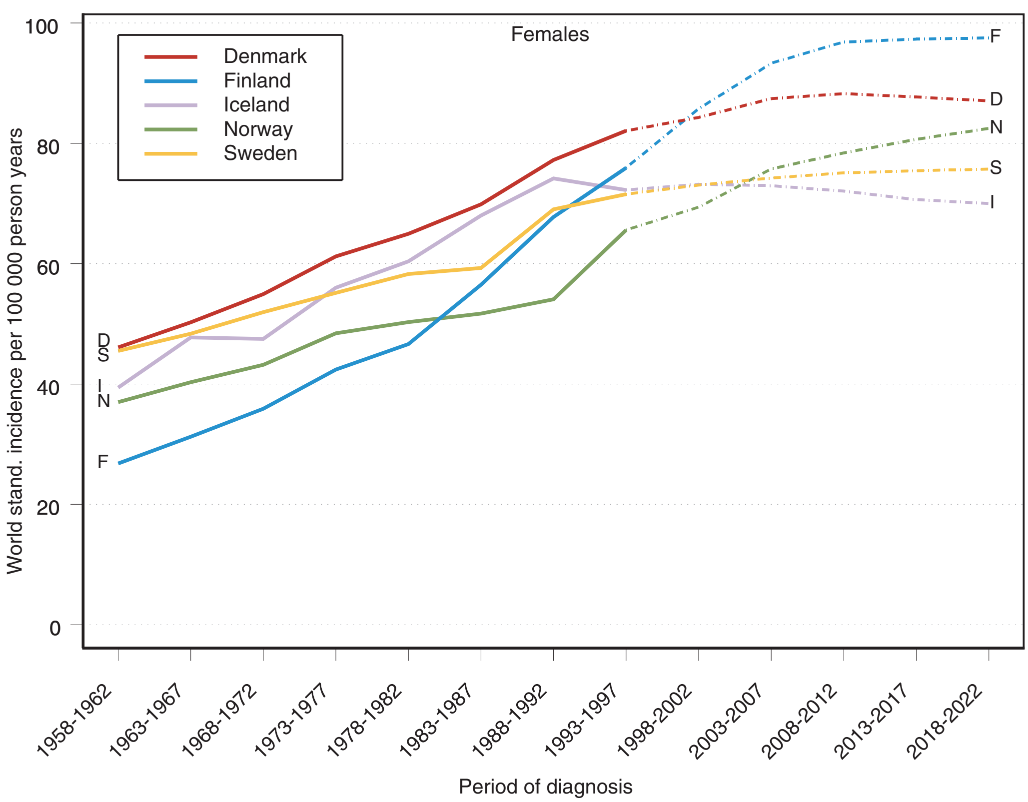


Figure 36. Observed and predicted age-adjusted incidence rates in the five Nordic countries: cancer of the breast, females.

Comments

Among established risk factors for breast cancer are nulliparity, high age at first birth and at menarche and low age at menopause, all being associated with increased risk (Tulinius *et al.*, 1990). It has been estimated for Norway that cohort-specific changes in childbearing patterns during the 20th century explain part of the observed increase in breast cancer risk (Tretli and Haldorsen, 1990). Another small part may be related to the declining age at menarche, reported by some of the countries (Tryggvadottir *et al.*, 1994). However, most of the variation in incidence within and between countries remains unexplained.

Cancer of the cervix uteri

Model considerations

Nationwide screening programmes to detect precancerous lesions have existed since the beginning of 1970s in Iceland, Finland and Sweden, while Denmark reached national coverage in 1991. In Norway, nationwide organized screening started in 1995. Smears are frequently taken outside the programme in most of the countries, and have probably contributed to the observed decrease in cancer incidence.

Information on screening activity has not been included in the prediction model for cancer of the cervix uteri. For countries where screening programmes have existed for several decades, the rationale is that a prediction model without explicit inclusion of screening effects will probably give reasonable predictions because the incidence rates have stabilized. For Norway, where the rates have not stabilized, it is difficult to estimate the future effects of the screening programme. The effect of screening depends on the frequency and age distribution of smear-taking before the organized screening programme starts, and the quality and extent of the programme. These factors varied between the countries, so it is not reasonable to apply the effects observed in the other Nordic countries to Norway. Instead, predictions can be adjusted at a later point in time, based on the first assessment of the effects of the introduced programme.

Results

In the period 1993–1997, the average annual number of cases for cancer of the cervix uteri was 1491 for all the Nordic countries combined (Table 14), comprising 2.9% of all female cancer cases.

The pattern of age-specific rates of this type of cancer differs from those of most others. The median age of patients in 1993–1997 was 51 years. The incidence rate increased with age at diagnosis to 21 per 100 000 person-years in the age group 35–39 years, followed by a second peak for the age group 70–74 years (Figure 37).

In all countries, the incidence rates have decreased with time, from a world standardized rate of 19.4 for all countries combined in 1958–1962 to 8.9 per 100 000 in 1993–1997 (Figure 38). Apart from Norway, all the Nordic countries had similar patterns over this period, but at different levels. Finland, which has had the lowest rates throughout the observation period, experienced a slight increase in the last five years. In terms of cohort-specific risks, Finnish women born around 1948 and later have a higher risk of cervical cancer than earlier cohorts. The elevated risk in these younger cohorts of women is assumed to persist in the future, resulting in incidence rates in Finland reaching the levels in Sweden and Iceland by 2010. For the other four countries, incidence rates will decrease up to the period 2018–2022, with an additional reduction in Norway expected (but not calculated here), due to the introduction of the screening

Table 14. Observed and predicted average annual numbers of new cases by age, and crude and world-standardized rates in the five Nordic countries; cancer of the cervix uteri.

		DENMARK			FINLAND			ICELAND		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	266	264	260	79	117	137	11	9	7
Number	55-74	137	102	117	57	66	141	4	3	4
of cases	≥ 75	67	50	32	34	35	34	1	1	1
	Total	470	417	409	170	218	312	15	13	12
Crude rate[a]		17.8	15.2	14.2	6.5	8.2	11.5	11.4	8.6	7.5
World stand. rate		**12.7**	**11.2**	**11.2**	**4.2**	**5.6**	**7.8**	**9.6**	**7.1**	**5.9**
		NORWAY			SWEDEN			TOTAL		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	211	218	210	261	234	197	828	843	811
Number	55-74	99	86	115	141	146	184	438	403	561
of cases	≥ 75	45	45	31	78	72	70	225	204	168
	Total	355	350	356	480	452	451	1491	1450	1540
Crude rate[a]		16.1	15.1	14.4	10.8	10.0	9.5	12.4	11.7	11.9
World stand. rate		**12.2**	**11.3**	**10.9**	**7.7**	**7.0**	**6.4**	**8.9**	**8.4**	**8.7**

[a]Crude rate should not be used to compare the risk of cancer in different countries, or the change of risk over time, since it is not adjusted for differences in age distribution. It can, however, be used to compare the relative cancer burden between countries.

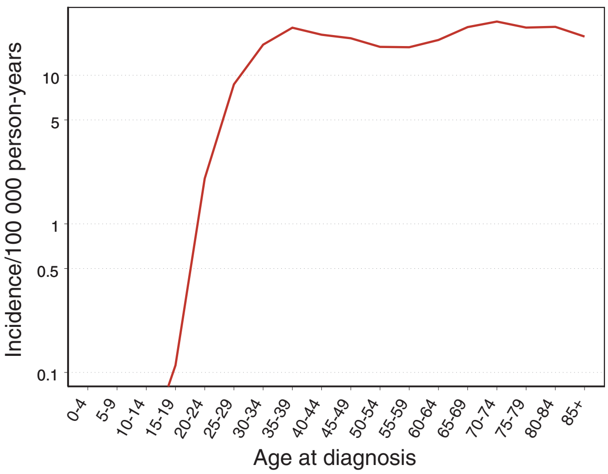


Figure 37. Age-specific incidence rates of cervical cancer in the Nordic countries, 1993–1997.

programme in 1995. The annual number of cases for all the Nordic countries combined is predicted to be stable around 1500 in the period 1998–2022 (Table 14).

Comments

The future numbers of cases of cervical cancer are likely to be more affected by the success of the mass-screening programmes (Hristova and Hakama, 1997) than by changes in the known risk factors (Tomatis *et al.*, 1990). The recent unfavourable development in Finland may be attributed to changes in the effectiveness of the mass-screening programme as well as in risk factors, such as sexual behaviour and smoking habits (Anttila *et al.*, 1999). Unless a continuous successful mass-screening is conducted and action against risk factors is taken when necessary, the incidence may rise even in the other Nordic countries in the future.

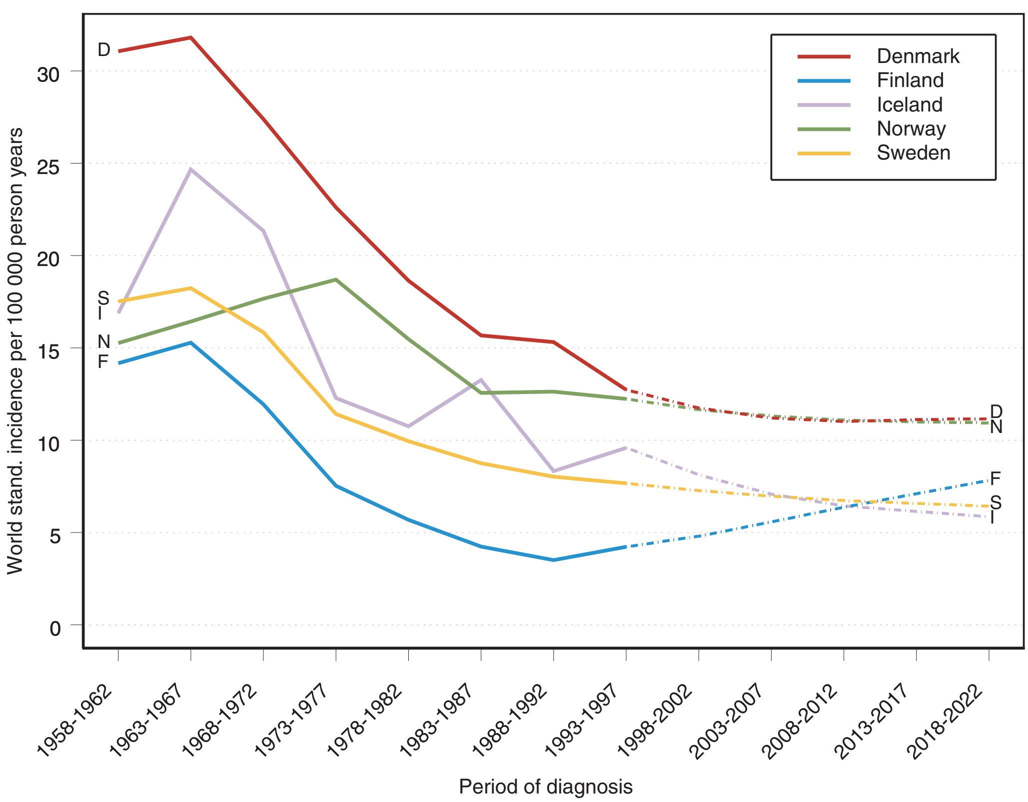


Figure 38. Observed and predicted age-adjusted incidence rates in the five Nordic countries: cancer of the cervix uteri.

Cancer of the corpus uteri

The average annual number of new cases of cancer of the corpus uteri in 1993–1997 in the Nordic countries was 2894, comprising 5.6% of the female cancer cases (Table 15).

The median age of patients in 1993–1997 was 68 years. The incidence rate increased with age at diagnosis to 87 per 100 000 person-years for the age group of 70–74 years, followed by a slight decline in the age-specific rates (Figure 39).

In 1958–1962, there were wide differences between the Nordic countries, with Danish women having about twice the rate of Norway (Figure 40). By 1993–1997, the rates have become more uniform, with standardized rates of 13 to 14 per 100 000 in all the countries. In Denmark, the rate peaked in 1978–1982, but in the other countries, the rates have increased throughout the period. Cohort-specific risks indicate that Danish and Swedish women born after 1928 subsequently had lower risk of cancer of the corpus uteri. The change towards lower risks occurred 15 years later in Norway and Finland, and the relative reduction for subsequent cohorts was less pronounced. There are too few cases in Iceland to study cohort-specific risks.

The differences in the cohort-specific patterns of cancer of the corpus uteri influence the predictions. Denmark and Sweden will experience a substantial fall in rates, if the reduced risk for women born after 1928 persists. The rates in Norway and Finland will stabilize, whereas the moderate increase in Iceland is predicted to continue. For all the Nordic countries combined, the incidence rates are predicted to decline by 15% from 1993–1997 to 2018–2022, but due to the ageing of the population, the annual number of cases will increase by more than 500 cases, to around 3400 per year in 2018–2022 (Table 15).

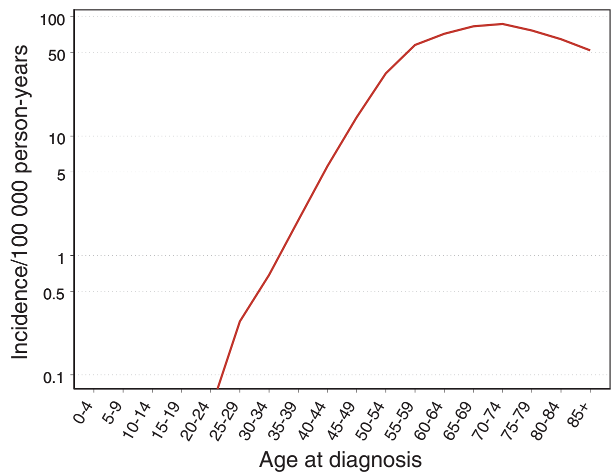


Figure 39. Age-specific incidence rates of cancer of the uterine corpus in the Nordic countries, 1993–1997.

Comments

Rates in Denmark, Finland, Norway and Sweden are predicted to decline or stabilize, in contrast to the increase

Table 15. Observed and predicted average annual numbers of new cases by age, and crude and world-standardized rates in the five Nordic countries; cancer of the uterine corpus.

		DENMARK			FINLAND			ICELAND		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual Number of cases	0-54	90	70	56	100	128	122	5	9	10
	55-74	371	324	303	397	442	521	12	13	21
	≥ 75	151	172	148	138	238	305	5	6	7
	Total	612	566	506	634	808	949	22	28	38
Crude rate[a]		23.2	20.7	17.6	24.2	30.2	35.1	16.2	19.0	23.3
World stand. rate		**13.3**	**10.8**	**8.2**	**14.2**	**15.0**	**15.0**	**13.0**	**14.0**	**14.4**
		NORWAY			SWEDEN			TOTAL		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual Number of cases	0-54	102	121	136	150	128	145	447	456	469
	55-74	252	260	319	679	692	579	1710	1732	1743
	≥ 75	115	149	145	328	528	585	736	1092	1191
	Total	469	530	601	1157	1348	1309	2894	3279	3403
Crude rate[a]		21.2	22.9	24.4	26.0	29.7	27.7	24.0	26.4	26.3
World stand. rate		**13.5**	**13.4**	**12.9**	**14.0**	**13.5**	**11.1**	**13.8**	**13.3**	**11.7**

[a]Crude rate should not be used to compare the risk of cancer in different countries, or the change of risk over time, since it is not adjusted for differences in age distribution. It can, however, be used to compare the relative cancer burden between countries.

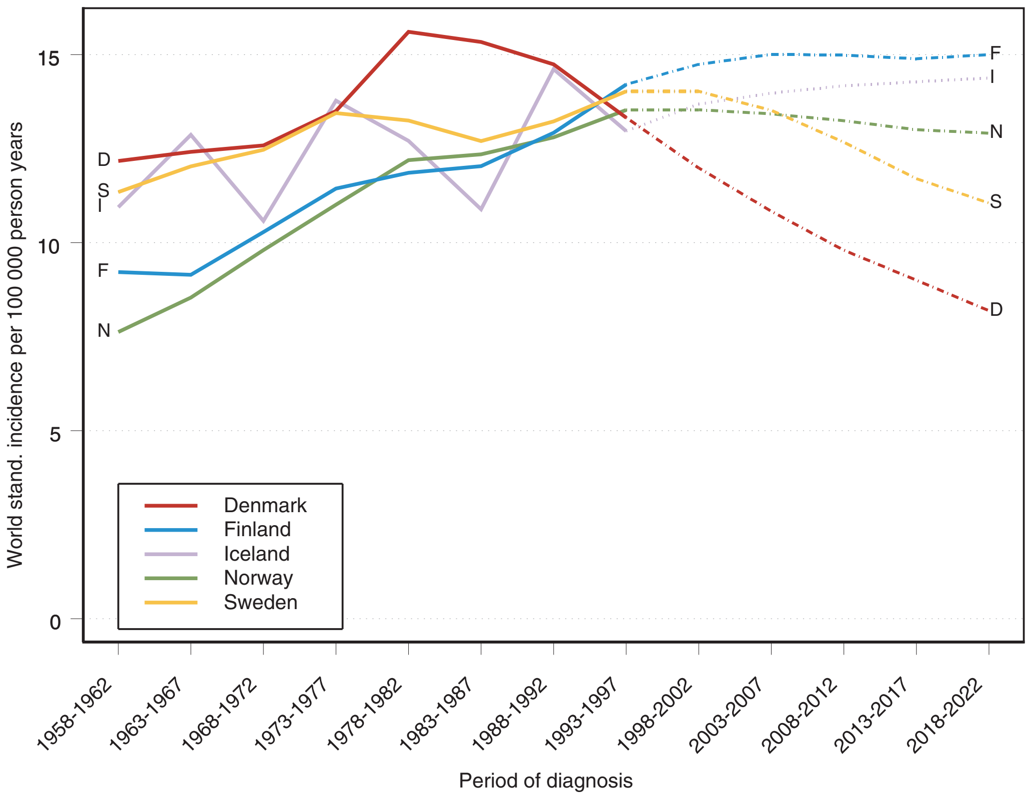


Figure 40. Observed and predicted age-adjusted incidence rates in the five Nordic countries: cancer of the uterine corpus.

in Iceland. Because the prediction for Iceland deviates from those of the other countries, the drift component in Iceland has been halved.

Early menarche, late menopause, low parity and obesity are associated with increased risk of cancer of the corpus uteri (Tomatis *et al.*, 1990). Tretli and Haldorsen (1990) estimated that about 27% of the increase in Norway between 1955 and 1984 could be attributed to childbearing patterns. Use of combined oral contraceptives has been consistently reported to protect against endometrial cancer (Olsen *et al.*, 1997). Trends in risk-increasing factors are consistent with the temporal evolution of the past rates.

Cancer of the ovary

The average annual number of new cases of cancer of the ovary in 1993–1997 in the Nordic countries was 2410, comprising 4.6% of all female cancer cases (Table 16).

The median age of patients in 1993–1997 was 65 years. The incidence rate increased with age at diagnosis to 58 per 100 000 person-years for the age group 70–74 years, followed by a slight decline in rate (Figure 41).

Sweden and Denmark used to have the highest rates of ovarian cancer, but the rates have declined since 1978–1982, and by 1993–1997, only Finland had lower rates than Sweden (Figure 42). In contrast, the Finnish and Norwegian rates have increased steadily since 1958–1962. In Sweden, risks have declined regularly for women in all consecutive birth cohorts. A similar but less pronounced decline occurred in Denmark, but the rate levelled off for women born after around 1948. In Finland and Norway, risks increased for women born up to around 1933. In subsequent cohorts, the risks levelled off in Finland, but started to decline in Norway. There were too few cases in Iceland to study cohort-specific risks.

If the cohort-specific risk patterns of ovarian cancer persist, incidence rates will decrease for all the Nordic countries, with the most marked reductions in Norway and Sweden. For all the five countries combined, incidence rates will drop by 15% from 1993–1997 to 2018–2022, but due to the ageing of the population, the annual number of cases will increase by around 200, to more than 2600 per year in 2018–2022 (Table 16).

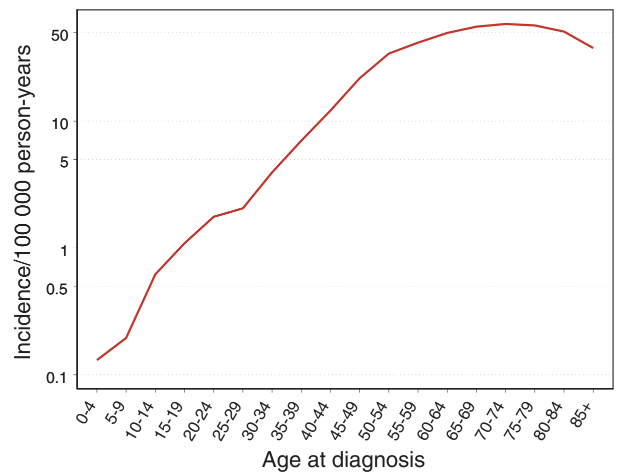


Figure 41. Age-specific incidence rates of ovarian cancer in the Nordic countries, 1993–1997.

Comments

Low parity is a risk factor for ovarian cancer (Tomatis *et al*., 1990), but the epidemiological literature in general reflects substantial reductions in the risks of all types of epithelial ovarian cancers associated with use of combined oral contraceptives (Olsen *et al*., 1997). However, differences between the Nordic countries have not reflected this association. Finland and Norway had the lowest consumption of oral contraceptives among the Nordic countries in the 1970s (Nordic

Table 16. Observed and predicted average annual numbers of new cases by age, and crude and world-standardized rates in the five Nordic countries; cancer of the ovary.

		DENMARK			FINLAND			ICELAND		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual Number of cases	0-54	165	165	169	138	133	101	7	7	8
	55-74	295	303	375	237	262	310	8	11	16
	≥ 75	125	140	162	107	143	165	4	5	6
	Total	584	608	706	482	537	577	20	23	30
Crude rate[a]		22.1	22.2	24.6	18.4	20.1	21.3	14.8	15.6	18.2
World stand. rate		**13.8**	**13.2**	**13.3**	**11.3**	**10.9**	**10.1**	**12.1**	**11.4**	**11.2**

		NORWAY			SWEDEN			TOTAL		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual Number of cases	0-54	131	142	124	244	189	175	685	636	576
	55-74	206	212	262	426	399	390	1172	1186	1354
	≥ 75	122	144	142	196	208	219	554	640	694
	Total	459	498	528	866	797	784	2410	2462	2624
Crude rate[a]		20.8	21.5	21.4	19.5	17.5	16.6	20.0	19.8	20.3
World stand. rate		**13.2**	**12.9**	**11.5**	**11.9**	**9.9**	**8.6**	**12.4**	**11.4**	**10.6**

[a]Crude rate should not be used to compare the risk of cancer in different countries, or the change of risk over time, since it is not adjusted for differences in age distribution. It can, however, be used to compare the relative cancer burden between countries.

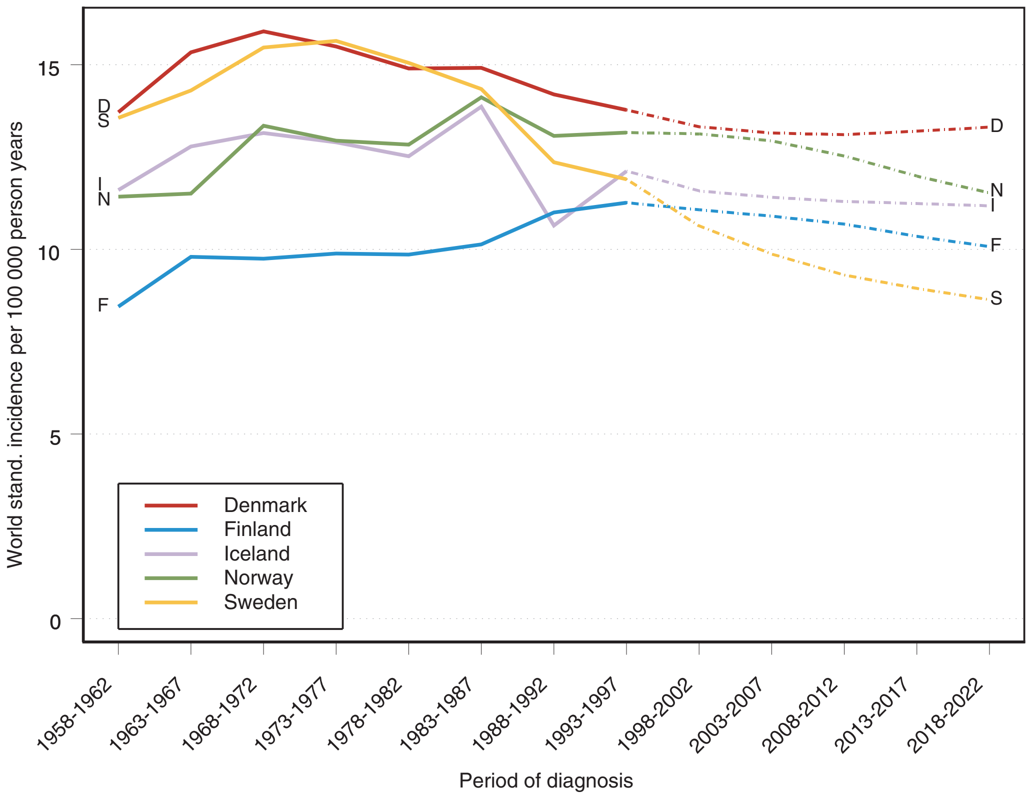


Figure 42. Observed and predicted age-adjusted incidence rates in the five Nordic countries: cancer of the ovary.

Medico-Statistical Committee, 1992), but Finland clearly had the lowest rates of ovarian cancer. Recent changes in the levels, however, are more consistent with this effect. The rates in Denmark and Sweden have decreased in the latest decade more rapidly than those in Norway and Finland.

Cancer of the prostate

Model considerations

Incidence rates for prostate cancer are greatly influenced by the introduction of diagnostic testing for PSA. PSA testing has been available in the Nordic countries since the early 1990s. Both symptomatic and asymptomatic men are tested, but none of the countries has decided to introduce a national screening programme based on PSA testing. If a screening programme had been introduced based on systematic testing of asymptomatic men, a similar effect might have been observed to that resulting from mammographic screening for breast cancer: as a result of the initial screening round, incidence of prostate cancer would increase strikingly because of the detection of cancers from the prevalent pool of undiagnosed prostate cancers. After this, the incidence rate would decrease, but stabilize at a higher level than before the introduction of PSA testing. Finally, in screened men towards the upper age limit covered by the programme, incidence would be expected to drop to a lower level than in unscreened men.

The incidence rates in all the Nordic countries except Denmark turned upwards in 1993–1997. Even though it is clear that PSA testing has influenced the rates, it is very difficult to incorporate the effect into a statistical model, because information on the extent of PSA testing is lacking. Likewise, the basis for assumptions that would have to be made about future use of PSA testing is very uncertain.

Prediction of incidence rates for prostate cancer has been based on the following approach. The model was fitted for the period 1973–1997, but instead of projecting the average trend over this period, the trend from 1973 to 1993 was used. This trend was not influenced by PSA testing. The difference between observed rates in 1993–1997 and predicted rates from using the average trend in 1973–1993 can be ascribed to PSA testing. This effect was then added in all future prediction periods. The consequence of only including the observed effect of PSA testing for the period 1993–1997, and not future effects, is equivalent to assuming that the different future effects of PSA testing will cancel each other out. This includes the effects of the prevalence round, the subsequent rounds and post-screening. These effects are dependent on the proportion of men who are tested. If a high proportion of men took their first PSA test in 1993–1997, one would expect a drop in the incidence rates after the rapid increase. If a lower proportion were tested in that period, there is potential for a high proportion of men taking their first PSA test in one of the future periods. Although we cannot tell whether it is reasonable to assume that different future effects of PSA testing cancel each other out, the assumption gives a good basis for comparing future rates with predictions from this model.

In Iceland, incidence rates have increased much more steeply than in the other Nordic countries. It seems unlikely that incidence rates will continue to rise at the same pace in the future. Therefore, the drift component has been halved in making the predictions for Iceland.

Results

Cancer of the prostate is the most common cancer among men in all the Nordic countries except Denmark, where lung cancer is more frequent. The annual number of cases in 1993–1997 was 12 182, comprising 23.9% of all male cancer cases (Table 17).

The median age of patients in 1993–1997 was 75 years, and only 1.8% were under 55 years. The incidence of prostate cancer increased more rapidly with age than any other cancer, from 23 per 100 000 in the age group 50–54 years to 980 per 100 000 for ages above 84 years (Figure 43).

Up to 1988–1992, Denmark, Finland, Norway and Sweden had a similar steady increase in the rates, while the Icelandic rates increased more steeply (Figure 44). Judged by the change in trends in 1993–1997, all countries except Denmark were influenced by the introduction of PSA testing, with Finland displaying the largest effect. In contrast to the other countries, Danish males, who have the lowest level of prostate cancer among the Nordic countries, experienced a drop in the incidence rates in the last observed period.

Because of the uncertainties connected with the present and future extent of PSA testing, the predictions of prostate cancer must be interpreted with great caution. If current trends up to 1992 continue, and the different effects of PSA testing cancel each other out, incidence rates will increase in all the Nordic countries. The annual number of cases will double, from nearly 12 200 cases in 1993–1997 to almost 24 000 in 2018–2022 (Table 17). The gap between Denmark and the other countries will increase, and Finland, Sweden and Norway are predicted to experience similar incidence rates in the next 20 years.

Comments

A large European randomized screening trial (de Koning *et al.*, 2002) is currently being conducted, with men aged 55–69 years recruited during the period 1992–2001.

Table 17. Observed and predicted average annual numbers of new cases by age, and crude and world-standardized rates in the five Nordic countries; cancer of the prostate.

		DENMARK			FINLAND			ICELAND		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual Number of cases	0-54	29	29	34	45	59	55	3	4	5
	55-74	677	815	1159	1336	1832	2707	79	96	174
	≥ 75	738	859	1259	1021	1704	2943	57	94	140
	Total	1444	1702	2451	2402	3595	5705	139	194	319
Crude rate[a]		56.2	63.4	86.8	96.4	140.5	218.4	103.4	132.3	194.2
World stand. rate		**30.0**	**32.5**	**34.2**	**62.8**	**72.5**	**74.7**	**75.9**	**86.3**	**95.2**
		NORWAY			SWEDEN			TOTAL		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual Number of cases	0-54	47	51	65	98	108	127	221	252	286
	55-74	1211	1506	2240	2862	3587	4956	6165	7835	11235
	≥ 75	1168	1522	2151	2812	3839	5958	5796	8018	12451
	Total	2425	3079	4456	5772	7535	11041	12182	16106	23972
Crude rate[a]		112.2	135.3	183.4	132.9	169.1	236.2	104.1	132.9	188.7
World stand. rate		**61.1**	**73.6**	**77.8**	**62.9**	**74.6**	**81.1**	**55.4**	**64.9**	**69.4**

[a]Crude rate should not be used to compare the risk of cancer in different countries, or the change of risk over time, since it is not adjusted for differences in age distribution. It can, however, be used to compare the relative cancer burden between countries.

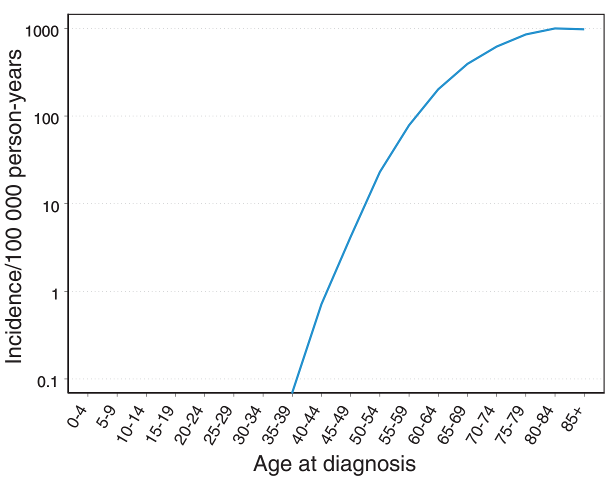


Figure 43. Age-specific incidence rates of prostate cancer in the Nordic countries, 1993–1997.

Approximately 20 000 Finnish and 10 000 Swedish men are participating in this trial, comprising about 6% and 2% of the respective male populations in this age group. The effects on cancer incidence on these men have not been taken into account in the prediction model.

In Finland, rates started to increase markedly in 1991, and have increased for seven consecutive years, with a total increase of about 86% from 1990 to 1997. Rates in the USA (from the Surveillance, Epidemiology, and End Results [SEER] programme) are useful for comparison. In a three-year period, from 1990 to 1992, rates increased by about 70%, then dropped markedly in the following two years, and have been stable since 1994 (NCI, 2002). This suggests that the Finnish rates are close to a peak, and will stabilize at a lower level. When this peak will occur and the level at which the rates will stabilize are impossible to predict without knowledge of the extent of PSA testing in the USA and Finland.

The decline in the last five-year period in Denmark is probably due to the general recommendation in Denmark not to conduct PSA testing. Of course, it is possible that Denmark, Norway and Sweden will all experience, at some later time, the marked effects of PSA testing that have apparently been observed in Finland and Iceland, making the predictions void.

Little is known about the risk factors for prostate cancer, but it has been estimated that about 6% of the Nordic prostate cancer cases could be avoided if obesity [body mass index (BMI) above 30 kg/m^2] were eliminated (Olsen *et al.*, 1997). High intake of saturated fat and meat is suspected to increase the risk of this cancer.

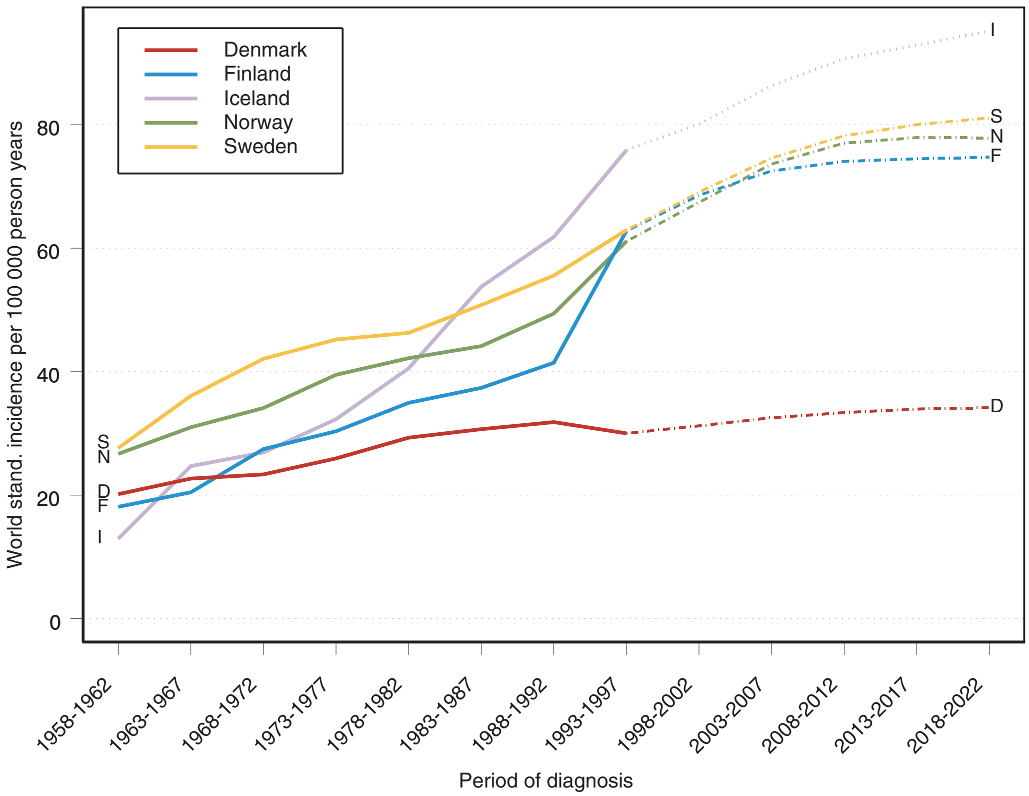


Figure 44. Observed and predicted age-adjusted incidence rates in the five Nordic countries: cancer of the prostate.

Cancer of the testis

The average annual number of new cases of cancer of the testis in 1993–1997 in the Nordic countries was 812, comprising 1.6% of all male cancer cases (Table 18). Testicular cancer is primarily a disease of young and middle-aged men, the median age of patients in 1983–1987 being 34 years; only 10% were aged over 54 years.

The pattern of age-specific rates is very different from those for most other cancers. The highest rates, about 18 per 100 000 person-years, were in the age group 30–34 years and the rates declined after that age (Figure 45).

The standardized rates more than doubled from 1958–1962 to 1993–1997 for all the Nordic countries (Figure 46). Denmark and Norway have had the highest rates, which were among the highest in the world. The rates in Finland were less than a third of the Danish and Norwegian rates. The rates in all five countries have increased steadily and are predicted to continue to increase. For all countries combined, the rates will increase by 16% from 1993–1997 to 2018–2022. The annual number of new cases will increase by more than 200, to around 1000 per year in 2018–2022 (Table 18).

Comments

No information is available on risk factors that could explain the large differences in incidence between the Nordic countries.

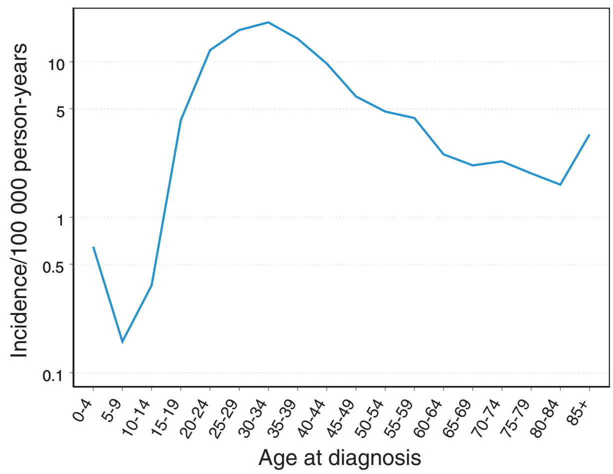


Figure 45. Age-specific incidence rates of testicular cancer in the Nordic countries, 1993–1997.

Table 18. Observed and predicted average annual numbers of new cases by age, and crude and world-standardized rates in the five Nordic countries; cancer of the testis.

		DENMARK			FINLAND			ICELAND		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual Number of cases	0-54	271	297	300	65	86	100	8	11	13
	55-74	20	25	39	6	9	9	0	1	1
	≥ 75	5	4	6	1	2	2	0	0	0
	Total	296	326	345	73	96	111	8	12	14
Crude rate[a]		11.5	12.2	12.2	2.9	3.8	4.2	6.3	7.9	8.6
World stand. rate		**9.9**	**11.2**	**11.9**	**2.7**	**3.7**	**4.4**	**5.7**	**7.3**	**8.5**

		NORWAY			SWEDEN			TOTAL		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual Number of cases	0-54	192	232	260	203	210	219	739	836	892
	55-74	14	15	31	19	19	32	60	68	112
	≥ 75	3	4	5	4	4	5	13	14	18
	Total	209	251	295	225	233	257	812	918	1022
Crude rate[a]		9.7	11.0	12.2	5.2	5.2	5.5	6.9	7.6	8.0
World stand. rate		**8.7**	**10.3**	**11.7**	**4.9**	**5.0**	**5.3**	**6.3**	**7.2**	**7.9**

[a]Crude rate should not be used to compare the risk of cancer in different countries, or the change of risk over time, since it is not adjusted for differences in age distribution. It can, however, be used to compare the relative cancer burden between countries.

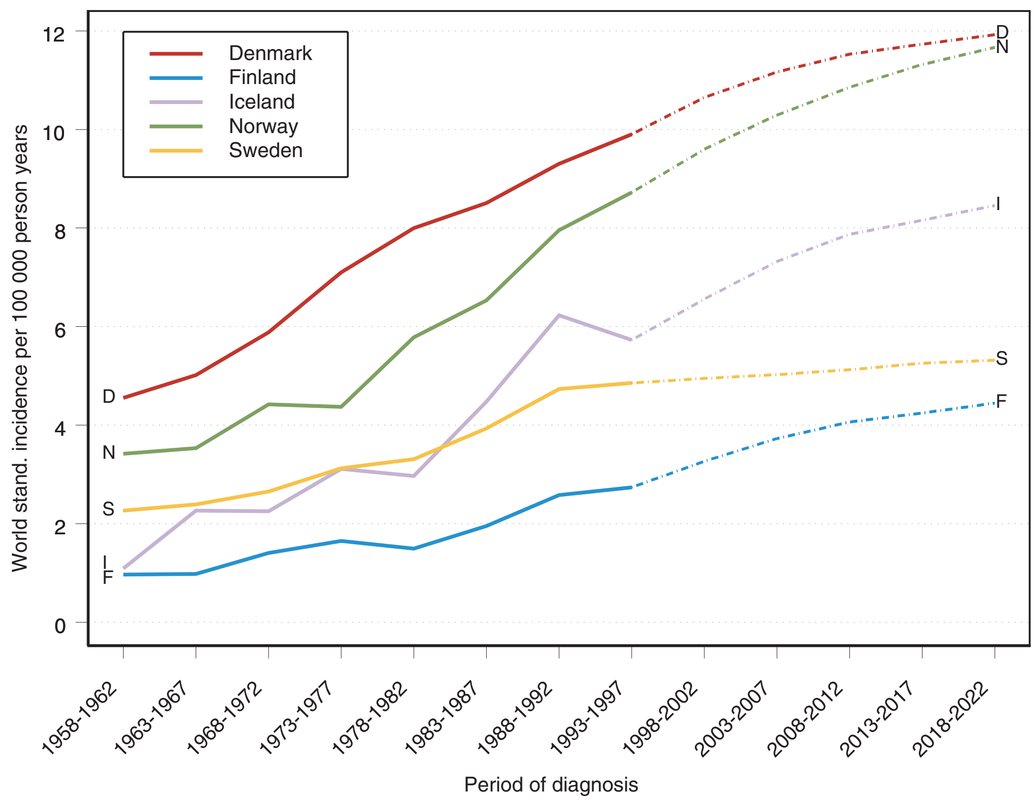


Figure 46. Observed and predicted age-adjusted incidence rates in the five Nordic countries: cancer of the testis.

Cancer of the kidney

The average annual numbers of new cases of cancer of the kidney in 1993–1997 in the Nordic countries were 1818 in males and 1316 in females, comprising 3.6% and 2.5% of all male and female cancer cases, respectively (Table 19).

The median ages of patients in the last observation period were 68 years for men and 71 years for women. The rates in the age group 0–9 years were higher than those in subsequent age groups (Figure 47) and most of the cases in this age group are nephroblastomas (Wilms tumours). The incidence rate increased with age at diagnosis for groups above 15–19 years, with a male:female ratio of about 2 after the age of 25 years.

Iceland has had the highest rates of kidney cancer, for both males and females, and the rates have increased steadily since 1958–1962 (Figure 48). In Denmark and Finland, the rates increased up to 1983–1987, but started to decline in the last 10 years for both sexes. A similar increase occurred in Finland and Norway, but the rates stabilized around 1988–1992.

The rates of kidney cancer in the Nordic countries are predicted to decrease, except for Finnish males, for whom the rates are predicted to stabilize, and for both sexes in Iceland, where a moderate increase is predicted.

Table 19. Observed and predicted average annual numbers of new cases by age, and crude and world-standardized rates in the five Nordic countries; cancer of the kidney.

Males		DENMARK			FINLAND			ICELAND		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	78	69	67	94	91	88	4	7	7
Number	55-74	216	224	302	230	289	373	15	16	27
of cases	≥ 75	95	99	130	80	122	194	8	11	15
	Total	388	392	498	404	501	655	27	34	49
Crude rate[a]		15.1	14.6	17.7	16.2	19.6	25.1	20.3	23.2	29.7
World stand. rate		**9.9**	**8.9**	**9.0**	**11.6**	**11.7**	**11.8**	**16.8**	**16.4**	**16.8**

		NORWAY			SWEDEN			TOTAL		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	55	49	48	106	66	57	337	281	267
Number	55-74	179	184	220	351	302	300	992	1015	1221
of cases	≥ 75	108	124	125	199	186	214	489	542	679
	Total	343	356	393	655	554	571	1818	1838	2166
Crude rate[a]		15.9	15.7	16.2	15.1	12.4	12.2	15.5	15.2	17.1
World stand. rate		**10.1**	**9.5**	**8.1**	**8.9**	**6.7**	**5.5**	**10.0**	**8.8**	**8.2**

Females		DENMARK			FINLAND			ICELAND		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	37	28	23	51	43	36	2	3	3
Number	55-74	134	93	100	155	162	198	9	11	18
of cases	≥ 75	92	78	73	112	145	174	6	7	10
	Total	264	200	196	317	349	408	17	21	30
Crude rate[a]		10.0	7.3	6.8	12.1	13.1	15.1	12.9	14.3	18.5
World stand. rate		**5.4**	**3.7**	**3.2**	**6.5**	**6.1**	**5.8**	**8.8**	**9.5**	**9.7**

		NORWAY			SWEDEN			TOTAL		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	32	32	37	61	43	38	183	150	137
Number	55-74	103	105	123	241	199	203	643	569	641
of cases	≥ 75	97	114	102	184	173	193	491	517	551
	Total	232	251	262	486	415	434	1316	1236	1329
Crude rate[a]		10.5	10.8	10.6	10.9	9.1	9.2	10.9	10.0	10.3
World stand. rate		**5.5**	**5.5**	**5.0**	**5.5**	**4.3**	**3.8**	**5.7**	**4.8**	**4.4**

[a]Crude rate should not be used to compare the risk of cancer in different countries, or the change of risk over time, since it is not adjusted for differences in age distribution. It can, however, be used to compare the relative cancer burden between countries.

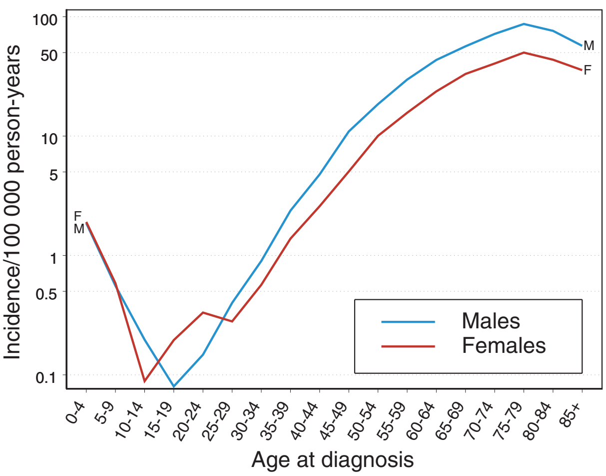


Figure 47. Age-specific incidence rates of kidney cancer in the Nordic countries, 1993–1997.

For all the Nordic countries combined, rates will decrease by 18% (males) and 23% (females) from 1993–1997 to 2018–2022. Despite this decreasing risk of kidney cancer, the annual number of male cases will increase by around 350 cases, to more than 2100 per year, due to the ageing of the population (Table 19 top). The annual number of female cases will stabilize around 1300 cases per year (Table 19 bottom).

Comments

Rates in Denmark, Finland, Norway and Sweden are predicted to decline or stabilize, in contrast to the increasing rates in Iceland. Because the predictions in Iceland deviate from those for the other countries for both males and females, the drift component in Iceland has been halved.

There is a strong association between tobacco smoking and cancers of the renal pelvis and ureter. If smoking was eliminated, 30–40% of these cancers could be avoided in the Nordic countries (Olsen *et al.*, 1997). About 10–15% of renal cell cancers are estimated to be caused by smoking, while around 10% of the cases could be avoided if obesity (BMI > 30 kg/m^2) was eliminated. A smaller fraction (2%) of the male cases is estimated to be caused by exposure to polycyclic aromatic hydrocarbons (PAHs).

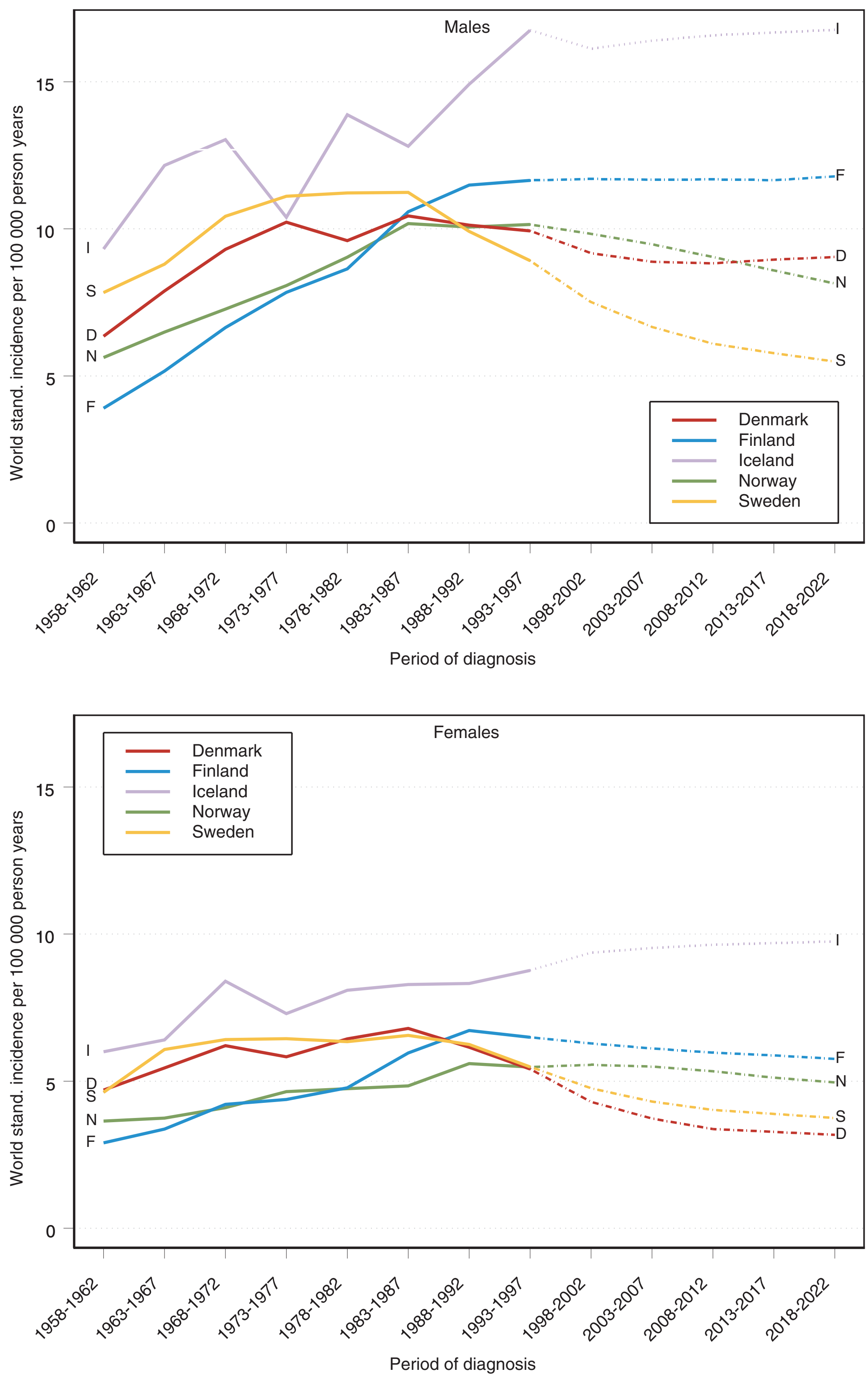


Figure 48. Observed and predicted age-adjusted incidence rates in the five Nordic countries: cancer of the kidney.

Cancer of the urinary bladder

The average annual numbers of new cases of cancer of the urinary bladder (including tumours of the urethra and papillomas) in 1993–1997 in the Nordic countries were 4126 in males and 1396 in females, comprising 8.1% and 2.7% of all male and female cancer cases, respectively (Table 20).

The median ages of patients in the last observation period were 72 years for men and 74 years for women. The incidence rates increased with age at diagnosis to 274 per 100 000 person-years in males and 65 in females (Figure 49). The male:female ratio of the rates increased with age, from about 1.5 at younger ages (20–24 years) to about 4.2 in the oldest.

Since 1958–1962, the rates in all the Nordic countries have more than doubled for men and increased by about 70% for women (Figure 50). In the last 10 years, however, they have stabilized. In males, rates were about four times higher than those in females, but the internal ranking between the countries was similar for both sexes, with the highest rates in Denmark and lowest in Finland. Cohort-specific risks increased for males born up to around 1928 in all the Nordic countries. After this point, risks decreased markedly for consecutive cohorts in Denmark, but remained stable or slightly decreased in

Table 20. Observed and predicted average annual numbers of new cases by age, and crude and world-standardized rates in the five Nordic countries; cancer of the urinary bladder.

Males	Age	DENMARK 1993-1997	DENMARK 2003-2007	DENMARK 2018-2022	FINLAND 1993-1997	FINLAND 2003-2007	FINLAND 2018-2022	ICELAND 1993-1997	ICELAND 2003-2007	ICELAND 2018-2022
Annual Number of cases	0-54	124	104	103	61	68	60	5	7	8
	55-74	641	637	726	338	406	580	18	18	27
	≥ 75	419	449	532	219	336	506	14	23	24
	Total	1184	1190	1361	619	809	1145	37	47	59
Crude rate[a]		46.1	44.4	48.2	24.8	31.6	43.8	27.3	32.4	35.8
World stand. rate		**27.7**	**24.6**	**21.8**	**16.6**	**17.0**	**16.8**	**20.8**	**21.1**	**19.2**

Males	Age	NORWAY 1993-1997	NORWAY 2003-2007	NORWAY 2018-2022	SWEDEN 1993-1997	SWEDEN 2003-2007	SWEDEN 2018-2022	TOTAL 1993-1997	TOTAL 2003-2007	TOTAL 2018-2022
Annual Number of cases	0-54	72	68	65	138	110	104	401	357	339
	55-74	404	402	484	736	784	860	2138	2247	2676
	≥ 75	329	388	403	607	729	909	1587	1925	2375
	Total	806	859	952	1481	1623	1873	4126	4528	5390
Crude rate[a]		37.3	37.7	39.2	34.1	36.4	40.1	35.3	37.4	42.4
World stand. rate		**21.8**	**21.2**	**17.9**	**17.8**	**17.2**	**15.3**	**20.4**	**19.4**	**17.5**

Females	Age	DENMARK 1993-1997	DENMARK 2003-2007	DENMARK 2018-2022	FINLAND 1993-1997	FINLAND 2003-2007	FINLAND 2018-2022	ICELAND 1993-1997	ICELAND 2003-2007	ICELAND 2018-2022
Annual Number of cases	0-54	41	39	39	18	21	18	1	2	2
	55-74	204	186	195	90	94	134	5	7	10
	≥ 75	152	161	183	95	134	156	6	6	7
	Total	397	386	417	203	248	308	12	14	19
Crude rate[a]		15.0	14.1	14.5	7.8	9.3	11.4	8.8	9.5	11.7
World stand. rate		**7.6**	**6.7**	**5.9**	**3.5**	**3.6**	**3.8**	**5.6**	**5.9**	**5.9**

Females	Age	NORWAY 1993-1997	NORWAY 2003-2007	NORWAY 2018-2022	SWEDEN 1993-1997	SWEDEN 2003-2007	SWEDEN 2018-2022	TOTAL 1993-1997	TOTAL 2003-2007	TOTAL 2018-2022
Annual Number of cases	0-54	23	27	30	45	49	52	128	138	140
	55-74	116	119	169	217	242	309	632	648	818
	≥ 75	132	163	165	250	290	330	636	753	841
	Total	271	309	364	513	581	691	1396	1539	1800
Crude rate[a]		12.3	13.3	14.8	11.5	12.8	14.6	11.6	12.4	13.9
World stand. rate		**5.6**	**5.9**	**6.0**	**4.8**	**5.2**	**5.4**	**5.3**	**5.3**	**5.3**

[a]Crude rate should not be used to compare the risk of cancer in different countries, or the change of risk over time, since it is not adjusted for differences in age distribution. It can, however, be used to compare the relative cancer burden between countries.

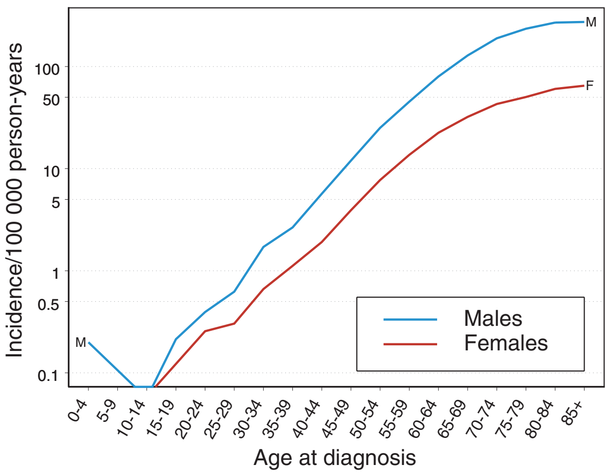


Figure 49. Age-specific incidence rates of cancer of the urinary bladder in the Nordic countries, 1993–1997.

Finland, Iceland, Norway and Sweden. Due to the low number of cases, cohort-specific risks have not been estimated for Icelandic women. For women in the other countries, cohort-specific risks show a pattern similar to that in men. Risk increased for women born up to around 1933, and stabilized or slightly declined up to around 1943 in all the countries. Cohort-specific risks have not been studied for women born after this, because the numbers of cases were too low.

Male rates are predicted to stabilize in Finland and decline in the other countries. The rates for females will increase slightly in all countries except Denmark, where a decline is predicted. For all the Nordic countries combined, rates in males will decrease by 14%, whereas those in females will remain unchanged. Despite the decline among males, the annual number of cases from 1993–1997 to 2018–2022 will increase by more than 1300 cases to around 5400 per year (Table 20 top). For women, the annual number of cases will increase from around 1400 to 1800 per year (Table 20 bottom).

Comments

Tobacco smoking is the major known risk factor for this type of cancer, and it is estimated that 30–40% of bladder cancers could be avoided if smoking was eliminated (Olsen *et al.*, 1997). Exposure to PAHs at work accounts for about 2% of male cases.

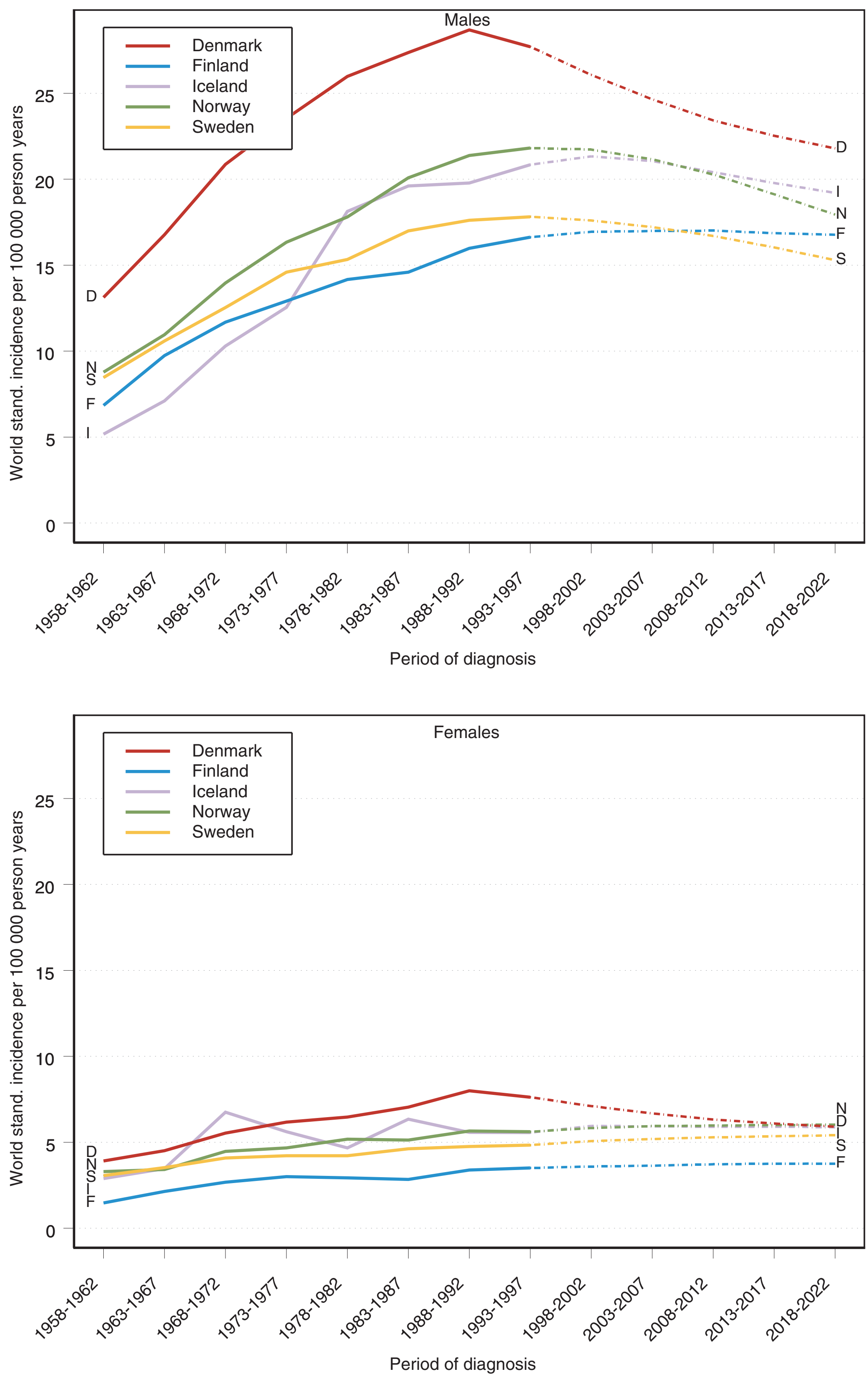


Figure 50. Observed and predicted age-adjusted incidence rates in the five Nordic countries: cancer of the urinary bladder.

Melanoma of the skin

For all the Nordic countries combined, the average annual numbers of melanoma of the skin in 1993–1997 were 1848 for males and 2078 for females, comprising 3.6% and 4.0% of all male and female cases, respectively (Table 21).

The median ages of patients in the last observation period were 61 years for men and 57 years for women. The incidence rates increased with age at diagnosis to 54 per 100 000 person-years in males and 37 in females (Figure 51). The rates were higher in females than in males in age groups below 55 years, and higher in males than in females above that age.

Over the observation period, the incidence rates have increased rapidly in all countries, and have more than tripled since 1958–1962 (Figure 52). In Finland, Norway and Sweden, the increase was less steep in the latest period. There are large differences between the levels in the countries, but the internal ranking of the countries is similar for males and females. Patterns of cohort-specific risks in the countries were similar. The Icelandic data are too sparse to allow estimation of cohort-specific risks, but in all the other countries, risks increased for males born up to around 1943. This was followed by a levelling off for men born up to around 1953. After this point, the risks increased again for subsequent birth cohorts. For

Table 21. Observed and predicted average annual numbers of new cases by age, and crude and world-standardized rates in the five Nordic countries; melanoma of the skin.

Males		DENMARK			FINLAND			ICELAND		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	158	169	162	106	99	80	5	6	7
Number	55-74	158	238	277	121	170	180	4	5	8
of cases	≥ 75	61	94	156	45	70	123	2	3	5
	Total	378	501	595	272	339	383	11	14	20
Crude rate[a]		14.7	18.7	21.1	10.9	13.2	14.7	8.1	9.8	12.4
World stand. rate		**10.4**	**12.2**	**12.1**	**8.0**	**8.3**	**7.4**	**6.7**	**7.4**	**8.0**
		NORWAY			SWEDEN			TOTAL		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	177	163	152	246	250	243	692	687	644
Number	55-74	188	238	272	334	404	451	805	1054	1187
of cases	≥ 75	79	118	161	163	243	344	351	528	790
	Total	445	518	585	743	897	1038	1848	2269	2622
Crude rate[a]		20.6	22.8	24.1	17.1	20.1	22.2	15.8	18.7	20.6
World stand. rate		**14.9**	**15.3**	**13.8**	**11.2**	**12.0**	**11.6**	**11.0**	**11.8**	**11.1**

Females		DENMARK			FINLAND			ICELAND		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	263	306	370	110	111	95	11	13	16
Number	55-74	157	219	269	102	121	151	4	7	12
of cases	≥ 75	84	108	139	62	84	116	2	4	6
	Total	504	633	778	274	317	362	17	24	34
Crude rate[a]		19.1	23.1	27.1	10.4	11.9	13.4	12.6	16.6	20.9
World stand. rate		**13.5**	**16.0**	**18.3**	**6.7**	**7.0**	**6.9**	**10.7**	**12.9**	**15.0**
		NORWAY			SWEDEN			TOTAL		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	243	267	288	335	368	394	962	1066	1162
Number	55-74	179	211	250	253	331	374	695	888	1056
of cases	≥ 75	93	137	168	180	228	285	420	562	714
	Total	515	616	705	768	926	1053	2078	2516	2932
Crude rate[a]		23.3	26.6	28.6	17.3	20.4	22.3	17.2	20.3	22.7
World stand. rate		**17.0**	**18.1**	**18.1**	**11.5**	**13.0**	**13.5**	**11.9**	**13.3**	**14.1**

[a]Crude rate should not be used to compare the risk of cancer in different countries, or the change of risk over time, since it is not adjusted for differences in age distribution. It can, however, be used to compare the relative cancer burden between countries.

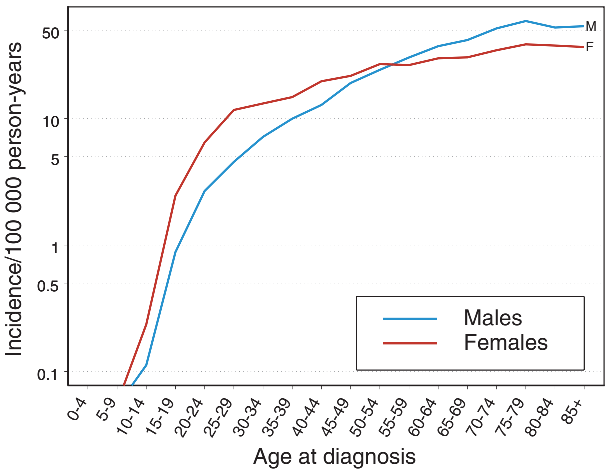


Figure 51. Age-specific incidence rates of melanoma of the skin in the Nordic countries, 1993–1997.

females, the same pattern was evident in all the countries, but instead of risks stabilizing for cohorts born after 1943, there was merely less pronounced increase in risk for women born up to around 1953. As for men, cohort-specific risks increased more rapidly again after this point. The cohorts of men and women born in a period after the second world war were 50 years or older in 1993–1997, and will have a large influence on the rates in the next 20 years.

The difference in the cohort-specific risks between males and females explains the difference in the shape of the curves for the predicted rates. Incidence rates of melanoma of the skin for males are predicted to peak after 5–15 years, whereas the future rates for females do not display a similar downward trend. For all the Nordic countries combined, standardized rates for men are predicted to remain around 11 per 100 000 in the next 20 years, but the annual number of new cases will increase from less than 1900 cases in 1993–1997 to more than 2600 in 2018–2022 (Table 21 top). For women, incidence rates will increase slightly, and the annual number of cases will increase from less than 2100 in the last observed period to more than 2900 in 2018–2022 (Table 21 bottom).

Comments

Rates among males in Denmark, Finland, Norway and Sweden are predicted to peak by 2008–2012, in contrast to the continued increase in Iceland. Because the predictions in Iceland deviate from those for the other countries, the drift component for Icelandic males has been halved.

Sunlight is the major risk factor for malignant melanoma. Up to 95% of the cases could be avoided if exposure to solar radiation was avoided (Olsen *et al.*, 1997). Short-term intense exposure to sunlight increases the risk for melanoma more than long-term moderate exposure.

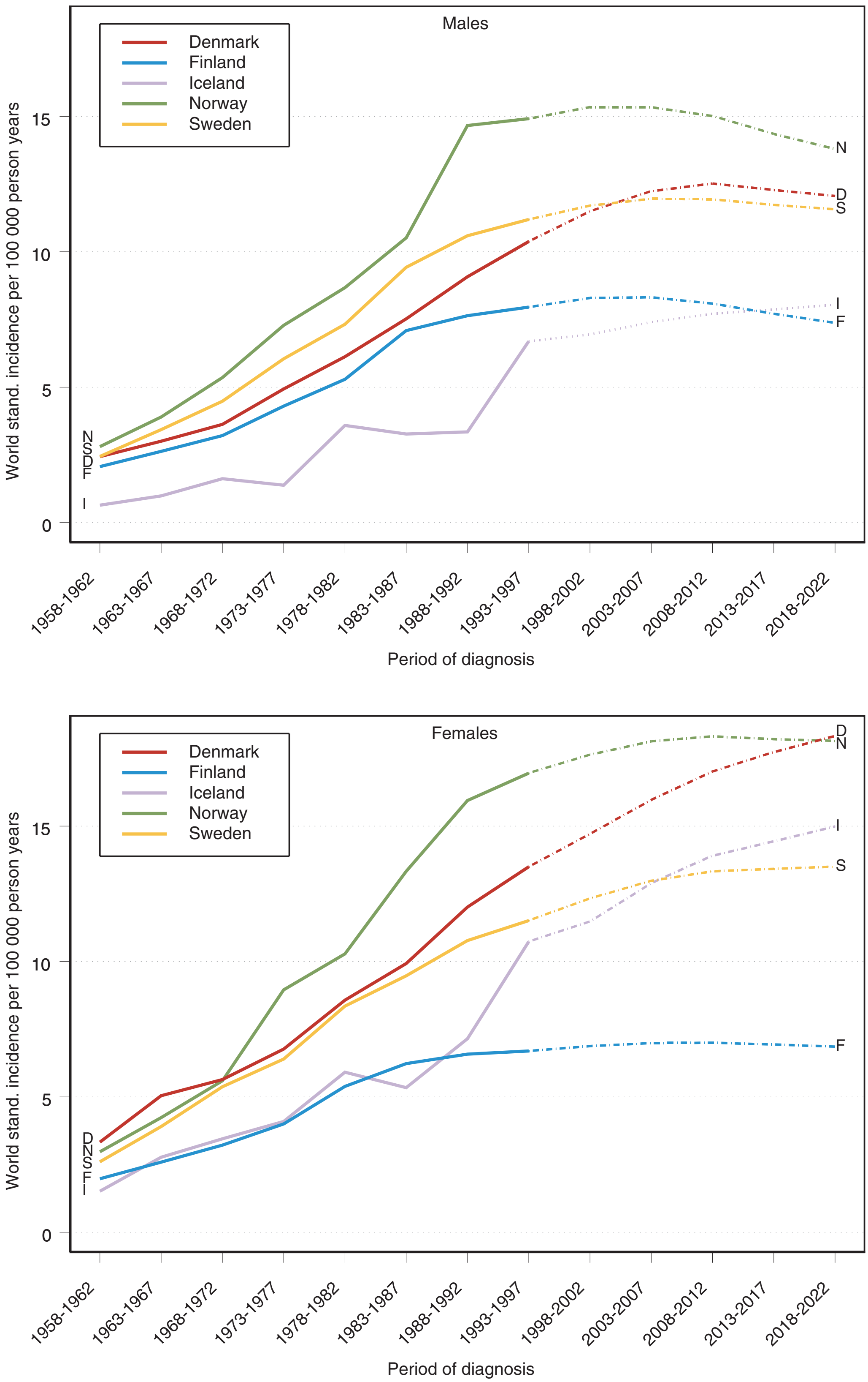


Figure 52. Observed and predicted age-adjusted incidence rates in the five Nordic countries: melanoma of the skin.

Cancer of the thyroid

The average annual numbers of new cases of cancer of the thyroid in 1993–1997 in the Nordic countries were 248 in males and 722 in females, comprising 0.5% and 1.4% of all male and female cancer cases, respectively (Table 22).

The median ages of patients in the last observation period were 58 years for men and 52 years for women. The incidence rates increased with age at diagnosis to 8 per 100 000 person-years in males and 12 in females (Figure 53). The rates were higher in females than in males in all age groups, and the female:male ratio was highest in the youngest age groups. At ages below 55 years, the rates in females were more than three times higher than those in men.

Iceland has the highest rates of thyroid cancer and Denmark the lowest rates (Figure 54). Cohort-specific risks in Denmark indicate that females born up to around 1933 had successively decreasing risks. Women born after this time have had a steady increase in risk. The cohort-specific risks for males are uncertain in all countries, due to the low numbers of cases, but the male pattern in Denmark resembles the cohort-specific risks for females. In the period from 1958 to 1997, the rates in Finland, especially for females, increased steadily.

Table 22. Observed and predicted average annual numbers of new cases by age, and crude and world-standardized rates in the five Nordic countries; cancer of the thyroid.

Males		DENMARK			FINLAND			ICELAND		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	17	21	23	40	43	43	1	3	3
Number	55-74	13	17	29	26	48	80	3	4	5
of cases	≥ 75	5	5	9	10	13	28	2	2	3
	Total	35	43	61	76	104	152	7	9	11
Crude rate[a]		1.3	1.6	2.2	3.0	4.1	5.8	4.9	5.8	6.8
World stand. rate		**1.0**	**1.2**	**1.4**	**2.3**	**2.8**	**3.3**	**3.9**	**4.4**	**4.3**
		NORWAY			SWEDEN			TOTAL		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	20	19	20	34	26	24	113	113	114
Number	55-74	17	24	31	32	39	43	90	131	188
of cases	≥ 75	8	8	11	20	18	24	45	45	75
	Total	45	51	62	86	83	91	248	290	376
Crude rate[a]		2.1	2.2	2.5	2.0	1.9	1.9	2.1	2.4	3.0
World stand. rate		**1.5**	**1.6**	**1.6**	**1.3**	**1.2**	**1.1**	**1.5**	**1.6**	**1.8**

Females		DENMARK			FINLAND			ICELAND		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	48	56	64	161	198	201	10	10	10
Number	55-74	21	30	58	81	134	249	6	6	8
of cases	≥ 75	17	14	19	29	46	84	2	4	5
	Total	86	100	140	271	378	534	19	20	23
Crude rate[a]		3.2	3.6	4.9	10.3	14.2	19.8	14.4	13.5	13.9
World stand. rate		**2.3**	**2.6**	**3.3**	**7.8**	**10.1**	**12.6**	**12.2**	**10.2**	**9.5**
		NORWAY			SWEDEN			TOTAL		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	71	69	73	107	102	107	397	435	455
Number	55-74	34	36	45	65	58	67	207	264	427
of cases	≥ 75	24	19	21	46	42	40	118	125	168
	Total	130	125	139	217	202	214	722	825	1050
Crude rate[a]		5.9	5.4	5.6	4.9	4.4	4.5	6.0	6.6	8.1
World stand. rate		**4.4**	**4.1**	**4.1**	**3.5**	**3.2**	**3.2**	**4.4**	**4.8**	**5.5**

[a]Crude rate should not be used to compare the risk of cancer in different countries, or the change of risk over time, since it is not adjusted for differences in age distribution. It can, however, be used to compare the relative cancer burden between countries.

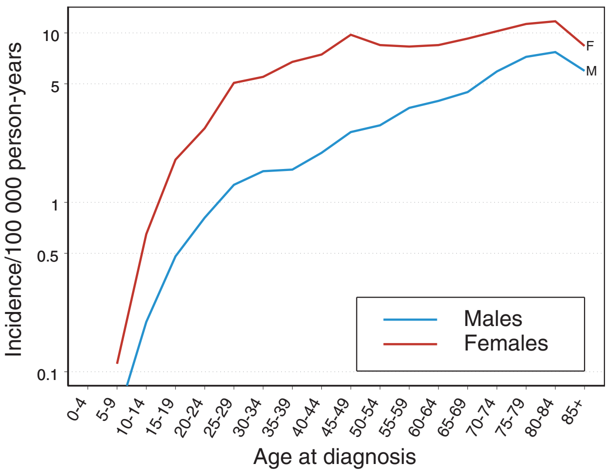


Figure 53. Age-specific incidence rates of thyroid cancer in the Nordic countries, 1993–1997.

Cohort-specific risks have increased for all cohorts of Finnish females born after 1913, and the increase escalated after around 1928. For Finnish men, risks declined for cohorts born up to around 1928, but increased markedly for men born after that time. The rates in Norwegian females and Swedish males and females have declined since 1982–1987, whereas the rates have been stable for Norwegian men. In Norway and Sweden, only the Swedish women have had a change in the cohort-specific risks, with a decline in risks for women born up to around 1938, and a stable level after that.

For both males and females, the rates of thyroid cancer are predicted to increase in Denmark and Finland, but will stabilize or slightly decrease in Norway, Sweden and Iceland. For all the Nordic countries combined, the rates are predicted to increase by 20% (males) and 23% (females) in the period 1993–1997 to 2018–2022. In the same period, the annual number of male cases will increase by more than 100 cases, to almost 400 per year, whereas the number of female cases will increase by over 300, to more than 1000 cases per year (Table 22).

Comments

The reason for the relatively high incidence of thyroid cancer in Iceland is not known. The Nordic differences (Franssila *et al*., 1981) and the recent increase in Finland are largely attributed to papillary carcinoma.

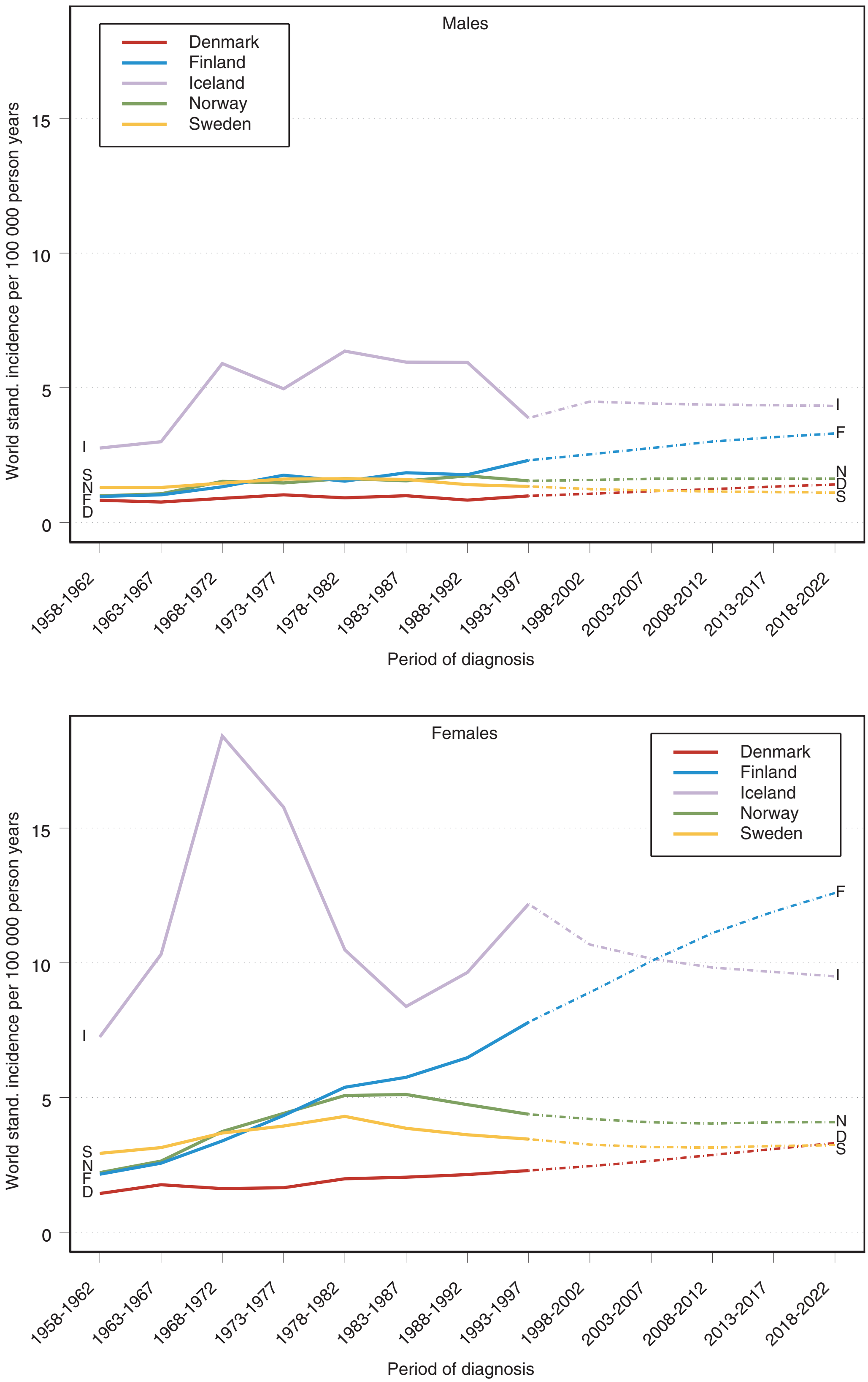


Figure 54. Observed and predicted age-adjusted incidence rates in the five Nordic countries: cancer of the thyroid.

Non-Hodgkin lymphomas

The average annual numbers of new cases of non-Hodgkin lymphomas in 1993–1997 in the Nordic countries were 1901 in males and 1684 in females, comprising 3.7% and 3.2% of all male and female cancer cases, respectively (Table 23).

The median ages of patients in the last observation period were 66 years for men and 70 years for women. The incidence rates increased with age at diagnosis to 93 per 100 000 person-years in males and 60 in females (Figure 55). The rates were higher in males in all age groups.

The standardized incidence rates of non-Hodgkin lymphomas increased steadily in all countries for both sexes in the period 1958–1997, tending to stabilize during the last ten years in Norway and Sweden (Figure 56). Even though the rates were very similar for all the countries in this period, they are predicted to diverge in the future. Finland and Iceland have had the most marked increase, and their rates are predicted to continue to increase. The rates in Denmark, Norway and Sweden will change only marginally. For all the Nordic countries combined, the rates will increase by about 10% for both sexes from 1993–1997 to 2018–2022. The annual numbers of cases will increase by approximately 1000 for males and 700

Table 23. Observed and predicted average annual numbers of new cases by age, and crude and world-standardized rates in the five Nordic countries; non-Hodgkin lymphomas.

Males		DENMARK			FINLAND			ICELAND		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	131	125	115	129	155	148	6	9	10
Number	55-74	157	223	296	183	289	441	7	10	17
of cases	≥ 75	90	102	153	81	136	256	4	6	9
	Total	379	450	565	394	580	845	18	24	36
Crude rate[a]		14.7	16.8	20.0	15.8	22.7	32.3	13.3	16.6	21.6
World stand. rate		**10.2**	**10.8**	**10.9**	**11.6**	**14.2**	**15.9**	**11.1**	**12.5**	**13.6**

Males		NORWAY			SWEDEN			TOTAL		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	107	100	99	185	170	166	559	559	539
Number	55-74	138	180	250	337	391	446	823	1092	1450
of cases	≥ 75	85	98	123	258	288	384	519	630	925
	Total	330	378	473	780	849	996	1901	2281	2914
Crude rate[a]		15.3	16.6	19.5	18.0	19.1	21.3	16.2	18.8	22.9
World stand. rate		**10.6**	**11.1**	**10.9**	**10.8**	**10.7**	**10.3**	**10.8**	**11.6**	**11.8**

Females		DENMARK			FINLAND			ICELAND		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	85	80	83	89	92	88	4	5	6
Number	55-74	142	187	240	174	252	352	6	9	15
of cases	≥ 75	110	118	165	143	206	295	4	5	8
	Total	336	385	488	406	550	736	13	19	29
Crude rate[a]		12.7	14.1	17.0	15.5	20.6	27.2	9.7	12.9	17.6
World stand. rate		**7.3**	**7.8**	**8.1**	**8.5**	**10.0**	**10.8**	**7.3**	**9.0**	**10.1**

Females		NORWAY			SWEDEN			TOTAL		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	70	69	72	108	99	102	355	344	351
Number	55-74	119	132	166	281	309	331	721	888	1104
of cases	≥ 75	92	99	108	259	314	385	607	743	960
	Total	281	300	345	648	722	818	1684	1975	2416
Crude rate[a]		12.7	12.9	14.0	14.6	15.9	17.3	14.0	15.9	18.7
World stand. rate		**7.6**	**7.6**	**7.3**	**7.2**	**7.4**	**7.0**	**7.6**	**8.1**	**8.2**

[a]Crude rate should not be used to compare the risk of cancer in different countries, or the change of risk over time, since it is not adjusted for differences in age distribution. It can, however, be used to compare the relative cancer burden between countries.

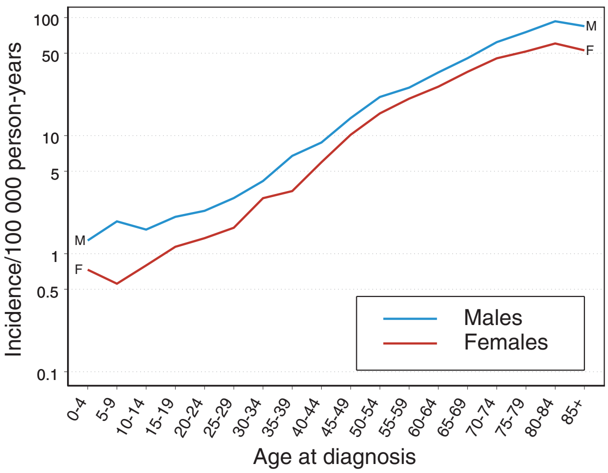


Figure 55. Age-specific incidence rates of non-Hodgkin lymphomas in the Nordic countries, 1993–1997.

for females, to around 2900 and 2400 per year, respectively (Table 23).

Comments

If there is a significant curvature in the rates in the prediction base, the slope from the last 10 years was used in the model, as described in "Methods for prediction". Denmark, Norway and Sweden have all had similar changes in trends in non-Hodgkin lymphomas in the last 10 years for both sexes, and the curvature was significant for all except males in Denmark. Because of the similarity of the rates, the slope from the last 10 years was also used for Danish males, even though the curvature was not statistically significant.

In Iceland, incidence rates have increased more steeply than in the other Nordic countries for both males and females. It seems unlikely that incidence rates will continue to rise at the same pace in the future. Therefore, the drift component was halved in the Icelandic predictions.

Risk factors for non-Hodgkin lymphomas include immunosuppressive states, perhaps mediated through viruses such as human immunodeficiency virus (the AIDS virus; HIV), the retrovirus human T-cell lymphotropic virus (HTLV) and the Epstein–Barr virus (EBV). Viruses also seem to act directly as causative factors (Scherr *et al.*, 1996). A few studies also suggest an increased risk related to radiation exposure. Occupational exposures to pesticides and herbicides, to some other chemicals and in various industries are clearly associated with increased risk, but are too rare to be responsible for the observed rates. Other known environmental exposures cannot explain the rather similar rise in incidence seen in the Nordic countries and elsewhere (Hartge *et al.*, 1994). Changes in diagnostic practice also need to be taken into account. Distinguishing lymphomas from leukaemias can be difficult or even arbitrary, since chronic lymphatic leukaemia and low-grade non-Hodgkin lymphoma are considered the same disease, as are lymphoblastic lymphoma and acute lymphoblastic leukaemia. Misclassification has also occurred between non-Hodgkin lymphomas and Hodgkin disease (Hartge *et al.*, 1994), but the incidence of Hodgkin disease is so low that this cannot explain the increase in non-Hodgkin lymphomas. Both classification systems and diagnostic methods have now improved.

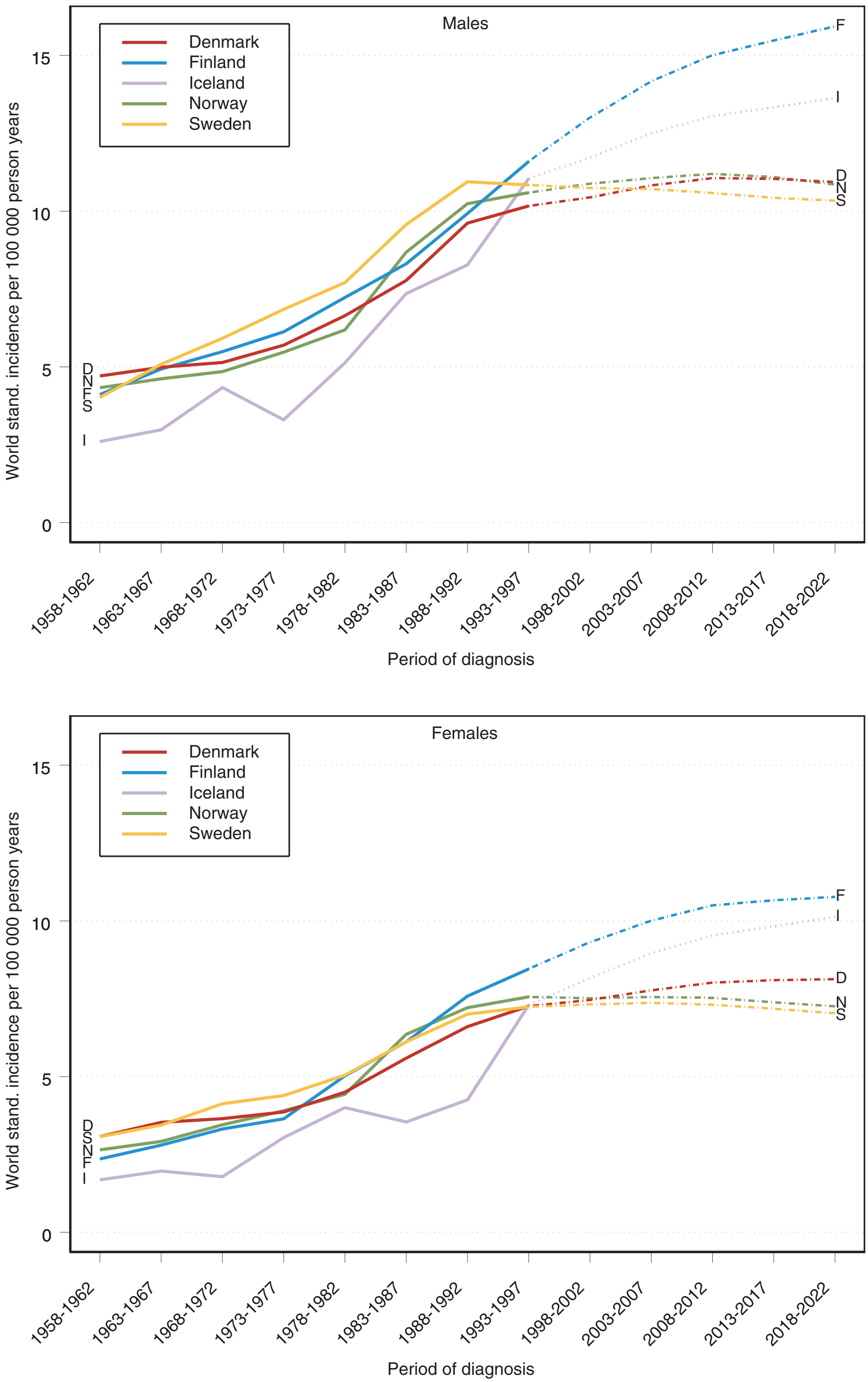


Figure 56. Observed and predicted age-adjusted incidence rates in the five Nordic countries: non-Hodgkin lymphomas.

Hodgkin disease

The average annual numbers of new cases of Hodgkin disease in 1993–1997 in the Nordic countries were 298 in males and 220 in females, comprising 0.6% and 0.4% of all male and female cancer cases, respectively (Table 24).

The median ages of patients in the last observation period were 72 years for men and 74 years for women. The incidence rate displays two peaks with age: first the rate increases up to the age group 20–24 years, followed by a decline, then a further rise above the age of about 50 years (Figure 57). The rates were higher in males than females and the bimodal pattern was more pronounced in females.

Up to around 1983–1987, rates in Denmark, Finland, Norway and Sweden declined for both males and females (Figure 58). After this period, the rates seemed to stabilize or, in the case of Finland, even start to increase. The four countries have some similarities in their cohort-specific risk patterns. In Finland, risks decreased for successive cohorts of people born up to around 1928 (women) or 1933 (men), and the risks have remained at a stable level in subsequent cohorts. Denmark, Norway and Sweden have experienced the same decrease for older cohorts, but in Denmark the

Table 24. Observed and predicted average annual numbers of new cases by age, and crude and world-standardized rates in the five Nordic countries; Hodgkin disease.

Males		DENMARK			FINLAND			ICELAND		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	50	48	47	54	54	56	4	3	2
Number	55-74	14	13	15	16	17	11	0	1	1
of cases	≥ 75	7	5	5	5	5	4	0	0	0
	Total	71	66	67	74	77	71	4	3	3
Crude rate[a]		2.8	2.5	2.4	3.0	3.0	2.7	3.0	2.3	2.1
World stand. rate		**2.4**	**2.2**	**2.2**	**2.7**	**2.8**	**2.8**	**3.0**	**2.3**	**2.1**
		NORWAY			SWEDEN			TOTAL		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	39	37	38	64	57	57	211	199	201
Number	55-74	8	9	12	22	20	21	61	60	60
of cases	≥ 75	3	1	2	12	7	9	27	19	19
	Total	50	47	52	99	84	87	298	278	280
Crude rate[a]		2.3	2.1	2.1	2.3	1.9	1.9	2.6	2.3	2.2
World stand. rate		**2.2**	**2.0**	**2.0**	**2.0**	**1.7**	**1.7**	**2.3**	**2.1**	**2.1**

Females		DENMARK			FINLAND			ICELAND		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	34	31	32	40	35	32	2	1	1
Number	55-74	7	8	10	11	12	14	0	1	1
of cases	≥ 75	6	4	4	7	7	7	1	0	1
	Total	48	43	45	58	54	53	3	2	3
Crude rate[a]		1.8	1.6	1.6	2.2	2.0	2.0	1.9	1.7	1.7
World stand. rate		**1.6**	**1.5**	**1.5**	**2.1**	**1.9**	**1.9**	**1.6**	**1.4**	**1.4**
		NORWAY			SWEDEN			TOTAL		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	25	23	24	51	52	53	152	142	143
Number	55-74	3	3	3	16	11	14	37	34	41
of cases	≥ 75	3	2	1	14	10	7	31	24	18
	Total	31	28	28	80	73	74	220	200	203
Crude rate[a]		1.4	1.2	1.1	1.8	1.6	1.6	1.8	1.6	1.6
World stand. rate		**1.3**	**1.3**	**1.2**	**1.6**	**1.5**	**1.6**	**1.7**	**1.5**	**1.5**

[a]Crude rate should not be used to compare the risk of cancer in different countries, or the change of risk over time, since it is not adjusted for differences in age distribution. It can, however, be used to compare the relative cancer burden between countries.

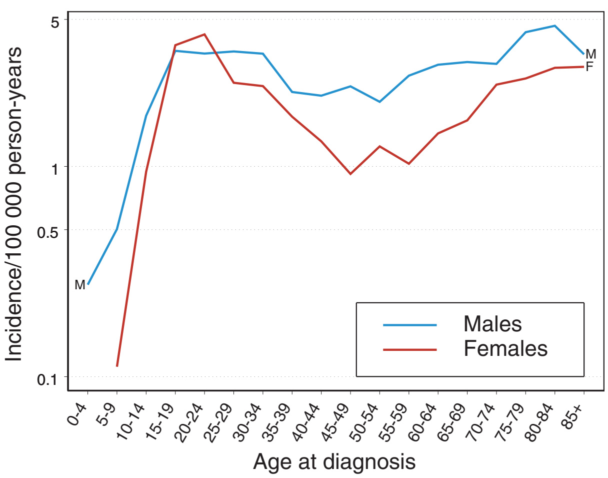


Figure 57. Age-specific incidence rates of Hodgkin disease in the Nordic countries, 1993–1997.

rates stabilized after the 1938 cohort, in Norway after the 1943 cohort and in Sweden after the 1943 cohort in men and after the 1958 cohort in women. The Icelandic rates behaved very erratically, as there were only three or four cases per year, making it difficult to interpret the trends.

The rates of Hodgkin disease are predicted to stabilize or slightly decrease in all the countries. For all the Nordic countries combined, the rates will decrease in the period from 1993–1997 to 2018–2022 by around 10% for both males and females, and the annual number of cases will decrease by about 20, to around 300 per year for men and 200 for women (Table 24).

Comments

Improved diagnosis of Hodgkin disease may explain part of the observed decreasing trend in incidence; some cases now are classified as non-Hodgkin lymphomas. Changes in diagnosis and classification make the trends difficult to interpret (Hartge *et al*., 1994). The aetiology of Hodgkin disease is not well understood, but is probably shared to some extent with both non-Hodgkin lymphomas and leukaemias. The major candidate aetiological factor for Hodgkin disease is infection with Epstein–Barr virus. The infection hypothesis is supported by the observation of clusters of cases (Mueller, 1996). Familial aggregation and a higher incidence among the higher social classes have been observed.

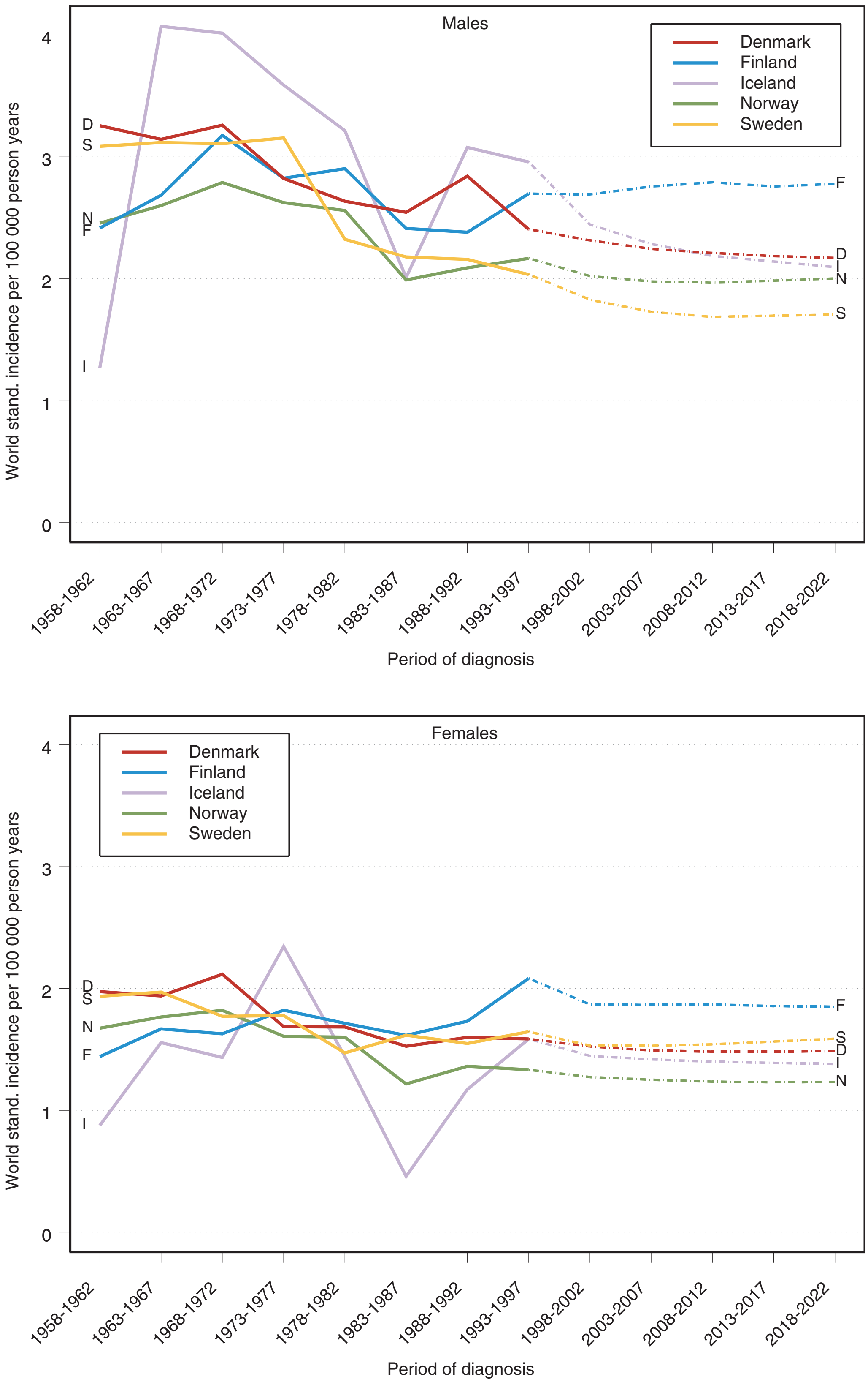


Figure 58. Observed and predicted age-adjusted incidence rates in the five Nordic countries: Hodgkin disease.

Multiple myeloma

The average annual numbers of new cases of multiple myeloma in 1993–1997 in the Nordic countries were 718 in males and 659 in females, comprising 1.4% and 1.3% of all male and female cancer cases, respectively (Table 25).

The median ages of patients in the last observation period were 72 years for men and 74 years for women. The incidence rates increased with age at diagnosis to 49 per 100 000 person-years in males and 29 in females (Figure 59). The male:female ratio of the rates was around 1 for patients below 45 years, and increased to around 1.8 in the oldest age group.

The rates for males in Iceland and Norway increased up to around 1973–1977, after which they declined (Figure 60 top). In Finland and Sweden, a similar decline occurred some five years later, but in Denmark, the rates continued to increase throughout the whole period. For females, the rates increased up to 1973–1977 in Norway and Sweden, after which they stabilized or decreased slightly (Figure 60 bottom). A similar peak occurred some 10 years later in Finland and Iceland, and 15 years later in Denmark.

Table 25. Observed and predicted average annual numbers of new cases by age, and crude and world-standardized rates in the five Nordic countries; multiple myeloma.

Males		DENMARK			FINLAND			ICELAND		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	20	20	21	16	14	11	1	1	1
Number	55-74	91	116	154	54	53	62	3	3	5
of cases	≥ 75	55	64	101	38	40	53	2	2	2
	Total	166	200	276	107	107	127	6	7	9
Crude rate[a]		6.5	7.5	9.8	4.3	4.2	4.8	4.3	4.5	5.2
World stand. rate		**3.9**	**4.3**	**4.4**	**2.9**	**2.3**	**2.0**	**3.4**	**3.3**	**3.0**
		NORWAY			SWEDEN			TOTAL		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	14	14	16	34	29	27	84	79	76
Number	55-74	68	68	95	138	137	161	355	378	476
of cases	≥ 75	65	67	64	120	113	141	280	285	362
	Total	147	150	174	292	278	329	718	741	914
Crude rate[a]		6.8	6.6	7.2	6.7	6.2	7.0	6.1	6.1	7.2
World stand. rate		**3.9**	**3.7**	**3.5**	**3.6**	**3.1**	**2.9**	**3.6**	**3.3**	**3.1**

Females		DENMARK			FINLAND			ICELAND		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	14	14	16	13	13	11	1	1	2
Number	55-74	61	70	87	69	68	83	3	4	6
of cases	≥ 75	58	60	67	60	77	85	2	3	4
	Total	133	144	170	141	158	180	6	8	11
Crude rate[a]		5.0	5.3	5.9	5.4	5.9	6.6	4.6	5.4	6.9
World stand. rate		**2.4**	**2.5**	**2.5**	**2.5**	**2.4**	**2.2**	**3.3**	**3.4**	**3.6**
		NORWAY			SWEDEN			TOTAL		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	8	10	11	21	19	19	58	58	58
Number	55-74	49	45	54	112	102	114	294	290	345
of cases	≥ 75	69	64	53	118	118	123	307	322	333
	Total	126	120	119	252	239	256	659	669	736
Crude rate[a]		5.7	5.2	4.8	5.7	5.3	5.4	5.5	5.4	5.7
World stand. rate		**2.5**	**2.3**	**2.0**	**2.4**	**2.1**	**2.0**	**2.5**	**2.3**	**2.2**

[a]Crude rate should not be used to compare the risk of cancer in different countries, or the change of risk over time, since it is not adjusted for differences in age distribution. It can, however, be used to compare the relative cancer burden between countries.

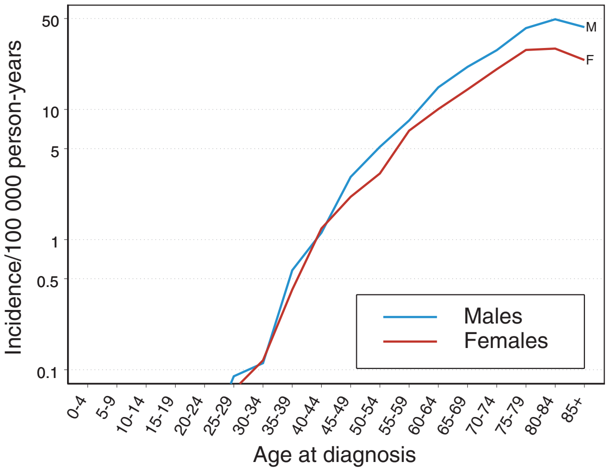


Figure 59. Age-specific incidence rates of multiple myeloma in the Nordic countries, 1993–1997.

Rates of multiple myeloma are predicted to increase for Danish males and, more marginally, for Danish and Icelandic females. For both sexes, rates in the other countries will decline, and for all the Nordic countries combined, rates will decrease by 14% (males) and 12% (females) from 1993–1997 to 2018–2022. The annual number of male cases will increase by around 200 to about 900 per year, and the number of female cases by around 80 to more than 700 per year (Table 25).

Comments

Rates for females in Denmark, Finland, Norway and Sweden are predicted to decline or stabilize, in contrast to the increasing rates in Iceland. Because the predictions in Iceland deviate from those for the other countries, the drift component for Icelandic women has been halved.

The cause of multiple myeloma is unknown. Autoimmune disorders, chronic immune stimulation, exposure to ionizing radiation, hair dyes, occupation, tobacco and alcohol have been implicated, without finding a clear candidate (Herrington *et al.*, 1996). Considering the differences seen in incidence and survival in the Nordic countries (Engeland *et al.*, 1993 and 1995) the possibility of differences in recording of multiple myeloma is currently under study. A candidate is monoclonal gammopathy of unknown significance (MGUS), a precursor of multiple myeloma being recorded as multiple myeloma in Sweden and Norway and not in the other countries. It has also been suggested that increasing trends worldwide may simply be due to better case ascertainment (Cuzick, 1994).

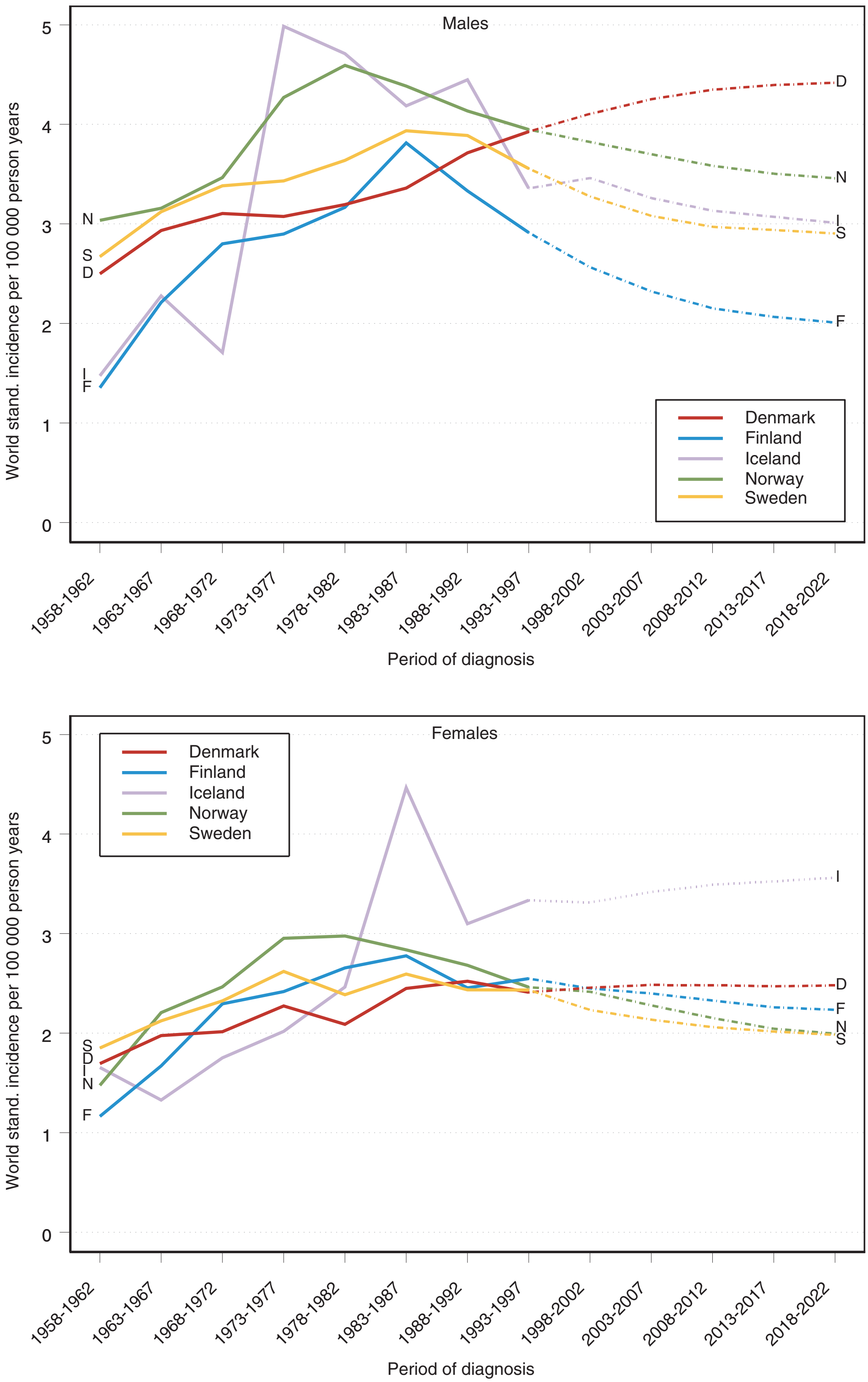


Figure 60. Observed and predicted age-adjusted incidence rates in the five Nordic countries: multiple myeloma.

Acute leukaemia

The average annual numbers of new cases of acute leukaemia in 1993–1997 in the Nordic countries were 565 in males and 533 in females, comprising 1.1% and 1.0% of all male and female cancer cases, respectively (Table 26).

The median ages of patients in the last observation period were 62 years for men and 65 years for women. From a level of 7–8 per 100 000 person-years in the youngest age group, the age-specific rate declined to around 1 at the age of 30 years (Figure 61). Above that age, the rates increased to 25 per 100 000 in males and 16 in females. The rates were similar in males and females up to the age of 64 years, but in the oldest age groups, the rates in males were about 1.6 times those in females.

For both males and females, the rates of acute leukaemia in all the Nordic countries increased up to around 1983–1987 (Figure 62). The rates seem to have levelled off in Iceland and Finland, and are declining in Denmark, Norway and Finland. If these trends continue, the rates for both sexes in Denmark, Norway and Sweden will decline up to 2020, whereas in Finland and Iceland the rates will stabilize. For all the Nordic countries combined, the rates will decrease by 24% (males) and 6% (females) from 1993–1997 to 2018–2022, while the annual number of cases will change only marginally (Table 26).

Table 26. Observed and predicted average annual numbers of new cases by age, and crude and world-standardized rates in the five Nordic countries; acute leukaemia.

Males		DENMARK			FINLAND			ICELAND		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	56	50	45	55	52	49	2	4	4
Number	55-74	47	55	62	30	34	43	3	2	3
of cases	≥ 75	38	42	50	24	25	28	1	2	2
	Total	140	147	157	109	111	120	6	8	10
Crude rate[a]		5.5	5.5	5.6	4.4	4.3	4.6	4.6	5.2	5.9
World stand. rate		**4.5**	**4.3**	**3.9**	**4.1**	**4.0**	**3.9**	**4.1**	**4.6**	**4.6**

Males		NORWAY			SWEDEN			TOTAL		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	41	31	27	85	56	48	239	193	173
Number	55-74	35	30	35	66	55	52	181	176	195
of cases	≥ 75	24	29	28	58	51	58	145	149	167
	Total	100	89	90	209	163	158	565	518	535
Crude rate[a]		4.6	3.9	3.7	4.8	3.7	3.4	4.8	4.3	4.2
World stand. rate		**3.9**	**3.1**	**2.7**	**3.9**	**2.9**	**2.4**	**4.1**	**3.5**	**3.1**

Females		DENMARK			FINLAND			ICELAND		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	46	41	38	50	48	48	3	3	3
Number	55-74	42	44	49	32	33	38	1	2	3
of cases	≥ 75	36	34	39	26	29	31	2	2	2
	Total	123	119	127	108	110	116	6	7	8
Crude rate[a]		4.7	4.4	4.4	4.1	4.1	4.3	4.3	4.5	4.7
World stand. rate		**3.6**	**3.3**	**3.1**	**3.6**	**3.7**	**3.8**	**3.5**	**3.7**	**3.6**

Females		NORWAY			SWEDEN			TOTAL		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	37	38	38	73	67	70	208	198	197
Number	55-74	26	25	31	68	61	60	169	165	180
of cases	≥ 75	29	30	27	63	67	70	156	161	169
	Total	92	93	96	204	195	200	533	524	546
Crude rate[a]		4.2	4.0	3.9	4.6	4.3	4.2	4.4	4.2	4.2
World stand. rate		**3.3**	**3.2**	**3.2**	**3.5**	**3.3**	**3.1**	**3.5**	**3.4**	**3.3**

[a]Crude rate should not be used to compare the risk of cancer in different countries, or the change of risk over time, since it is not adjusted for differences in age distribution. It can, however, be used to compare the relative cancer burden between countries.

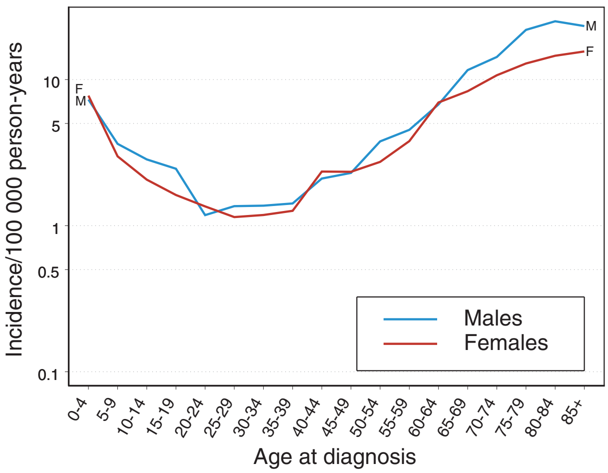
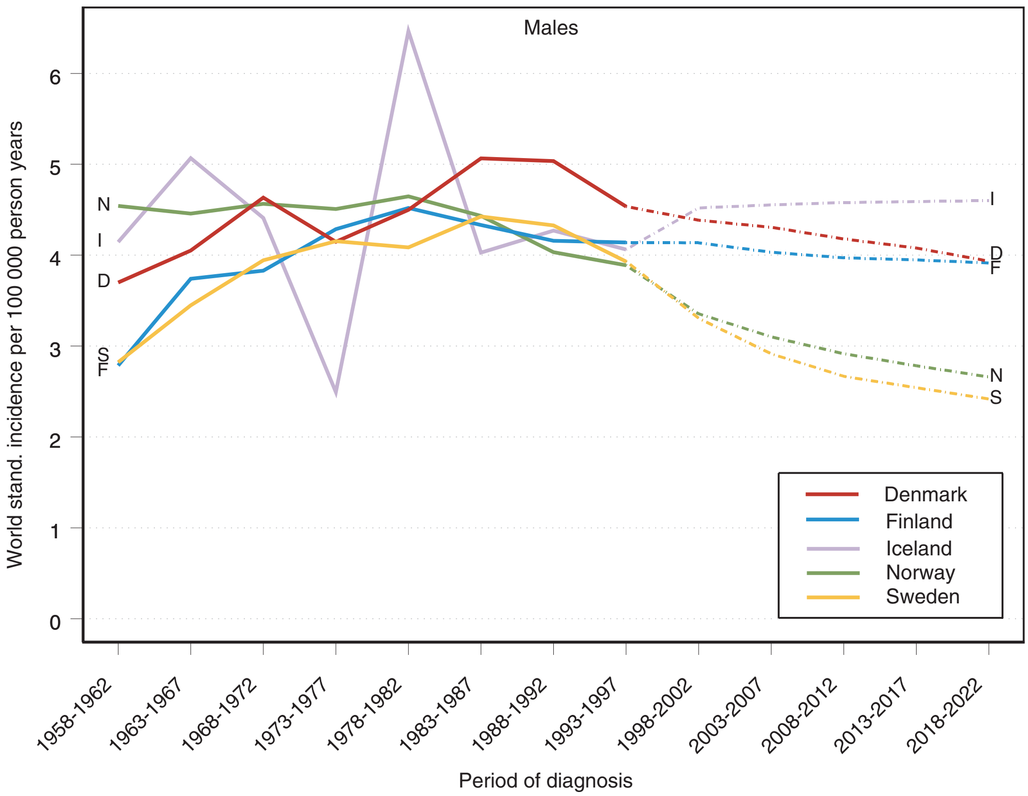


Figure 61. Age-specific incidence rates of acute leukaemia in the Nordic countries, 1993–1997.

Comments

Distinguishing leukaemias from lymphomas may be difficult if not arbitrary even for some acute types since lymphoblastic lymphoma and acute lymphoblastic leukaemia are considered the same disease. The observed trends may thus be influenced by changes in classification; the decline in incidence of acute leukaemias may not be due to a change in risk factors. Among the few established risk factors for acute leukaemia, ionizing radiation is the best known. It has been estimated that in the Nordic countries 190 cases, equal to 14% of all acute cases, could be avoided if radiation from all natural sources (excluding radon, for which evidence of a leukaemogenic effect is lacking) were eliminated (Olsen *et al*., 1997). Occupational exposures were estimated to account for only 1% of cases. Exposures to medical ionizing irradiation, cytotoxic drugs (in particular alkylating agents) and benzene and its derivatives (Souhami and Tobias, 1986) can explain only a limited fraction of the cases.



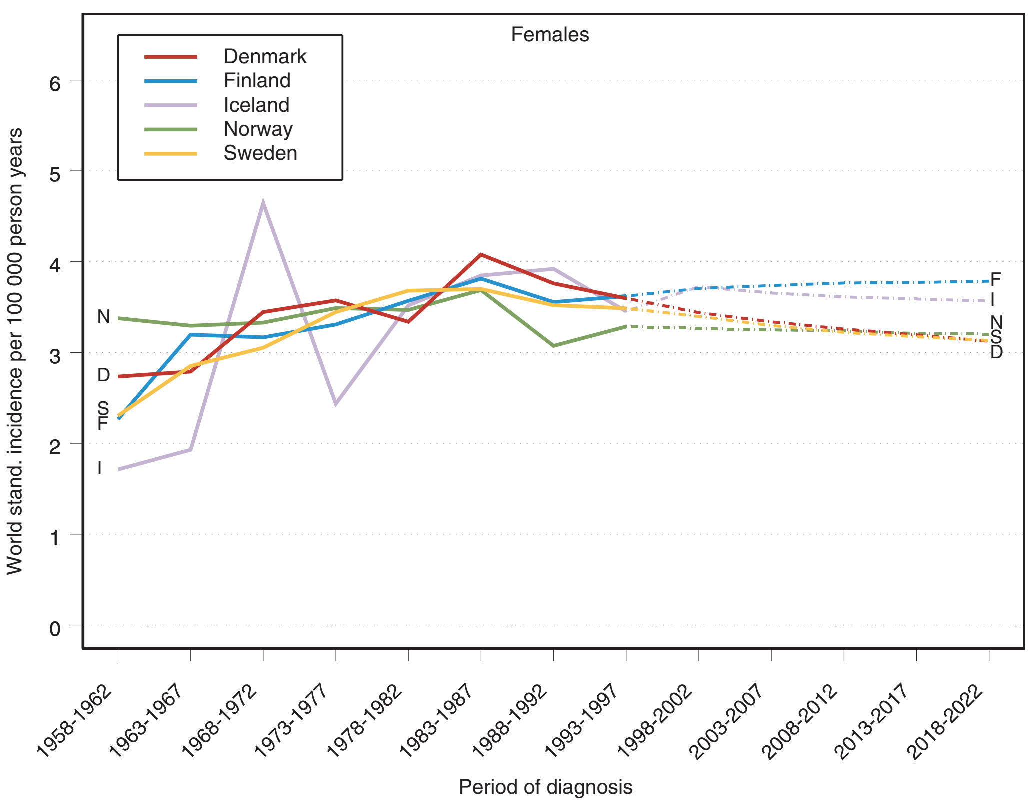


Figure 62. Observed and predicted age-adjusted incidence rates in the five Nordic countries: acute leukaemia.

Cancers at other sites

Cancer types that are not described separately (excluding skin cancers other than melanomas) include:

ICD-7	Site
140	Lip (females)
142	Salivary glands
146	Nasopharynx
152	Small intestine
155.0	Liver
155.1	Gallbladder and extrahepatic bile ducts
158	Peritoneum
159	Unspecified digestive organs
160	Nose, nasal cavities, middle ear and accessory sinuses,
161	Larynx (females)
162.2	Pleura
164	Mediastinum
170	Breast (male)
173	Other parts of uterus
174	Uterus (unspecified)
176	Other, unspecified female genital organs
179	Other, unspecified male genital organs
192	Eye
193	Brain and other parts of nervous system
195	Other endocrine glands

Table 27. Observed and predicted average annual numbers of new cases by age, and crude and world-standardized rates in the five Nordic countries; other sites.

Males		DENMARK			FINLAND			ICELAND		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	450	484	513	342	353	328	16	18	19
Number	55-74	849	1069	1333	536	656	940	24	28	38
of cases	≥ 75	519	620	877	307	412	622	15	21	31
	Total	1817	2174	2723	1184	1421	1889	55	67	87
Crude rate[a]		70.7	81.0	96.5	47.5	55.5	72.3	41.0	45.7	53.1
World stand. rate		**47.3**	**51.4**	**52.0**	**35.1**	**35.4**	**36.5**	**33.9**	**33.9**	**31.8**

		NORWAY			SWEDEN			TOTAL		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	290	325	326	701	707	778	1799	1888	1964
Number	55-74	550	589	849	1283	1491	1873	3241	3833	5033
of cases	≥ 75	411	497	544	856	1006	1393	2107	2557	3467
	Total	1251	1412	1720	2840	3205	4044	7147	8278	10464
Crude rate[a]		57.9	62.0	70.8	65.4	71.9	86.5	61.1	68.3	82.4
World stand. rate		**38.5**	**40.1**	**39.7**	**41.0**	**42.2**	**44.5**	**40.5**	**42.2**	**43.2**

Females		DENMARK			FINLAND			ICELAND		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	409	458	521	348	328	311	21	18	19
Number	55-74	793	948	1242	604	641	859	24	32	44
of cases	≥ 75	710	869	1099	620	743	931	19	23	37
	Total	1912	2275	2862	1572	1712	2101	64	74	101
Crude rate[a]		72.4	83.1	99.6	59.9	64.1	77.7	48.1	50.3	61.4
World stand. rate		**40.1**	**44.5**	**48.2**	**32.7**	**31.5**	**32.8**	**36.7**	**35.1**	**34.3**

		NORWAY			SWEDEN			TOTAL		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	287	311	319	751	745	809	1815	1861	1978
Number	55-74	489	523	677	1466	1596	1979	3377	3741	4801
of cases	≥ 75	551	627	663	1247	1439	1731	3147	3701	4462
	Total	1327	1461	1658	3464	3781	4519	8339	9303	11242
Crude rate[a]		60.1	63.1	67.3	77.9	83.3	95.5	69.2	75.0	86.9
World stand. rate		**33.3**	**34.7**	**34.1**	**42.2**	**42.9**	**45.2**	**38.0**	**39.1**	**40.9**

[a]Crude rate should not be used to compare the risk of cancer in different countries, or the change of risk over time, since it is not adjusted for differences in age distribution. It can, however, be used to compare the relative cancer burden between countries.

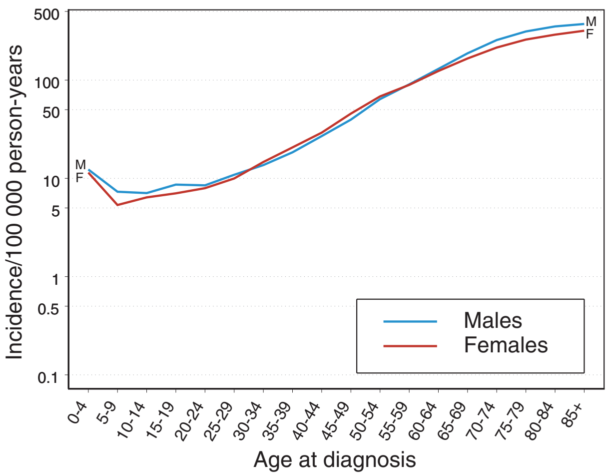


Figure 63. Age-specific incidence rates of other sites in the Nordic countries, 1993–1997.

196 Bone
197 Connective tissue
199 Other and unspecified sites
204 (–204.3) Leukaemias other than acute

The average annual numbers of new cases in this group in 1993–1997 in the Nordic countries were 7147 in males and 8339 in females, comprising 14.0% and 16.1% of all male and female cancer cases, respectively (Table 27).

The median ages of patients in the last observation period were 68 years for men and 71 years for women. The incidence rates increased with age at diagnosis to 373 per 100 000 person-years in males and 317 in females (Figure 63), with small differences in age-specific rates between the sexes.

The rates increased in all the Nordic countries in the period 1958–1997 (Figure 64). In Finland, Norway, and Iceland, the rates are predicted to stabilize for both sexes, whereas a slight increase is expected in Denmark and Sweden, if current trends in this heterogeneous group of cancers continue in the future. For all the Nordic countries combined, the rates will increase by around 7% for both sexes from 1993–1997 to 2018–2022. The annual number of cases will increase by more than 3300 for men and 2900 for women, to almost 10 500 male cases, and more than 11 200 female cases per year (Table 27).

Comments

The group 'cancers at other sites' is, of course, very heterogeneous. It was included in order to allow construction of predictions for all sites combined, by adding predictions from each individual cancer site.

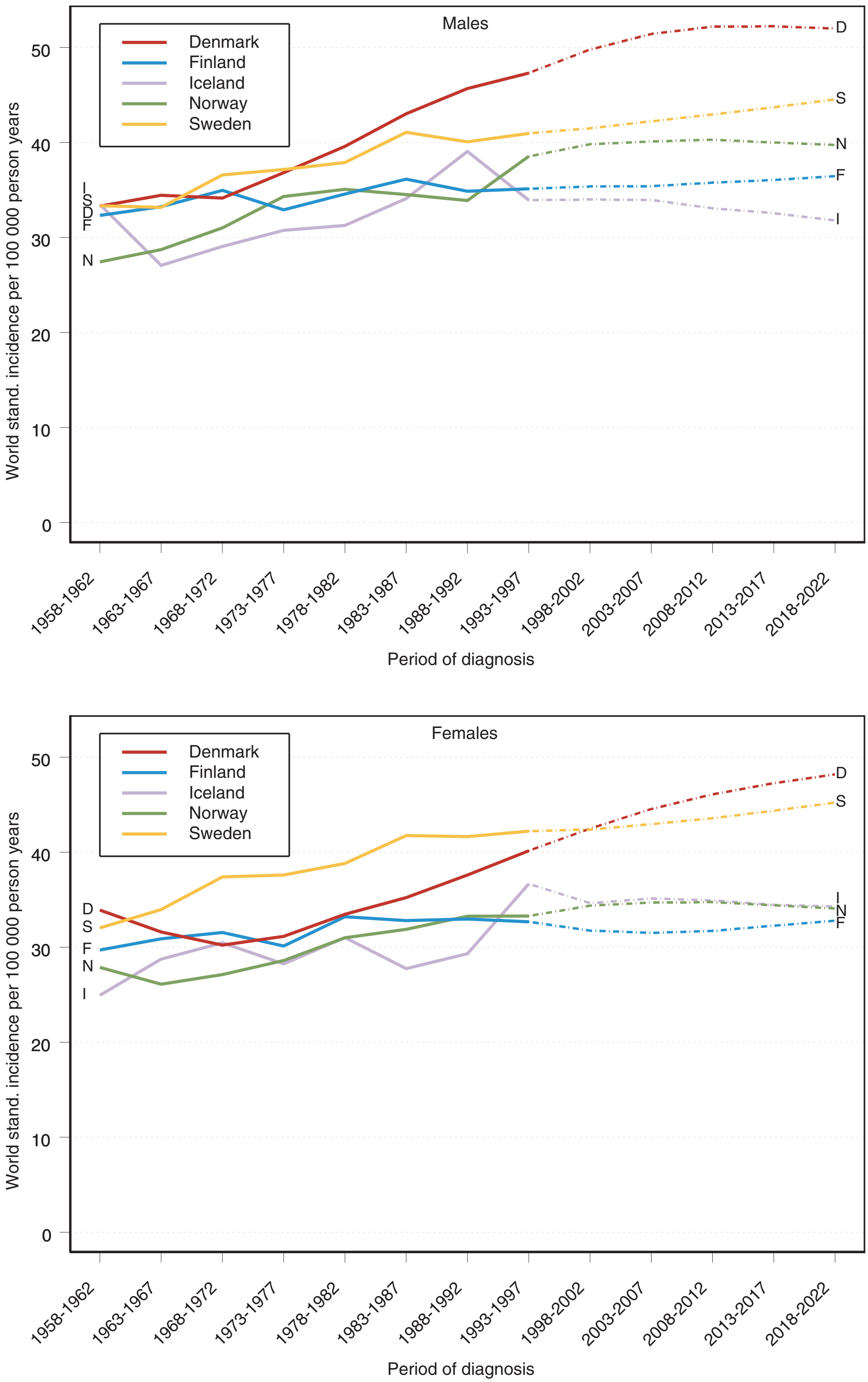


Figure 64. Observed and predicted age-adjusted incidence rates in the five Nordic countries: other sites.

Cancers at all sites

Skin cancers other than melanomas (ICD-7: 191) are not included in 'all sites'. In the Nordic countries, disregarding basal-cell carcinomas, about 3% (males) and 2% (females) of the total number of cancer cases are skin cancers other than melanomas. The average annual numbers of new cases of cancer in 1993–1997 in the Nordic countries were 50 915 in males and 51 880 in females (Table 28).

The median ages of patients in the last observation period were 71 years for men and 68 years for women. The incidence rates increased with age at diagnosis to about 3000 per 100 000 person-years in males and about 1550 in females (Figure 65). The rates were higher in the youngest age group (0–4 years) than in the age group 5–14 years. Among people aged 30–54 years, the rates in females were up to double those in males. In the older age groups, the rates were higher in males than females.

Incidence rates in Danish and Swedish males increased steadily up to around 1983–1987, after which they stabilized (Figure 66 top). The Norwegian and Icelandic rates increased throughout the whole period, whereas the Finnish rates have been stable since around 1968–1972. For females, rates have increased steadily in all five countries from 1958–1962 to 1993–1997 (Figure 66 bottom).

Table 28. Observed and predicted average annual numbers of new cases by age, and crude and world-standardized rates in the five Nordic countries; all types of cancer.

Males		DENMARK			FINLAND			ICELAND		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	2057	2097	2144	1487	1531	1398	75	97	107
Number	55-74	5813	6751	8763	5117	6063	8426	245	281	450
of cases	≥ 75	3591	3986	5550	2909	4195	6529	167	243	331
	Total	11461	12835	16457	9513	11789	16353	488	622	888
Crude rate[a]		445.8	478.3	582.9	381.9	460.8	626.1	363.9	423.8	540.6
World stand. rate		**282.3**	**285.7**	**288.4**	**264.8**	**262.7**	**262.0**	**282.2**	**294.4**	**295.8**
		NORWAY			SWEDEN			TOTAL		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	1471	1519	1546	2536	2302	2325	7625	7547	7520
Number	55-74	4898	5400	7323	9440	10505	12998	25513	29001	37960
of cases	≥ 75	3635	4438	5306	7474	8935	12662	17777	21798	30378
	Total	10004	11357	14175	19449	21743	27985	50915	58346	75858
Crude rate[a]		462.9	499.2	583.3	448.0	488.0	598.8	435.2	481.4	597.2
World stand. rate		**286.7**	**299.1**	**287.0**	**246.4**	**246.6**	**246.7**	**264.9**	**267.9**	**267.0**

Females		DENMARK			FINLAND			ICELAND		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	3093	3158	3338	2742	2953	2595	140	162	178
Number	55-74	5828	6674	7913	4375	5510	7424	192	235	348
of cases	≥ 75	3763	4315	5568	3140	4085	5538	131	165	222
	Total	12683	14146	16819	10257	12548	15556	462	561	748
Crude rate[a]		480.4	516.8	585.2	390.9	469.9	575.1	346.8	383.2	454.3
World stand. rate		**279.1**	**286.3**	**288.9**	**224.0**	**244.0**	**254.4**	**261.3**	**264.9**	**263.8**
		NORWAY			SWEDEN			TOTAL		
	Age	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022	1993 -1997	2003 -2007	2018 -2022
Annual	0-54	2308	2669	2881	4416	4241	4340	12698	13182	13332
Number	55-74	3855	4285	5749	8374	9218	10497	22624	25921	31931
of cases	≥ 75	3203	3842	4078	6322	7139	8631	16558	19547	24036
	Total	9365	10796	12708	19112	20598	23468	51880	58650	69299
Crude rate[a]		423.9	466.1	515.9	429.9	453.8	495.9	430.5	472.6	535.6
World stand. rate		**247.9**	**264.8**	**267.5**	**236.0**	**235.1**	**233.8**	**245.0**	**253.8**	**256.9**

[a]Crude rate should not be used to compare the risk of cancer in different countries, or the change of risk over time, since it is not adjusted for differences in age distribution. It can, however, be used to compare the relative cancer burden between countries.

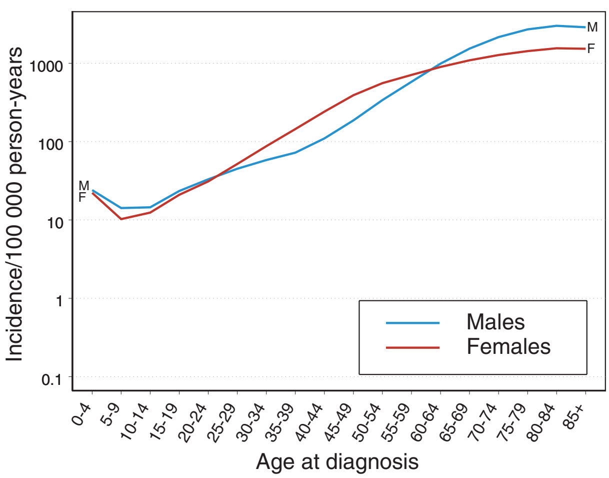
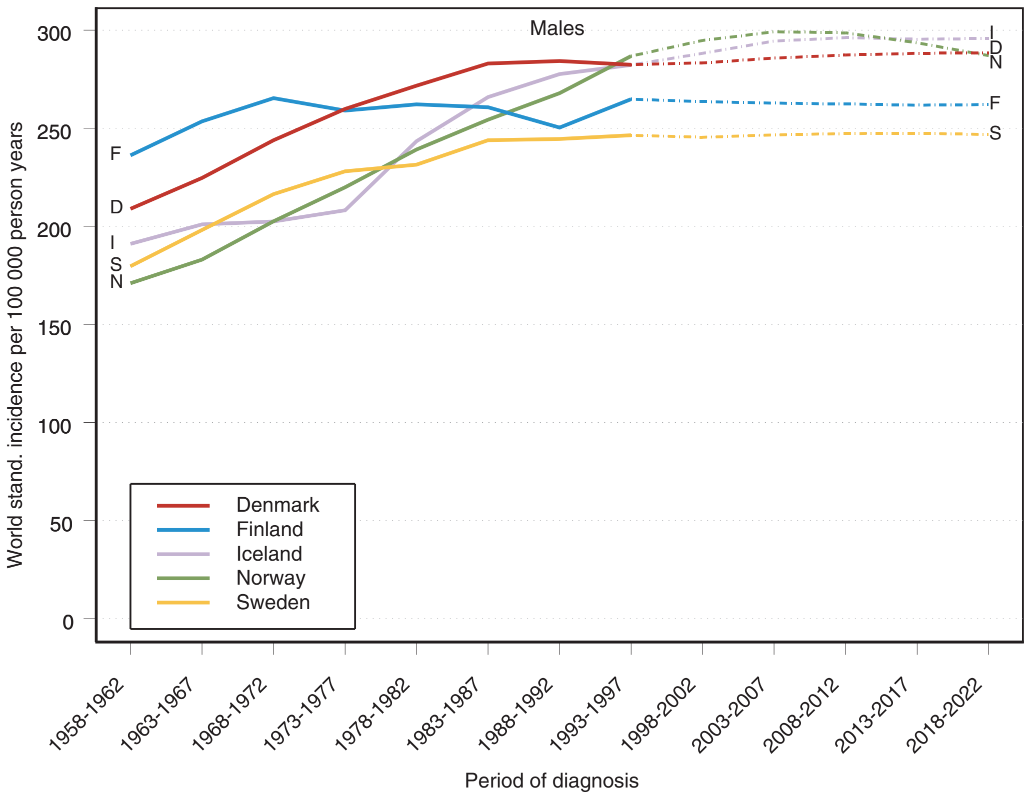


Figure 65. Age-specific incidence rates of all types of cancer in the Nordic countries, 1993–1997.

The predicted rates were calculated by summing the predicted rates from all the individual cancer sites. For males, rates in Denmark and Iceland will increase slightly, and the rates in Finland and Sweden are predicted to remain at a stable level over the next 25 years. In Norwegian males, the rates will increase until around 2003–2007, and then decrease up to 2018–2022. For females, rates are predicted to increase in Denmark, Finland, Iceland and Norway, with the most marked increase in Finland. The rates in Sweden, on the other hand, are predicted to slightly decrease. For all the Nordic countries combined, the standardized rates will increase by 1% in males and 5% in females from 1993–1997 to 2018–2022. Due to the large changes in the size and age structure of the population, the annual number of cases will increase by 49% in males to almost 76 000 cases, and by 34% in females to over 69 000 new cases per year (Table 28).

Comment

Cancer of the prostate constitutes about 24% of the male cases. Due to the introduction of PSA testing, it is very difficult to predict the future incidence of this type of cancer. The uncertainty associated with the prostate cancer predictions is then reflected in the predicted number of cases of all cancers.



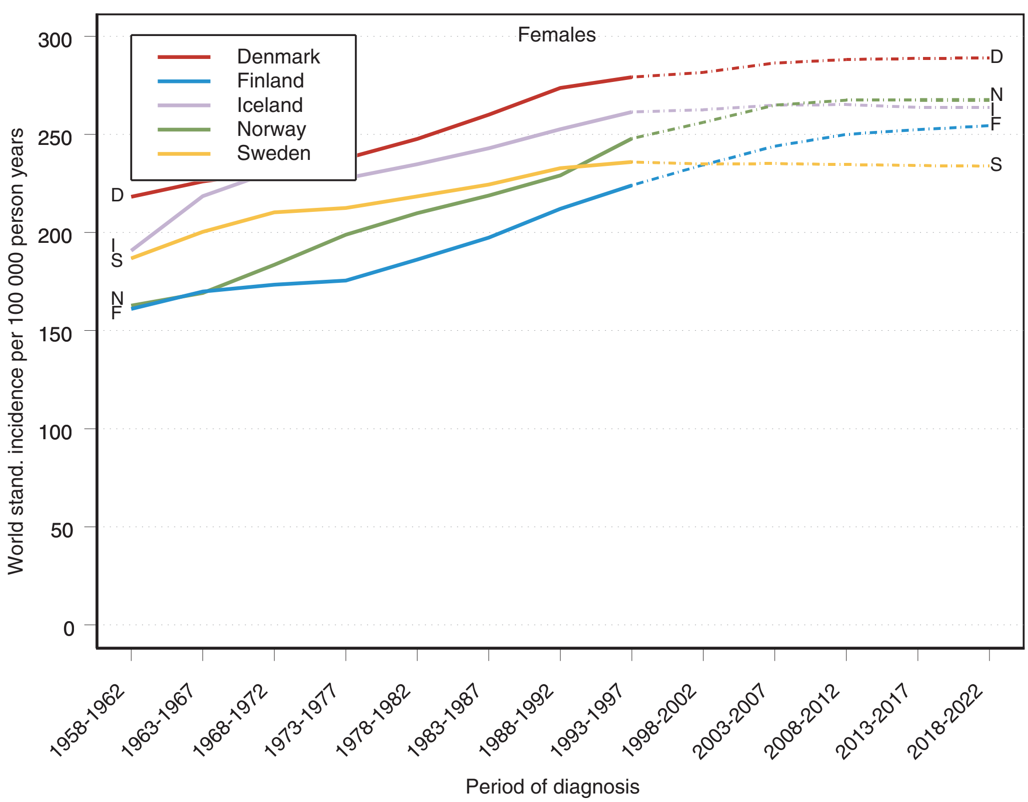


Figure 66. Observed and predicted age-adjusted incidence rates in the five Nordic countries: all types of cancer.

Changes due to risk and population

The numbers of new cases were predicted by multiplying the projected incidence rates by the population forecasts made by the central statistical offices in the Nordic countries. The changes in the annual numbers of cases are influenced both by changes in the risk for cancer and by changes in the size and age structure of the population. Let N_{ras} be the number of cases given a cancer risk r, an age structure a and a population size s, where r, a and s are levels for the observed period 1993–1997 (o) or the future period 2018–2022 (f). N_{ooo} is then the expected number of cases applying the rates, age structure and population size of 1993–1997, which is the observed number of cases in 1993–1997. Similarly, N_{fff} is the predicted number of cases in 2018–2022. $N_{fff} - N_{ooo}$ is the change in the annual number of cases, and following Engeland *et al*. (1993), this increase (or decrease) can be decomposed into two components:

$$\begin{aligned}\Delta_{tot} &= N_{fff} - N_{ooo} = \\ &= (N_{fff} - N_{off}) + (N_{off} - N_{ooo}) \\ &= \Delta_{risk} + \Delta_{pop},\end{aligned}$$

where N_{off} is the expected number of cases in 2018–2022 when the rates in 1993–1997 are applied. The component Δ_{risk} is thus the difference between the numbers of cases in the future calculated using the predicted or observed rates, while Δ_{pop} is the difference between the number of cases found when present rates are applied to present or the future age distribution and population size. The two components can differ from zero in either a positive or a negative direction.

Tables 29 and 30 show the predicted total change in the number of new cases, Δ_{tot}, the relative difference as a percentage, Δ_{tot}/N_{ooo}, the difference due to change of risk, Δ_{risk}/N_{ooo} and the difference due to change of age distribution and population size, Δ_{pop}/N_{ooo}. Comments on the results for each country are presented below.

The change due to age structure and population size, Δ_{pop}, can naturally be divided into two sub-components, the first due to the change in age distribution, the second due to changes in population size:

$$\begin{aligned}\Delta_{pop} &= N_{off} - N_{ooo} = \\ &= (N_{off} - N_{oof}) + (N_{oof} - N_{ooo}) \\ &= \Delta_{age} + \Delta_{size},\end{aligned}$$

where N_{oof} is the expected future number of cases if the present rates and age structure are applied. Table 31 gives the relative increase in the population size, which is equal to the relative change in the number of new cases due to population size, Δ_{size}/N_{ooo}. For each site, the relative change due to age structure can, if desired, be calculated using the formula $\Delta_{age}/N_{ooo} = \Delta_{pop}/N_{ooo} - \Delta_{size}/N_{ooo}$.

The splitting of the change in the number of cases due to risk, age distribution and population size is not unambiguous, because the three components mutually affect each other. For example, if the population size increases, Δ_{risk} will be larger than if the population size does not change. This is because the number of cases attributed to cancer risk is calculated based on the future population size. If it had been calculated based on the present population size (i.e., $N_{ffo} - N_{ofo}$), a smaller number would be attributed to cancer risk, and the difference is due to the fact that the increased cancer risk is applied to the increase in the population size.

Bashir and Estève (2000) have made a similar partition of the change in the number of cases between two time periods, but instead of starting with the risk component, they started by adjusting for population size, $\Delta_{tot} = (N_{fff} - N_{ffo}) + (N_{ffo} - N_{ofo}) + (N_{ofo} - N_{ooo})$. The consequence of starting by adjusting for the population size is that the mutual effects from applying the increased cancer risk to the increasing population size are attributed to changes in population size instead of to changes in risk.

We chose to start with the difference due to change of risk when splitting the total change in the number of cases (Δ_{tot}). From a preventive perspective, it is natural to focus on the risk component; if a future increase can be prevented, so that risk remains at the present level, Δ_{risk} cases can potentially be avoided. By choosing population size (as opposed to age distribution) as the last of the three components, $\Delta_{size}/\Delta_{tot}$ is equal to the relative increase in population size. For simplicity, the changes due to age distribution (Δ_{age}) and to population size (Δ_{size}) have been combined as Δ_{pop} in the presentation of the results.

Denmark

Males

The male population will increase by about 10% (Table 31) up to 2018–2022, and the predicted annual number of cases will increase by around 5100, which is 44% higher than the number in 1993–1997 (Table 29). Changes in risk will increase the number of cases by 4%, while changes in population age structure and size will increase the number by a further 40%. The numbers of cases of the two most common types of cancer, lung and prostate cancer, will increase by 23% and 70%, respectively. For lung cancer, the risk will

Table 29. Changes in annual numbers of cases between 1993–1997 and 2018–2022 and relative changes due to changed risk and to changed population size and age structure, by country and site, males.

	DENMARK				FINLAND				ICELAND			
	Change in annual number		Change (%) due to		Change in annual number		Change (%) due to		Change in annual number		Change (%) due to	
Site	No.	%	risk	pop	No.	%	risk	pop	No.	%	risk	pop
Lip	-31	-37	-80	43	-25	-25	-107	82	0	13	-72	85
Tongue, etc.	409	141	107	34	145	119	75	45	5	103	31	72
Oesophagus	278	119	77	42	88	77	6	71	11	105	28	78
Stomach	139	39	-2	42	67	14	-64	78	11	41	-38	79
Colon	458	46	2	43	591	101	26	75	33	85	11	74
Rectum	283	44	0	44	253	73	-3	76	8	67	-9	76
Pancreas	110	36	-6	42	167	52	-22	74	7	61	-10	71
Larynx	89	41	2	40	32	29	-34	62	2	53	-19	73
Lung	461	23	-22	44	33	2	-77	79	23	39	-35	74
Prostate	1007	70	22	47	3303	137	43	95	180	130	51	79
Testis	49	16	20	-4	38	53	55	-3	6	67	52	16
Kidney	110	28	-11	39	250	62	3	59	22	79	5	74
Bladder	177	15	-29	44	526	85	2	83	22	60	-12	73
Melanoma	218	58	30	28	111	41	-3	43	9	88	32	55
Thyroid	26	76	53	23	76	101	72	28	5	70	-2	72
Non-Hodgkin	185	49	17	32	451	115	62	53	18	99	40	59
Hodgkin	-5	-6	-17	11	-3	-4	-17	13	-1	-14	-26	12
Myeloma	110	66	22	44	20	19	-57	75	3	47	-25	72
Acute leukaemia	17	12	-18	30	11	10	-30	40	3	55	-2	58
Other sites	906	50	13	37	705	60	0	60	32	59	-3	61
All sites	**4996**	**44**	**4**	**40**	**6840**	**72**	**-3**	**75**	**400**	**82**	**10**	**72**

	NORWAY				SWEDEN				TOTAL			
	Change in annual number		Change (%) due to		Change in annual number		Change (%) due to		Change in annual number		Change (%) due to	
Site	No.	%	risk	pop	No.	%	risk	pop	No.	%	risk	pop
Lip	-27	-43	-84	41	-9	-8	-49	41	-92	-25	-78	53
Tongue, etc.	203	119	78	41	183	60	28	32	945	106	70	36
Oesophagus	88	80	37	43	140	59	21	39	605	86	40	46
Stomach	-18	-4	-41	37	-67	-9	-49	40	133	7	-43	49
Colon	346	38	-1	39	434	29	-11	40	1863	46	0	46
Rectum	208	40	-1	41	454	46	6	40	1206	48	2	46
Pancreas	14	5	-33	38	86	17	-22	39	384	27	-21	48
Larynx	39	36	-8	45	-22	-14	-50	37	140	23	-21	44
Lung	215	17	-25	43	35	2	-37	39	767	11	-40	51
Prostate	2031	84	45	39	5269	91	48	43	11790	97	43	54
Testis	87	41	39	2	31	14	13	1	210	26	27	-1
Kidney	51	15	-24	39	-84	-13	-49	36	348	19	-24	43
Bladder	146	18	-21	39	392	26	-13	40	1264	31	-17	48
Melanoma	141	32	-1	32	295	40	12	28	773	42	10	31
Thyroid	17	38	9	29	5	6	-19	25	129	52	24	28
Non-Hodgkin	143	43	10	33	215	28	-5	33	1013	53	16	37
Hodgkin	2	4	-8	12	-12	-12	-25	13	-18	-6	-18	12
Myeloma	27	19	-19	38	36	12	-26	38	196	27	-18	45
Acute leukaemia	-10	-10	-37	27	-51	-24	-49	24	-30	-5	-35	29
Other sites	469	37	3	34	1204	42	10	32	3317	46	8	39
All sites	**4171**	**42**	**4**	**37**	**8536**	**44**	**6**	**38**	**24943**	**49**	**4**	**45**

decrease, but the ageing of the population will more than compensate for this. For prostate cancer, the increase is caused by both increasing risk and population changes. The risks for eight of the 20 sites are predicted to decline, with cancer of the lip having the largest relative reduction in number of cases due to risk. The largest relative increases in numbers of cases due to risk are predicted for cancers of the tongue, oral cavity and pharynx, the oesophagus and the thyroid, all by more than 50%.

Table 30. Changes in annual numbers of cases between 1993-1997 and 2018-2022 and relative changes due to changed risk and to changed population size and age structure, by country and site, females.

	DENMARK				FINLAND				ICELAND			
	Change in annual number		Change (%) due to		Change in annual number		Change (%) due to		Change in annual number		Change (%) due to	
Site	No.	%	risk	pop	No.	%	risk	pop	No.	%	risk	pop
Tongue, etc.	114	84	58	26	53	55	23	32	8	127	63	64
Oesophagus	57	60	33	26	-7	-8	-54	46	2	47	-17	64
Stomach	-15	-7	-32	25	-28	-7	-48	41	2	11	-54	64
Colon	196	16	-9	26	443	61	21	40	24	70	12	58
Rectum	84	18	-9	26	193	57	17	39	6	58	-1	59
Pancreas	6	2	-24	26	60	16	-28	44	5	49	-13	62
Lung	939	70	41	29	270	61	21	39	50	100	37	63
Breast	1378	40	18	23	2317	74	53	21	63	53	-6	59
Cervix uteri	-62	-13	-24	11	142	84	67	17	-3	-19	-50	30
Corpus uteri	-106	-17	-46	29	314	50	14	36	17	78	12	66
Ovary	122	21	-3	24	95	20	-8	28	10	51	-8	59
Kidney	-68	-26	-52	27	90	28	-9	37	13	77	13	64
Bladder	21	5	-22	27	105	52	8	43	7	63	2	61
Melanoma	274	54	40	14	88	32	10	22	18	105	72	33
Thyroid	54	64	52	12	264	97	88	9	4	19	-26	45
Non-Hodgkin	152	45	23	23	330	81	48	33	16	122	64	58
Hodgkin	-3	-6	-13	7	-5	-9	-15	6	0	6	-17	23
Myeloma	38	28	3	25	39	27	-14	41	5	84	17	67
Acute leukaemia	3	3	-16	19	8	8	-11	19	2	34	-7	41
Other sites	950	50	27	23	529	34	-1	34	37	57	4	54
All sites	**4135**	**33**	**9**	**24**	**5300**	**52**	**21**	**30**	**286**	**62**	**5**	**57**

	NORWAY				SWEDEN				TOTAL			
	Change in annual number		Change (%) due to		Change in annual number		Change (%) due to		Change in annual number		Change (%) due to	
Site	No.	%	risk	pop	No.	%	risk	pop	No.	%	risk	pop
Tongue, etc.	39	45	21	25	120	68	46	22	334	67	41	26
Oesophagus	17	40	17	24	27	26	1	25	96	29	-3	31
Stomach	-40	-14	-34	21	-93	-19	-42	22	-174	-12	-41	28
Colon	352	32	9	23	210	13	-10	23	1226	26	0	27
Rectum	141	33	8	25	160	21	-2	23	584	29	2	27
Pancreas	68	22	0	22	-13	-2	-26	24	126	8	-21	29
Lung	606	101	71	31	788	74	52	22	2653	76	47	29
Breast	1248	56	30	26	1491	28	10	19	6497	46	24	22
Cervix uteri	1	0	-17	17	-30	-6	-18	11	48	3	-10	14
Corpus uteri	132	28	-3	31	153	13	-11	24	510	18	-11	29
Ovary	69	15	-12	27	-82	-9	-29	19	214	9	-15	24
Kidney	30	13	-11	24	-52	-11	-33	23	13	1	-27	28
Bladder	93	34	11	23	178	35	11	23	404	29	1	28
Melanoma	190	37	15	22	285	37	22	15	854	41	24	18
Thyroid	9	7	-10	17	-4	-2	-15	13	327	45	32	13
Non-Hodgkin	65	23	-1	24	169	26	5	22	732	43	18	25
Hodgkin	-3	-11	-19	8	-7	-8	-15	7	-18	-8	-15	7
Myeloma	-8	-6	-28	22	4	2	-21	23	77	12	-16	27
Acute leukaemia	3	4	-13	16	-4	-2	-17	15	13	2	-15	17
Other sites	331	25	3	22	1055	30	10	20	2903	35	11	24
All sites	**3343**	**36**	**11**	**24**	**4356**	**23**	**3**	**20**	**17419**	**34**	**9**	**24**

Females

The female population will increase by about 9% (Table 31) from 1993–1997 to 2018–2022, and the annual number of cancer cases will increase by more than 4100 (33%) (Table 30). The predicted change in risk will increase the number of cases by 9%, and the changes in population age structure and size will increase the number by a further 24%. The number of cases of the most common type of cancer, of the breast, is predicted to increase by 40%, of which over half is attributed to population changes. The largest relative reduction in the number of cases due to risk is predicted for cancers of the kidney, the corpus uteri and the stomach. The largest increase in

Table 31. Population sizes (per cent) for the period 2018–2022 relative to 1993–1997.

	Males	Females
Denmark	109.8	108.9
Finland	104.9	103.1
Iceland	122.5	123.5
Norway	112.4	111.5
Sweden	107.7	106.5
Total	108.6	107.4

risk will occur for cancers of the tongue, oral cavity and pharynx, the thyroid and the lung, all by more than 40%.

Finland

Males

From 1993–1997 to 2018–2022, the number of male inhabitants will increase by about 5% (Table 31), while the annual number of new cancer cases will increase by around 6800 (72%) (Table 29). The rates are predicted to slightly decline, so the large increase in the number of cases is attributable to changes in population size and structure. Since the population size will increase by only 5%, most of the increase is due to the ageing of the population. The numbers of cases of cancer of the lung and prostate will increase by 2% and 137%, respectively. The risk of lung cancer will decrease by 77%, but the ageing of the population will compensate for this. One third of the increase in the number of cases of prostate cancer is due to the predicted risk increase. Up to 1997, the rates for prostate cancer increased dramatically, mostly due to PSA testing. Experience from USA suggests that this increase will be followed by a decline, so that our predictions are probably too high (see the results chapter). The largest relative reduction in the number of cases due to changes in risk are seen for cancers of the lip, the lung and the stomach, all by more than 60%. The largest increases due to risk occur for cancers of the tongue, oral cavity and pharynx and the thyroid, non-Hodgkin lymphoma and testicular cancer.

Females

The female population will increase by only about 3% from 1993–1997 to 2018–2022 (Table 31), but the annual number of cases is predicted to increase by 5300 (52%) (Table 30). Of these, 21% are attributable to changes in risks and 30% to changes in the population size and structure. The number of breast cancer cases is predicted to increase by 74%, with increased risk accounting for 53%. The decrease in the number of cases due to change in risk is most pronounced for cancer of the oesophagus, the stomach and the pancreas. The largest increases due to risk are predicted for cancers of the thyroid, the cervix uteri and the breast, and for non-Hodgkin lymphoma, all by 48% or more.

Iceland

Males

The male population will increase by about 23% from 1993–1997 to 2018–2022 (Table 31) and the annual number of cases is predicted to increase by 400 (82%) (Table 29). An increase of 72% is due to the changes in the population age structure and size, the remaining 10% being attributable to change of risk. The change due to population factors is similar to the corresponding change in Finland, and the change due to risk is the highest predicted among Nordic males. The numbers of cases of cancer of the lung and the prostate will increase by 39% and 130%, respectively. The number of cases of lung cancer will fall by 35% due to decreased risk, but the ageing of the population will more than compensate for this. The large increase in the number of cases of prostate cancer is due to a combination of increased risk and changes in the population.

Females

The female population will increase by about 24% (Table 31) from 1993–1997 to 2018–2022, an even larger increase than for males. The annual number of cancer cases is predicted to increase by almost 300 (62%) in the same period (Table 30). Of this increase, 5% is due to changes in risk and 57% to changes in population size and structure. For breast cancer, although the risk will decrease, the number of cases will increase by 53%, due to changes in the population size and age structure. The only site that is predicted to have a lower number of cases (19%) in 2018–2022 than in 1993–1997 is cervical cancer.

Norway

Males

From 1993–1997 to 2018–2022, the number of male inhabitants will increase by about 12% (Table 31) and the annual number of new cancer cases is predicted to increase by almost 4200 (42%) (Table 29). The predicted change in risk will increase the number of cases by only 4%, while changes in population size and age structure will increase the number by a further 37%. A reduction of 25% in the number of lung cancer cases due to changes in risk is more than compensated by the changes in population, resulting in a total increase of 17% in the number of cases. The number of prostate cancer cases will increase by 84%, about half of which can be attributed to change in risk. The numbers of cancers of the lip and the stomach and of acute leukaemia will decrease because of large reductions in the risks, whereas a large increase is expected for cancers of the tongue, oral cavity and pharynx, the oesophagus and the prostate.

Females

The population will increase by about 12% (Table 31) from 1993–1997 to 2018–2022 and the annual number of cases is predicted to increase by more than 3300 (36%) (Table 30). Changes in risk will increase the number of cases by 11%, while changes in population size and structure will increase the number by a further 24%. The number of breast cancer cases is predicted to increase by 56%, about half of which can be attributed to increased risk. Lung cancer is predicted to have the largest relative increase, with a doubling of the number of cases, of which about 70% can be attributed to increased risk.

Sweden

Males

The population will increase by about 8% (Table 31) from 1993–1997 to 2018–2022, and the annual number of cases is predicted to increase by over 8500 (44%) (Table 29). Of this, 6% is due to increased risk, and 38% to changes in population size and structure.

The number of lung cancer cases will remain approximately unchanged, because a large reduction of risk is compensated by increasing population size and ageing of the population. The risk of prostate cancer will increase the number of cases by 48%, and together with changes in population size and structure, this will almost double the numbers. The risk will decline for 13 of the 20 sites, with the largest relative decreases for acute leukaemia and for cancers of the larynx, lip, stomach and kidney.

Females

The population of Swedish women will increase by about 7% (Table 31) from 1993–1997 to 2018–2022, and the annual number of cases of cancer will increase by more than 4300 (23%) (Table 30). Changes in risk will increase the number of cases by only 3%, while changes in population size and structure will further increase the number by 20%. The numbers of cases of cancers of the breast and the lung will increase by 28% and 74%, respectively. Higher risk will increase the number of lung cancer cases by more than 50%. Despite the ageing of the population, a reduction or stabilization in the number of cancer cases is predicted for nine of the 20 sites. Cancers of the stomach, ovary and the kidney will have the largest reductions in the number of cases.

All Nordic countries combined

Males

From 1993–1997 to 2018–2022, the male population of the Nordic countries will increase by about 9% (Table 31) and there will be almost 25 000 (49%) more cancer cases annually in the future (Table 29). Change in risk will increase the number of cases only by 4%, while changes in population size and structure will add a further 45%. The numbers of cases of the two commonest types of cancer among males, of the prostate and the lung, are predicted to increase by 97% and 11%. Increased risk, increased population size and ageing of the Nordic population all contribute to the doubling of the number of prostate cancer cases. The modest increase in the number of lung cancer cases is due to the fact that a large decrease in risk will be more than compensated by changes in population size and structure. The largest relative reductions in numbers of cases due to changes in risk are predicted for cancers of the lip, the stomach and the lung and for acute leukaemia.

Females

The number of female inhabitants in the Nordic countries will increase by about 7% (Table 31) from 1993–1997 to 2018–2022, and the number of cases will increase by over 17 400 (34%) (Table 30). Changes in risk will increase the number of cases by 9%, while changes in population size and age structure will increase the number by a further 24%. The numbers of cases of cancer of the breast and the lung will increase by 46% and 76%, respectively. The largest relative reductions due to changes in risk are predicted for cancers of the stomach and the kidney, while the largest increases will be for cancers of the tongue, oral cavity and pharynx, the lung and the thyroid.

Summary of results

Predictions of the future numbers of cancer cases have been made for 20 types of cancers for each sex. The predicted numbers for all sites combined were calculated by summing the predicted numbers of cases for all the individual cancer sites. The annual number of male cancer cases is predicted to increase by 49%, from around

51 000 in 1993–1997 to almost 76 000 per year in 2018–2022. For females, the numbers are predicted to increase by 34%, from below 52 000 per year in 1993–1997 to over 69 000 in 2018–2022. The largest part of the increase in number of cases can be attributed to changes in the population size and structure. The predicted increase in risk will result in an increase of 4% in the number of cases among males; the ageing of the population will increase the numbers by a further 36% and the increasing population size by another 9%. The increases due to changes in population size and structure are largest in Finland and Iceland, amounting to more than 70% in both countries. For women, the predicted increases in numbers due to risk, age structure and population size are 9%, 17% and 7%, respectively.

In males, cancer of the prostate is the most frequent type. Due to uncertainty concerning the extent of PSA testing, it is very difficult to predict the future incidence of prostate cancer. Considering all sites combined, except cancer of the prostate, risk is predicted to decline or stabilize for males in all the Nordic countries. In addition to prostate cancer, lung, colorectal and urinary bladder cancers are the most common types, and together they account for 58% of all male cases. From 1993–1997 to 2018–2022, risks are predicted to decline for 10 of the 20 sites. The reduction in the number of cases due to the reduction of risk, will, for all sites except cancer of the lip, Hodgkin disease and acute leukaemia, be more than compensated by the changes in population size and age distribution.

Lung cancer rates are predicted to decline in all the Nordic countries, most markedly in Finland. Population changes will result in predicted increases in the number of lung cancer cases of between 2% (Finland) and 39% (Iceland). Incidence rates for colon and rectum cancer are predicted to stabilize in all the countries, except for colon cancer in Finland, where an increase is predicted. Due to population changes, the number of cases of colorectal cancer will increase by almost 50% for all the countries combined. For urinary bladder cancer, the number of cases is predicted to increase by 19%, despite reductions in the rates in all countries except Finland.

In females, the commonest types are cancers of the breast, the colorectum, the lung and the corpus uteri, which account for 53% of the female cases. Cancer of the breast alone accounts for 27%, and the number of breast cancer cases is predicted to increase by almost 50%, with about half the increase attributable to increased risk. The largest relative increase in the number of breast cancer cases is predicted for Finland (74%) and the smallest for Sweden (28%). For all sites combined, excluding breast cancer, the rates are predicted to stabilize or slightly decline in all the countries.

As for males, female rates for colorectal cancer are predicted to stabilize in all countries except Finland, where an increase is predicted. For all the Nordic countries combined, the number of colorectal cancer cases is predicted to increase by almost 30%, mostly due to population changes. In contrast to the decline in males, the risk of lung cancer in females is predicted to increase in all countries. In Iceland and Norway, the annual numbers of cases are predicted to double, and for the other countries, the increase is predicted to be around 70%.

The annual numbers of cases of melanoma of the skin are predicted to increase by about 40% for both males and females. The increase is caused both by increasing risk and changes in the population, and the ageing of the population will have a larger effect on the change in the number of male cases. The rates for cancers of the tongue, oral cavity and pharynx are predicted to increase for both males and females in all the Nordic countries. For all countries combined, the numbers of cases are predicted to increase by 106% and 67% for males and females, respectively.

Discussion

The prerequisites for predicting cancer incidence are favourable in the Nordic countries. Each country has an efficient population-based cancer registry, established by 1958 at the latest and using comparable coding systems. Previous predictions were made in each country separately, the first in Finland in 1974 (Teppo *et al.*, 1974). Engeland *et al*. (1993) published predictions for all of the Nordic countries up to the year 2010, and the present study is a follow-up of that work.

Engeland *et al*. (1993) based their calculations on observed cancer incidence rates for 1958–1987. They used the same power model as in the present study, but instead of using the trend from the ten most recent years if there was significant curvature in the rates over the last 20–30 years, they used the average drift consistently. Since the prediction method used in the present study is based on the models used for this previous prediction, we summarize here some of the observed numbers for the first part of the period (1988–1997) covered by the predictions of Engeland *et al*.

For all the countries combined, the standardized incidence rates increased by 4.6% from 1983–1987 to 1993–1997, compared with a predicted increase of 7.6%. For males, the annual number of cases increased by around 5100 cases (11%), from about 45 800 in 1983–1987 to around 50 900 in 1993–1997, whereas an increase of 7800 new cases (17%) was predicted. The number of female cases increased by around 6800 (15%), from around 45 100 cases to about 51 900 in the same period, while around 8700 was predicted (19%).

This shows that the risk of cancers of all sites did not increase as much as predicted, because previous increasing trends did not continue to the same extent in the ten years following 1987, resulting in less cases per year than predicted.

It is of interest to look at how precise the predictions were for each site. Engeland *et al*. made predictions for 200 combinations of 20 sites in each sex for five countries. The median of the absolute value of the relative deviation between the observed and predicted numbers of cases in 1993–1997 was about 13%. An important question is whether this number is representative of what can be expected for the predictions in the present publication. If similar calculations are made using rates up to 1977 to compare 10-year predictions with observed rates in 1983–1987, a median deviation of about 9% is found. These median numbers of 13% and 9% show that trends continued to a lesser extent after 1987 than they did 10 years earlier, but it is difficult to make firm statements about the applicability of this finding to future periods. These results do, however, quantify the uncertainties of prediction for a typical cancer site. The median errors might be regarded as somewhat high, and a baseline comparison would be useful to put them into perspective. A natural baseline to use is simply the number of cancer cases in the last period as an estimate of the future numbers. Using this approach would have resulted in a 20% median absolute relative deviation in 10-year predictions based on rates up to 1977, and 15% for comparisons performed 10 years later. The median deviations of 9% and 13% in the two previous decades indicate that a model-based prediction of cancer incidence can be useful as a basis for health planning.

In addition to improving the accuracy of predictions, the modelling approach used is helpful in making predictions to highlight current trends. One example of this in the present publication is the predictions for colon cancer in Norway, where the rates have increased in each new five-year period up to 1993–1997, but which are predicted to peak in 2003–2007 due to a decline in risk in younger cohorts. Another example is cancer of the cervix uteri in Finnish women, where rates declined steadily up to 1988–1992, but turned upwards in the last period. Due to increasing cohort-specific risks for women born after around 1943, the increase in rates for future periods is predicted to accelerate.

A third benefit of making predictions is that they are useful in evaluating the effects of preventive actions. Predictions are calculated based on the assumption that current trends will continue similarly in the future. If rates observed in the future are lower than those predicted, this means that the forces previously influencing the rates have changed. For example, widespread campaigns against excessive sunbathing have been conducted in the Nordic countries, to prevent new cases of melanoma of the skin. From 1983–1987 to 1993–1997, rates were predicted to increase from 8.7 to 12.2 (world age-standardized rates per 100 000) in males, and from 9.6 to 13.4 in females, whereas the observed rates in 1993–1997 were 11.0 and 11.9 for males and females, respectively.

The classical model to use when making cancer incidence and mortality predictions is the multiplicative age–period–cohort model. The problem with this model is that it can yield rates that grow exponentially with time. We have compared the power model used in this publication with the multiplicative model, in predictions for the period 1993–1997 based on the rates up to 1987. We found that the multiplicative model had higher median deviations between predicted and observed rates and that it more often overestimated the future rates.

The predictions depend not only on the type of model, however, but also on the method of extrapolating the model components. It is not realistic to assume that the effect of current trends will continue to the same extent throughout the 25-year prediction period. If there was a large observed increase in rates in the base period, this would give very high and possibly unrealistic long-term predictions. Instead, a gradual reduction after the five first years has been implemented, based on experience from previous periods (i.e., predictions up to 1993–1997 calculated based on rates up to 1977). It is only the drift component that has been reduced, not the cohort-specific deviations from the linear trend, which means that interesting cohort-specific patterns were included to their full extent in the predictions. This, however, sometimes led to debatable predictions. An example is stomach cancer in Danish males. Here, the cohort-specific risks have declined linearly for cohorts born up to around 1948, and then stabilized for the next two cohorts. The rates in Denmark are predicted to slightly increase, despite the fact that the drift component is (marginally) negative. The reason is that since the cohort-specific curvature is retained, the curvature towards stabilization for men born after 1948 turns to a slight increase when a diminishing drift component is applied.

All cancer sites, except cancers of the breast and the prostate, have been handled in a standardized way. Predictions are based on modified versions of age–period–cohort models, and direct information about present and past distributions of causes or known cause—effect relationships has not been used. For most sites, the known causes have either weak associations with the disease, or detailed information about the prevalence and trends in distributions of the risk factor is difficult to obtain. There are exceptions; information on smoking habits, for example, could potentially be used to improve predictions for lung cancer, but this approach has not been pursued in the present study. The effects of risk factors have instead been modelled indirectly, through the period and cohort effects in the model. The standard method was not, however, applicable for cancers of the breast and prostate, due to mammographic screening and PSA testing.

Mammographic screening is conducted to detect breast cancers at an earlier point in time, which naturally will lead to an increase in incidence among screened women. The effect of screening has been coarsely modelled by first calculating how large a proportion of the women in a given age group and calendar period who have been offered to participate in screening, and then entering this proportion into the age–period–cohort model. The effect of screening has been divided into three components, the effects of the initial screening round, of subsequent rounds and of post-screening. Screening was first introduced in Sweden, and because screening was introduced at different times in different counties, useful contrasts were seen when the information from the different counties was compared. Quantitative effects of screening have thus been calculated, and combined with assumptions about the extent of future screening programmes, these data have allowed better predictions to be made. In all countries except Denmark, all the women in selected age groups were assumed to be invited for screening by 2003. In Denmark, only 31.4% of the women in the age group 50–69 years will receive written invitations for screening by 2003. The decision of whether to screen is up to each county in Denmark, and some counties also offer screening without written invitation. If more counties decide to start screening in the future, this will of course affect the Danish rates.

The effects of screening vary somewhat between the countries. The effects depend on the rates of participation in the programmes as well as on the quality of the programmes. In terms of making predictions, it is less relevant to compare the countries than to look at the consistency between the past and the future within each country with respect to screening coverage and quality. The assumption about consistency is difficult to evaluate, since it concerns the future, but we believe that the model will provide sensible predictions for breast cancer.

The introduction of PSA testing has made it difficult to make predictions for prostate cancer. The main problem is the lack of information about the extent of PSA testing, such that it is impossible to model the effects as was done for breast cancer screening, with effects corresponding to initial PSA testing, subsequent testing and post-testing. Instead, trends up to 1992 have been used to make predictions, assuming that the increase in 1993–1997 beyond that expected from the trends can be attributed to PSA testing, and that future effects of PSA testing will cancel each other out. This is not necessarily a realistic assumption, but it is a choice based on a lack of alternatives. The incidence rates for 1993–1997 in Norway, Sweden and Denmark did not show a radical change following the introduction of PSA testing. We have no basis to assume that the extent of PSA testing will increase or decrease in these countries, and if we had, it would have been very difficult to quantify. In Iceland, the rate was about five times higher in 1987–1992 than in 1958–1962, and it is difficult to say how much of the increase in 1993–1997 can be attributed to PSA testing. In Finland, rates started to increase markedly in 1991, and increased for seven consecutive years, from 1991 to 1997. In the USA, the rates declined after only four years and then stabilized at a higher level than before the introduction of PSA testing. Based on the American experience, it is likely that the Finnish rates will start to decline sometime in the future. This could be adjusted for pragmatically by reducing the future rates in Finland by some fraction, but deciding which time periods to adjust, and by how much, would, to a great extent, be arbitrary. We have chosen to not make any such adjustments, so that the predicted number of prostate cancer cases in Finland may be too high.

Elements of subjectivity enter the construction of all prediction methods, both the choice of model and the extrapolation of the components into the future. Such choices can have strong effects on the resulting predictions. The large uncertainties associated with the specification of the models used in the predictions makes the calculation of prediction intervals inappropriate. To check this supposition, we constructed prediction intervals for predicted incidence rates in 1993–1997 based on observed rates up to 1987, and found that 95% prediction intervals covered less than 70% of the observed values. The coverage was strongly dependent on the number of cases on which the predictions were based. The more cases, the worse was the coverage. This is because prediction intervals only include parameter uncertainty, which becomes very small when the number of cases is large, and the Poisson uncertainty in the future number of cases, and not uncertainty regarding model assumptions, such as the continuation of current trends. A prediction interval for male lung cancer in Sweden in 2018–2022, for example, would be relatively narrow, possibly giving a false impression about the true uncertainties associated with cancer incidence predictions.

We believe that the results of the present study will, taking into account the weaknesses and difficulties discussed, provide a useful basis for planning cancer control and treatment in the Nordic countries for the years to come.

References

ANCR (2001) Survey of Nordic Cancer Registries. http://www.cancer.dk/ANCR . 5-31-2001.

Anttila A, Pukkala E, Söderman B, Kallio M, Nieminen P, Hakama M (1999). Effect of organised screening on cervical cancer incidence and mortality in Finland, 1963–1995: recent increase in cervical cancer incidence. *Int J Cancer* **83:** 59–65.

Bashir S, Esteve J (2000). Analysing the difference due to risk and demographic factors for incidence or mortality. *Int J Epidemiol* **29:** 878–884.

Boer R, Warmerdam P, de Koning H, van Oortmarssen G (1994). Extra incidence caused by mammographic screening. *Lancet* **343:** 979.

Breslow NE, Day NE (1987*). Statistical Methods in Cancer Research. Volume II-The Design and Analysis of Cohort Studies*. (IARC Scientific Publications No. 82) Lyon, International Agency for Research on Cancer: 1-406.

Clayton D, Schifflers, E (1987). Models for temporal variation in cancer rates. II: Age-period-cohort models. *Stat Med* **6:** 469–481.

Cuzick J (1994). Multiple myeloma. *Trends in cancer incidence and mortality* (eds Doll R, Fraumeni JF Jr, Muir CS); Cancer Surveys, Cold Spring Harbor Laboratory Press, New York, 453–474.

de Koning HJ, Liem MK, Baan CA, Boer R, Schroder FH, Alexander FE (2002). Prostate cancer mortality reduction by screening: power and time frame with complete enrollment in the European Randomised Screening for Prostate Cancer (ERSPC) trial. *Int J Cancer* **98:** 268–273.

Engeland A, Haldorsen T, Tretli S, *et al*. (1993). Prediction of cancer incidence in the Nordic countries up to the years 2000 and 2010. A collaborative study of the five Nordic Cancer Registries. *APMIS Suppl* **38:** 1–124.

Engeland A, Haldorsen T, Tretli S, *et al*. (1995). Prediction of cancer mortality in the Nordic countries up to the years 2000 and 2010. A collaborative study of the five Nordic Cancer Registries. *APMIS Suppl* **49:** 1–163.

Franssila K, Saxen E, Teppo L, *et al*. (1981). Incidence of different morphological types of thyroid cancer in the Nordic countries. *Acta Pathol Microbiol Scand Section A* **89:** 49–55.

Hakama M, Pukkala E, Heikkilä M, Kallio M (1997). Effectiveness of the public health policy for breast cancer screening in Finland: population based cohort study. *BMJ* **314:** 864–867.

Hakama M, Pukkala E, Söderman B, and Day N (1999). Implementation of screening as a public health policy: issues in design and evaluation. *J Med Screen* **6:** 209–216.

Herrington LJ, Weiss NS, Olshan AF (1996). Multiple myeloma. *Cancer Epidemiology and Prevention, 2nd ed* (eds Schottenfeld D, Fraumeni JF); Oxford University press, New York, 946–970.

Hartge P, Devesa SS, Fraumeni JF Jr (1994). Hodgkin's and Non-Hodgkin's Lymphomas. *Trends in cancer incidence and mortality* (eds Doll R, Fraumeni JF Jr, Muir CS); Cancer Surveys, Cold Spring Harbor Laboratory Press, New York, 423–453.

Hristova L, Hakama M (1997). Effect of screening for cancer in the Nordic countries on deaths, cost and quality of life up to the year 2017. *Acta Oncol* **36(Suppl 9):** 1–60.

Lynge, E. (1998). Mammography screening for breast cancer in Copenhagen April 1991–March 1997. Mammography Screening Evaluation Group. *APMIS Suppl* **83**: 1–44.

Mueller NE (1996). Hodgkin's disease. *Cancer Epidemiology and Prevention, 2nd ed* (eds Schottenfeld D, Fraumeni JF); Oxford University press, New York, 893–919.

NCI (2002) Fast stat: Prostate cancer. http://seer.cancer.gov. 4-15-2002.

Nordic Council and Nordic Statistical Secretariat (1973, 1986, 1992). *Yearbook of Nordic Statistics 1972, 1985, 1991*, **11, 24, 30**. Stockholm.

Nordic Medico-Statistical Committee (1992). *Health Statistics in the Nordic Countries 1990,* **38**. Copenhagen.

Olsen JH, Andersen A, Dreyer L, *et al*. (1997). Avoidable cancers in the Nordic countries. *APMIS Suppl* **76:** 1–146.

Olsson S, Andersson I, Karlberg I, Bjurstam N, Frodis E, Hakansson S (2000). Implementation of service screening with mammography in Sweden: from pilot study to nationwide programme. *J Med Screen* **7:** 14–18.

Osmond C (1985). Using age, period and cohort models to estimate future mortality rates. *Int J Epidemiol* **14:** 124–129.

Rostgaard K, Vaeth M, Holst H, Madsen M, Lynge E (2001). Age-period-cohort modelling of breast cancer incidence in the Nordic countries. *Stat Med* **20:** 47–61.

Saracci R (1987). The interactions of tobacco smoking and other agents in cancer etiology. *Epidemiol Rev* **9:** 175–193.

Scherr PA, Mueller NE (1996). Non-Hodgkin's lymphomas. *Cancer Epidemiology and Prevention, 2nd ed* (eds Schottenfeld D, Fraumeni JF); Oxford University press, New York, 920–945.

Sigurdsson K, Adalsteinsson S, Ragnarsson J (1991). Trends in cervical and breast cancer in Iceland. A statistical evaluation of trends in incidence and mortality for the period 1955–1989, their relation to screening and prediction to the year 2000. *Int J Cancer* **48:** 523–528.

Souhami R, Tobias J (1986). *Cancer and its Management*; Blackwell, Oxford, 429–507.

Teppo L, Hakulinen T, Saxen E (1974). The prediction of cancer incidence in Finland for the year 1980 by means of cancer registry material. *Ann Clin Res* **6:** 122–125.

Tomatis L, Aitio A, Day NE, *et al*. (1990). *Cancer: Causes, Occurrence and Control* (IARC Scientific Publications No. 100), Lyon, International Agency for Research on Cancer.

Tretli S, Haldorsen T (1990). A cohort analysis of breast cancer, uterine corpus cancer, and childbearing pattern in Norwegian women. *J Epidemiol Community Health* **44:** 215–219.

Tryggvadottir L, Tulinius H, Larusdottir M (1994). A decline and a halt in mean age at menarche in Iceland. *Ann Hum Biol* **21:** 179–186.

Tulinius H, Sigvaldason H, Hrafnkelsson J, Olafsdottir G, Tryggvadottir L, Sigurthsson K (1990). Reproductive factors and breast cancer risk in Iceland. A second cohort study. *Int J Cancer* **46:** 972–975.

Wang H, Kåresen R, Hervik A, Thoresen SO (2001). Mammography screening in Norway: results from the first screening round in four counties and cost-effectiveness of a modeled nationwide screening. *Cancer Causes Control* **12:** 39–45.

Appendix A. Prediction Model for Breast Cancer

Screening variables

Mammographic screening was introduced at different times in the Nordic countries. Sweden started screening in 1974, and by 1997, all Swedish counties offered screening to women in the age group 50–69 years, but some counties started at 40 or 45 years and/or ended at 74 years (Olsson *et al.*, 2000). Finland started a nationwide programme for screening women from selected cohorts in 1987 (Hakama *et al.*, 1997, 1999). In Iceland, a national screening programme was introduced in the end of 1987 and it covers the age group 40–69 years (Sigurdsson *et al.*, 1991). Denmark has a screening programme in two counties that started in 1991 and 1993, respectively (Lynge, 1998); together they cover 18.2% of Danish women aged 50–69 years. Norway started screening in four counties in 1995/1996, covering about 40% of the women in the age groups 50–69 years (Wang *et al.*, 2001).

As mentioned in the results chapter, the effect of screening can be divided into three main components: the initial screening round, the subsequent rounds, and post-screening. The first of these three effects can be described in the following way. As a result of the initial screening round, incidence of breast cancer will increase strikingly because of the detection of cases from the prevalent pool of undiagnosed breast cancers. The variable $screen_1$ is defined as the proportion of person-years which are within two years of the starting date of their first screening round (Rostgaard *et al.*, 2001). Table A1 shows the observed values up to 1997 and the future assumed values up to 2022, for all the Nordic countries.

After the first two years since the start of initial screening, there is still an increased incidence rate among women who continue to be screened (Boer *et al.*, 1994). This is because cancers are detected earlier by screening, and incidence increases strongly with age. The variable $screen_2$ is defined as the proportion of person-years with continued screening after the first two years of initial screening. The sum of $screen_1$ and $screen_2$ is the cumulative proportion of the person-years which currently are being screened. The problem with over-diagnosis (the diagnosis of tumours which would never have been discovered without screening) will not be discussed here, but both effects of $screen_1$ and $screen_2$ might partially reflect this phenomenon. Table A2 gives the observed and future values of $screen_2$. In Finland, the programme covers women aged 50–59 years, but it can be continued up to 69 years. Since we do not have information on how a large proportion of the women who are offered screening in the age group 60–69, this proportion is assumed to be 50% in the calculations.

When a screening programme stops, usually when the women are 65 or 70 years old, the incidence in the screened women is expected to drop to a lower level than in unscreened women (Boer *et al.*, 1994). This is because some of the potential future cancer cases have already been diagnosed during screening. The variable $screen_3$ is defined as the proportion of person-years which are within five years above the upper age-limit of the screening programme. Table A3 lists the calculated values for this variable.

Model fit

The three screening variables are entered into the age–period–cohort model:

$$R_{ap} = \exp\,(A_a + D \cdot p + P_p + C_c + S1 \cdot screen_1 + S2 \cdot screen_2 + S3 \cdot screen_3)$$

For the presentation of the effects of the screening variables, the multiplicative model is used instead of the power model. This is because the parameters have a more natural interpretation in this model. When making the actual predictions, the three screening variables are estimated using the power model described in the chapter on data and methods.

A pure age–period–cohort model does not give a good fit in any of the countries, except possibly Iceland (Table A4). In Denmark, the deviance drops from 53.6 to 22.8 when both $screen_1$ and $screen_2$ are added to the model. With 22 degrees of freedom, this is a good fit.

In Finland, the deviance drops from 55.3 to 26.7 with 23 degrees of freedom when $screen_1$ is added. Adding $screen_2$ and $screen_3$ does not greatly improve the model.

For Iceland, the full age–period–cohort model gave a deviance of 38.9 with 33 degrees of freedom. The three screening variables slightly improved the fit, reducing the deviance to 32.6 collectively.

Screening started late in Norway, and adding $screen_1$ reduced the deviance from 75.4 to 37.7, with 23 degrees of freedom. Adding an interaction term between $screen_1$ and age, giving separate effects for 50–59 and 60–69 years, did not improve the fit (change in deviance: 1.9 with 1 degree of freedom).

In Sweden, all the four periods in the analysis are affected by screening. A full age–period–cohort model without the screening variables therefore has a large deviance of 206.0. The three screening variables each have a substantial effect on the fit, but the deviance is still 39.2 with 21 degrees of freedom after the screening variables are entered. Including an interaction term

Table A1. *Screen*$_1$, percentage of person-years which are within two years of the starting date of their first screening[a], by country, age and period. For age groups not specified, the percentage is 0.

	Observed periods					Future periods			
Age	1978-1982	1983-1987	1988-1992	1993-1997	1998-2002	2003-2007	2008-2012	2013-2017	2018-2022
Denmark									
50-54	0.0	0.0	2.2	7.7	8.2	12.6	12.6	12.6	12.6
55-59	0.0	0.0	2.2	5.1	0.9	4.4	0.0	0.0	0.0
60-64	0.0	0.0	2.2	5.1	0.9	4.4	0.0	0.0	0.0
65-69	0.0	0.0	2.2	5.1	0.9	4.4	0.0	0.0	0.0
Finland									
50-54	0.0	2.0	46.0	40.0	40.0	40.0	40.0	40.0	40.0
55-59	0.0	4.0	38.0	0.0	0.0	0.0	0.0	0.0	0.0
60-64	0.0	0.0	16.0	0.0	0.0	0.0	0.0	0.0	0.0
Iceland									
40-44	0.0	0.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
45-49	0.0	0.0	40.0	0.0	0.0	0.0	0.0	0.0	0.0
50-54	0.0	0.0	40.0	0.0	0.0	0.0	0.0	0.0	0.0
55-59	0.0	0.0	40.0	0.0	0.0	0.0	0.0	0.0	0.0
60-64	0.0	0.0	40.0	0.0	0.0	0.0	0.0	0.0	0.0
65-69	0.0	0.0	40.0	0.0	0.0	0.0	0.0	0.0	0.0
Norway									
50-54	0.0	0.0	0.0	15.9	31.1	40.0	40.0	40.0	40.0
55-59	0.0	0.0	0.0	15.9	15.1	5.3	0.0	0.0	0.0
60-64	0.0	0.0	0.0	15.9	15.1	5.3	0.0	0.0	0.0
65-69	0.0	0.0	0.0	15.9	15.1	5.3	0.0	0.0	0.0
Sweden									
40-44	5.0	7.8	18.4	18.9	19.2	19.2	19.2	19.2	19.2
45-49	3.8	3.4	11.9	1.9	1.5	1.3	1.3	1.3	1.3
50-54	3.3	6.0	27.4	19.9	19.7	19.5	19.5	19.5	19.5
55-59	3.3	6.0	24.2	3.8	0.4	0.0	0.0	0.0	0.0
60-64	3.3	6.0	24.2	3.8	0.4	0.0	0.0	0.0	0.0
65-69	3.3	6.0	24.2	3.8	0.4	0.0	0.0	0.0	0.0
70-74	2.1	5.0	13.2	0.5	0.0	0.0	0.0	0.0	0.0

[a]In all the countries, calendar date of start of screening is rounded to the nearest of 1 January and 1 July. If only year of start is given, 1 July that year is used. In Denmark, Norway and Sweden, all counties are assumed to have similar age distribution in the screened age interval. In Finland, all the women in those cohorts that are offered mammography screening, are assumed to be included in the programme. If 100% of the women are within 2 years of their initial screening in the five-year period, the proportion of person-years screened is 2/5 (40%). In the period the screening programme is introduced, the proportion can exceed 40%. For example, the proportion for Finnish women aged 50–54 in 1988–1992 is 46%. This is because some women were screened for the first time at ages 52–54, in addition to all the women who turned 50 in the period.

between *screen*$_1$ and age, giving separate effects for 40–49, 50–59, 60–69 years and 70–74 years, improves the fit (change in deviance: 19.2 with 3 degrees of freedom).

Effect estimates

In Table A5, the effects of the different screening variables are given. The estimates for *screen*$_1$ in the table are the ratio between the rates for women who are within their first screening round and rates for women who are not. Similarly, the effect for *screen*$_2$ is the ratio between the rate for women who continue to be screened and the rate for women who are not in this group, and the effect of *screen*$_3$ is the ratio between the rates for women who have and have not passed their final screening round. These simple interpretations of the effect estimates of the screening variables result from using the exponential link between the rate and the covariates. As noted earlier, the power link is fitted when making the actual predictions. Since the effects of the screening variables do not have the same simple interpretations in this model, the

Table A2. *Screen*$_2$, percentage of person-years which are continuing to be screened after the first two years of the initial screening round, by country, age and period. For age groups not specified, the percentage is 0.

	Observed periods					Future periods			
Age	1978-1982	1983-1987	1988-1992	1993-1997	1998-2002	2003-2007	2008-2012	2013-2017	2018-2022
Denmark									
50-54	0.0	0.0	0.0	9.9	10.9	18.9	18.9	18.9	18.9
55-59	0.0	0.0	0.0	12.5	18.2	27.0	31.4	31.4	31.4
60-64	0.0	0.0	0.0	12.5	18.2	27.0	31.4	31.4	31.4
65-69	0.0	0.0	0.0	12.5	18.2	27.0	31.4	31.4	31.4
Finland									
50-54	0.0	0.0	20.0	40.0	60.0	60.0	60.0	60.0	60.0
55-59	0.0	0.0	36.0	100.0	100.0	100.0	100.0	100.0	100.0
60-64	0.0	0.0	17.0	50.0	50.0	50.0	50.0	50.0	50.0
65-69	0.0	0.0	0.0	0.0	0.0	50.0	50.0	50.0	50.0
Iceland									
40-44	0.0	0.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0
45-49	0.0	0.0	60.0	100.0	100.0	100.0	100.0	100.0	100.0
50-54	0.0	0.0	60.0	100.0	100.0	100.0	100.0	100.0	100.0
55-59	0.0	0.0	60.0	100.0	100.0	100.0	100.0	100.0	100.0
60-64	0.0	0.0	60.0	100.0	100.0	100.0	100.0	100.0	100.0
65-69	0.0	0.0	60.0	100.0	100.0	100.0	100.0	100.0	100.0
Norway									
50-54	0.0	0.0	0.0	0.0	26.7	60.0	60.0	60.0	60.0
55-59	0.0	0.0	0.0	0.0	42.7	91.1	100.0	100.0	100.0
60-64	0.0	0.0	0.0	0.0	42.7	91.1	100.0	100.0	100.0
65-69	0.0	0.0	0.0	0.0	42.7	91.1	100.0	100.0	100.0
Sweden									
40-44	7.5	7.5	22.9	28.2	28.7	28.7	28.7	28.7	28.7
45-49	10.3	13.5	32.5	48.5	49.6	49.9	49.9	49.9	49.9
50-54	10.8	16.8	45.0	76.2	80.3	80.5	80.5	80.5	80.5
55-59	10.8	16.8	48.2	92.4	99.6	100.0	100.0	100.0	100.0
60-64	10.8	16.8	48.2	92.4	99.6	100.0	100.0	100.0	100.0
65-69	10.8	16.8	48.2	92.4	99.6	100.0	100.0	100.0	100.0
70-74	6.8	11.6	34.1	55.2	55.8	55.8	55.8	55.8	55.8

estimates from the power model are not given. However, comparing the effects in the exponential model and the power model indicates that they are consistent, regarding both the directions and the relative sizes of the effects. The primary interest is in using these effect estimates to improve the predictions of breast cancer incidence, so consistency within each country is more important than comparing the size of the effects between countries.

In Sweden, the interaction term between *screen*$_1$ and age was significant, giving 1.8, 1.7, 2.8 and 4.1 as the effects of *screen*$_1$ for the age groups 40–49, 50–59, 60–69 and 70–74 years, respectively. These separate effects have been used in the predictions. The effect of the highest age group is unrealistically large, but nobody in this age group will be screened for the first time in the prediction periods.

In Finland and Iceland, the effects of *screen*$_2$ and *screen*$_3$ are not significant. Since the effects are in the anticipated direction, with increased risks in the subsequent screening round and decreased risks after the final round, the effects of all three screening variables were used in the predictions (Table A5).

In Norway, the relative risk for *screen*$_1$ was 5.04 for the whole country. If only the four counties that have introduced a screening programme are analysed, the effect is 2.19. The reason why the effect is larger when the whole country is analysed is probably that the introduction of a screening programme in some counties has led to an increase in screening activity in the counties that have not yet started a screening programme. The effect from the increase in incidence in the non-screened counties is then (wrongly) attributed to the screened counties. It is therefore more appropriate to use 2.19 as our estimate of the effect of *screen*$_1$ in the predictions. Sweden has a similar estimate of 2.20 for *screen*$_1$, with reasonable relative risk estimates of 1.34 and 0.68 for *screen*$_2$ and

Table A3. *Screen*$_3$, percentage of person-years which are within five years past the upper age-limit of the screening programme, by country, age and period. For age groups not specified, the percentage is 0.

	Observed periods					Future periods			
Age	1978-1982	1983-1987	1988-1992	1993-1997	1998-2002	2003-2007	2008-2012	2013-2017	2018-2022
Denmark									
70-74	0.0	0.0	0.0	13.3	18.2	27.0	31.4	31.4	31.4
Finland									
60-64	0.0	0.0	0.0	50.0	50.0	50.0	50.0	50.0	50.0
65-69	0.0	0.0	0.0	30.0	50.0	0.0	0.0	0.0	0.0
70-74	0.0	0.0	0.0	0.0	0.0	50.0	50.0	50.0	50.0
Iceland									
70-74	0.0	0.0	0.0	100.0	100.0	100.0	100.0	100.0	100.0
Norway									
70-74	0.0	0.0	0.0	0.0	42.7	91.1	100.0	100.0	100.0
Sweden									
70-74	0.0	1.5	5.2	8.4	35.0	43.5	44.2	44.2	44.2
75-79	0.0	3.7	8.9	22.1	54.6	55.8	55.8	55.8	55.8

Table A4. Age–period–cohort analysis of breast cancer in the Nordic countries 1978–1997. Deviance (dev.) and degrees of freedom (d.f.[b]) for various models.

	Denmark		Finland		Iceland		Norway		Sweden	
Model[a]	d.f.	dev.	d.f.	dev.	d.f.	dev.	d.f.	dev.	d.f.	dev.
A+P+C	24	53.6	24	55.3	33	38.9	24	75.4	24	206.0
A+P+C+ *screen*$_1$	23	34.7	23	26.7	32	36.8	23	37.7	23	128.2
A+P+C+ *screen*$_1$ + *screen*$_2$	22	22.8	22	24.9	31	33.9	-	-	22	60.8
A+P+C+ *scr.*$_1$ + *scr.*$_2$ + *scr.*$_3$	21	22.8	21	24.0	30	32.6	-	-	21	39.2

[a]A+P+C is the full Age–Period–Cohort model.
[b]All countries are based on 14 age groups and 4 periods, except Iceland, which has 13 age groups and 5 periods.

Table A5. Relative risk (RR[b]) of screening, by country and screening variable.

	Denmark		Finland		Iceland		Norway[a]		Sweden	
Variable	RR	95 % CI	RR	95 % CI	RR	95 % CI	RR	95 % CI	RR	95 % CI
screen$_1$	1.84	(0.4–8.5)	1.40	(1.1–1.8)	1.41	(0.9–2.3)	2.19	(1.7–2.9)	2.20	(1.8–2.6)
screen$_2$	2.96	(1.6–5.5)	1.06	(0.8–1.4)	1.21	(0.8–1.9)	-		1.34	(1.2–1.5)
screen$_3$	1.01	(0.5–2.1)	0.91	(0.7–1.3)	0.76	(0.5–1.2)	-		0.68	(0.6–0.8)

[a]Only based on four counties that started screening before 1997.
[b]RR: exp(Sj) for j = 1,2,3. ie. the risk for *screen*$_j$ = 1 vs *screen*$_j$ = 0. For example, for *screen*$_2$ this is the relative risk if all the person-years are continued to be screened vs none of the person-years continues to be screened, in a five-year age group and five-year calendar period.

screen$_3$ respectively (Table A5). These estimates for *screen*$_2$ and *screen*$_3$ have also been used for Norway.

Denmark is in a similar situation to Norway. Up to 1997, only two counties offered mammographic screening and the introduction of screening in some counties has probably led to increasing screening activity outside the programme. In the period 2001–2003, three more counties are starting mammography screening in Denmark, based on written invitations. There are large uncertainties in the Danish estimates, judged by the width of the confidence intervals, which makes it difficult to apply the estimates in the predictions. Instead, the Swedish estimates for the three screening variables have been used.

Appendix B. Details about the statistical models

Table B1. Lower limit of the age group used in the age-period-cohort models (age), number of periods used (base), and whether average (A) or recent (R) trend was projected (trend).

	DENMARK						FINLAND						ICELAND					
	Males			Females			Males			Females			Males			Females		
Site	Age	Base	Trend	Age	Base	Trend	Age	Base	Trend	Age	Base	Trend	Age	Base	Trend	Age	Base	Trend
Lip	50	6	R	-	-	-	50	6	A	-	-	-	55	6	A	-	-	-
Tongue, etc.	45	6	R	50	6	R	45	4	A	50	6	A	50	6	A	65	6	A
Oesophagus	50	6	R	60	6	A	50	6	A	60	6	A	60	6	A	65	6	A
Stomach	35	6	R	40	5	R	35	5	A	40	6	R	55	6	A	55	6	A
Colon	35	4	R	35	5	R	35	6	A	35	4	A	55	6	A	60	6	A
Rectum	40	6	A	40	6	A	40	5	R	40	6	A	50	6	A	50	6	A
Pancreas	40	4	R	45	6	R	40	6	R	45	6	R	45	6	A	55	6	A
Larynx	45	5	R	-	-	-	45	6	R	-	-	-	50	5	A	-	-	-
Lung	35	5	R	40	5	R	35	4	A	40	6	R	45	6	A	50	6	A
Breast	-	-	-	25	4	A	-	-	-	25	4	A	-	-	-	35	5	A
Cervix uteri	-	-	-	25	4	A	-	-	-	25	4	R	-	-	-	25	6	A
Corpus uteri	-	-	-	35	6	R	-	-	-	35	4	R	-	-	-	35	6	A
Ovary	-	-	-	25	6	A	-	-	-	25	6	R	-	-	-	30	6	A
Prostate	45	5	A	-	-	-	45	5	A	-	-	-	20	5	A	-	-	-
Testis	20	6	R	-	-	-	20	6	A	-	-	-	20	6	A	-	-	-
Kidney	35	5	R	40	5	R	35	5	R	40	6	R	40	6	A	50	6	A
Bladder	35	6	R	50	6	R	35	6	A	50	6	A	50	6	A	50	6	A
Melanoma	25	6	R	20	6	R	25	6	R	20	6	R	40	6	A	20	6	A
Thyroid	30	6	A	25	6	R	30	6	A	25	6	R	40	6	A	25	5	A
Non-Hodgkin	20	6	R	40	6	R	20	6	A	40	6	R	35	6	A	45	6	A
Hodgkin	20	6	A	25	6	A	20	6	A	25	6	A	20	6	A	25	6	A
Myeloma	50	6	A	50	6	A	50	6	R	50	6	R	55	5	A	50	6	A
Acute leukaemia	0	6	A	0	6	R	0	4	A	0	6	R	0	6	A	0	6	A
Other sites	0	4	R	0	5	A	0	6	A	0	6	R	0	6	A	0	6	A

	NORWAY						SWEDEN					
	Males			Females			Males			Females		
Site	Age	Base	Trend	Age	Base	Trend	Age	Base	Trend	Age	Base	Trend
Lip	50	6	R	-	-	-	50	6	R	-	-	-
Tongue, etc.	45	6	R	50	6	A	45	6	R	50	6	A
Oesophagus	50	6	A	60	6	A	50	6	R	60	6	A
Stomach	35	6	A	40	6	A	35	6	R	40	6	R
Colon	35	6	R	35	6	A	35	5	R	35	4	R
Rectum	40	6	R	40	6	R	40	6	R	40	4	A
Pancreas	40	6	R	45	6	A	40	4	R	45	4	R
Larynx	45	6	A	-	-	-	45	6	R	-	-	-
Lung	35	6	R	40	6	A	35	4	R	40	4	R
Breast	-	-	-	25	4	A	-	-	-	25	4	A
Cervix uteri	-	-	-	25	4	R	-	-	-	25	4	R
Corpus uteri	-	-	-	35	6	A	-	-	-	35	4	R
Ovary	-	-	-	25	4	R	-	-	-	25	4	A
Prostate	45	5	A	-	-	-	45	5	A	-	-	-
Testis	20	6	R	-	-	-	20	6	R	-	-	-
Kidney	35	6	R	40	6	A	35	4	R	40	5	R
Bladder	35	6	R	50	6	A	35	6	R	50	6	A
Melanoma	25	6	R	20	6	R	25	6	R	20	6	R
Thyroid	30	6	A	25	6	R	30	6	R	25	4	A
Non-Hodgkin	20	6	R	40	6	R	20	4	R	40	6	R
Hodgkin	20	4	A	25	4	A	20	6	R	25	6	R
Myeloma	50	6	R	50	6	R	50	5	R	50	6	R
Acute leukaemia	0	6	R	0	6	A	0	6	R	0	6	R
Other sites	0	4	A	0	4	A	0	4	R	0	4	R

Table B2. Construction of new rates in the eight oldest age groups (for definitions of *A*, *C*, *D* and *P* see "Data and methods").

Observed rates

1968-1972	1973-1977	…	1993-1997
$(A_1+1\cdot D+C_8+P_1)^5$	$(A_1+2\cdot D+C_9+P_2)^5$	…	$(A_1+6\cdot D+C_{13}+P_6)^5$
$(A_2+1\cdot D+C_7+P_1)^5$	$(A_2+2\cdot D+C_8+P_2)^5$	…	$(A_2+6\cdot D+C_{12}+P_6)^5$
$(A_3+1\cdot D+C_6+P_1)^5$	$(A_3+2\cdot D+C_7+P_2)^5$	…	$(A_3+6\cdot D+C_{11}+P_6)^5$
$(A_4+1\cdot D+C_5+P_1)^5$	$(A_4+2\cdot D+C_6+P_2)^5$	…	$(A_4+6\cdot D+C_{10}+P_6)^5$
$(A_5+1\cdot D+C_4+P_1)^5$	$(A_5+2\cdot D+C_5+P_2)^5$	…	$(A_5+6\cdot D+C_9+P_6)^5$
$(A_6+1\cdot D+C_3+P_1)^5$	$(A_6+2\cdot D+C_4+P_2)^5$	…	$(A_6+6\cdot D+C_8+P_6)^5$
$(A_7+1\cdot D+C_2+P_1)^5$	$(A_7+2\cdot D+C_3+P_2)^5$	…	$(A_7+6\cdot D+C_7+P_6)^5$
$(A_8+1\cdot D+C_1+P_1)^5$	$(A_8+2\cdot D+C_2+P_2)^5$	…	$(A_8+6\cdot D+C_6+P_6)^5$

Predicted rates

1998-2002	2003-2007	2008-2012	2013-2017	2018-2022
$(A_1+7\cdot D+C_{13})^5$	$(A_1+7.75\cdot D+C_{13})^5$	$(A_1+8.25\cdot D+C_{13})^5$	$(A_1+8.5\cdot D+C_{13})^5$	$(A_1+8.75\cdot D+C_{13})^5$
$(A_2+7\cdot D+C_{13})^5$	$(A_2+7.75\cdot D+C_{13})^5$	$(A_2+8.25\cdot D+C_{13})^5$	$(A_2+8.5\cdot D+C_{13})^5$	$(A_2+8.75\cdot D+C_{13})^5$
$(A_3+7\cdot D+C_{12})^5$	$(A_3+7.75\cdot D+C_{13})^5$	$(A_3+8.25\cdot D+C_{13})^5$	$(A_3+8.5\cdot D+C_{13})^5$	$(A_3+8.75\cdot D+C_{13})^5$
$(A_4+7\cdot D+C_{11})^5$	$(A_4+7.75\cdot D+C_{12})^5$	$(A_4+8.25\cdot D+C_{13})^5$	$(A_4+8.5\cdot D+C_{13})^5$	$(A_4+8.75\cdot D+C_{13})^5$
$(A_5+7\cdot D+C_{10})^5$	$(A_5+7.75\cdot D+C_{11})^5$	$(A_5+8.25\cdot D+C_{12})^5$	$(A_5+8.5\cdot D+C_{13})^5$	$(A_5+8.75\cdot D+C_{13})^5$
$(A_6+7\cdot D+C_9)^5$	$(A_6+7.75\cdot D+C_{10})^5$	$(A_6+8.25\cdot D+C_{11})^5$	$(A_6+8.5\cdot D+C_{12})^5$	$(A_6+8.75\cdot D+C_{13})^5$
$(A_7+7\cdot D+C_8)^5$	$(A_7+7.75\cdot D+C_9)^5$	$(A_7+8.25\cdot D+C_{10})^5$	$(A_7+8.5\cdot D+C_{11})^5$	$(A_7+8.75\cdot D+C_{12})^5$
$(A_8+7\cdot D+C_7)^5$	$(A_8+7.75\cdot D+C_8)^5$	$(A_8+8.25\cdot D+C_9)^5$	$(A_8+8.5\cdot D+C_{10})^5$	$(A_8+8.75\cdot D+C_{11})^5$