Cancer in Finland

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Cancer in Finland
First edition in English

ISBN 978-952-5815-16-0
ISBN 978-952-5815-17-7 (pdf)
Cancer Society of Finland Publication No. 86

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Layout and graphics Hannu Rinne and Jaana Viitakangas Atelier GraGra

Publisher Cancer Society of Finland
Printed by Erweko, Helsinki 2013
To the readers

*Cancer in Finland* aims to give a balanced overview of cancer incidence, prevalence, and mortality in Finland. The report also presents current information on the causes of cancer and the possibilities for cancer prevention. The Finnish Cancer Registry, an institute for epidemiological and statistical cancer research, was founded in 1952. At first, reporting of cancer cases was voluntary, but in 1961 the National Board of Health issued a by-law making reporting compulsory for all physicians, hospitals and other relevant institutions. Primary medical care in Finland is provided to the entire population at only a nominal fee. Every cancer patient receives adequate and modern treatment as required. Most of the information presented in this book is based on the comprehensive, high quality registration of cancers over the last 60 years and on the extensive epidemiological research done in Finland.

Trends in cancer incidence have been studied in Finland for an exceptionally long time period. With the help of information from the registry files, many studies are done at the Finnish Cancer Registry on risk factors for cancer, prevention, and early diagnosis. The efficacy of the health care system has been followed using survival statistics of cancer patients.

There are outstanding possibilities in Finland and in the other Nordic Countries for cancer research due to comprehensive data of high quality and the availability of data for research purposes. Employing and safeguarding these can be considered an important international obligation.

Helsinki, June 2013

*Nea Malila*
Professor, Director of the Finnish Cancer Registry
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Introduction

This publication deals with the occurrence of cancer in Finland. The goal is to distribute information related to cancer to those who have something to do with cancer in their work or studies, or to those who are otherwise interested in the topic. The publication describes the frequency of cancer among different population groups, risk factors for cancer, treatments for cancer, the detection of cancer in pre-malignant and early stages through mass screening, the survival of cancer patients as well as projections of cancer occurrence in the future.

The publication is based for the most part on the data and results from the research work of the Finnish Cancer Registry.

The Finnish Cancer Registry

The Finnish Cancer Registry is an institute for statistical and epidemiological cancer research founded in 1952. In 2013 there were some 30 permanent employees in the Cancer Registry: administrative personnel as well as experts in medicine, epidemiology, and statistics. In addition, there are a number of researchers working on project-based funding.

The Finnish Cancer Registry

- produces descriptive information on the incidence, prevalence and mortality of cancer as well as changes and predicted changes in the situation;
- produces countrywide and regional estimates of cancer patient survival;
- acts as a specialist organization in questions related to cancer epidemiology and in the planning and evaluation of mass-screening programmes and other actions against cancer, and
- researches the causes of cancer and the effectiveness of treatments using epidemiology and statistics, provides data to outside researchers and helps them in the planning and execution of their studies.
Cancer Registration

The registration of cancers began countrywide in Finland in 1953. The National Board of Health requested at that time all doctors, hospitals and laboratories in Finland to report all information about cancer cases to the cancer registry that was overseen by the Finnish Cancer Registry. Notification of cancer cases has been compulsory since 1961.

Notifications from doctors, hospital and laboratories, as well as death certificate information from Statistics Finland, are built into a database that is suitable for statistical use, and which produces graphs and other summaries. These research materials are published as reports of the Cancer Registry and as part of the official statistics for Finland and the European Union. The Registry covers over 99 percent newly diagnosed cancers and deaths from cancer in Finland since 1953 (Teppo et al 1994).

Comprehensive statistical and epidemiological research is done on the basis of the Registry database and various other study materials collected for the purpose of research. During the existence of the Cancer Registry about 2000 scientific articles and some 200 doctoral dissertations have been published in which Cancer Registry researchers or its data have had a central role. Research related to the countrywide mass screening programmes is performed in the Mass Screening Registry, which is part of the Finnish Cancer Registry.

Acknowledgements

We thank Prof. Lauri Aaltonen from the University of Helsinki and from the Center of Excellence on Cancer Genetics – in which ”Team Pukkala” from the Finnish Cancer Registry is one of the five partners (Kaasinen et al. 2013) – and Prof. Jaakko Kaprio from the University of Helsinki for updating the text on heritability with the most recent references on this topic.

We also thank Dr. Harry Comber from the Irish National Cancer Registry for valuable comments.

1 stats.cancerregistry.fi/Publications/publications.html
Risk factors for cancer and their effect

Factors associated with a person’s lifestyle and environment are significant in the development of many cancers but for some cancers genetic characteristics may also be an important factor. In order to prevent cancer, it is crucially important to know those factors which influence the probability of developing cancer.

Risk factors for cancer can be roughly divided into the following groups:

- biological or internal factors such as age, gender, the metabolism of foreign substances in the body, inherited genetic faults and skin type
- environmental exposures such as radon and ultraviolet radiation, as well as fine particles
- work-related exposures such as chemicals, radioactive materials and asbestos
- lifestyle related factors such as physical activity and diet

The development of cancer is a series of events occurring over many years, where the DNA of a normal, healthy cell is damaged. The cells change, through many stages, into malignant cells which grow independently of the normal regulatory systems of the tissues and finally cause symptoms. A single cause cannot be identified for the majority of cancer cases.

Cancer is a complex group of diseases whose causes, development, symptoms and treatment can differ greatly from one to another.

Internal factors

**AGE.** The majority of cancer cases are related to the process of aging. During a long life, there is more time for exposure to the risk factors that cause the cell mutations related to the development of cancer. The longer a person lives, the more probable it is that his or her cells will accumulate cancer-causing damage. Aging also weakens the cell’s ability to prevent and repair this damage.

**GENDER.** Gender-related characteristics (such as hormones) also influence the risk of cancers other than those of the reproductive organs.

**HERITABILITY.** A cancerous tumour or cell is not contagious, nor is it passed from parent to child. As cancer is a common disease, approximately every third Finn will fall ill from cancer during his or her lifetime. Thus it is normal that in nearly every family there will be some cancer patients, but this results from both genetic and environmental influences. Susceptibility to
Cancer (an increased risk of developing cancer) can be inherited. This means that one or more inherited gene defects relevant to the development of cancer are already in place in all of the person's cells, and they can be passed on to offspring through the germ line.

While in rare cases a single gene defect may lead to a greatly increased risk of cancer, it is much more common that there are multiple gene defects, each contributing a minor increase in risk. Depending on the inherited combination of such genes, inherited susceptibility may be larger or smaller. In addition to such defects, environmental risk factors are also required to cause the additional changes in the cells necessary for the development of a malignant tumour.

For cancers where there are only a single or few gene defects it is typical that cancer of the same organ presents in several affected family members. Young age at onset, and the occurrence of multiple primary tumours, are also features suggestive of hereditary predisposition. Dominantly inherited susceptibility is passed on to an average of every second offspring. If a member of a family with hereditary susceptibility has not inherited the faulty gene(s), his or her children do not have an increased risk of cancer. These types of cancer are rare and account for only a small fraction of all cancers.

However, most common cancers have some hereditary component, including breast and intestinal cancers, thyroid cancer, uterine and ovarian cancers as well as prostate cancer, based on analyses of large twin cohorts (Lichtenstein et al 2000). In the past five years, genome-wide studies have discovered tens of genetic loci associated with increased risk of common cancers.


Genetic tests have been developed for diagnosing hereditary susceptibility. Some of these are still only in research use while others have been implemented for clinical use. There remain a number of unsolved problems with regard to the relevance of genetic testing, interpretation of the results and counselling of at-risk individuals. The identification of multiple genes, each having a small effect on risk, poses particular challenges for clinical use.

The Cancer Society’s advisory services (also website www.neuvontahoitaja.fi, in Finnish) offer advice to persons concerned about hereditary susceptibility to cancer. For many of the hereditary cancer syndromes management strategies for prevention and early detection are available, and cancer incidence and mortality can be reduced in at-risk individuals.

Environmental exposures

**RESIDENTIAL POLLUTION.** Impurities in the air and emissions from nearby industry and traffic increase, to some extent, the risk of lung cancer. Differences in the incidence of cancer in different parts of Helsinki, however, are not connected to sulphur or nitrogen oxide emissions, nor to traffic volumes (Pönkä et al. 1993). Lung cancer in men appears most frequently in those parts of Finland where the air is clean. Thus, air pollutants are insignificant risk factors compared to tobacco.

In the production of drinking water, the chlorination of surface water produces compounds that can cause mutations which may slightly increase the risk of bladder cancer, for example (Koivusalo et al. 1997). Arsenic in drilled wells appears to have the same kind of effect (Kurtio et al. 1999). In a village in Southern Finland, chlorophenol in the ground water was estimated to have caused approximately one additional cancer case every two years (Lampi et al. 1992) during 1972–1986; there was no excess risk following closure of the old water intake plant (Lampi et al. 2008). Another study is investigating, among other things, whether dioxins from a river in south-eastern Finland increase the risk of cancer for people who eat fish containing dioxins from that river (Verkasalo et al. 2004).

Another target of investigation in environmental health have been residents of buildings constructed over the garbage dump in a residential area of Helsinki. According to the first results, slightly more cancer and asthma were diagnosed in the residents than in residents of comparable buildings (Pukkala and Pönkä 2001), but based
on the latest research, the people who lived in those – now demolished – buildings have not had any more cancers than others in Helsinki after 1999.

In recent years, there have been more measurements of the environmental situation, and with their help, we can better evaluate the association between environmental pollutants and cancer risk.

OCCUPATIONAL HAZARDS. The influence of work-related hazards, such as chemicals, on the risk of cancer has been identified in hundreds of different studies. The web page of the Finnish Institute for Occupational Health (www.occuphealth.fi) has good information about cancer risks resulting from occupational environment hazards and about their measurement.

In the Cancer Registry, research has been done over many decades on the risk of cancer, among others, for healthcare personnel, workers in the chemical wood processing industry and sawmill industry, employees in the printing industry, shipyard workers and machinists, oil refinery employees, glass and glass fibre workers, shipping personnel, airline personnel, train engineers, farmers, bush insecticide sprayers, hairdressers as well as employees exposed to asbestos, styrene, trichloroethylene, formaldehyde, PCB, lead, nickel and other metals. Many of these worker cohorts are still being followed.

Asbestos is considered to be an important factor in increasing the risk of cancer in the working environment, and that is why, for example, clear regulations have been given for the repair and demolition of older houses. The regulations are intended to ensure that the exposure of workers to asbestos remains as small as possible. Despite this, for those who have done asbestos spraying work, the risk of developing mesothelioma and lung cancer is still greater than for the rest of the population (Oksa et al 1997). Tobacco has, however, proven to be many times more important as a cause of cancer than asbestos. The risk of lung cancer for a non-smoking asbestos worker is only 1.4 times that of a non-smoker not exposed to asbestos. However, a smoker not exposed to asbestos has a 14-times greater risk, and a smoker exposed to asbestos has a 17-times greater risk, of lung cancer. Almost all mesotheliomas are caused by asbestos (Meurman et al 1994).

Exposures considered to be relatively safe in the working environment may change into significant risk factors, if they occur together, for example, with tobacco use. The Finnish Job Exposure Matrix (FINJEM), developed by the Finnish Institute of Occupational Health, helps to estimate exposures to different chemicals and other factors for workers in different occupations. With its help, we can estimate quantitative amounts of exposure to carcinogenic factors for every person in the population (Pukkala et al 2005). Currently, comparable estimates can be made for the populations of all Nordic countries (Kuupinnen et al 2009).

Large variations in cancer risk in different occupational categories have been demonstrated in the large Nordic Occupational Cancer Study, NOCCA (astra.cancer.fi/nocca) which studied the risks for cancers associated with different occupations.
FIGURE 2
TABLE 1

Occupations with the highest and lowest cancer incidence in Finland 1971–2005: Standardized incidence ratios (SIR) that are statistically significantly increased in relation to the mean in the population (SIR = 1.00) are highlighted in red and those which are decreased in green (Pukkala et al. 2009). N = number of cancers.

### MEN

<table>
<thead>
<tr>
<th>Occupational category</th>
<th>N</th>
<th>SIR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tobacco industry work</td>
<td>26</td>
<td>1.30</td>
</tr>
<tr>
<td>Mine work</td>
<td>1398</td>
<td>1.28</td>
</tr>
<tr>
<td>Seafarers</td>
<td>1742</td>
<td>1.19</td>
</tr>
<tr>
<td>Waiters</td>
<td>251</td>
<td>1.15</td>
</tr>
<tr>
<td>Construction work</td>
<td>10939</td>
<td>1.14</td>
</tr>
<tr>
<td>Assistant nurses</td>
<td>38</td>
<td>1.12</td>
</tr>
<tr>
<td>Plumbers</td>
<td>2488</td>
<td>1.11</td>
</tr>
<tr>
<td>Packers</td>
<td>5670</td>
<td>1.11</td>
</tr>
<tr>
<td>Cooks and head waiters</td>
<td>252</td>
<td>1.10</td>
</tr>
</tbody>
</table>

### WOMEN

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<th>Occupational category</th>
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<th>SIR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Military work</td>
<td>20</td>
<td>1.36</td>
</tr>
<tr>
<td>Security work</td>
<td>175</td>
<td>1.27</td>
</tr>
<tr>
<td>Dentists</td>
<td>440</td>
<td>1.22</td>
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<tr>
<td>Physicians</td>
<td>438</td>
<td>1.19</td>
</tr>
<tr>
<td>Traffic work</td>
<td>677</td>
<td>1.17</td>
</tr>
<tr>
<td>Directors</td>
<td>1507</td>
<td>1.14</td>
</tr>
<tr>
<td>Journalists</td>
<td>434</td>
<td>1.12</td>
</tr>
<tr>
<td>Building hands</td>
<td>897</td>
<td>1.12</td>
</tr>
<tr>
<td>Technical, scientific, etc.</td>
<td>1651</td>
<td>1.11</td>
</tr>
<tr>
<td>Teachers</td>
<td>8093</td>
<td>1.11</td>
</tr>
<tr>
<td>Chemists and laboratory assistants</td>
<td>894</td>
<td>1.10</td>
</tr>
<tr>
<td>Nurses</td>
<td>4543</td>
<td>1.10</td>
</tr>
<tr>
<td>Office work</td>
<td>26565</td>
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<tr>
<td>Tobacco industry work</td>
<td>95</td>
<td>1.10</td>
</tr>
<tr>
<td>Farmers</td>
<td>6526</td>
<td>0.90</td>
</tr>
<tr>
<td>Drivers</td>
<td>262</td>
<td>0.89</td>
</tr>
<tr>
<td>Fishermen and hunters</td>
<td>42</td>
<td>0.88</td>
</tr>
<tr>
<td>Wood work</td>
<td>1803</td>
<td>0.88</td>
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<tr>
<td>Welders</td>
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<tr>
<td>Gardeners</td>
<td>18024</td>
<td>0.86</td>
</tr>
<tr>
<td>Mine work</td>
<td>31</td>
<td>0.81</td>
</tr>
<tr>
<td>Beverage industry</td>
<td>120</td>
<td>0.79</td>
</tr>
<tr>
<td>Seafarers</td>
<td>9</td>
<td>0.71</td>
</tr>
<tr>
<td>Bricklayers</td>
<td>17</td>
<td>0.60</td>
</tr>
<tr>
<td>Forestry work</td>
<td>50</td>
<td>0.53</td>
</tr>
</tbody>
</table>
The NOCCA study confirms known connections between occupational factors and cancer, but points in addition to the influence of lifestyle related choices such as use of tobacco and alcohol. The increase in office work reduces work-related physical activity, which would protect against cancer. Shift work is now also seen to be a probable cancer risk factor (Straif et al 2009). Ultraviolet rays from sunlight are a significant risk for certain occupations: for example lip cancer is found particularly often in fishermen and farmers, while the risk of skin melanoma is greatest for indoor workers whose skin is not accustomed to the sun and burns easily on holiday.

The greatest cancer risk for Finnish men is in the tobacco industry and in mining work (Table 1). The occurrence of cancer for those working in these areas is about thirty percent more than the average for Finnish men.

The biggest cancer risk for Finnish women is in military and security work, which also includes women working as police officers or as security guards. There is a significantly less-than-average cancer risk, for example, for women forest workers and bricklayers.

**Radiation.** Ionizing radiation is ubiquitous, because radiation is produced, for example, by natural radioactive materials in the Earth’s crust. Ionizing radiation has been estimated to cause 1–3 percent of all cancers. X-rays were found to cause cancer in the early 1900s. Strong scientific proof that small doses increase the impact of radiation risk was obtained from research on survivors of the Hiroshima and Nagasaki nuclear bombs in the 1950s. Radiation particularly increases the risk of leukaemia, thyroid cancer, breast cancer, lung cancer and bladder cancer.

The most important source of radiation among the Finnish population is radon in indoor air, with a dose averaging 2 mSv received annually, which is about half of the total radiation received by Finns. Alpha radiation produced by radon does not penetrate material deeply, and therefore inhaled radon results in radiation exposure only to the lung. The only clearly established health impact of radon is increased lung cancer risk. In an extensive European study, also involving Finnish researchers, the proportionate increase in lung cancer risk was 8 percent (Darby et al 2005) at a concentration close to the average in Finnish houses (100 Bq/m³). Radon in indoor air is estimated to cause about ten percent of lung cancer among Finns or about two hundred lung cancer cases every year, which is far less than that attributable to smoking but comparable to the burden from e.g. environmental tobacco smoke.

In diagnostic radiology the benefits of investigations using x-rays need to be considered relative to the small risk caused by radiation exposure. Occupational groups exposed to radiation include, for example, radiologists, x-ray technicians or nurses and nuclear power plant workers. The radiation doses received by these groups nowadays are generally rather small. No increased cancer risk has been shown among Finnish nuclear power station workers or physicians occupationally exposed to radiation (Auvinen et al 2002, Jartti et al 2006). The production of nuclear energy in normal circumstances causes radiation exposure, in practice,
only to workers, and no excess of cancer has been found around nuclear power stations in Finland (Heinävaara et al 2010). The nuclear power station disaster in Chernobyl in 1986 resulted in some additional radiation to nearly all Finns. The dose, even at its largest, was only the same as that received annually from other natural sources (about 1 mSv). Leukaemia among children or thyroid cancers did not increase after the accident (Auvinen 1994, But 2006), nor did the fallout from atmospheric nuclear tests in the 1960s result in a detectable excess of cancer in the most heavily exposed population of Northern Finland (Figure 3, Kurttio et al 2010).

Cancer patients receiving radiation therapy are exposed to very high radiation doses, and in addition to the tumour, the surrounding tissues are also affected. Patients treated with radiation therapy involving substantial doses to the bone marrow have an increased risk of leukaemia and other cancers (Travis et al 2000, Worrillow et al 2003, Hill et al 2005, Salminen et al 2006 and 2007), but the benefits of treatment clearly outweigh the risks.

Cosmic radiation is sparse at sea level, but increases with altitude. Exposure to cosmic radiation is considerable in air travel, but the increased breast and skin cancer risk among pilots and flight attendants is not related to the radiation dose (Pukkala et al 1995, 2002 and 2012).

Non-ionizing radiation does not have sufficient energy to remove electrons from an atom. It includes ultraviolet radiation as well magnetic and electric fields. Ultraviolet radiation is received from the sun and solarium and causes skin cancer. The most important cause of melanoma is

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**FIGURE 3**

Doses of radiation among reindeer herders and other people in northern Finland in 1950–2005. Those who had eaten the most reindeer meat did not have more cancer than others (Kurttio et al 2010).

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intensive UV-radiation to skin unaccustomed to this, causing burning of the skin, particularly in children and adolescents. In particular, light skinned, blue-eyed people and those who burn easily and tan poorly are at risk. Some melanomas occur in moles, and having a large number of moles (over 100 pigmented naevi) increases melanoma risk.

Power lines and electrical appliances generate low frequency magnetic fields (50–60 Hz). The impact on cancer risk, and particularly on childhood leukaemia, has been studied extensively, and increased risk estimates for childhood leukaemia, related to very high exposure levels, have been shown in several studies. For other cancers, no clear indication of excess risk has been demonstrated. According to Finnish research series covering the entire population, children and adults do not have an increased cancer risk related to proximity to power lines (Verkasalo et al 1993 and 1996). Occupational exposure to electromagnetic fields occurs in many workplaces, but there is no indication of cancer risk as a result of such exposures.

Radar, radio transmitters, mobile phones and base stations, among others, generate radiofrequency electromagnetic fields (in the megahertz range). Radiofrequency fields do not cause genetic changes, and have not increased cancers in animal tests. In epidemiologic research, the use of mobile phones has been linked to an increased cancer risk (Interphone Study Group 2010), but problems with this research include a fairly short ten-year follow-up period and the unreliability of information on mobile phone use based on questionnaires. More reliable evidence is expected from follow-up studies ongoing in Finland, Sweden, Denmark, Great Britain and the Netherlands.

Lifestyle

TOBACCO. The use of tobacco products is the most important single factor that increases cancer risk. The risk from tobacco is based on a large amount of carcigenic (cancer-causing) compounds, which are already in tobacco products or are formed during the burning process.

It has been estimated that tobacco products cause one third of all cancers. The impact of smoking on lung cancer is the best known. The probability of getting lung cancer is greater the younger a person starts smoking, the more the person smokes daily and the longer the smoking continues (Hakulinen and Pukkala 1981). If a person has smoked 20 cigarettes daily for 50 years, his or her risk of getting lung cancer is 50 times higher than that of non-smokers. After stopping smoking, the danger of lung cancer quite rapidly approaches the lung cancer risk of a non-smoker of the same age, but never drops to the same level. Those who have smoked for a long time will still benefit the most from stopping smoking.

Smoking is a significant cause of laryngeal cancer, and is also linked to cancers of the mouth, throat, kidney, pancreas, oesophagus, uterus and bladder. Smoking may also increase the risk of breast cancer (Xue et al 2011).

In 2009, 22 percent of Finnish men and 16 percent of Finnish women smoked daily (Helakorpi 2010). In addition, about 8 percent of adults smoked occasionally. Smoking among men
has been decreasing for decades, but smoking among women has begun to reduce slightly only in the last few years. There are major differences between social groups in the frequency of smoking, and these differences continue to grow. Fifteen percent of men with a higher level of education, but 37 percent of men with the lowest level of education, are smokers. At least two out of three smokers have attempted to stop smoking.

Snus is being used daily by 1.7 percent of Finnish men and 0.1 percent of women (Helakorpi et al 2011). Recent research has indicated a clear cancer risk resulting from using snus. The danger of cancers of the mouth, throat, pancreas, stomach as well as oesophagus is much greater in those using snus than those not using tobacco products (Luo et al 2007, Roosaar et al 2008, Zendehdel et al 2008).

The prevalence of lung cancer in Finland’s male population has been among the highest in the world, and 20 years ago it was five times higher than that in Norwegians. This big difference was explained by different smoking habits some decades ago (Hakulinen et al 1987). Lung cancer develops only decades after the smoking started, and therefore lung cancer incidence reflects the smoking habits of 20–50 years ago. Nowadays Norwegians have more lung cancer than Finns (Figure 4).

Exposure to cigarette smoke in the environment increases the risk of lung cancer. It has been estimated that involuntary smoking causes 10–50 new lung cancers every year in Finland. Involuntary smoking in previous decades may be one of the explanations for the fact that restaurant

![Figure 4](image-url)
workers have the highest cancer risk of all occupations in the Nordic countries (Pukkala et al 2009).

Cancer risk often increases significantly through the combined impact of smoking and some other factor. Smoking and outdoor work together increase increase for instance the risk of lip cancer by 15-fold, although outdoor work alone or smoking increases lip cancer risk only by two-fold (Lindqvist 1979). Correspondingly, smoking increases the impact of asbestos and many such materials used in the working environment, which alone are not particularly dangerous.

**ALCOHOL.** There is a clear causal relation between the use of alcohol and several cancers. There is convincing evidence that the use of alcohol increases cancers of the mouth, throat, larynx, oesophagus and liver (Baan et al 2007, www.dietandcancerreport.org).

Four daily servings of alcohol (50 g ethanol), for example, increase the risk of mouth and pharynx cancers by two-fold. Other factors may increase the impact of alcohol. Drinking alcohol and smoking together very strongly increase the risk of cancers of the mouth, throat and larynx.

With regard to breast cancer, there is no safe amount of alcohol intake, but rather the risk of cancer increases directly in relation to the amount of alcohol consumed. Moderate amounts of alcohol taken infrequently are not significant. On the other hand, excessive use of alcohol increases the cancer risk and causes other clear health problems regardless of whether drinking alcohol is infrequent or regular. The cancer risk does not differ significantly with the type of alcohol drink consumed. The most important risk factor is the amount of ethanol consumed.

Alcohol, or ethanol, may cause cancer through several possible mechanisms. The most significant is probably that, in the body, alcohol breaks down into acetaldehyde, which are capable of causing DNA damage (Salopuro 2009). In addition, the breakdown of alcohol blocks the body’s removal of toxins and makes it possible for the other cancer risk factors to accumulate in tissues. Alcohol is also an efficient solvent, which may harm mucous membranes from the mouth to the stomach and, therefore, make it possible for other substances to have an influence.

**DIETARY FACTORS.** The effects of diet on cancer have been researched intensively for decades. Thirty years ago it was estimated that diet was the most important modifiable cause of cancer. Diet is a complex mix of components in which combined and contradictory effects are difficult to understand.

Diet has been considered to have the strongest influence on the risk of cancer of the stomach, colon, rectum, as well as the oesophagus, kidney, bladder, prostate, lung, breast and corpus uteri. These are common cancers in Finland and other countries with western diets. Dietary factors can cause cell transformations in many ways:

- Some dietary factors can in themselves cause cancer (for example alcohol).
- Cancer causing substances can be found in
food which is spoiled or not clean (for example aflatoxin of certain moulds).

- In some methods of preparing food, cancer-causing substances are formed (for example polycyclic aromatic hydrocarbons when grilling).

- Certain dietary factors can become cancer-causing in the body (nitrites).

- The lack of dietary factors which are protective against cancer (for example a lack of vitamins and minerals) increase the risk of getting disease.

A diet that has an excessive energy content, or the resulting excess in body weight, increases the risk of many cancers. Based on many animal experiments, it has been found that fat in the diet increases the risk of cancers of the breast, colon and pancreas. Information concerning humans is not yet so convincing that dependable conclusions could be drawn on the impact of fat in the diet on the cancer risk. Cancer tissue also needs energy and minerals, and therefore, dietary factors can – as well as causing cancer – also influence the growth of cancer.

Dietary fibre probably protects against colon cancer (Bingham 2003). Hence root vegetables and rye bread, which belong to the traditional Finnish diet, are also healthy in this regard.

Vitamins are one of the most important areas of research concerning links between food and cancer. The greatest interest has been in carotenoids, A, E, C and D vitamins and folates. Many of these vitamins are important antioxidants in the body. They prevent oxidation of fatty acids and protect the body from harmful substances arising from oxidation. Low levels of vitamin D seem to be linked to an increased risk of some cancers, but high levels of vitamin D are also linked to a higher than usual cancer risk (Tuohimaa et al 2007).

Several studies have indicated that a diet rich in vegetables and fruit decreases the risk of many cancers. Vitamin products have been also researched in cancer prevention experiments, but none have so far been proven to prevent cancer alone or in combination (ATBC 1994). It is probable that from the point of cancer prevention, a balanced totality, not single nutrient factors, is the most crucial aspect of diet.

Among the minerals, selenium has been the most researched. It is estimated that a lack of selenium increases cancer risk. The selenium content of Finnish food is nowadays sufficient; therefore additional selenium products are not needed.

Some food preparation methods cause chemical changes that lead to cancer-causing factors. Smoking and grilling fatty food on an open fire or otherwise at a high temperature creates small amounts of polycyclic aromatic hydrocarbons (PAH) on the surface of the food, which increase the cancer risk. Acrylamide in potato chips, French-fries and hard bread is classified as a possible cancer risk compound, but eating food containing acrylamide has not been found to have a connection to cancers (Mucci et al 2003). Excessive use of food preserved by salt increases the risk of gastric cancer.
EXERCISE AND WEIGHT CONTROL. A link between exercise and cancer risk has been observed in several studies. Scientific proof has been collected of the protective effects of exercise, particularly concerning cancers of the breast, colon, uterus and prostate (www.dietandcancerreport.org).

Moderate exercise changes the metabolism of certain hormones and strengthens the functioning of the body’s general protective mechanisms. Exercise reduces the amount of fat tissue, and the amounts of different growth factors become more balanced. The diet of an actively exercising person often includes more components that protect from cancer.

According to the latest research, the benefits of exercise are generally achieved by about an hour of daily exercise, such as walking or cycling to work or to the shops, going up the stairs or raking the yard. For weight control, it is sufficient to have half an hour of exercise three times a week. Those doing office work in particular should exercise regularly in order to avoid being overweight. Brisk exercise several times a week can give an extra benefit in preventing cancer (Latikka et al 1998).

Exercise is also beneficial when rehabilitating from cancer or in preventing a relapse (Knols et al 2005). Finnish BREX study concerning this issue started in 2005 (Penttinen et al 2009). While nothing can yet be said of the cancer prevention potential of exercise, this 12-month aerobic jumping and circuit training intervention completely prevented femoral neck bone loss in premenopausal breast cancer patients (Saarto et al 2012).

REPRODUCTION AND HORMONES. Cancer of women’s reproductive organs and breast cancer are clearly linked to sexual and reproductive behaviour. If a woman herself – or her sexual partner – has had several partners, she is more likely than other women to get cervical cancer. The explanation for this is that sexually transmitted viruses are important factors in cervical cancer (see Infections).

Giving birth at a young age and having many children protect from breast cancer. The protective impact is increased if a woman has many children (Hinkula et al 2001). Not having children is also a risk factor for cancers of the ovary and corpus uteri, and early sexual maturity and late menopause increase the number of a woman’s menstrual cycles and increase the risks of the above-mentioned cancers.

Modern contraceptive pills protect against cancers of the ovary and corpus uteri. During menopause, women who have undergone lengthy hormone therapy are, on the other hand, diagnosed with more cancers of the breast, endometrium and ovary than women who do not use hormone therapy (Jaakkola et al 2009, Lyttinen et al 2010, Koskela-Niska et al 2013). Linking the progesterone hormone to estrogen replacement therapy increases the risk of breast cancer, but protects against cancer of the uterus. The benefits of hormonal therapy during menopause must be considered individually in relation to the cancer risk.

INFECTIONS. Some viral infections increase cancer risk. Infections caused by some bacteria may also increase risks of certain cancers. For example, Helicobacter pylori increases the risk
of gastric cancer (Rehnberg-Laiho et al 2001). Some tropical parasitic diseases also increase the cancer risk, but they are very unusual in Finland.

Human papilloma viruses (HPV) are the most researched virus family of those which cause cancer. Some cause chronic infection and, through this, cervical cancer (Lehtinen et al 1996). Papilloma viruses may also cause other cancers, such as pharyngeal cancer (Mork et al 2001).

Vaccines aimed at preventing infections caused by papilloma viruses have been on the market for some years. Vaccine efficacies against low-grade cervical intraepithelial neoplasia (CIN) have been defined for both licensed vaccines (Lehtinen et al 2013). Ongoing studies with long-term follow-up will by 2015 and 2022 find out if HPV-vaccines also prevent higher grades of CIN3 and invasive cervical cancer, respectively (Lehtinen et al 2006, Rana et al 2012).

An increased risk of liver cancer is also linked to chronic liver infection (hepatitis B and C viral infections). The Hepatitis B virus (HBV) vaccination campaign that began in Taiwan in 1984 led first to a reduction in HBV incidence and then to a significant reduction in liver cancer incidence in the age groups vaccinated (Chang 2011).

HIV infection and AIDS are linked to an increased risk of lymphoma and Kaposi sarcoma, which would otherwise be a very rare disease (Kaasinen et al 2013). These cancers are not caused directly by cancer-causing features of the HIV virus, but by the collapse of general immune defence linked to the illness. In this situation, the HHV8 virus can cause Kaposi sarcoma.

Socio-economic position

The overall cancer incidence for working aged men in the lowest social class is about one third higher than in the highest class. On the other hand, the cancer incidence for women is highest in the highest social class. Typical cancers in the lower class are those of the lip, stomach and nose as well as throat and laryngeal cancer (Figure 5). In the lower classes, there are also more cervical cancers and vaginal cancers in women and lung cancers in men. Cancers linked to a high standard of living are cancers of colon, breast and testis as well as melanoma of skin on the trunk and limbs. Differences in cancer incidence between social classes may be as great as five-fold.

Differences between social classes have increased rather than decreased (Pukkala and Weiderpass 1999 and 2002). The socio-economic pattern can also change: for example, lung cancer in women changed very rapidly from an illness related to a high standard of living to one related to a low standard of living at the turn of 1980s.

Socio-economic position impacts on cancer risk through lifestyle and work-related factors. In most cancers in the lower social classes, smoking is an important cancer risk factor. Smoking among men and young women in Finland is most common in the lower social classes. For more than three decades, smoking differences have been accepted as explaining almost all of the differences in the frequency of lung cancer and many other cancers between the social
Figure 5
Connection of socio-economic position to cancer incidence in Finland 1971–2005. The graph is based on information from NOCCA study (Pukkala et al 2009) and it shows standardized incidence ratios (SIR) in relation to the population mean (1.0).

**MEN**

<table>
<thead>
<tr>
<th>Cancer Type</th>
<th>SIR</th>
<th>SIR</th>
<th>SIR</th>
<th>SIR</th>
<th>SIR</th>
<th>SIR</th>
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</thead>
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<td>Lip cancer</td>
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<tr>
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<tr>
<td>Lung cancer</td>
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**WOMEN**

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<th>SIR</th>
<th>SIR</th>
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<tbody>
<tr>
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<td>Lung cancer</td>
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<tr>
<td>Breast cancer</td>
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<td></td>
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<tr>
<td>Cervical cancer</td>
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<tr>
<td>Skin melanoma</td>
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classes (Pukkala et al 1983). Dietary differences have been suggested to be related to social class differences in cancer risk (Pukkala and Teppo 1986).

Cancer and other illnesses

Generally, cancer risk is independent of that for other illnesses. For example, cancer risk does not increase in those with injuries from accidents or in those receiving treatment for heart ailments. Although lung cancer risk is increased for people suffering from asthma (Vesterinen et al 1993), the risk is not caused by asthma but by smoking, which causes both illnesses.

Depression, anxiety, grief and work-related stress have little impact on cancer risk. Finnish schizophrenics have less cancer than the population average (Lichtermann et al 2001). Hip or knee prostheses (Visuri et al 2010, Mäkelä et al 2012) and silicone breast implants (Pukkala et al 2002 a) do not lead to an increased cancer risk.

Normal everyday ailments of the working age population, such as headache, tiredness, diarrhoea, weak spells or anaemia connected to the menstrual cycle, are not normally associated with cancer, although they can sometimes be symptoms of cancer. Epilepsy does not increase the risk of cancer, but epilepsy can be a symptom of a hidden brain tumour (Lamminpää et al 2002).

Medicines are tested in clinical research before they are used. Research and development work is stopped if there are even small indications that the medicine being developed could cause cancer. The side effects of medicines that are already on the market are monitored closely, and manufacturers remove products readily from the market. However, it is unlikely that medicines already in use nowadays or those which are newly introduced new medicines have significant cancer risks. For example the risks of cancer associated with the use of antibiotics and statins have been researched in Finland (Kilkkinen et al 2008, Haukka et al 2010). At the moment, diabetes medicines are being researched for any possible impact on cancer risk. Preliminary results suggest that, although diabetics have an increased risk of getting cancer, there is no connection between diabetic medication and cancer.

Relatively toxic medicines and other treatments which are used for treating complex illnesses are a different matter. For example, radiation therapy for cancer, and some medical treatments, may increase the risk of getting cancer later (Kumpulainen et al 1998, Salminen et al 1999, Metayer et al 2000, Travis et al 1999, 2002, 2003, Dores et al 2002, Pukkala et al 2002 c, Gilbert et al 2003, Worrillow et al 2008, Jakobsen et al 2011, Morton et al 2011). However, the benefits of these types of cancer treatment have been estimated to be greater than their adverse effects.

The body’s immune system must be suppressed for organ transplants, so that the transplanted organ will not be rejected. Because the immune system protects against cancer, the cancer risk for people who have received kidney or liver transplants, for example, is above average (Birkeland et al 1995, Åberg et al 2008). The virus
causing HIV infection and AIDS suppresses the immune system and increases the risk of cancer. The body’s disturbed immune system in rheumatic illnesses (Kauppi et al 1997, Hill et al 2001), in certain intestinal tract and skin ailments (Collin et al 1996) as well as in cartilage-hair hypoplasia (Mäkitie et al 1999) also increase the cancer risk.

Many genetic syndromes also include cancers as one aspect, sometimes giving rise to several tumours in different organs. For some inherited illnesses, the cancer risk is increased, although cancer itself does not belong to the group of symptoms. For example Down syndrome is linked to an increased risk of leukaemia (Patja et al 2006).

Getting one cancer does not protect against other cancers. Cancer patients can develop new cancers just like healthy people. According to the data of the Finnish Cancer Registry, among those who have recovered from the first cancer about one in ten gets a new cancer (Sankila et al 1995). The factors causing the first cancer can also increase the risk of the second cancer: for example patients with laryngeal cancer have an increased risk of getting lung cancer (Teppo et al 1985).

Attributable fractions of risk factors

There have been attempts to put the population attributable fractions of different cancer-related factors in order of importance. The most well-known estimate of the contribution of environmental and other causes to the risk of cancer is the study of Doll and Peto in 1981, according to which tobacco and diet were both responsible for one third of cancer deaths in the United States (Doll and Peto 1981). According to Nordic estimates (Olsen et al 1997) tobacco causes only about 15 percent of new Finnish cancer cases. The difference is explained, among other things, by the fact that lung cancer is a disease with a poor prognosis and its proportionate share of cancer deaths is therefore bigger than its share of cancer incidence. The significance of various factors also differs according to regional and local circumstances, health behaviour and socio-economic situation.

Possibilities for cancer prevention

It is in principle possible to attempt to prevent cancer at different phases of the chain of events leading to the disease. We may affect the factors that begin the process, or its progression, by helping the body to correct early changes or by treating early stages of disease before the actual cancer has developed.

The possibility of preventing cancer depend on whether it is possible to change cancer risk factors related to environment and lifestyle. It was estimated in 1980 that the annual number of lung cancer cases in men would decrease from 2000 cases, at that time, to a few hundred if all Finns stopped smoking immediately (Hakulinen and Pukkala 1981). Smoking did not stop completely, but has decreased so much that the age-adjusted incidence of lung cancer has fallen to less than half of the highest level in 1970s. According to estimates, the incidence of lung cancer will continue to decrease up to the year 2020 (see page 65).
Finland was the first country to add tobacco smoke to the list of carcinogenic substances and, in its legislation, states that tobacco smoke causes cancer. The aim of the tobacco law of 2010 is to stop smoking in Finland by the year 2040. If this happened, it would have a great impact on the incidence of lung and other cancers.

The potential of reducing other risk factors does not look as promising. For example, the cancer-causing and cancer-protective characteristics of food products are not well enough known for cancer risk to be reduced through specific changes in eating habits. The knowledge of many other risk factors is equally insufficient and inaccurate.

Recently, many have begun to consider increasing exercise as a significant method of cancer prevention. For example, the European recommendations on cancer prevention (Boyle et al. 2003) list avoiding obesity and taking daily exercise as the second most important practical steps in cancer prevention. Only refraining from smoking is more important. The World Cancer Research Fund and the American Cancer Society published in 2007 the recommendations of an extensive group of experts on reducing the risk of cancer through diet and exercise. The recommendations and justifications can be found on the Internet (www.dietandcancerreport.org). The messages of most dietary recommendations are similar: they underline the importance of staying as slim as possible, as long as weight remains within normal limits. Exercise should be taken every day. Diet should be mainly of vegetable origin. Intake of high-energy foods, red meat, meat products, alcohol, salt and mouldy products should be limited. Artificial dietary supplements should not be used.

The development of cancer normally requires a long time. Any current changes in exposure will mainly impact on cancer risk after the 2020s. Although significant changes in cancer incidence cannot be expected in the coming decades, deaths from cancer can be reduced through the development of methods for early cancer detection and improvement in treatments, amongst others. An excellent example of cancer prevention is the systematic screening of cell changes in the cervix by the Pap test and the treatment of these cell changes, which has dramatically reduced cervical cancer in Finland (see page 50).

There are excellent conditions in Finland for carrying out epidemiologic research on cancer risk factors. A well-functioning personal identity code system makes it possible for information collected from different sources to be combined reliably (Pukkala 2011). In addition, Finnish legislation allows the combination of information from different registries, for scientific studies that will benefit society and individuals. For example, research on dietary factors, the risks of living in certain areas, working environments, heritable factors and the inequality of social groups have all been based on combining information from registries. It is of the utmost importance that the possibility of doing high quality epidemiologic research is safeguarded when cancer research becomes more and more complex and requires detailed information. Then the co-operation of several information providers is needed even more than before.
Currently in our country there are 250 000 people who have had cancer at some point in their lives. Some of them are fully recovered; some of them have a problem or side-effect caused by the disease or its treatment. The number of prevalent cancer patients is continuously increasing.

In 2011 more than 30 000 new cancer cases were diagnosed in Finland. The most common cancer in women was breast cancer and in men prostate cancer. Nearly 4 900 women got breast cancer and over 4 700 men got prostate cancer (Figure 6). More than 3 000 intestinal tract cancers were found for men and women combined. Only 656 cases of gastric cancer, which was the most common cancer for both men and women in the 1950s, were detected. Statistics on the amount of cancer cases and cancer deaths are given by age group and health districts on the website of the Finnish Cancer Registry (www.cancerregistry.fi, section Statistics).

About 11 700 Finns die of cancer annually, making cancer the main cause of every fifth Finnish death. The number of cancer deaths has remained quite stable for a long time. The commonest cause of cancer death is lung cancer (Figure 7).

Changes in cancer frequency

Cancer is a disease which becomes more common with increasing age (Figure 8). Although
FIGURE 6
Number of cancer cases for men and women in 1953 and 2011. The surface area of the circle describes the total number of cancer cases.
Figure 7

Number of deaths caused by cancer in Finland in 2011.
FIGURE 8
Cancer incidence and mortality per 100,000 person-years by age group in Finland in 2005–2011.

FIGURE 9
Trends of annual numbers in new cancer cases and cancer deaths in Finland in 1953–2011.
the number of those getting cancer annually has increased over three-fold in 50 years (Figure 9), this increase does not describe changes in the risk of getting cancer. Population increase, particularly in older age groups, also has an impact on the growth in case numbers.

Cancer risks at different time periods, in different regions and populations, can be made comparable using age-standardization. Figure 10 shows trends in the age-standardized cancer incidence and mortality rate for all cancers over the years. In the absence of population aging, the annual number of cancers would have stayed approximately the same, if breast cancers detected by screening and prostate cancers detected by PSA tests were excluded from the figures. The age-standardized cancer mortality is now only one-half the rate of the peak years.

Gastric cancer, which was the most common cancer in men and women up to the 1950s, has decreased during the whole period of cancer registration (Figure 11). Since the 1950s, lung cancer in men has increased dramatically, as men had started smoking during the war in the early 1940s. Thereafter, smoking among men has decreased, which can be seen as a reduced lung cancer risk. The risk of prostate cancer has increased steadily since the early 1990s. Since then, PSA testing, used in the early diagnosis of prostate cancer, has become increasingly common. This has increased the detection rate of prostate cancer so strongly up to the year 2005 (Figure 11), that it has produced an overall increase in the incidence of all cancers (Figure 10).

Of the more rare cancers among Finnish men, for example, the incidence of bladder cancer increased at first and then reduced as smoking declined. The same phenomenon is seen, but slightly less marked, in the incidence of pancreatic cancer (Figure 12). Developing lymphoma is linked, among other things, to the reduced functioning of the immune system. This happens, for example, when many serious illnesses are treated successfully. This phenomenon may explain the increasing risk for lymphoma at the population level. The incidence of lip cancer has decreased heavily, reflecting the fact that Finns have moved to indoor work and that their exposure to sunlight and tobacco has reduced.

The risk of breast cancer in women has increased continuously, and breast cancer is now the most common cancer among women (Figure 11). The occurrence of breast cancer increased by about one-tenth in 1987, when the national mammographic screening programme for breast cancer began (see page 52). More than one thousand breast cancers are detected annually through screening, most of which are asymptomatic. Another significant reason for the increase in breast cancers is hormone treatment of menopause (Jaakkola et al 2009, Lyytinen et al 2010). The reduction of lengthy hormone therapy at the beginning of 2000s is seen clearly in a decrease in breast cancer incidence in Norway and Sweden, with a smaller decrease in Finland (Hemminki et al 2008).

The increase in the risk of cancer of corpus uteri ended in the 2000s (Figure 11). This phenomenon is partly explained by the fact that the uterus has been removed from nearly one-third of all 70-year old women, and that there is no longer a risk of cervical cancer (Luoto et al 2004). No clear reasons have been found for
Age-standardized cancer incidence and mortality in Finland 1953–2011.
FIGURE 11
Age-standardized incidence of the most common cancers in Finland 1953–2011.

MEN

- Prostate cancer
- Lung cancer
- Colorectal cancer
- Gastric cancer
WOMEN

Incidence/100,000

Year

Breast cancer
Colorectal cancer
Endometrial cancer
Gastric cancer
**Figure 12**
Age-standardized incidence rates for selected cancers in men in Finland 1957–2011 in five-year periods.

**Figure 13**
Age-standardized incidence rates for selected cancers in women in Finland 1957–2011 in five-year periods.
the changes in the incidence of ovarian cancer (Figure 13). In other Nordic countries ovarian cancer risk has decreased even more than in Finland, which might suggest a role of decreasing use of lengthy hormone therapies (Koskela-Niska et al 2013). The incidence of female lung cancer has increased continuously as smoking among women has become more common.

Tumours of the central nervous system, and especially benign tumours of brain membranes (meningiomas) in women have become more common. This is linked to more advanced imaging techniques, through which symptomless tumours inside the skull are found, for example, in connection with the examination of the blood circulation in the brain.

Skin melanoma is one of the increasingly common cancer types in both women and men. This is linked to travel to the south, the popularity of sun tanning and repeated sunburning. Skin melanomas are found mostly among clerical workers in towns and much less in those who work outside and whose skin, being used to sun, does not burn (Pukkala et al 1995). On the other hand the most important cause of the other main types of skin cancer, basal cell carcinoma and squamous cell carcinoma, is the cumulative lifespan dose of UV-radiation.

Cancer and gender

Of the new female cancers detected in 2011, 44 percent were in the breast or the reproductive organs (Figure 14). Prostate cancer made up 31 percent of all cancers in men. Apart from gender-based cancers, there are other clear differences between men and women in cancer frequency. The age-standardized rate of laryngeal cancer for men is ten times that for women. For lung and lip cancers, the difference is currently about three times, but in the 1950s the risk was 15 times greater. This phenomenon is mainly explained by the fact that smoking habits among men and women have developed different manners in recent decades.

Bladder cancer risk is four times greater, and gastric cancer risk nearly two times greater for men than for women, and many other cancers are more common in women. On the other hand, thyroid cancer is over three times more common in women than in men.

Cancer and age

Cancer is typically an illness of elderly people. People aged under 40 get cancer only rarely, but after that the probability of getting cancer grows rapidly with increasing age (Figure 8). For some cancers, the dependency of incidence on age differs from the average (Figure 15). For instance, at the start of the 1960s cervical cancer was the most common cancer among women aged 50-54 years, and the disease risk was relatively high even for 40-year old women. Nowadays the cancer is most common in 70-year old women. For the middle-aged and younger, disease risk has reduced considerably because of mass screening.

Lung cancer is most common among people in their eighties, but quite rare in even older age groups (Figure 15). Smoking increases mortality rates for causes other than lung cancer, which is why there are fewer long-term smokers among people over 80 years. For men over 50
FIGURE 14
Age-standardized incidence of cancer by gender in 2011.

Prostate cancer
Breast cancer
Lung cancer
Colon cancer
Skin melanoma
Non-Hodgkin lymphoma
Cancer of central nervous system
Skin cancer, non-melanoma
Rectum cancer
Bladder cancer
Kidney cancer
Pancreatic cancer
Leukaemia
Cervical cancer
Gastric cancer
Thyroid cancer
Ovary cancer
Liver cancer

Incidence/100 000
FIGURE 15
years of age, prostate cancer, which is very rare for men under 45, is clearly the most common cancer. Before PSA screening, prostate cancer was mostly detected in even older age groups than nowadays (Figure 15).

About 150 young Finns, under the age of 15 years, develop cancer each year. The portion of childhood cancer is therefore about half a percent of the total population cancer cases. Childhood cancer can differ from adult cancer, among other ways, in the cell type and in its biological behaviour. The most common childhood cancers are leukaemia and brain tumours, the combined number of which comprises over half the cancers for those under 15 years (Table 2). The different cancer types are almost equal in number for boys and girls. The frequency of childhood cancers has not changed significantly over the past decades.

The incidence of brain and nervous system tumours and leukaemia (Figure 15), on the other hand, is quite high among children. Testicular cancer and Hodgkin lymphoma are typical malignancies of young adults (Figure 15).

The likelihood of an individual getting cancer can be estimated from the age-specific incidence figures. For example, about one in 15 women will develop breast cancer before reaching retirement age, and more than every tenth woman during her entire life span (Figure 16). Almost every third Finn has been diagnosed with cancer by the age of 85 years.

### Table 2

Average annual cancer cases for children under 15 years old in Finland 2005–2009.

<table>
<thead>
<tr>
<th>Number of cases</th>
<th>Proportion of all childhood cancers (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leukaemia</td>
<td>53</td>
</tr>
<tr>
<td>Brain tumours</td>
<td>34</td>
</tr>
<tr>
<td>Lymphomas</td>
<td>15</td>
</tr>
<tr>
<td>Neuroblastoma</td>
<td>9</td>
</tr>
<tr>
<td>Soft tissue sarcomas</td>
<td>8</td>
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<tr>
<td>Kidney tumours</td>
<td>7</td>
</tr>
<tr>
<td>Germ cell tumours</td>
<td>5</td>
</tr>
<tr>
<td>Bone sarcomas</td>
<td>4</td>
</tr>
<tr>
<td>Liver tumours</td>
<td>3</td>
</tr>
<tr>
<td>Retinoblastoma</td>
<td>2</td>
</tr>
<tr>
<td>Others</td>
<td>8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>148</strong></td>
</tr>
</tbody>
</table>
**FIGURE 16**
Differences between generations

Time factor changes in incidence result mainly from the different exposures of each generation to cancer risk factors. Smoking among men was most common during the first two decades of the 1900s, and as a result the incidence of lung cancer for men is highest for those born in 1900–1924. However, smoking by women has increased continually from one age group to the next so the incidence of lung cancer for women is systematically higher for those women born later.

Skin melanoma is one of the most rapidly increasing cancers. For women born in 1950, the risk of getting melanoma by the age of 30 was as great as the risk of developing it by the age of 65 for those born around 1900 (Figure 17). The probability of getting gastric cancer, by contrast, is smaller for those born later. For those born in the 1940s, gastric cancer risk at each age is about one-tenth the risk of those born in 1900 (Figure 17).

Regional variation

The risk to Finns of getting cancer is close to the average of the countries in the European Union (Figure 18).

Changes in cancer incidence in Finland reflect the improving standard of living. Gastric cancer was the most common cancer in Finland in the 1950s, but has become rarer in all western countries (Figure 19). Comparison of the frequency of colorectal cancer in the Nordic countries shows clearly the impact of changes in the standard of living (Figure 19). The recent wealth of Norway has changed the nutritional and other habits of its population, shown as a much greater increase in colorectal cancer than in Finland.

Cervical cancer incidence decreased drastically when organised mass screening started in the 1960s (see page 50). In comparing Nordic countries, it can be clearly seen that the risk of cervical cancer in Denmark has always been greater than in other countries (Figure 20). In other Nordic countries, the decline in cervical cancer risk started earlier than in Norway, where the organization of screening was improved later than elsewhere.

The incidence of skin melanoma in the Nordic countries decreases towards the north, and people living in the same latitude in different countries do not differ much in their incidence of melanoma (Figure 21). On the other hand, the map of lung cancer in women (Figure 22) shows that although female lung cancer is one of the most rapidly increasing diseases in Finland, the risk in Finnish women is still far from the high figures for Denmark and Norway. In Iceland the prevalence of lung cancer is the same for men and women.

Municipalities are such small units that it is very seldom possible to draw reliable conclusions from cancer incidence for an individual municipality. In a typical Finnish municipality of 10 000 people, normally only about eight cases of cancer are diagnosed annually for each of the most common cancers – prostate cancer in men and breast cancer in women. More reliable information can be deduced about cancer incidence in different regions when informa-
FIGURE 17

MEN, gastric cancer

WOMEN, skin melanoma
FIGURE 18
Variations in incidence of some cancers in EU countries 2008 (Ferlay et al 2010).
FIGURE 19

MEN, gastric cancer

WOMEN, colorectal cancer
The cancer risk for women living in towns in southern Finland has been consistently about one and a half times greater than that for women in the north-east of Finland, whose incidence has been the lowest in the country (Figure 24). For example, lung and breast cancer are most common for women living in Helsinki and the surrounding areas. A benign papillary form of thyroid cancer has been diagnosed mostly around Oulu, which probably derives from different regional diagnostic practices for thyroid masses.
Regional variations in overall cancer incidence among men are small. In the 1950s the incidence in coastal towns was slightly above average, and from there the higher incidence spread to other towns, until regional variations disappeared entirely in the 1980s (Pukkala and Patalma 2010). Prostate cancer, which became more common in the 1990s, increased the number of cancer cases firstly mainly in the capital city area but in more recent years also in the Tampere area in southern mid-Finland (Figure 23). The cancer burden is lowest in the most northern part of Finland, due to an exceptionally low cancer incidence rate among the Sami population: the Sami people have fewer cancers of any kind than other people living in the same area (Soininen et al 2002). This difference is not explained by known variations in lifestyle.

The geographical variation in most cancers has remained relatively constant, although the overall incidence level has changed in the whole country. Changes in the factors causing cancer can however little by little alter the regional emphasis in cancer incidence. The different development of smoking habits in different parts of Finland has shifted the main focus of lung cancer in men from southern Finland to the east-central part of Finland, where lung cancer incidence was least common in the 1950s. On the other hand, prostate cancer was diagnosed in the 1990s mostly in the Tornio area in the southwest part of Lapland, then in the capital area and Tampere, and in the 2000s in South Ostrobothnia in western Finland. The webpage of the Cancer Registry has illustrative map animations on this subject (see for example astra.cancer.fi/cancermaps/suomi5308/fi).

Most cancer types are more common in towns than in rural areas. For many cancers this difference has declined over the decades, but the incidence of lung cancer in women is still about two times higher in bigger towns than in rural towns. Lip cancer is the only type that is found more frequently in rural areas than in towns. Similar differences have been found when municipalities are classified according to average income or family size of the population, because the income of those living in rural areas is lower and there are more children in families than in those living in industrialized communities (Teppo et al 1980).

The impact on cancer incidence of the environment in which people live can be studied, for example, through the quality of soil, air or drinking water. This can be studied when good background information about the environment is available. The excellent Finnish population registry system makes this kind of research possible for very small area units – even for a 250 meter square map grid (Kokki et al 2002).

Comparing differences in regional incidence and their trends can indicate possible causes of cancer. More accurate clarification of causal relations, however, requires studies in which large numbers of people, who are exposed in different ways, are compared using individual-level information.
FIGURE 21
FIGURE 22
FIGURE 23
Variation in incidence of some cancer types among men in Finland 2000–2009. Average in Finland = 1.00.
Figure 24
Variation in incidence of some cancer types among women in Finland 2000–2009. Average in Finland = 1.00.
Cancer screening

The objective of cancer screening is to detect pre-clinical disease in its early stages, when cancer can still be cured. The main aim is to reduce mortality from cancer, and also sometimes its incidence. The latter is possible if the progression of pre-cancerous lesions to cancer can be prevented by treating them in the precursor phase.

Municipalities in Finland are obliged to organise free cancer screening for their population. The Health Care Act (1326/2010) and the Government Decree on Screening (339/2011) regulate this area. According to the Decree on Screenings, screening for cervical cancer should be offered to women aged 30–60 years every 5 years and breast cancer screening to those aged 50–69 at 20–26 month intervals. The obligation to organise breast cancer screening for women over 60 years concerns women born in 1947 and later. In addition to these mandatory screening programmes, some municipalities have voluntarily started colorectal cancer screening for men and women aged 60–69 years every two years.

Cervical cancer screening

Cervical cancer screening began in Finland at the initiative of the Cancer Society of Finland at the beginning of the 1960s. Based on the decree on screening, about 250 000 women between the ages of 30–60 years are screened annually. All women belonging to the target age group are invited for smear taking every five years. Certain high risk women are referred for testing more often than the normal five year interval. This improves early detection of cancer cases (Hakama and Pukkala 1977, Hakama et al 1979).

Cervical cancer screening is carried out using cells from the cervix, the so-called Papanicolau test. Since 1999 new screening techniques have also been studied, such as automated PAPNET screening (Anttila et al 2006) and HPV-based screening test to indicate the presence of the human papilloma virus (Kotaniemi-Talonen et al 2005). In addition to these, screening samples taken at home have been tried for those women who have not participated in regular screening (Virtanen et al 2011).

The number of cervical cancer cases began to decrease rapidly when screening for cervical cancer had almost reached its full extent at the end of the 1960s. The number of new cases in the most completely screened age group (35–59 years) decreased from 300 to 40 annually. On the other hand, the number of cancer cases in unscreened women remained largely the same or even increased (Figure 25). The same
has happened in other Nordic countries when screening for cervical cancer has become part of the healthcare system (Figure 20).

Since the start of screening, cervical cancer has become rarer, and the mortality rate has decreased. Annually detected new cases in the population and the mortality rate from cancer of uterine cervix have reduced to a fifth from the starting point. It has been estimated that screening averts over 200 deaths from cervical cancer annually.
Breast cancer has been the most common cancer among women since the 1960s. The incidence of cancer starts to increase from 40 years of age. Breast cancer screening is based on mammographic tests or x-ray examination of the breasts, in which an x-ray is taken from one or more directions. If the mammography finding is abnormal, the woman is invited for further investigation. This further investigation may include additional mammograms, ultrasound examination or fine or core needle biopsies. If the possibility of cancer cannot be excluded, investigation will continue in hospital, and a biopsy sample is taken from the breast in order to determine the tumour type.

The national mammographic screening for breast cancer started in Finland at the beginning of 1987, the first of its kind in the world (Elovainio et al 1989). Nearly 90 percent of the invited age groups participate in screening. About three percent of screened women are invited for supplementary examination, and breast cancer is detected about in one out of three hundred. Mass screening has led to a reduction in breast cancer mortality by one quarter for 50–59-year-old women, which means averting one death against every 10 000 examinations (Hakama et al 1997). Breast cancer incidence has strongly increased in age groups participating in screening (Figure 26).

Research has been carried out on screening which was implemented by the units of the Cancer Society of Finland from the 1990s to the start of the 2000s. The activity of these units was of good quality and met the European Un-
ion quality specifications. Breast cancer mortality for 50–69-year-old women was 22 percent lower in those invited for screening than the estimated rate without screening. Breast cancer mortality was reduced by 28 percent in screening participants (Hakama et al 1997, Sarkeala et al 2005, Sarkeala 2008).

Colorectal cancer screening

Cancer of the colon and rectum are the third most common cancers of Finns, after prostate cancer and breast cancer. The primary treatment of these cancers is surgery. In most cases the patient will be cured if the cancer is limited to the bowel wall. If the cancer has spread into regional lymph nodes or further within the body, chemotherapy and possibly radiation therapy are given as additional treatments.

In Finland, almost half of all colorectal cancers have already spread beyond the bowel wall in patients seeking treatment based on symptoms. Early detection is difficult, because symptoms of cancer in the abdominal area are often unclear or there are no symptoms at all.

In randomized screening studies carried out abroad, it has been observed that screening can reduce the mortality rate for colorectal cancer by about 16 percent (Hewitson 2007). Colorectal cancer is screened using a test indicating faecal blood. The screening sample is taken at home and is returned by mail to the screening centre. Those with faecal blood detected are referred for follow-up examination by colonoscopy. Two to three persons of every hundred have occult faecal blood. For most, the occult blood is caused by something else than cancer, such as haemorrhoids, infection of the intestinal tract or benign polyps.

Screening of men and women aged 60–69 for colorectal cancer has begun in Finland since 2004 in municipalities that were willing to start the screening program. In 2010, 45 percent of 60–69-year-old people were living in municipalities taking part in the screening program. Screening begins with those aged 60–64 years, and expands gradually to include the entire 60–69-year-old age group in the screening program within five years. In the implementation phase, only half of this age group is screened and the other half remains as a control group, as the benefit-risk ratio is not yet clear.

In Finland, the screening program for colorectal cancer works well, and population participation in screening is extremely high. About 70 percent of those invited participate in screening (Malila et al 2008, 2011). Follow-up investigations associated with the screening program have also been effective, and it has been possible to do colonoscopies with very short waiting times. Colorectal cancer or neoplastic early stages have been detected as predicted, i.e. about in every tenth of those sent for a colonoscopy.

Colorectal cancer can also be screened by colonoscopy, but screening carried out this way is expensive, and serious harm may be caused by the procedure. The use of colonoscopy as a screening method is currently being studied in Europe and the United States. In Finland colonoscopy screening is used only if a person has an increased risk of getting bowel cancer, for example, in patients suffering from adenomas.

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or in close relatives of those with an inherited susceptibility to colorectal cancer.

Screening for prostate cancer

Prostate cancer is the most common cancer in men in Finland. Finland has been participating in the European Randomised Prostate Cancer Screening (ERSPC) trial, the results of which indicate that PSA testing reduced deaths from prostate cancer by one fifth (Schroder et al 2009). These findings are based on the screening of 262,000 people during a nine-year period. Altogether 80,000 men from Finland were randomised, of whom 30,000 were screened with PSA-testing at age 55–71 years 2–3 times at four-year intervals. The remaining men formed the control group. Men from the area surrounding Tampere and from the Helsinki capital area were invited for screening. The actual screening stage was concluded at the end of 2007.

Screening can detect cancer at an early stage, when it can still be cured. However, many more prostate cancers were detected in the screened group than in the control group in the ERSPC. This could mean that not all early stage tumours would have ever advanced to harmful cancer. Based on the results, it is not certain if screening causes more benefit or harm. The most important disadvantage of screening for prostate cancer is the detection of indolent cases, i.e. cancers that would not have been found without screening and would not have caused any harm during the man’s lifetime. It is not possible to differentiate the detectable small, histologically malignant but clinically benign, prostate cancers from those aggressive cancers that would spread and cause death eventually.

Screening for other cancers

Other cancers considered for screening are, for example, oral cancer, especially in developing countries, ovarian cancer, stomach or gastric cancer, and lung cancer. It is not yet known if screening would reduce mortality for these cancers in the population, but the issue is being investigated in randomised studies. Of these, the results of the effects of a screening for lung cancer directed towards smokers and based on low dose spiral computer tomography were published in 2011 (The National Lung Screening Trial Research Team 2011).
Treatments

Surgery, radiation therapy, chemotherapy, hormone treatment and biologic treatments (for example interferon treatment) are used in treating cancer. Different treatment methods are often combined, in order to get the best possible result.

The selection of treatment methods is based on cancer type and stage, the general condition and age of the patient, among other things. Experts from different areas of medicine take part in the selection of the treatment method. The newest treatments are targeted drugs, which affect only the cancer. They cause fewer side effects for the patient than cytotoxic drugs and hormonal treatments. The treatment of each patient is planned individually, and so patients with the same cancer may have different treatments. Some cancers can progress so slowly that the situation can be followed up for some time before selecting a treatment method.

After cancer is suspected and detected, a diagnosis is made and the stage is defined. In these investigations, ultrasound, x-ray and magnetic resonance imaging are used in addition to laboratory tests. Pathologists also identify the cancer grade in order to determine the most appropriate treatment combination for each cancer.

Breast cancer, for example, may be treated either by removal of the whole breast or by local removal of the tumour, sparing the breast. It is often necessary to also remove lymph nodes from the armpit. The patient is generally given radiation therapy and chemotherapy in addition to surgery in order to secure the destruction of all tumour cells. Long-term hormonal treatment can be given as follow-up treatment in order to prevent a relapse of the cancer. In some cases, a surgically removed breast can be replaced with a silicon prosthesis or with the patient’s own tissue. If the cancer has spread, the patient’s symptoms can often be relieved with additional surgery or radiation therapy.

Combinations of medical treatment may be changed if one combination begins to lose effect. If the cancer has spread and death gets closer, the focus changes to relieving pain and symptoms so that the patient’s quality of life remains as good as possible. A cancer patient’s final treatment stage is called hospice care.
Cancer treatments have progressed considerably in the last decades. Nowadays a large number of cancer patients live a normal life after the detection and treatment of cancer and eventually die from causes other than cancer.

The relative survival ratio is used as an indirect measure of recovery from cancer. It indicates the proportion of cancer patients that live for a certain period after diagnosis, compared to the rest of the population of the same age during the same period. If the annual relative survival ratio is less than 100 percent, cancer has caused additional deaths. Five years is generally considered the statistical limit of recovery, although for some cancers there are a small number of extra deaths after that limit, and in some cases statistical recovery may be reached earlier (Dickman et al 1999).

The five-year relative survival ratio is 62 percent for men and 65 percent for women for Finnish patients who developed cancer in 2007–2009 (Table 3). This calculation does not take into consideration basal cell carcinomas, which cause almost no additional deaths. The higher survival ratio for women is largely a result of the considerably better prognosis for breast cancer, the most common cancer for women, compared to lung cancer, the most common for men.

The five-year survival ratio is 89 percent for those Finns who got breast cancer in 2007–2009. Correspondingly, for those with prostate cancer the five-year survival ratio is predicted to be 93 percent, but this figure is distorted by the many good prognosis prostate cancers discovered through PSA testing. Many of the cancers discovered by PSA testing are such that they do not have an impact on life span and these men will die of other diseases. The five-year relative survival ratio for testicular cancer has improved considerably due to improved treatment and nowadays exceeds 95 percent (Figure 27). The notorious skin melanoma is discovered nowadays mainly in the form of a thin local tumour, for which surgery is almost always curative (Table 3).

The most common cancer types of recent decades, gastric cancer and lung cancer, are cancers with a poor prognosis. However, as the proportion of these cancers of the overall cancer burden is decreasing, and the prognosis for other cancers is improving, the overall reputation of cancer as a killing disease is slowly changing.

Some cancers remain difficult to cure. Among these are cancers of the liver, gallbladder and pancreas. Less than three percent of those suffering from pancreatic cancer will survive five years from the date of diagnosis. However, with modern treatments, even cancer that has already spread can be controlled for some time and survival ratios improve, although the patient finally dies of cancer.
Factors contributing to survival

Survival ratios of cancer patients vary considerably depending on how far the cancer has spread when it is detected. The prognosis for those patients whose cancer has been detected while local is best, because it is often possible to remove the entire tumour at surgery. For example, for men whose local skin melanoma was diagnosed in the 2000s, the five-year relative survival ratio was 94 percent, but the survival ratio was only 9 percent if the skin melanoma had already spread. Although gastric cancer patients have a relatively poor prognosis on average, the five-year relative survival ratio was over 60 percent when the cancer was detected at the local stage.

Breast cancer is an example of a disease where, although the disease has already spread, the patient may have a long survival due to effective treatment. For those with a local breast cancer in the 2000s, the five-year relative survival ratio was as much as 98 percent. If the disease had spread only to the lymph nodes in the armpit, the figure was 88 percent. Even when the disease had spread further, the relative survival ratio at five years was 42 percent.

Young patients recover from almost all cancers better than elderly ones. In the past leukaemia was an exception; in the early 1970s the relative survival ratio for patients under five years of age was less than 10 percent, while for those aged 45 years or more it was over 20 percent. This is because children are more likely than adults to get leukaemia in the acute form. Survival ratios for children with leukaemia have, however, improved enormously in recent years: since the

### Table 3

Projected relative five-year survival ratios for cancer patients in 2007–2009 (%).

<table>
<thead>
<tr>
<th>Cancer type</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>Testicular cancer</td>
<td>96</td>
<td></td>
</tr>
<tr>
<td>Prostate cancer</td>
<td>93</td>
<td></td>
</tr>
<tr>
<td>Thyroid cancer</td>
<td>90</td>
<td>93</td>
</tr>
<tr>
<td>Hodgkin lymphoma</td>
<td>91</td>
<td>92</td>
</tr>
<tr>
<td>Skin cancer, non-melanoma</td>
<td>89</td>
<td>91</td>
</tr>
<tr>
<td>Breast cancer</td>
<td>89</td>
<td></td>
</tr>
<tr>
<td>Skin melanoma</td>
<td>83</td>
<td>88</td>
</tr>
<tr>
<td>Cancer of corpus uteri</td>
<td>82</td>
<td></td>
</tr>
<tr>
<td>Cervical cancer</td>
<td>68</td>
<td></td>
</tr>
<tr>
<td>Bladder cancer</td>
<td>71</td>
<td>62</td>
</tr>
<tr>
<td>Non-Hodgkin lymphoma</td>
<td>64</td>
<td>64</td>
</tr>
<tr>
<td><strong>All cancers</strong></td>
<td>62</td>
<td>65</td>
</tr>
<tr>
<td>Rectum cancer</td>
<td>62</td>
<td>65</td>
</tr>
<tr>
<td>Cancer of central nervous system</td>
<td>57</td>
<td>69</td>
</tr>
<tr>
<td>Kidney cancer</td>
<td>61</td>
<td>63</td>
</tr>
<tr>
<td>Colon cancer</td>
<td>60</td>
<td>61</td>
</tr>
<tr>
<td>Leukaemia</td>
<td>51</td>
<td>48</td>
</tr>
<tr>
<td>Ovary cancer</td>
<td>49</td>
<td></td>
</tr>
<tr>
<td>Myeloma</td>
<td>33</td>
<td>30</td>
</tr>
<tr>
<td>Gastric cancer</td>
<td>23</td>
<td>25</td>
</tr>
<tr>
<td>Oesophageal cancer</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>Lung cancer</td>
<td>8</td>
<td>13</td>
</tr>
<tr>
<td>Gallbladder cancer</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>Liver cancer</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Pancreatic cancer</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>
FIGURE 27
1990s more than four patients out of five are still alive five years after the disease was detected (Figure 27). The average five-year survival ratio for all cancer patients has increased by nearly 10 percent units in ten years.

There generally are no major differences between sexes in the survival ratios of the same cancer. The prognosis for women with skin melanoma is better than for men, which is explained largely by the fact that most melanoma in the men is on the trunk, where the prognosis is worst, while most of the melanomas in women are located on the limbs. The social status of the patient has some impact on the patient’s prognosis: the well-to-do and well-educated recover from nearly all cancers a little better than those belonging to a lower social group or with a low level of education (Auvinen et al 1995, Pokhrel et al 2010).

There are large differences in the survival ratios of patients treated with different methods, but it is not possible to draw direct conclusions whether one method is better than another. Extensive treatments that give the best results are most suited to patients who are most likely to be cured. The condition of these patients must also be adequate to tolerate the strain of treatment. The best prognosis, for localised cancers treated with extensive surgery, was a 100 percent relative survival already at the end of the 1960s, for example, for cervical cancer (Hakulinen et al 1981).

Sizable variations in the survival ratios for different treatment institutions and in different countries are often due to differences in patients. In international comparisons, the survival ratios of Finnish patients are at the top level both in Europe and worldwide (Sant et al 2009).

Years of life lost

When estimating the significance of different cancers to national health, attention should be paid to the years of life lost because of different cancers, as well as to the number of cancer cases and survival rates of cancer patients. The quality of additional years of life also has significance, and should influence the selection of the treatment method.

In Figures 28–29 the average age of detection, duration of illness and estimated years of life lost due to cancer are described for different types of cancer. The target of comparison is the remaining years of life for the population of the same age. The average age at diagnosis varies from 35 years for those with testicular cancer to 77 years for women with squamous cell carcinoma of the skin.

The relative survival ratios do not tell how much a life is shortened because of cancer. Although in 2002–2009 the relative survival rate for men with a brain tumour was 57 percent and for those who had lung cancer it was 8 percent, the brain tumour patients lost more years of life on average than the lung cancer patients, who were older.
FIGURE 28
Average cancer detection age for men and number of life years lost due to cancer: Cancers detected in 1998–2007.
Average cancer detection age for women and number of life years lost due to cancer: Cancers detected in 1998–2007.
Cancer in the future

Predictions of future developments in cancer incidence are needed when planning hospital beds, equipment and number of staff needed for cancer treatment. Predictions are also beneficial because, using them, actions can be targeted at cancer prevention and early detection as well as estimating the outcome of different cancer prevention methods.

In the Finnish Cancer Registry, predictions of cancer incidence have been developed on several occasions, and there is a lot of experience concerning the accuracy of different methods. According to a prediction made in 2009 (Finnish Cancer Registry 2009) age-standardized cancer incidence in men will reduce noticeably in the coming years, and the cancer incidence for women will also reduce slightly (Table 4). Although the age-standardized incidence will fall as predicted, in 2020 about 3 000 more cancers will be detected than in 2011. According to the prediction, about 17 700 cancer cases will be detected among Finnish men in 2020 and about 16 100 cases among women. This increase in case numbers is due to the fact that the average life span for Finns is longer and the more populous age groups born after World War II will move into the ages in which cancer incidence is the highest.

The prediction of cancer incidence for men is affected largely by what will happen with regard to prostate cancer. A prediction model for this book assumes that prostate cancer incidence will remain at the 2007–2009 level (Figure 30) for all age groups. The assumption is that the incidence for prostate cancer was at its peak in 2004–2005 and that prostate cancer incidence will return close to the trend seen before the use of PSA testing increased. This kind of change has been observed in the United States (Oliver et al 2001) and in Sweden (Engholm et al 2011).

Future trends for most cancer types will follow the previously observed directions (Figures 30–31). Intestinal cancer will probably become still more common, and will probably be the second most common cancer of men and women from 2015 onwards. Lung cancer among men will become rarer, but the age-standardized incidence for lung cancer in women is projected to continue to increase. In 2020 there will be over 900 cases of lung cancer detected among women, which would be only about 40% less than for men.

The increase in case numbers means that cancer will require more health care resources than today. Cancer types with a poor prognosis, for example lung cancer, gastric cancer and cancer of oesophagus will reduce in numbers. A larger portion of cancers will be cured. Treatments will develop, although in most cases in small increments. From the perspective of treatment results, it will be important that, in the future, cancer is detected in an early enough stage and that the cancer patient can get the best possible treatment without delay.
TABLE 4
Age-standardized incidence of most common cancers per 100 000 people in 2009 and prognosis for 2020 (Finnish Cancer Registry 2009).

<table>
<thead>
<tr>
<th></th>
<th>Number of cases</th>
<th>Age-standardized incidence</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MEN</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>2009</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All cancers</td>
<td>14 863</td>
<td>304.9</td>
</tr>
<tr>
<td>1 Prostate cancer</td>
<td>4 595</td>
<td>89.5</td>
</tr>
<tr>
<td>2 Lung cancer</td>
<td>1 676</td>
<td>32.0</td>
</tr>
<tr>
<td>3 Colorectal cancer</td>
<td>1 391</td>
<td>27.5</td>
</tr>
<tr>
<td>4 Skin cancer</td>
<td>1 344</td>
<td>26.8</td>
</tr>
<tr>
<td>5 Non-Hodgkin lymphoma</td>
<td>650</td>
<td>14.6</td>
</tr>
<tr>
<td>6 Cancer of bladder</td>
<td>708</td>
<td>13.6</td>
</tr>
<tr>
<td>7 Cancer of central nervous system</td>
<td>409</td>
<td>11.3</td>
</tr>
<tr>
<td>8 Kidney cancer</td>
<td>500</td>
<td>10.4</td>
</tr>
<tr>
<td>9 Pancreatic cancer</td>
<td>506</td>
<td>9.9</td>
</tr>
<tr>
<td>10 Leukaemia</td>
<td>360</td>
<td>9.2</td>
</tr>
<tr>
<td><strong>2020</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All cancers</td>
<td>17 659</td>
<td>282.3</td>
</tr>
<tr>
<td>1 Prostate cancer</td>
<td>5 872</td>
<td>85.8</td>
</tr>
<tr>
<td>2 Colorectal cancer</td>
<td>1 980</td>
<td>30.7</td>
</tr>
<tr>
<td>3 Skin cancer</td>
<td>1 844</td>
<td>27.2</td>
</tr>
<tr>
<td>4 Lung cancer</td>
<td>1 550</td>
<td>22.3</td>
</tr>
<tr>
<td>5 Non-Hodgkin lymphoma</td>
<td>774</td>
<td>13.5</td>
</tr>
<tr>
<td>6 Cancer of bladder</td>
<td>715</td>
<td>9.9</td>
</tr>
<tr>
<td>7 Pancreatic cancer</td>
<td>698</td>
<td>10.7</td>
</tr>
<tr>
<td>8 Cancer of central nervous system</td>
<td>493</td>
<td>13.3</td>
</tr>
<tr>
<td>9 Leukaemia</td>
<td>432</td>
<td>10.2</td>
</tr>
<tr>
<td>10 Kidney cancer</td>
<td>385</td>
<td>6.4</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th></th>
<th>Number of cases</th>
<th>Age-standardized incidence</th>
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<tbody>
<tr>
<td><strong>WOMEN</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>2009</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All cancers</td>
<td>13 946</td>
<td>254.3</td>
</tr>
<tr>
<td>1 Breast cancer</td>
<td>4 469</td>
<td>92.1</td>
</tr>
<tr>
<td>2 Skin cancer</td>
<td>1 200</td>
<td>18.8</td>
</tr>
<tr>
<td>3 Colorectal cancer</td>
<td>1 255</td>
<td>18.4</td>
</tr>
<tr>
<td>4 Cancer of corpus uteri</td>
<td>808</td>
<td>14.0</td>
</tr>
<tr>
<td>5 Cancer of central nervous system</td>
<td>591</td>
<td>13.9</td>
</tr>
<tr>
<td>6 Lung cancer</td>
<td>691</td>
<td>11.0</td>
</tr>
<tr>
<td>7 Non-Hodgkin lymphoma</td>
<td>559</td>
<td>9.7</td>
</tr>
<tr>
<td>8 Ovary cancer</td>
<td>435</td>
<td>8.2</td>
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<tr>
<td>9 Thyroid cancer</td>
<td>298</td>
<td>8.2</td>
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<tr>
<td>10 Kidney cancer</td>
<td>399</td>
<td>6.9</td>
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<tr>
<td><strong>2020</strong></td>
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<tr>
<td>All cancers</td>
<td>16 052</td>
<td>252.1</td>
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<tr>
<td>1 Breast cancer</td>
<td>5 119</td>
<td>90.2</td>
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<td>2 Colorectal cancer</td>
<td>1 528</td>
<td>22.3</td>
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<td>3 Skin cancer</td>
<td>1 421</td>
<td>18.5</td>
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<td>4 Cancer of central nervous system</td>
<td>749</td>
<td>16.2</td>
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<tr>
<td>5 Cancer of corpus uteri</td>
<td>1 015</td>
<td>13.6</td>
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<tr>
<td>6 Lung cancer</td>
<td>908</td>
<td>12.7</td>
</tr>
<tr>
<td>7 Non-Hodgkin lymphoma</td>
<td>655</td>
<td>10.1</td>
</tr>
<tr>
<td>8 Ovary cancer</td>
<td>495</td>
<td>8.6</td>
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<tr>
<td>9 Pancreatic cancer</td>
<td>770</td>
<td>8.3</td>
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<tr>
<td>10 Thyroid cancer</td>
<td>266</td>
<td>7.0</td>
</tr>
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</table>
FIGURE 30
Number of new cases detected annually for men in 1982–2009 and projected number of cases until 2027. Projection of prostate cancer has been made separately; others are carried out with the NORDCAN spreadsheet tool (Engholm et al 2011).
FIGURE 31
Number of new cases detected annually for women in 1982–2009 and projected number of cases until 2027. Projection of breast cancer is made separately; others are carried out with the NORDCAN spreadsheet tool (Engholm et al 2011).
**Figure 32**

Age-standardized cancer mortality rate for men in 1982–2009 and projected rate until 2027. Projections are made with the NORDCAN spreadsheet tool (Engholm et al 2011).
FIGURE 33
Age-standardized cancer mortality rate for women in 1982–2009 and projected rate until 2027. Projection is made with the NORDCAN spreadsheet tool (Engholm et al 2011).
Results presented in this book indicate that cancer is closely linked to the individual’s lifestyle, behavioural habits and environmental aspects. Some cancers can be prevented, and it is possible to change the future trends in the cancer incidence.

The main challenges for cancer research for the coming decades have not changed: it is still important to find the causes of cancer and to develop appropriate methods for detecting cancer in an early stage. It is left as a challenge to decision-makers in society to find means by which the living environment can be made safer and which can support the population to change their lifestyle habits to encourage better health.

Cancer is a very common group of diseases, and is familiar to every family. However, cancer deaths are becoming fewer (Figures 32–33). In a Gallup poll held in May 2006, every fourth Finn considered cancer a very scary disease, but in the future this fear is likely to lessen. Already the well-educated population fears cancer the least: correct knowledge reduces pain.
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Luoto R, Raitanen J, Pukkala E, Anttila A, Teppo L. Lönqvist J. Cancer incidence is decreased in schizophrenia patients, but decreased in their relatives. Arch Gen Psychiatry 2001; 58: 573–8.


Sur IK, Hallikas O, Vähärautio A et al. Mice Lacking a Myc enhancer element that includes human SNP rs6983267 are resistant to intestinal tumors. Science 2012; 338: 1360–3.


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HOW TO FIND INFORMATION ABOUT CANCER ON THE INTERNET

CANCER FREQUENCY (INCIDENCE, MORTALITY AND PREVALENCE) IN THE WHOLE OF FINLAND OR BY MUNICIPALITY

Go the Cancer Registry’s web page (www.cancer.fi) and click on the word “Statistics”. Choose the link “Cancer Statistics”. Choose an area of your interest and then a table. The selection of tables includes figures on the incidence, mortality and prevalence as numbers of cases and as rates. The table’s essential figures can be highlighted and copied, for example into Excel, from which presentation graphics can be made. Ready-made graphic presentations exist in the Statistics section link "Graphics about Cancer Frequencies" (www.cancer.fi/syoparekisteri/en/statistics/graphics-about-cancer-frequency/), but these graphic images are not regularly updated.

CANCER FREQUENCY IN AN OUT OF THE ORDINARY WAY

The Cancer registry can chart cancers in ways exceptional to the traditional categories, among others, according to topographical sub-categories (i.e., cardia), morphology (i.e. adenocarcinoma), staging (local, spread to regional lymph nodes, or spread further) and the method of detection (for example, microscopically confirmed), if the tables are for a justified need. Requests for tables should be sent to kirjaamo@cancer.fi.

CANCER FREQUENCY BY MUNICIPALITY

The frequency of cancer can also be charted according to justified need by municipality, but there may be questions of privacy protection connected to limited population based tables. Requests for these tables should also be sent to kirjaamo@cancer.fi.

If you want to compare the cancer situation between residential areas, it can easily be done by using the presentation materials in map format. That can be found through the link in Cancer Registry’s Statistics section “Graphics about Cancer Frequencies” (including the links “Spatial and Temporal change in relation, Finland animations” and “Nordic countries’ map animations” (http://astra.cancer.fi/cancermaps/Nord124/pub/)).

CANCER FREQUENCY IN FINLAND AND OTHER NORDIC COUNTRIES IN TABLES AND GRAPHS

Go to the Nordic Countries’ Cancer Registry (ANCR) website (www.ancr.nu) and choose the link NORDCAN - on the Web. Choose the language by clicking on the flag. If the basic information package is enough for you, choose the desired cancer and country from the selection “Cancer Fact Sheets” and click on “Go” (generate fact sheet). If you need other kinds of tables, they can easily be done through the link “Online Analysis”. Graphics that can be easily copied and pasted into a PowerPoint presentation, for example, appear within a few seconds. With the easy-to-use tool of NORDCAN, the user can make predictions about cancer frequency in the future.

CANCER FREQUENCY IN OTHER COUNTRIES

Estimation data about cancer incidence and mortality in the whole world can be found from the WHO’s international cancer research center’s (International Agency for Research on Cancer) GLOBOCAN data bank, which can be accessed through the website www-dep-iarc.fi. It can be navigated in the same way as the above-mentioned NORDCAN information database. Cancer data from the United States is related on the page seer.cancer.gov.

CANCER FREQUENCY ACCORDING TO OCCUPATION IN FINLAND AND OTHER NORDIC COUNTRIES

Thanks to broad Nordic countries’ cooperative NOCCA study (Nordic Occupational Cancer Study), plenty of informational tables about the number of cancer cases and the risk for cancer according to occupation categories (Pukkala, et al. 2009) are available. They are found on the website through the link astra.cancer.fi/NOCCA. For English language tables, click on the link “Table downloads”. After that, you can choose tables according to the cancer type (more than 80 alternatives) or the occupation (54 occupation categories). Word tables can be edited and sorted in the normal way or transferred, for example, to Excel.

CANCER PATIENT SURVIVAL

The Cancer Registry calculates at least every other year patients’ survival ratios, which are always a part of the published English language yearly statistics. Electronic versions of the statistics can be accessed by clicking on the book cover icons on the web page www.cancerregistry.fi => “Statistics”. Tables concerning the survival ratios for cancer patients from all of the Nordic countries can be found in NORDCAN.
Cancer stat fact sheets
Finland - All sites but non-melanoma skin cancer

<table>
<thead>
<tr>
<th></th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of new cases per year (incidence 2007–2011)</td>
<td>13621</td>
<td>13104</td>
</tr>
<tr>
<td>Proportion of all cancers (%)</td>
<td>95.4</td>
<td>95.4</td>
</tr>
<tr>
<td>Proportion of all cancers except non-melanoma skin (%)</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Risk of getting the disease before age 75 (%)</td>
<td>28.0</td>
<td>23.7</td>
</tr>
<tr>
<td>Age-standardized rate (W)</td>
<td>279.4</td>
<td>241.2</td>
</tr>
<tr>
<td>- Estimated annual change latest 10 years (%)</td>
<td>-0.7</td>
<td>+0.6</td>
</tr>
<tr>
<td>Number of deaths per year (2007–2011)</td>
<td>5899</td>
<td>5414</td>
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<tr>
<td>Proportion of all cancer deaths (%)</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Risk of dying from the disease before age 75 (%)</td>
<td>11.2</td>
<td>8.0</td>
</tr>
<tr>
<td>Age-standardized rate (W)</td>
<td>110.9</td>
<td>76.0</td>
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<tr>
<td>- Estimated annual change latest 10 years (%)</td>
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<td>-0.6</td>
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<tr>
<td>Persons living with the diagnosis at the end of 2011 (prevalence)</td>
<td>90513</td>
<td>124544</td>
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<tr>
<td>Number of persons living with the diagnosis per 100 000</td>
<td>3412</td>
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<tr>
<td>Relative survival (%) with [95% CI] (2004–2008)</td>
<td>78 [76–77]</td>
<td>78 [76–79]</td>
</tr>
<tr>
<td>1-year</td>
<td>78 [76–77]</td>
<td>78 [76–79]</td>
</tr>
<tr>
<td>5-year</td>
<td>60 [56–61]</td>
<td>63 [63–63]</td>
</tr>
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</table>

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17.5.2013
How common are cancers in Finland now and in the future? What do we know about the risk factors for cancer? How can cancer best be prevented? Should non-symptomatic cancers be screened from the whole population? How will cancer patients survive?

This book is based on solid data including hundreds of cancer studies collected over time and the Finnish Cancer Registry’s data collected in over 60 years time. The Cancer in Finland books have for over 30 years provided credible and up-to-date information about what kind of disease cancer is in the Finnish setting. This is the first edition in English. The book is meant to be suitable for all who are interested in cancer, not only for health care professionals.