Marja Niemi, Klas Winell

Diabetes in Finland

Prevalence and Variation in Quality of Care

Finnish Diabetes Association
STAKES – National Research and Development
Centre for Welfare and Health

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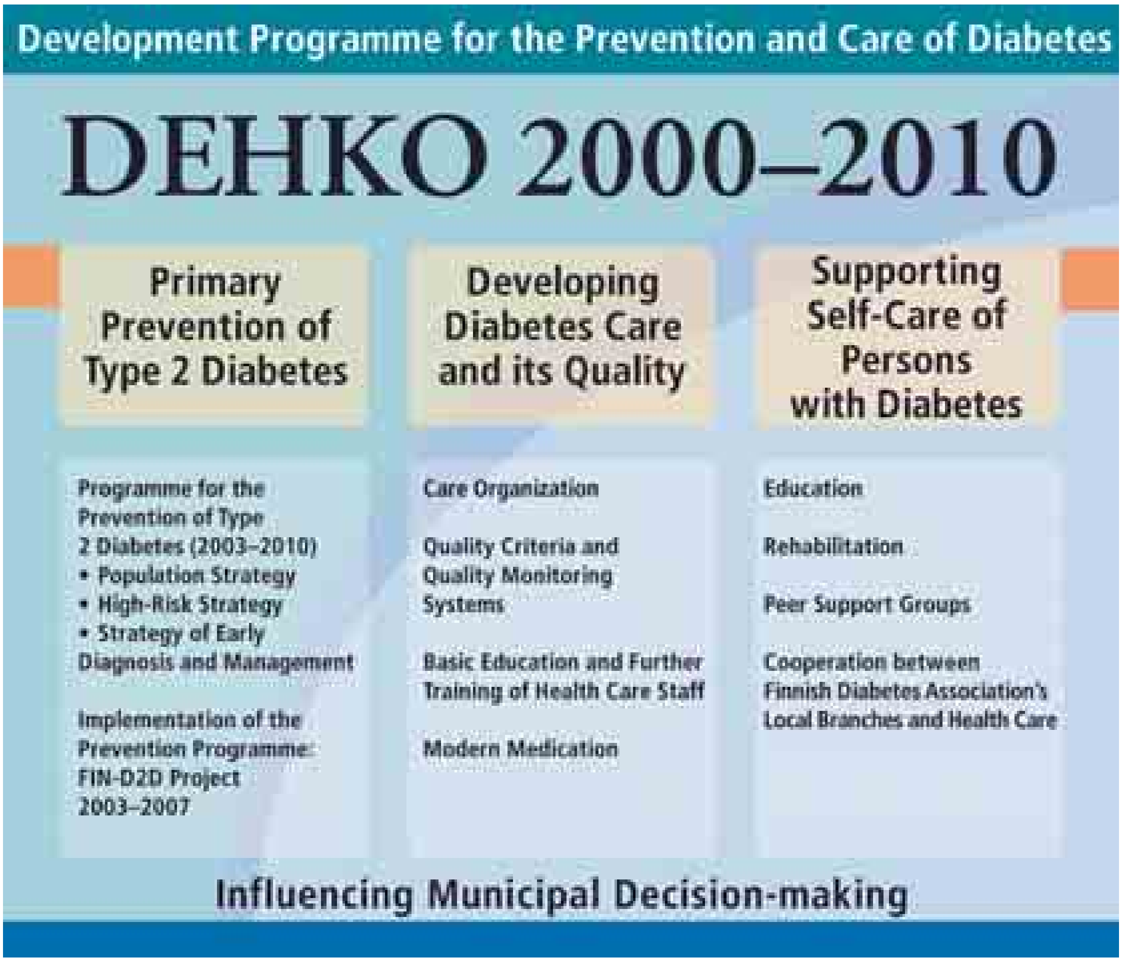
DEHKO


Development Programme for the Prevention and Care of Diabetes
DEHKO 2000–2010
Primary Prevention of Type 2 Diabetes
Programme for the Prevention of Type 2 Diabetes (2003–2010)
• Population Strategy
• High-Risk Strategy
• Strategy of Early Diagnosis and Management
Implementation of the Prevention Programme: FIN-D2D Project 2003–2007
Developing Diabetes Care and its Quality
Care Organization
Quality Criteria and Quality Monitoring Systems
Basic Education and Further Training of Health Care Staff
Modern Medication
Supporting Self-Care of Persons with Diabetes
Education
Rehabilitation
Peer Support Groups
Cooperation between Finnish Diabetes Association's Local Branches and Health Care
Influencing Municipal Decision-making

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Tampere 2006

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Foreword

In health care, increasing attention is paid to the quality and efficacy of care. New medications must be subject to efficacy studies before they can be released onto the market; the health-economic benefits of medications must also be shown before pricing applications are filed. The same trend in the development of care is seen everywhere. In Finland, the Finnish Office for Health Technology Assessment (FinOHTA) assesses the usefulness of various forms of care both in its own studies and by being engaged in extensive international cooperation.

Assessments of care serve as the basis for the national Current Care guidelines drawn up by experts. These guidelines can be used locally to create models for good care practices; their goal is then to ensure that patients get the best possible care with the resources available.

One cornerstone of the nationwide Development Programme for the Prevention and Care of Diabetes (DEHKO 2000–2010) is improvement of the quality of care. This calls for indicators that can be used to monitor quality. The DEHKO quality criteria working groups have therefore defined criteria for good care as concerns both the resources and processes of care as well as the outcomes. Diabetes care can be described as successful when good control of diabetes has been achieved but especially when the complications and premature deaths caused by diabetes are reduced.

The idea to conduct this study arose in one of the many preparatory groups set up for the extensive DEHKO project (Diabeteksen hoidon laatu ja seurantajärjestelmät [Diabetes care quality and monitoring systems] DEHKO Report 2002:2). On the basis of the group's recommendations, it was proposed that STAKES should prepare a report on the complications of diabetes and should investigate what information could be used for reporting about the complications of diabetes both nationally and for comparison of hospital districts. The study should also determine how often such a report should be compiled on the basis of information in registers.

The study started as a cooperation project between STAKES, the Social Insurance Institution of Finland (KELA) and the Finnish Diabetes Association in autumn 2003. Director General Mauno Konttinen played an important role in launching the study.

The success of the study can largely be attributed to the Steering Group, comprised of the following members: from STAKES, Development Manager Olli Nylander (Chairperson in 2003), Senior Researcher Annukka Ritvanen (Chairperson in 2004–2005), Senior Medical Officer Hannu Rintanen, and Development Manager Marja Niemi; from KELA, Research Professor Timo Klaukka and Leading Researcher Paula Hakala; from the National Public Health Institute, Research Professor Antti Reunanen; and from the Finnish Diabetes Association, Quality Manager Klas Winell. The following persons also participated in the Steering Group's work: from STAKES, Senior Planning Officer Simo Pelanteri, and Planning Officer Petri Matveinen; from KELA, IT Planner Timo Pitkonen; and as an outside IT specialist, Anneli Keinonen. Simo Pelanteri and Timo Pitkonen collected the data from the STAKES and KELA registers, Anneli Keinonen constructed the database, and Petri Matveinen executed the necessary analysis runs. The report was written by Marja Niemi and Klas Winell.

Pirjo Ilanne-Parikka, Chief Physician of the Finnish Diabetes Association, and numerous other specialists in various fields have contributed to the study by acting as consultants.

Helsinki, October 2005

Olli Nylander *Annukka Ritvanen*

Abstract

Marja Niemi, Klas Winell: Diabetes in Finland. Prevalence and Variation in Quality of Care. Translated by the Finnish Diabetes Association. 85 pages. Tampere 2006. ISBN 952-486-021-x.

This epidemiological study based on data in statutory registers investigated the quality of diabetes care and differences in the quality of care between various hospital districts in Finland between the years 1988 and 2002. The data were collected from the registers of STAKES, KELA, and Statistics Finland by using personal identity numbers. The material comprised 308,447 persons with diabetes, of whom 184,721 were alive at the end of the review period. In 1988, there were 93,831persons with diabetes. Thus a 97 per cent increase in their number had taken place by the year 2002. Growth was particularly rapid in the number of people with type 2 diabetes. In relative terms, their number was the greatest in the age bracket 80–84 years old. On the other hand, the number of people with type 2 diabetes in the age bracket 30–35 years old tripled between 1990 and 2002.

Three indicators were selected for determining the quality of diabetes care: myocardial infarctions, cerebral infarctions, and amputations of lower limbs. These indicators revealed clear regional differences, although towards the end of the review period (2000–2002), these differences were not statistically significant, with two exceptions. Differences between hospital districts were initially greater but evened out during the review period. A clear trend that could be observed was the fall in the incidence of myocardial and cerebral infarctions and amputations, when these were considered in proportion to the number of people who had diabetes. Between the years 1990 and 2002, the incidence of the first amputations fell by 46 per cent, and the incidence of the first myocardial and cerebral infarctions by 44 per cent. Mortality caused by myocardial and cerebral infarctions among people with diabetes also declined. In some hospital districts this trend was clearly more positive than the average for the whole country.

Seen for the whole of Finland, the difference in mortality between the diabetic and nondiabetic populations narrowed, and people with diabetes live increasingly older.

To enable comprehensive monitoring of changes among people with diabetes and in complications of diabetes, data are needed from the registers of KELA, STAKES, and Statistics Finland.

Keywords: diabetes, prevalence, incidence, complications, mortality, lower limb amputations, myocardial infarctions, cerebral infarctions

Contents

Abbreviations

DEHKO	Development Programme for the Prevention and Care of Diabetes
FINAMI	Finnish Myocardial Infarction Register
FINMONICA	FINnish MONItoring of trends and determinants in CArdiovascular disease
FinOHTA	Finnish Office for Health Technology Assessment
HDL	High-density lipoprotein
HILMO	National hospital discharge register maintained by STAKES
HUCH	Helsinki University Central Hospital
ICD-9	International Statistical Classification of Diseases and Related Health Problems, ninth revision
ICD-10	International Statistical Classification of Diseases and Related Health Problems, tenth revision
KELA	The Social Insurance Institution of Finland
LDL	Low-density lipoprotein
PTA	Percutaneous transluminal angioplasty
SD	Standard deviation
SMR	Standardised mortality ratio
STAKES	National Research and Development Centre for Welfare and Health
WHO	World Health Organisation

BACKGROUND

Diabetes is one of our major public health problems. It affects the quality of life of those who develop the disease, causes many complications and increases mortality. Care for the disease calls for massive resources (1), which are needed to an increasing extent because the number of persons with diabetes keeps rising constantly. This rise can be followed by means of KELA's special refund entitlement register, which indicates that the number of patients with diabetes is increasing at an ever faster rate (2). Most patients with diabetes have type 2 diabetes, which has also been called a new global epidemic (3). The reasons include the ageing of the population, increased obesity (4) and less exercise from daily activities.

Good care can reduce the complications associated with diabetes. When the prevalence of these complications is selected as one indicator for continuous quality monitoring, necessary changes can be made in care practices if the prevalence of complications is high (5). Monitoring of results is essential in quality assurance. Suitable indicators for quality assurance in diabetes care are the incidence of complications and the mortality of persons with diabetes.

The following goals have been set in the DEHKO programme: to reduce cardiovascular diseases among people with diabetes by at least one third; to reduce lower limb amputations by half; to reduce cases of retinopathy by at least one third; and to reduce cases of nephropathy by at least one third between the years 2000 and 2010 (6). This study determines the initial situation, against which developments can be compared.

One purpose of this study is to determine whether the prevalence of complications can be used as an indicator in regional comparisons of diabetes care quality. The results describe changes in the prevalence of diabetes in Finland within the past 15 years and analyse the frequency of lower limb amputations, myocardial infarctions and cerebral infarctions, together with differences observed between hospital districts. Mortality rates of persons with diabetes, and their causes of death, are also studied. In addition, the prevalence of some other complications of diabetes (diabetic retinopathy and nephropathy) is studied by means of data recorded in the Hospital Discharge Register (Hilmo). The study was carried out as a cooperation project between STAKES (The National Research and Development Centre for Welfare and Health), KELA (The Social Insurance Institution of Finland), and the Finnish Diabetes Association.

REVIEW OF THE LITERATURE

Types of diabetes and definition

According to the definition of the World Health Organisation (WHO), diabetes mellitus is a disease of multiple etiology basically characterised by a rise in the blood glucose level. This results either from reduced or lacking insulin secretion or from defective insulin action (7).

Diabetes is divided into two main types: type 1 and type 2 diabetes. They used to be called juvenile diabetes and adult-onset diabetes because of the age when the disease typically arises.

Besides these two, there is a small number of other specific diabetes types, which form their own group for classification (e.g. LADA and MODY types). In addition, gestational diabetes refers to a disorder of glucose metabolism that is detected for the first time during pregnancy.

Type 1 diabetes is caused by the destruction of cells that secrete insulin in the pancreas. Type 2 diabetes is mainly caused either by defective insulin action (insulin resistance) and the associated relative shortage of insulin, or by defective insulin secretion which is, or is not, associated with insulin insensitivity (7).

The WHO revised the diagnostic criteria of diabetes in 1999 so that the earlier cutoff point for diagnosing diabetes – fasting plasma glucose value of 7.8 mmol/l – was lowered to 7.0 mmol/l. This has increased the number of people diagnosed with type 2 diabetes, at least to some extent (7).

Complications caused by diabetes

The complications caused by diabetes can be divided into two categories: complications specific to diabetes and other complications. Complications that affect blood vessels are called either micro-angiopathic or macroangiopathic, depending on the size of the vessels affected.

Microangiopathic complications are caused by damage to small capillaries, and they are specific to diabetes. These include diabetic retinopathy and nephropathy.

Changes in the nervous system that arise as a result of diabetes are known as neuropathy. Neuropathy is also one of the complications specific to diabetes; the late complications of severe neuropathy include foot injuries and lower limb amputations.

Retinopathy, nephropathy and neuropathy are complications specific to diabetes (8).

Macroangiopathic complications include blood circulation problems in legs, coronary heart disease, and problems in the blood circulation of the brain. These are caused by accelerated and increased arteriosclerosis, for which there are also many other risk factors besides diabetes. In other words, these problems are not specific to diabetes. These macroangiopathic complications are dominant among people with type 2 diabetes, although these people may also have retinopathy, nephropathy and neuropathy (9).

Poor glycemic control increases the probability of artery diseases, and so do some other factors that are often associated especially with type 2 diabetes, namely abdominal obesity, hypertension and disorders of lipid metabolism. However, these risk factors alone are not sufficient to explain the overrepresentation of cardiovascular diseases as causes of death among people with diabetes. The risk is also higher because of other factors, such as insufficiency of the left ventricle of the heart, autonomic neuropathy, and increased formation of thrombi (10).

Diabetes as a public health problem

On the basis of statistics compiled by KELA and the Health 2000 study conducted by the National Public Health Institute, there were an estimated 196,500 persons with diabetes in Finland in 2000 (11). Based on the same sources, the number of persons with diabetes had risen to 220,000 in 2003. Of them, an estimated 30 per cent were able to control their diabetes with dietary changes, and persons with type 1 diabetes numbered about 30,000 (12). As concerns type 1 diabetes, Finland is a special case, since the incidence of the disease in Finland is the highest in the world (13). The prevalence of type 2 diabetes is also at "a good Western standard" (3). It has been estimated that the incidence of type 1 diabetes increases by about 3 per cent annually (14), and if the incidence of type 2 diabetes continues at the same rate as now, the number of persons with diabetes will reach about half a million by the year 2030 (12).

Although type 2 diabetes has been considered a problem that affects ageing people, the incidence of the disease seems to have shifted to ever younger age classes and even to children. Of children who had been referred to two university hospitals for examinations due to overweight, about 10 per cent (11 children) had disturbed glucose metabolism. Four of them had type 2 diabetes (15). A questionnaire study conducted by the Finnish Diabetes Association indicated that, among all patients (n = 3,654) in units that treat children with diabetes, less than 0.5 per cent had type 2 diabetes (Winell, Komulainen; personal communication).

The importance of diabetes to public health is mainly based on the complications associated with the disease. People with diabetes run a significantly higher risk of cardiovascular diseases (16). In type 1 diabetes, the risk of atherosclerotic diseases rises sharply after the age of 30 years and especially if nephropathy has developed (17). A Finnish study showed that among people who had contracted type 1 diabetes before the age of 18 years, nephropathy meant a ten-fold increase in the risk of cardiovascular diseases (18). A person with type 2 diabetes has a 2–4 times greater risk of myocardial infarction than the rest of the population. The risk of the disease is as great for a person with diabetes who has not had an infarction as it is for a nondiabetic person who has had an infarction (19). Diabetes is one of the most important risk factors for the peripheral vascular disease (20) and for the development of critical leg ischemia (21). Studies show that a person with diabetes has a five times greater risk of leg or thigh amputation than the rest of the population (22). The risk of any amputation is 15–24 times greater (23).

Since diabetic sensory neuropathy masks the pain that is a sign of minor injuries and wounds, these can subsequently develop into an ulcer that the person is unaware of (24).

Neuropathy itself is another independent risk factor for the emergence of ulcers, which can then also lead to amputations (25). Retinopathy can be a threat to the vision of a person with diabetes, owing to changes that develop in the retina (26).

On the basis of a study concerning the health services of, and the costs of these services for, people with diabetes in Helsinki, it can be estimated that the costs of the care provided for all people with diabetes constitute over 12 per cent of Finland's health care expenditure (1). An estimated 90 per cent of the costs caused by diabetes arise from treatment for complications. On average, complications bring a ten-fold increase in the costs of care for people with type 1 diabetes, and a twenty-fold increase in the costs of care for people with type 2 diabetes (1).

The total costs of pharmaceuticals for diabetes and its complications were 3.5 times greater than the costs for a nondiabetic control group (27).

Diabetes and registers

The registration of patients in the health care system is regulated by laws (28, 29, 30, 31, 32). Legislation divides health care registers into four categories: statutory registers, separate registers, research registers and patient registers.

Many statutory registers contain data about people who have contracted diabetes. These registers included the mortality register kept by Statistics Finland, the hospital discharge register, the register of births and the register of visual impairment kept by STAKES, and the special refund entitlement register and the prescription register kept by KELA.

Separate registers are generally based on the person's consent or on Section 14 of the Personal Data Act (research registers). Data meant for these registers can be collected for each operating unit, regionally, or nationally. Information on diabetes can be found, for instance, in the Finnish Registry of Kidney Disease, which is based on the consent given by people whose data have been registered.

In addition, many health care units maintain patient registers concerning persons with diabetes as part of the health record system. These include, for instance, registers concerning the distribution of free equipment for persons with diabetes.

Since 1967, patients receiving hospital care have been registered in the national hospital discharge register maintained by STAKES. Since 1994, the register has been known by the name Hilmo. The register data encompass the primary and secondary diagnoses of patients who have received hospital care, as well as the primary and secondary procedures carried out during the admission. Data in the hospital discharge register are considered reliable as concerns primary diagnoses (33), but it may be that patients' secondary diagnoses are recorded incompletely. In consequence, diabetes is not necessarily recorded as a diagnosis if it has no essential effect on the content of the hospital admission in question.

Data in the hospital discharge register were used in two studies on diabetes conducted within STAKES in the 1990s (34, 35). Of these two, the study published in 1996, "Diabetes ja sen komplikaatiot poistoilmoitusrekisterissä [Diabetes and its complications in the hospital discharge register], only deals with complications specific to diabetes and with procedures performed for persons with diabetes.

AIMS OF THE STUDY

The purpose of the study is to create an up-to-date picture of people with diabetes, of the reliability of diabetes data in registers, of the incidence and prevalence of complications, and of the mortality of people with diabetes. Answers are sought especially to the following questions:

- Is the information that is obtained from nationwide registers suitable for describing the quality of diabetes care in all parts of Finland?
- Is the information on the incidence of complications of diabetes, analysed periodically from the Hilmo register, applicable for use as a constant indicator of care quality?
- How often should this analysis be made when considering the incidence of various complications?
- Can hospital districts be used as units when reviewing the regional occurrence of complications of diabetes?

RESEARCH MATERIAL AND RESEARCH METHODS

Compilation of the research register

The study was based on a cooperation agreement between STAKES, KELA and the Finnish Diabetes Association. The necessary permission was acquired for using data administered by Statistics Finland.

For the research register, data on diabetes were collected from the registers of both KELA and STAKES. The personal identity numbers of patients treated in 1988–2002 were searched from the STAKES hospital discharge register using all diabetes diagnoses (ICD-9 and ICD-10 codes). The personal identity numbers were combined with data in KELA's special refund entitlement register for diabetes medications in 1964–2002 and with data in the prescription register in 1994–2002. Data on people who were not in the Hilmo register were collected from pharmaceutical registers.

The Hilmo register and the mortality register of Statistics Finland were then searched for data on the use of hospital services (inpatient care) and the mortality of people with diabetes. This was done by combining the personal identity numbers obtained from KELA again with data in the hospital discharge register; the data were then searched for all admissions of persons with diabetes and other relevant data for the years 1988–2002.

Data on the death of persons with diabetes who were included in the research population were collected from Statistics Finland (date and cause of death). In this way, data on fatal myocardial infarctions and cerebral infarctions outside hospitals were also included in the material concerning complications.

The compilation of the research material is illustrated in Figure 1.

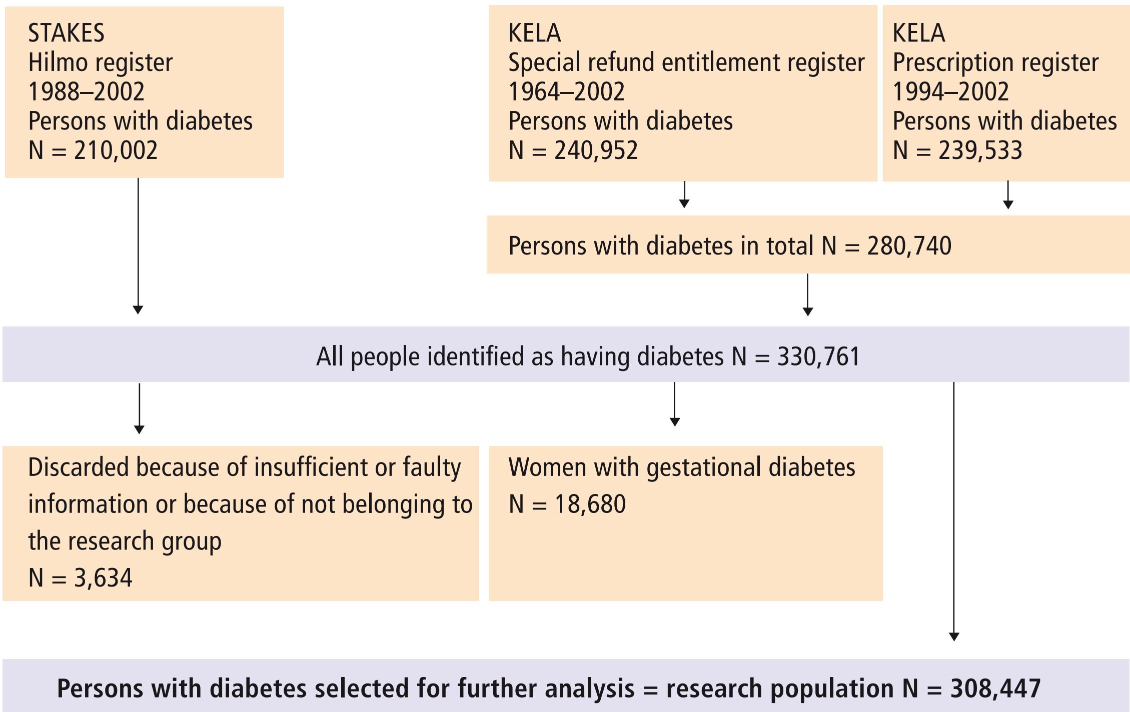


FIGURE 1. Formation of the research population
N.B. The same person can appear in more than one register; thus the research population is not the sum of all persons with diabetes found in the various registers.

Data in the research register

Using the Hilmo register, the KELA special refund entitlement register and the KELA prescription register, the following data were collected for all people who had been identified as having diabetes and who were included in the research population:

For each admission, the following data were taken from the hospital discharge register (Hilmo): the person's home municipality, the home country of a person living abroad, service sector, speciality, date of arrival, means of transport to the hospital, where the person came from, who had given the referral, date when the patient was put on the waiting list, primary and secondary diagnoses, external cause of accident, type of accident, date of the primary surgery and the primary procedure and other procedures, decision on long-term care, date of discharge, and the place of further care. This information is included in the basic data form for health care (Hilmo, Care Registers for Social Welfare and Health Care 2004, Definitions and guidelines, http://www.stakes.fi).

The KELA special refund entitlement register from the years 1964–2002 was searched for the personal identity numbers of people who had applied for the right to special reimbursement for diabetes medication. In addition, the following data were collected: the year when the right to special reimbursement for diabetes medication was granted, the year when the right to special reimbursement ended, if any, and the reason for ending the right, the language in which the decision was given, the person's nationality, and the KELA branch office closest to the person's home. For persons with diabetes included in the material, any special refund rights that they may have had, and the year when these rights had been granted, were also collected for the following diseases: complications of an organ transplant or a tissue transplant, uremia requiring dialysis, chronic hypertension, chronic coronary heart disease, familial severe dyslipidemia, and dyslipidemia associated with chronic coronary heart disease.

The KELA prescription register was searched for the pharmaceutical preparations purchased annually between 1994 and 2002 by persons included in the research population. The following categories of pharmaceuticals were included: medication for diabetes, nitrates, medication for hypertension, diuretics, beta-blockers, calcium channel blocking agents, drugs in the rennin-angiotensin group, medication for hyperlipidemias, for erection disorders and for gout, cytostatics, immunosuppressive preparations, and acetylsalicylic acid. In these groups, data were specified down to the level of medicinal substances. As concerns purchases of diabetes medications, the person's municipality of residence was collected at the end of each year.

The mortality statistics of Statistics Finland were searched for persons included in the research population who had died between 1988 and 2002. The following data were recorded: the day of death, the cause of death listed in the statistics, the cause of death given by the doctor, the diagnosis associated with the basic cause of death, the immediate cause of death, the intermediary cause of death, and complementary causes of death (1–4).

The completeness of the research register data was studied by searching the mortality register of Statistics Finland and the registers of visual impairment and births of STAKES for persons who, according to the data in these registers, had diabetes but who were not yet included in the research register.

Research material

The original material comprised 330,761 persons, of whom 3,634 persons had to be discarded because they did not belong to the population or because their data were insufficient and/or faulty. Persons with diabetes who had been found only in the register of visual impairment (5), the register of births (2,457) and the mortality register (5,481), as well as women with gestational diabetes, were not included in the research population. Thus the research population comprised 308,447 persons with diabetes, of whom 123,726 had died by the end of 2002 (184,721 were alive). Women numbered 161,796 and men 146,651.

Persons with diabetes who were only found in the hospital discharge register numbered 47,602, and persons with diabetes who were only found in the KELA registers numbered 118,340. Thus, 142,505 people had been listed in both registers.

If the diagnosis was some other type of diabetes than type 1 or type 2, or if the information on the type was missing or was contradictory, the person was placed in the group "diabetes type uncertain".

The KELA register had a substantial number of persons with diabetes (118,340) who were not in the hospital discharge register. In other words, they had not had hospital care during the period under review. In contrast, the hospital discharge register had patients with diabetes (47,602) who were not included in the KELA registers. This means that they had received no refunds for diabetes medication (e.g. patients in permanent institutional care) or their diabetes was controlled solely through diet. However, the latter reason is unlikely in view of the practice followed by hospitals in recording secondary diagnoses. Diabetes controlled through diet cannot generally be the reason for admitting a person to hospital, i.e. the primary diagnosis. It is therefore probable that the material does not include people who can control their diabetes by diet only. According to the Health 2000 study, these people make up about 30 per cent of all people with diabetes.

The classification criteria of all people with type 2 diabetes in this study were based on drug therapy. It can thus be assumed that the revision of the diagnostic criteria of diabetes which took place in 1999 (7) did not affect the number of people with diabetes, although the criteria changed during the period under study.

Classification of persons with diabetes

Study subjects were divided into persons with type 1 or type 2 diabetes using four different classification methods. The final classification was carried out by combining all these methods. The objective was to improve the reliability of the final outcome.

The hospital discharge register had many diagnoses of gestational diabetes. The correctness of these diagnoses was determined by excluding from this category those persons who had diabetes medication either two years before or two years after the pregnancy. Once women with gestational diabetes had been removed from the research population, the diabetes type for the rest was determined in accordance with the following algorithm:

Using the data in the Hilmo register, classification into diabetes types 1 and 2 was done on the basis of the diabetes type recorded in the hospital discharge register (in total 208,544 people). If a person had several hospital admissions, and the diabetes type varied from one admission to the next, the most likely type was then selected according to the following algorithm: first the type "unspecified" was excluded, after which the last three admissions were surveyed; if all these had the same diabetes type, the selection was made accordingly.

Using the data in the KELA and Hilmo registers, the classification was done based on information available from KELA and from the hospital discharge register. The procedure was the same as was used in the study "Diabeetikkojen terveyspalvelut ja niiden kustannukset" [The consumption and direct costs of health care services among persons with diabetes in Helsinki] (1). In that study, people who fulfilled the following criteria were defined as having type 1 diabetes: people whose medication had started before the age of 30 years and the treatment consisted only of insulin or of insulin and metformin; people whose diabetes medication had started when they were 30–40 years old and who were only treated with insulin; and people who were in institutional care before the age of 30 years even when the type of drug therapy could not be verified.

In this definition, all other people identified as having diabetes (whose diabetes medication had primarily started at the age of at least 30 years) and all people in institutional care who were at least 30 years of age, even though their drug therapy could not be verified, were classified as persons with type 2 diabetes.

Using the data in the KELA register, the classification was done based on the age when diabetes medication had started. Persons whose diabetes medication had started before the age of 30 years were defined as having type 1 diabetes. Persons whose medication had started after the age of 40 years were defined as having type 2 diabetes. Persons whose medication had started between the ages of 30 and 40 years were placed in the category "diabetes type uncertain". This classification method was also used in the study on the drug therapy of persons with diabetes (6), which was based on data in the KELA registers.

Classification based on the medication used was done by means of the prescription register kept by KELA. People who used only insulin (during the second year of therapy) were classified as having type 1 diabetes. People who used only oral medication (during the second year of therapy) were classified as having type 2 diabetes. People who used combination therapy (oral medication + insulin) were placed in the category "diabetes type uncertain".

The final division into type 1 and type 2 diabetes was done so that at least two classification methods had to result in the same diabetes type (either 1 or 2). Nor could type 1 and type 2 clash with each other in any of the definitions. If there were contradictions, the patients in question were put in the category "diabetes type uncertain". Everyone else was classified as having either type 1 or type 2 diabetes.

Following these classifications, the research population was divided into groups as shown in Table 1.

The classification for the years 1988–1993 was made less certain by the fact that the KELA prescription register only gives information on diabetes medication starting from 1994. For this reason, the proportion of people with unspecified diabetes is much greater during the early years of the study than after 1994.

TABLE 1. Classification into diabetes types.

	Diabetes type 1	Diabetes type 2	Diabetes type uncertain	Gestationa diabetes
First classification method	34,439	148,450	5,016	20,639
Second classification method	31,637	255,022		
Third classification method	25,680	240,391	14,660	
Fourth classification method	49,870	166,353	23,310	
Final classification	25,116	219,638	63,693	18,620
Percentage	8	67	19	6

Codes used

The hospital discharge register data of people with diabetes were searched for the following complications and resulting procedures: lower limb amputations and vascular procedures, myocardial infarctions, cerebral infarctions, kidney transplants, renal and ophthalmic complications.

The following ICD-9, ICD-10 or procedure codes were used in the collection of data:

- Lower limb amputations: 9571, 9572, 9573, 9574 and NFQ20, NGQ10, NGQ20, NHQ10, NHQ20, NHQ30, NHQ40.
- Vascular procedures on lower limbs: 5561, 5562, 5563, 5564, 5565, 5566, 5567, 5568, 5568+, 5579, 5583, 5585, 5653, 5659, PDE, PDF, PDH, PDP, PDU, PDQ20, PDQ21, PDQ22, PD3AT, PD3BT, PD4ST, PEE, PEF, PEH, PEN, PEP, PEQ, PEU, PE1AT, PE1BT, PFE, PFH, PFN, PFP, PFQ, PFU, PF1AT, PF1BT, PGH, PG1AT, PG1BT, PG1ST, PG1UT.
- Cerebral infarctions: 4330A, 4331A, 4339A, 4340A, 4341A, 4349A , I63.
- Renal complications: 2503, E11.2, E12.2, E132, E142, E102, 5818X, 585, N083
- Dialysis: Z491, Z492 (N.B. ICD-10 codes), TJA30, 6112
- Kidney transplant: KAS, 7151
- Ophthalmic complications: 2504, 3664A H3600, H3609, H280, E113, E123, E133, E143, E103, H368, H36.00, H36.09, H28.0, E11.3, H36.8, 3620B, 3656C, H3601, H3602, H3603, H3604, H3605, H431, H450, H334, H36.01, H36.03, H36.04, H36.05, H43.1, H45.0, H33.4.

DESCRIPTION OF THE RESEARCH MATERIAL

Prevalence and regional variation of diabetes

The number of persons with diabetes depends on two factors: mortality and the number of new cases. The number of persons with diabetes nearly doubled during the period under review (Table 2, Figure 2 and Maps 1–6). In 1988, they totalled 93,831. Type 1 diabetes accounted for 15.2 per cent of the total in that year (14,212 people), whereas the group "diabetes type uncertain" accounted for 27 per cent (25,338 people).

In 2002, there were 184,721 persons with diabetes. Of them, 13 per cent (23,613) had type 1 diabetes and 74 per cent (136,149) had type 2 diabetes; the type was uncertain for 13 per cent (24,959).

There were regional differences in the rate at which cases of diabetes increased in different hospital districts (Maps 1–6, p. 21 and Appended Tables 1 and 2).

In 1988, 1995 and 2002, type 2 diabetes was the most common in the hospital districts of Southern Ostrobothnia, Northern Ostrobothnia and Eastern Savo. The index describing the prevalence in Eastern Savo rose to the same level as the index in Northern Ostrobothnia, and the index for Southern Ostrobothnia was at its highest in 2002. The variation may result from real differences in the morbidity of the populations, but a contributing factor is the diagnostics of type 2 diabetes, which is problematic owing to the asymptomatic character of the disease. One consequence of this is that people don't think to seek examinations and treatment at the early stages of the disease.

When adjusted for the population and its age structure, the greatest number of persons with type 1 diabetes was recorded in 2002 in the hospital district of Northern Karelia.

The number of persons with type 1 diabetes increased by 20 per cent between 1995 and 2002. Cases of type 2 diabetes increased even more rapidly: at an annual rate of 6–7 per cent since 1995 (Figure 2).

The number of all cases of diabetes increased by 5.5 per cent from 2001 to 2002, and the same pace seems to be continuing because the number of patients with diabetes in KELA's special refund entitlement register increased by 5.7 per cent from 2003 to 2004 (36).

People with type 2 diabetes in this research population did not include people whose diabetes can be treated with diet, because classification into type 1 or type 2 diabetes required information on the use of diabetes medication. Of the patients who belonged to the group "diabetes type uncertain" in 2002 (24,959), only 6,611 did not have any purchases of diabetes medicines or had no special reimbursement right recorded in the KELA registers. They were included in the material through data given in the hospital discharge register. They were patients in institutional care who received their diabetes medication, if any, from their care institution, or their diabetes was controlled solely by means of dietary changes, or the data on medication were missing for some other reason. Of these 6,611 patients, 807 had received a decision on long-term care.

It is in many ways difficult to identify people who can control their diabetes through diet. Patients with no symptoms often forget to report their disease during contacts with the health care system. Diagnostic criteria have also changed over the years and may vary depending on the depth of doctors' knowledge; in other words, there may be cases of overdiagnostics as well. On average, 30 per cent of the persons with diabetes who participated in the Health 2000 study controlled their diabetes only by means of dietary adjustments.

If, based on this research material, we remove the 6,611 patients who had no information on their drug therapy from the total number of people with diabetes (type 1, type 2, diabetes type uncertain) who were alive in 2002, and if we assume that about 30 per cent of all people with diabetes can control their diabetes through dietary changes, we arrive at a total number of 261,053 persons with diabetes and 76,332 persons who control their diabetes by means of dietary changes.

On the basis of these figures, about 5.1 per cent of Finns had diabetes in 2002. This is slightly more than Antti Reunanen's estimate (220,000) for the year 2003 (12).

TABLE 2. Annual numbers of persons with diabetes.

Year	Total-number	Women (%)	Type 1	Women (%)	Type 2	Women	Diabetes type uncertain	Women (%)
1988	93 831	57	14 212	41	54 281	62	25 338	56
1989	102 181	57	14 899	41	61 965	61	25 317	55
1990	107 172	56	15 598	41	65 030	60	26 544	55
1991	112 591	55	16 355	41	68 761	59	27 475	55
1992	117 276	54	17 007	41	72 242	58	28 027	54
1993	121 628	54	17 698	41	75 737	57	28 193	54
1994	129 301	53	18 338	41	82 801	56	28 162	54
1995	134 411	53	18 921	42	88 068	55	27 422	53
1996	140 424	52	19 552	42	94 106	54	26 766	52
1997	146 256	51	20 179	42	100 020	53	26 057	51
1998	151 895	51	20 877	42	105 545	52	25 473	51
1999	158 439	50	21 589	42	111 825	52	25 025	50
2000	166 126	49	22 297	42	119 087	51	24 742	49
2001	174 996	49	23 015	42	127 200	50	24 781	49
2002	184 721	48	23 613	42	136 149	49	24 959	49

The gender distribution among people with type 1 and type 2 diabetes, and the changes in it between 1988 and 2000, differed from each other. The number of women among people with type 1 diabetes was smaller (41–42%) than the number of men throughout the period under review, but the share of women increased slightly (one percentage point). In 1988, women with type 2 diabetes outnumbered men (62%), but their relative share decreased so that in 2002 their total number was slightly smaller (49%) than that of men. In other words, the share of women fell by 13 percentage points.

It seems that type 2 diabetes is becoming increasingly often a men's disease if this same trend continues (Table 2). The percentage of women in the group "diabetes type uncertain" declined, which would indicate a large proportion of type 2 diabetes in this group.

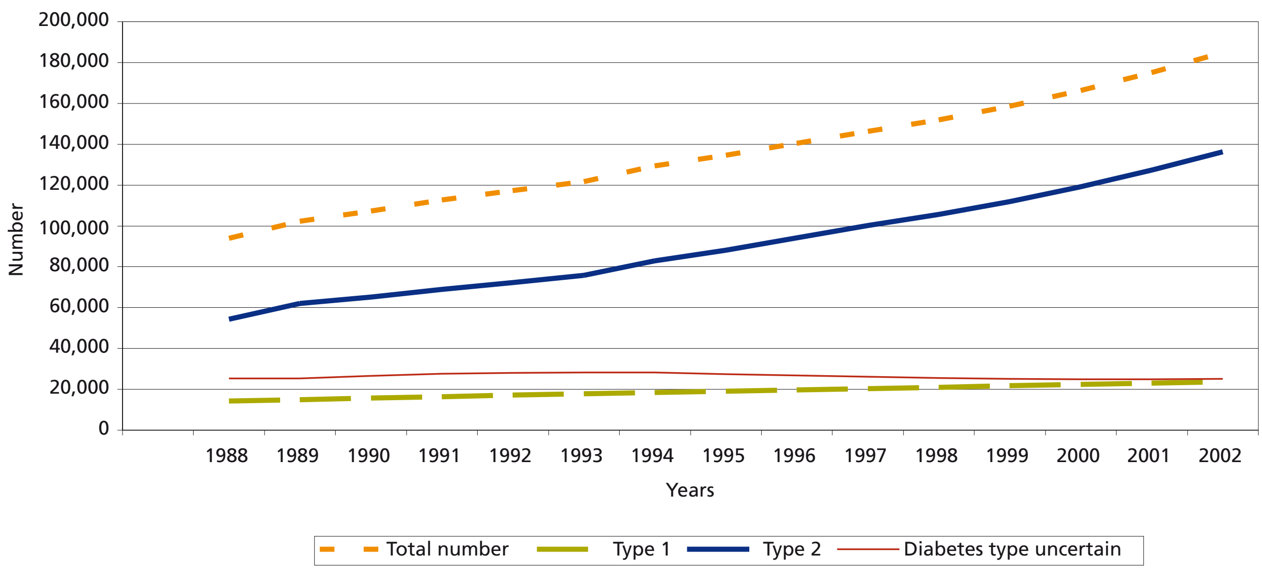
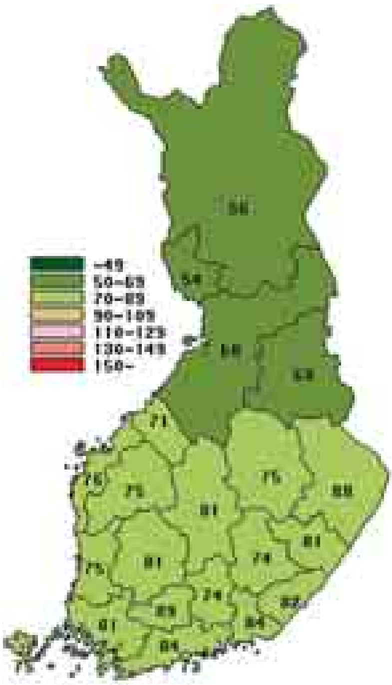


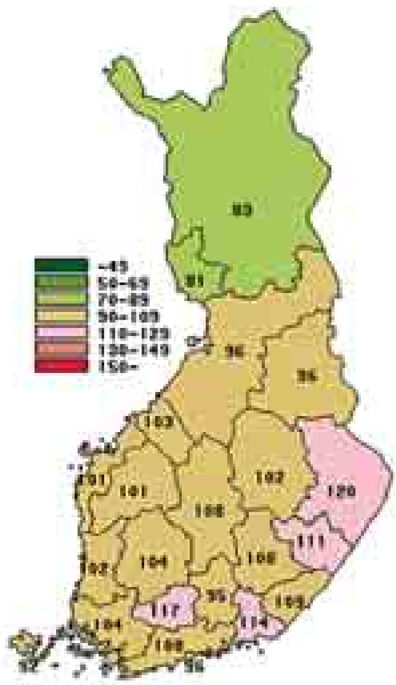
FIGURE 2. Trends in the number of people with diabetes in 1988–2002.

MAPS 1–3: People with type 1 diabetes in 1988, 1995 and 2002
Standardised for age and gender, the year 1994 = 100

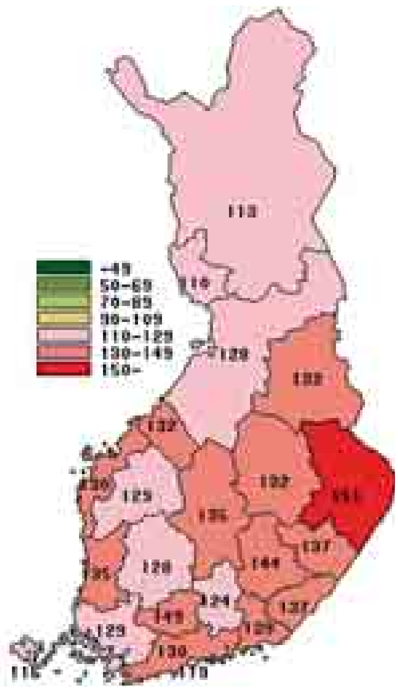
Map 1: The year 1988



Map 2: The year 1995

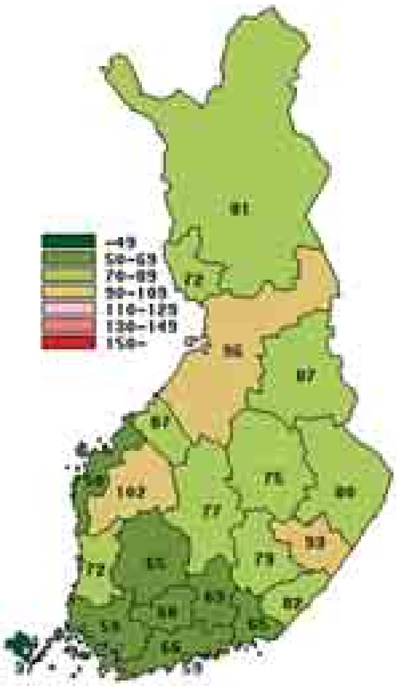


Map 3: The year 2002

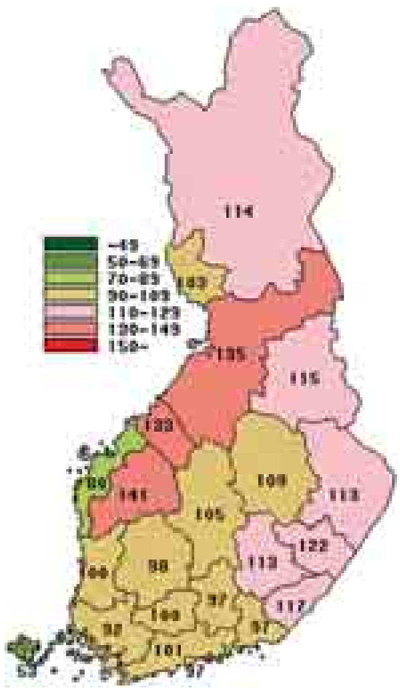


MAPS 4–6: People with type 2 diabetes in 1988, 1995 and 2002
Standardised for age and gender, the year 1994 = 100

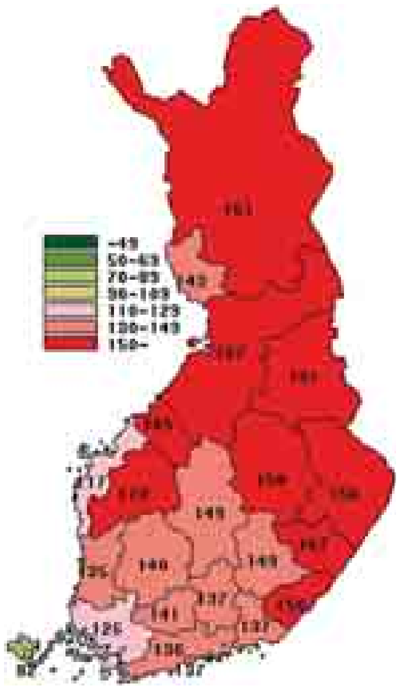
Map 4: The year 1988



Map 5: The year 1995



Map 6: The year 2002



Incidence of diabetes

A person was recorded as having diabetes for the first time in the year when the first entry about the disease was found in the research material, whether in the KELA special refund entitlement register or prescription register or in the hospital discharge register. In the case of type 2 diabetes, this is not often the same as the year of contracting the disease.

The annual number of new cases of diabetes increased by 38 per cent from 1989 to 2002. At the same time, the proportion of women among people who developed diabetes declined (Table 3). The great number of new cases of diabetes in 1994 is explained by the fact that KELA's prescription register was taken into use during that year and the register was searched for people using diabetes medication who had not been entered into the special refund entitlement register. The number of new cases of type 2 diabetes increased more rapidly than the number of new cases of type 1 diabetes. This trend is probably explained by the improved diagnostics of type 2 diabetes, the more active drug therapy, and unfavourable developments in obesity and exercise habits. The number of new cases of type 1 diabetes peaked in 1999, but has fallen since then. The great number of people in the group "diabetes type uncertain" makes it more difficult to draw reliable conclusions about the numbers of new cases of diabetes by type.

TABLE 3. New cases of diabetes annually in 1988–2002.

Year	Type 1	Women (%)	Type 2	Women (%)	Diabetes type uncertain	Women (%)	Total	Women (%)
1988	693	41	7,575	57	10,640	64	18,908	60
1989	687	38	7,685	55	5,510	61	13,882	57
1990	699	40	9,243	55	3,217	58	13,159	55
1991	757	38	9,937	53	2,932	57	13,626	53
1992	652	41	9,803	52	2,627	55	13,082	52
1993	691	40	10,070	53	2,425	57	13,186	53
1994	775	45	13,070	51	2,229	53	16,074	51
1995	774	46	11,272	51	1,930	51	13,976	51
1996	804	40	12,018	49	1,848	50	14,670	49
1997	800	40	12,073	49	1,643	49	14,516	49
1998	862	41	11,959	48	1,694	49	14,515	48
1999	882	41	12,922	48	1,742	49	15,546	47
2000	880	38	14,117	47	1,894	48	16,891	47
2001	862	43	14,988	47	2,053	48	17,903	47
2002	779	41	16,200	47	2,235	51	19,214	47
Total.	**11,597**		**172,932**		**44,619**		**229,148**	

Age distribution of persons with diabetes

Figures 3 and 4 show the age distributions of women and men who have type 1 or type 2 diabetes. In 1990, the biggest age brackets in type 1 diabetes were 30–34 years for both women and men, whereas in 2002, the biggest age brackets were 35–39 years for men and 40–44 years for women. In 1990, the material had no one over 70 years of age with type 1 diabetes; in 2002, their number had reached 214.

Among people with type 2 diabetes, the biggest age group for women was 75–79 years throughout the period under review. For men, the biggest age group in 1990 was 65–69 years of age, whereas in 2002 the greatest number of men with diabetes was found in the age group 55–59 years. In 1990, only 24 persons with type 2 diabetes were under 30 years of age, but in 2002 they numbered 659 (almost all of them women). The fact that the post-war baby-boom generation has reached the age where type 2 diabetes is more common was also reflected in the data for 2002, where the number of 55–59-year-old persons with diabetes was significantly greater than in 1996 (Figures 3 and 4).

When the numbers of persons with diabetes are examined by age class against 1,000 Finns of the same age, the number women with type 1 diabetes in 2002 was the greatest in relative terms in the age class 15–19 years (in absolute numbers the biggest group consisted of women of 40–44 years of age). In 1990 and 2002, the relative number of people with type 2 diabetes for 1,000 Finns of the same age was the greatest in the age groups 80–84 years for both genders (in absolute numbers the biggest age groups were younger age brackets) (Figures 5 and 6).

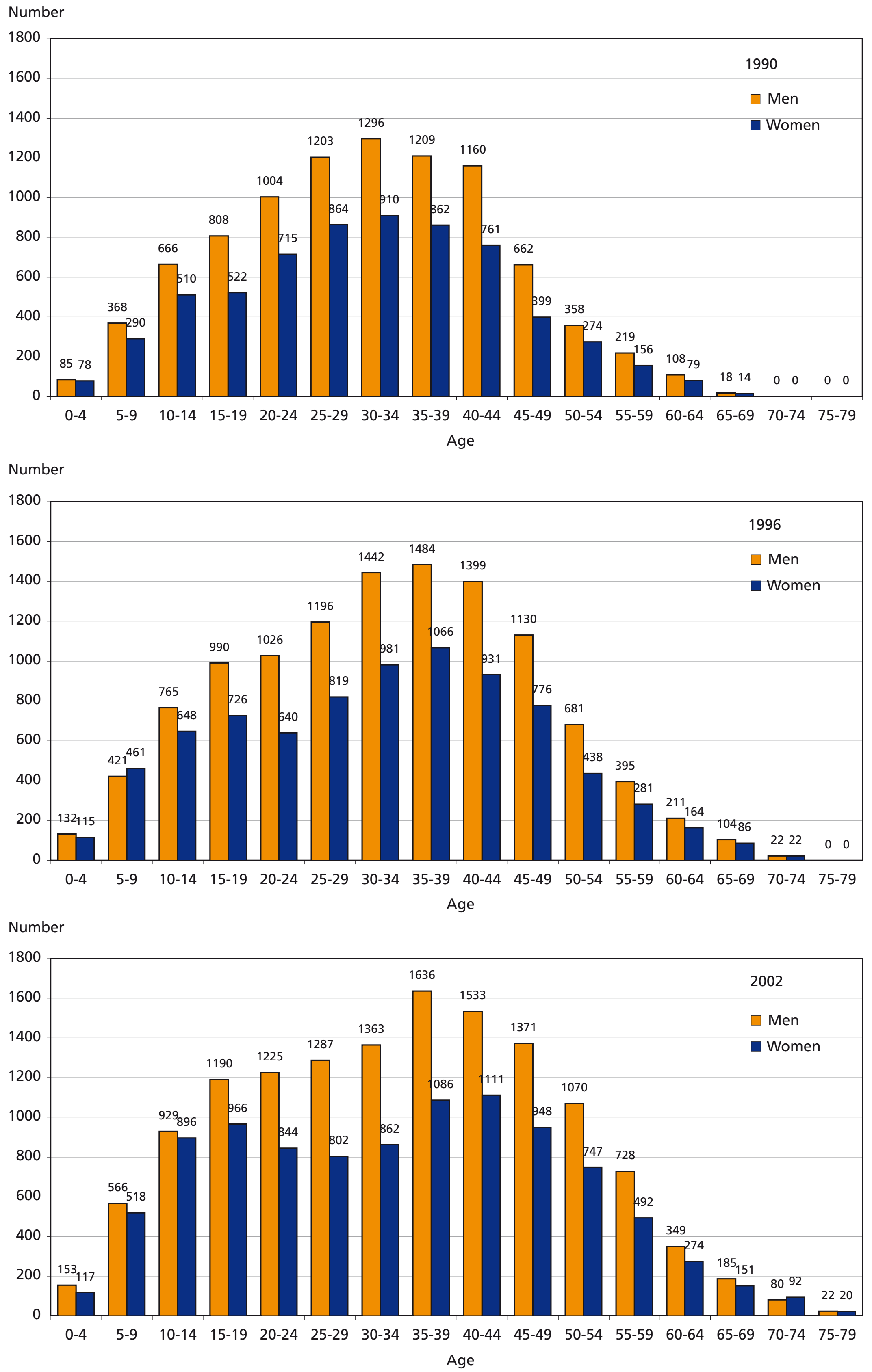


FIGURE 3. Age distribution of people with type 1 diabetes by gender in 1990, 1996 and 2002.

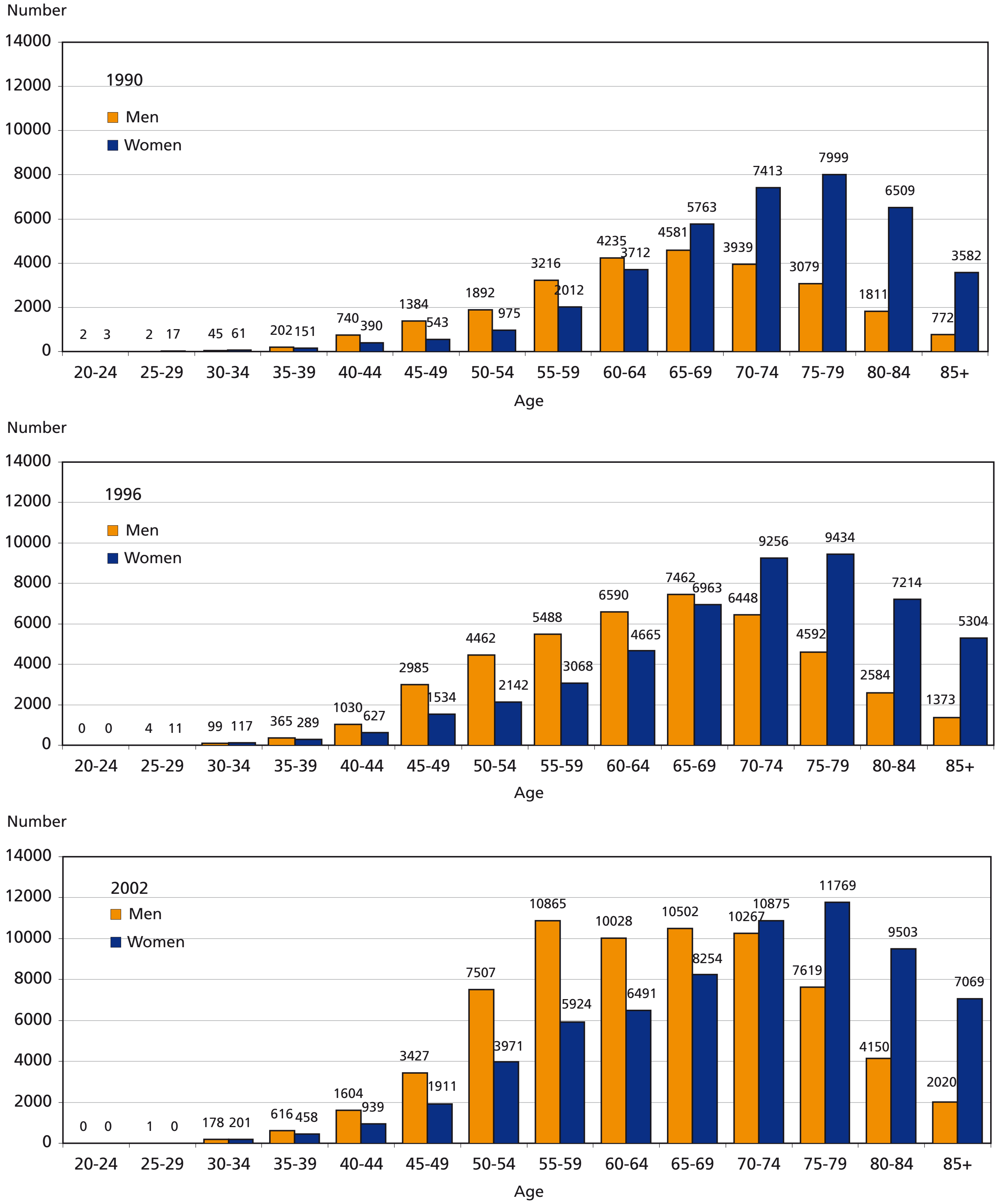


FIGURE 4. Age distribution of people with type 2 diabetes by gender in 1990, 1996 and 2002.

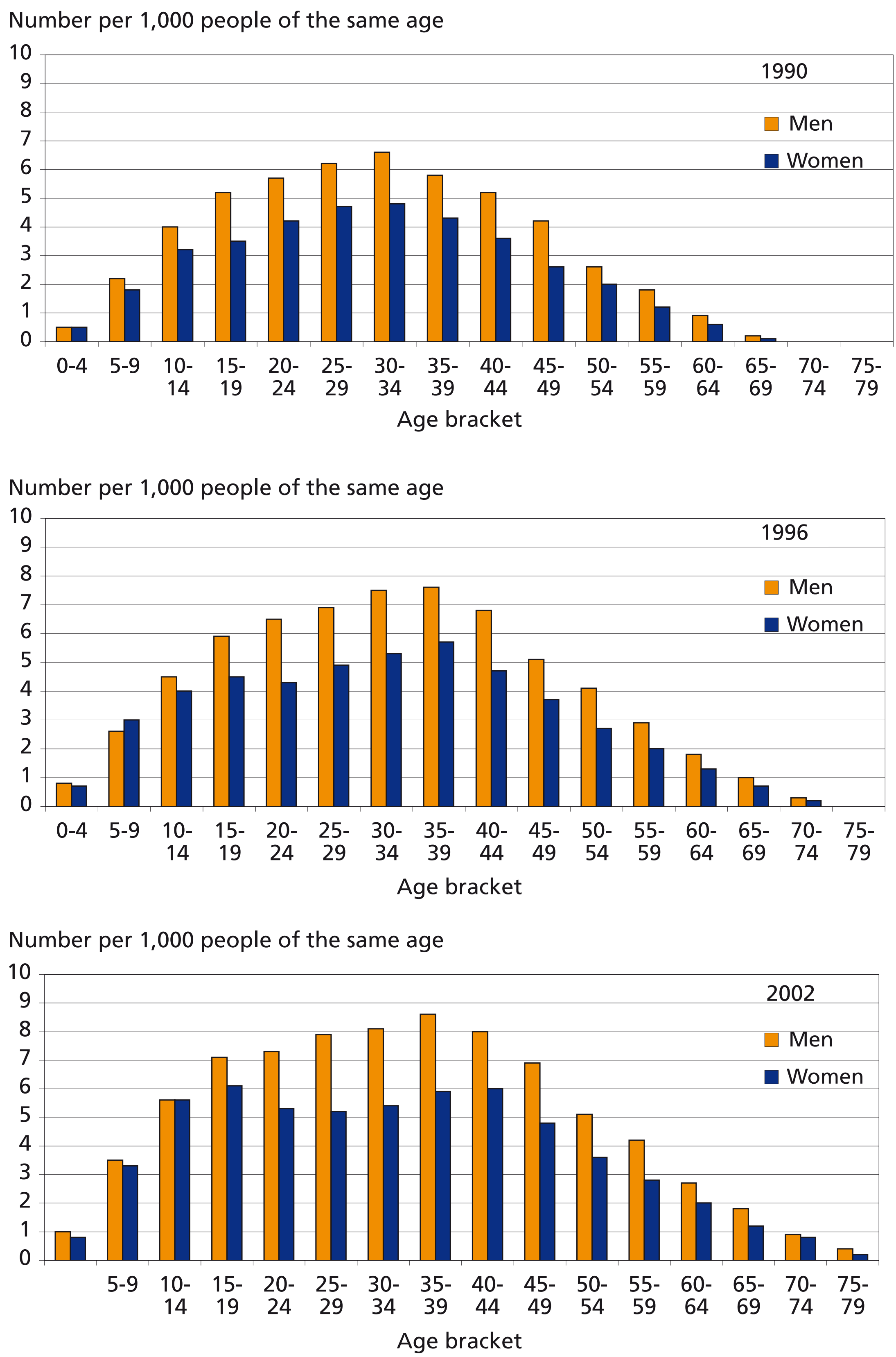


FIGURE 5. Number of people with type 1 diabetes per 1,000 people of the same age, by age group and gender in 1990, 1996 and 2002.

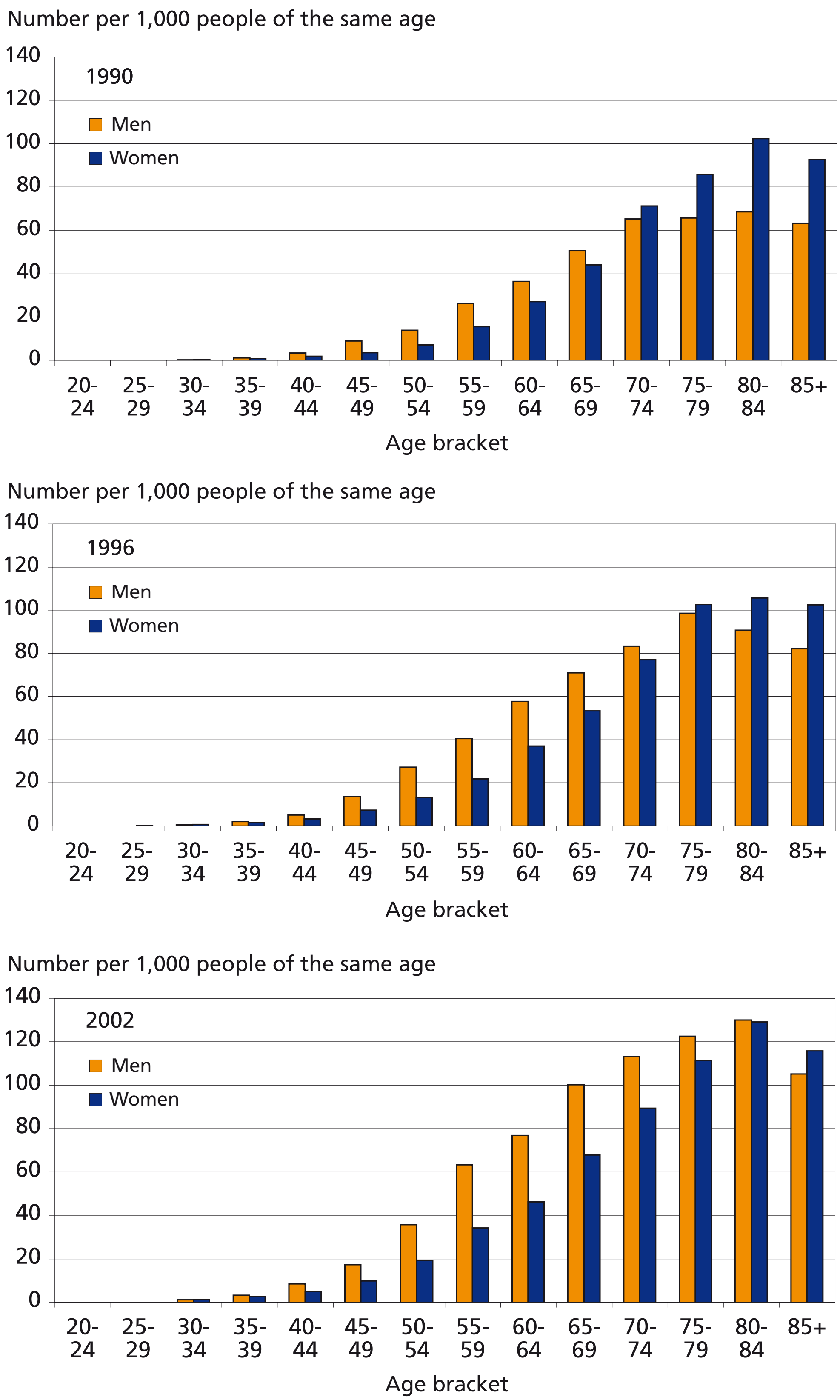


FIGURE 6. Number of people with type 2 diabetes per 1,000 people of the same age, by age group and gender in 1990, 1996 and 2002.

Median age

The median ages of living women and men with type 1 diabetes rose during the period under review. For people with type 2 diabetes, the median age declined slightly (Table 4).

TABLE 4. The median age of people with diabetes, by diabetes type and gender.

Year	Type 1 median age for men	Type 1 median age for women	Type 2 median age for men	Type 2 median age for women
1988	30	30	66	73
1989	31	30	66	74
1990	31	31	66	73
1991	32	31	65	73
1992	32	32	65	73
1993	33	32	65	73
1994	33	32	65	73
1995	33	33	65	73
1996	34	33	65	73
1997	34	33	65	73
1998	34	33	65	73
1999	34	34	65	73
2000	34	34	65	72
2001	35	34	65	72
2002	35	34	65	72

For people with type 1 diabetes, the age when starting medication is usually the same as the age of the onset of the disease, and it can therefore be used for following the duration of their disease. By contrast, people with type 2 diabetes may have had the disease undiagnosed for years, or they may have controlled the disease by means of diet alone before starting their medication. Based on this material, it is therefore not possible to determine the age at the onset of the disease for people with type 2 diabetes; nor is it possible to obtain information about the duration of their disease.

When the median age at the start of medication was examined by gender and diabetes type, it was found to be lower for women than for men with type 1 diabetes. For women with type 2 diabetes, the median age when starting medication was some 7–8 years higher than for men. This difference remained the same throughout the review period (Tables 5–6).

TABLE 5. Median age when starting medication, type 1 diabetes.

Year	Median men	Median women	Median total
1988	18	13	16
1989	15	16	16
1990	20	13	17
1991	18	11	15
1992	15	12	15
1993	16	12	14
1994	18	13	15
1995	16	12	14
1996	15	10	13
1997	15	11	13
1998	14	11	13
1999	14	12	13
2000	15	12	14
2001	15	10	13
2002	13	12	13

TABLE 6. Median for the average age when starting medication, type 2 diabetes.

Year	Median men	Median women	Median total
1988	62	70	67
1989	62	70	67
1990	62	70	67
1991	62	70	66
1992	62	70	66
1993	62	70	66
1994	63	71	67
1995	62	70	66
1996	62	69	66
1997	61	69	65
1998	61	69	65
1999	61	68	65
2000	61	68	64
2001	60	68	64
2002	60	67	63

RESEARCH FINDINGS DESCRIBING THE QUALITY OF CARE

Complications

By number, the biggest group among the complications of diabetes consists of artery diseases, i.e. myocardial and cerebral infarctions and leg amputations associated with artery diseases of lower limbs. They are always treated in hospital; therefore, the Hilmo hospital discharge register gives a reliable picture of the number of these complications.

Regional differences between the end-point events of these three vascular diseases (lower limb amputations, myocardial infarctions and cerebral infarctions) were examined separately by hospital district in 1988–2002. Åland is excluded from regional analyses because patients from Åland are also treated in Swedish hospitals; the figures obtained from Hilmo therefore do not give a true account of morbidity. However, Åland is included in the figures describing the whole of Finland.

One way to look at the complications of diabetes is to record the patient's first lower limb amputation, myocardial infarction or cerebral infarction during the study period. Since the data on these diseases were gathered from 1988 onwards (i.e. the start of the period of study) (the ICD classification was revised in 1987), it follows that the greatest number of end-point events was recorded for the year 1988. In reality, however, not all of these cases represent the first occurrences of the complications for the person, because the corresponding information for the previous years is missing. Thus the number of these "wrong" first end-point events falls year by year so that in 2002 the probability that the event really was the first for the patient is greater than in any previous year.

The material included 2,518 persons with diabetes whose home municipality had not been recorded or who lived abroad. Nevertheless, these persons are included in analyses describing the whole country (e.g. annual incidence of amputations).

For some people included in the research population, the end-point event appeared before the diagnosis of diabetes (known as cases of prediabetes). These end-point events were excluded from the analysis.

Lower limb amputations

Diabetes accelerates the development of all atherosclerotic complications, including peripheral vascular disease (37). Lower limb amputation generally follows from peripheral artery disease and is a significantly more common procedure among people with diabetes than among the nondiabetic population (38, 39). A person with diabetes has a 20 times greater probability of needing a lower limb amputation than a person without diabetes (40).

According to various studies, 40–60 per cent of all lower limb amputations are performed for persons with diabetes (41). Many studies have been conducted on the incidence of amputations among persons with diabetes; their results vary depending on the definition of amputation, on the selection of the target group, and on how the number of amputations has been proportioned (e.g. against all people with diabetes or against the entire population) (42–48).

This study excluded lower limb amputations performed for persons with diabetes because of a tumour or a trauma (in total 516), because diabetes was not the main factor affecting the procedure in these cases. Among the subjects who had undergone one or more lower limb amputations, there were 331 persons with prediabetes. They had undergone an amputation before the first entry of diabetes into registers (special reimbursement right to diabetes medication or a purchase of diabetes medicine). These amputations were not included in the analysis.

During the entire period under review, a total of 17,211 lower limb amputations were performed for 11,070 persons in the research population. Of these people, 68 had undergone their first amputation before the occurrence of diabetes, but they also had a subsequent amputation after diagnosis of diabetes. During our period of review, 6,992 patients had had only one amputation (41 per cent of persons with diabetes who had undergone amputation). The rest had from two to ten amputations (or correction of the stump).

The analysis focused on the first lower limb amputations among persons with diabetes (11,002) because on the basis of the hospital discharge register data it cannot be determined whether the procedure was a repeated amputation on the same leg (e.g. correction of the stump) or an amputation of the second leg. The importance of the procedure is very different in these two cases.

The incidence of the first amputations is shown, by age group and gender, in Figure 7 for 100,000 persons with diabetes during the years 1988–2002. Persons with diabetes who were under 25 years of age had had no amputations.

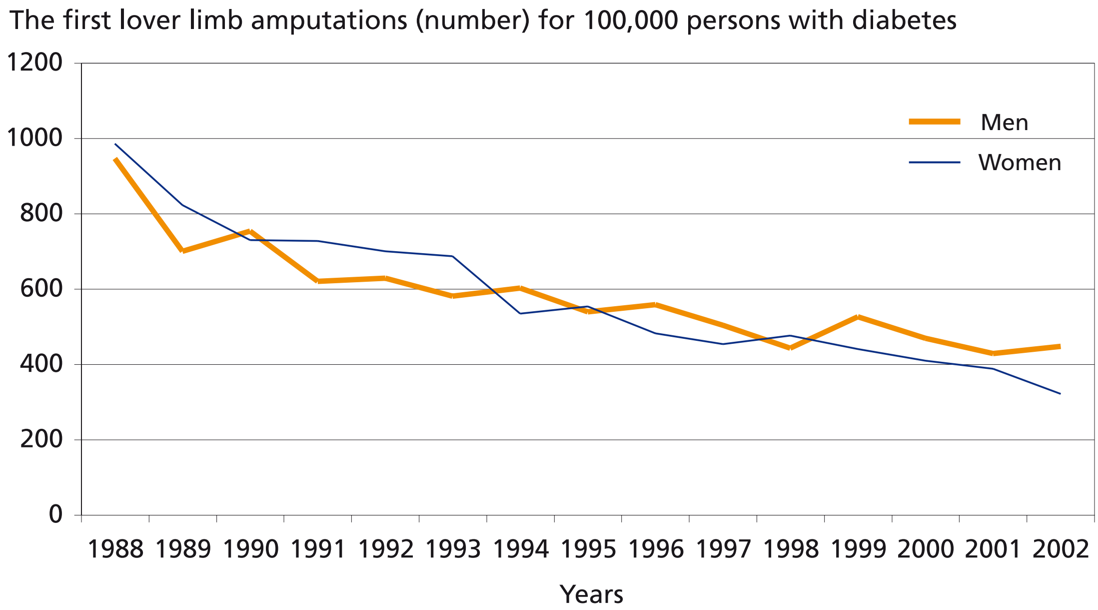


FIGURE 7. The first lower limb amputations (number) for 100,000 persons with diabetes, by gender in 1988–2002.

The incidence of the first amputations among all people with diabetes fell by 58 per cent between 1988 (924 per 100,000 persons with diabetes) and 2002 (386.5 per 100,000 persons with diabetes).

Between the ages of 25 and 54 years, the number of amputations was so small that random variation makes it impossible to detect any change in the trend. For men, the incidence of amputations fell the most among the oldest age group (over 75 years of age), but for women the sharpest decline was recorded in the age group 55–64 years (Table 7).

TABLE 7. The first amputations per 100,000 persons with diabetes, by gender and age group in 1988–2002.

Men Year	Age group 25-54	55-64	65-74	75+	All
1988	373.5	976.9	1,294.1	1,847.5	898.5
1989	239.1	534.6	1,072.6	1,419.2	659.0
1990	291.2	573.5	915.0	1,992.8	734.5
1991	270.3	593.4	716.4	1,247.0	576.9
1992	255.3	463.6	856.8	1,362.0	595.3
1993	316.4	382.1	934.0	979.3	560.8
1994	312.6	443.4	682.5	1,394.8	577.4
1995	205.2	436.0	759.6	1,095.9	520.1
1996	225.4	405.4	799.3	1,153.5	542.0
1997	240.6	425.2	630.1	1,022.9	489.8
1998	217.7	399.1	565.3	809.6	428.7
1999	226.0	509.6	731.4	878.2	512.2
2000	251.7	357.6	592.6	951.2	462.5
2001	244.6	352.9	582.7	729.8	424.4
2002	316.6	359.3	559.1	750.6	447.1

Women Year	Age group 25-54	55-64	65-74	75+	All
1988	155.8	507.2	1036.9	1,486.3	943.0
1989	85.8	326.3	827.6	1,319.4	799.7
1990	173.0	238.6	714.4	1,158.9	704.2
1991	226.9	310.3	620.8	1,200.8	708.0
1992	163.6	306.2	662.7	1,102.8	673.4
1993	184.1	281.1	605.3	1,127.5	664.5
1994	127.4	312.1	442.7	859.6	512.5
1995	102.3	257.9	522.0	905.7	539.8
1996	162.6	128.3	451.1	814.7	475.9
1997	161.7	231.4	392.2	730.6	441.2
1998	148.0	221.7	452.6	769.5	467.5
1999	148.3	237.5	367.9	740.1	434.5
2000	163.3	211.4	319.3	694.8	402.3
2001	146.0	155.1	309.1	691.6	386.2
2002	146.6	100.0	272.2	575.5	322.0

People with diabetes accounted for 54 to 60 per cent of all lower limb amputations performed in Finland in 1988–2002. The highest percentage was recorded in 2002, but both upward and downward variation occurred during the period under study. No clear trend could be detected.

The mean age of persons with diabetes at the time of their first amputation was 72 years (SD 12). For women, the mean age was 76 years (SD 10) and the median 77 years, whereas for men the mean age was 68 years (SD 12) and the median 69 years. The difference in the mean age between the genders was statistically significant ($p<0.001$). For both women and men, the mean age at the time of the amputation remained almost the same throughout the period under study.

The number of all lower limb amputations (including renewed operations) among people with diabetes peaked in 1999, when altogether 1,291 amputations were performed for persons with diabetes (this does not include amputations because of tumours or traumas). There was a statistically significant difference between amputations performed for men and for women. Amputations performed for men increased by 63 per cent whereas amputations performed for women decreased by 24 per cent (Table 8) ($p<0.0001$). The total number of people with diabetes who underwent a lower limb amputation kept rising until 1999. However, the incidence of amputations in proportion to the number of people with diabetes fell.

TABLE 8. All amputations performed on lower limbs (including renewed operations) among people with diabetes (excluding amputations because of a trauma or a tumour).

Year	Number of amputations (procedures)	Men	Women	All	All /100 000 people with diabetes
1988	998	360	507	867	924
1989	1,023	341	511	852	834
1990	1,071	409	494	903	843
1991	1,059	371	516	887	788
1992	1,131	408	513	921	785
1993	1,142	403	521	924	760
1994	1,135	448	446	894	691
1995	1,154	427	475	902	671
1996	1,161	476	430	906	645
1997	1,148	482	415	897	613
1998	1,178	453	460	913	601
1999	1,291	570	428	998	630
2000	1,245	547	421	968	583
2001	1,251	540	430	970	554
2002	1,224	585	384	969	525
Total	**17,211**				

N.B. A person may be included in the annual statistics during more than one year.

The number of amputations decreased at different rates in different hospital districts when the figures were standardised for age and gender and were proportioned to the number of people with diabetes. Especially in smaller hospital districts, random variation had a significant effect on the number of amputations in any single year. Therefore, the incidence figures were calculated for periods of three years.

Figures 8–11 show the numbers of lower limb amputations in three-year periods, as indices standardised for age and gender, for all hospital districts in 1988–2002. The hospital districts have been grouped so that there are 5–6 districts per Figure. The order follows the numbering given when statistics were compiled (1–21).

The only statistically significant difference ($p<0.05$) between hospital districts was observed in Northern Savo, where the incidence of the first lower limb amputations, standardised for age and gender, was greater than in the rest of Finland during the period 2000–2002.

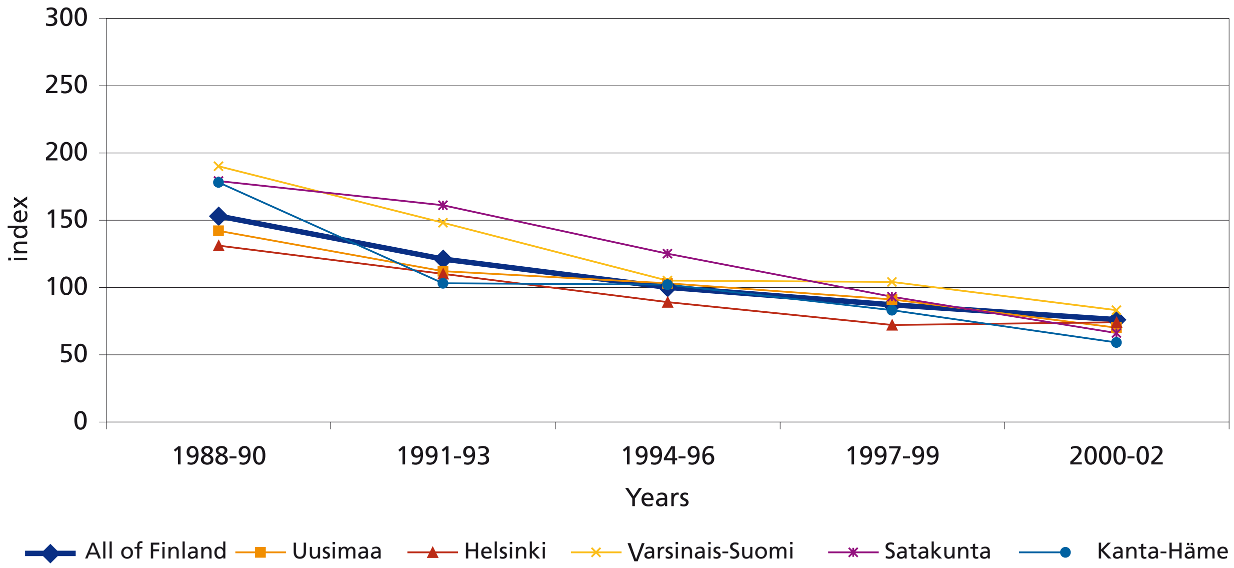


FIGURE 8. Change in the index describing the number of the first lower limb amputations among people with diabetes in the hospital districts of Uusimaa, Helsinki, Varsinais-Suomi, Satakunta and Kanta-Häme in the years 1988–2002. The amputations have been standardised for age and gender and they have been proportioned to the number of people with diabetes in each hospital district. The number of amputations in all of Finland in 1994–1996 = 100.

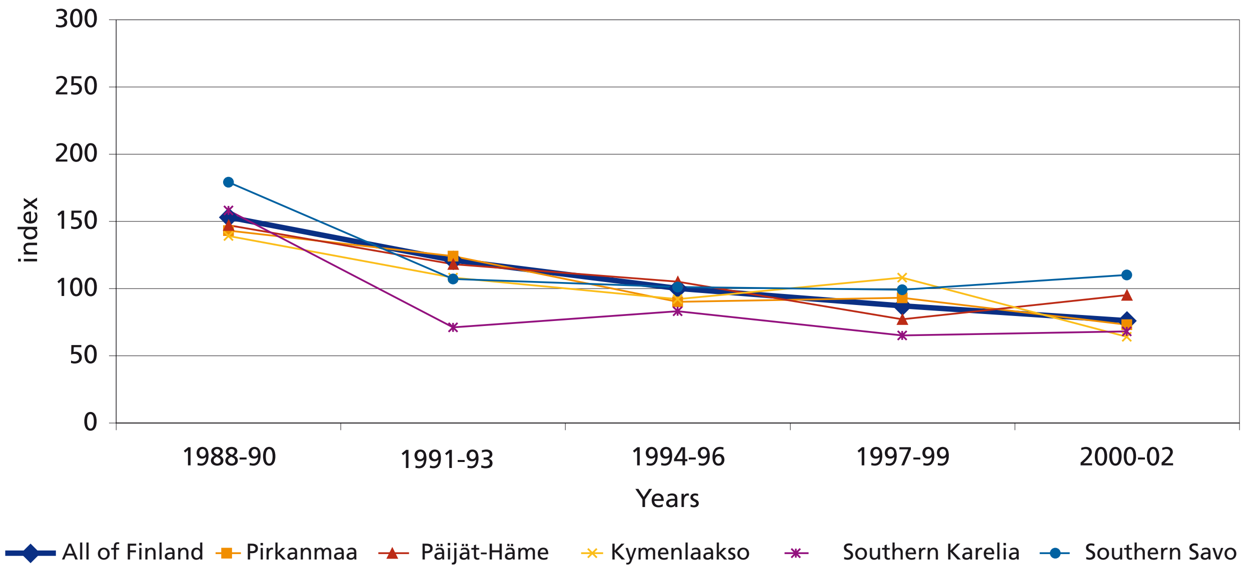


FIGURE 9. Change in the index describing the number of the first lower limb amputations among people with diabetes in the hospital districts of Pirkanmaa, Päijät-Häme, Kymenlaakso, Southern Karelia and Southern Savo in the years 1988–2002. The amputations have been standardised for age and gender and they have been proportioned to the number of people with diabetes in each hospital district. The number of amputations in all of Finland in 1994–1996 = 100.

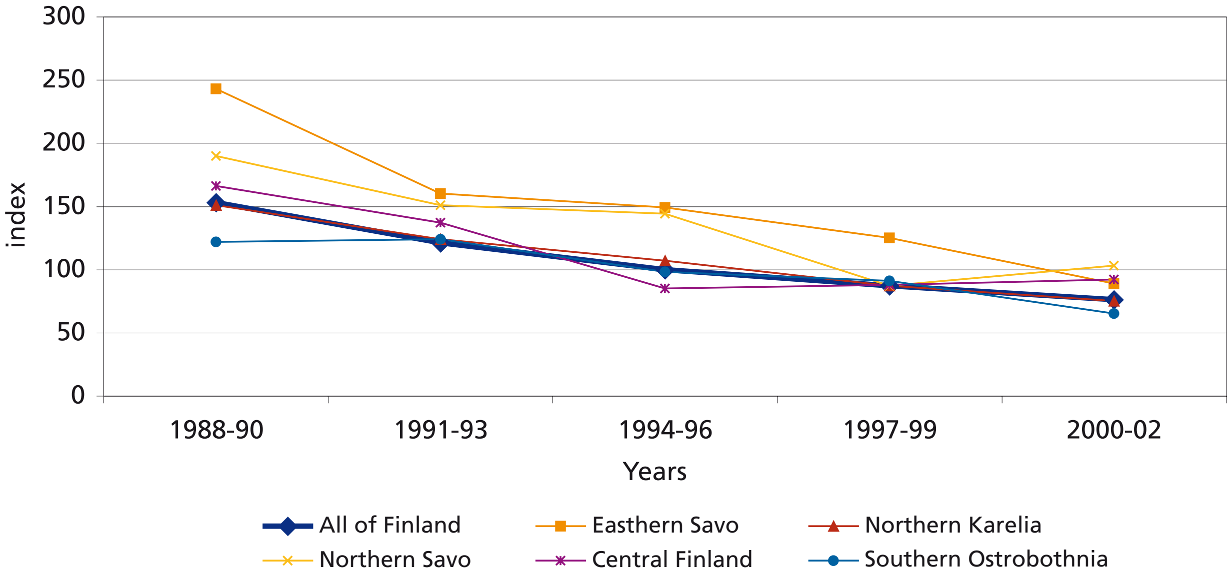


FIGURE 10. Change in the index describing the number of the first lower limb amputations among people with diabetes in the hospital districts of Eastern Savo, Northern Karelia, Northern Savo, Central Finland and Southern Ostrobothnia in the years 1988–2002. The amputations have been standardised for age and gender and they have been proportioned to the number of people with diabetes in each hospital district. The number of amputations in all of Finland in 1994–1996 = 100.

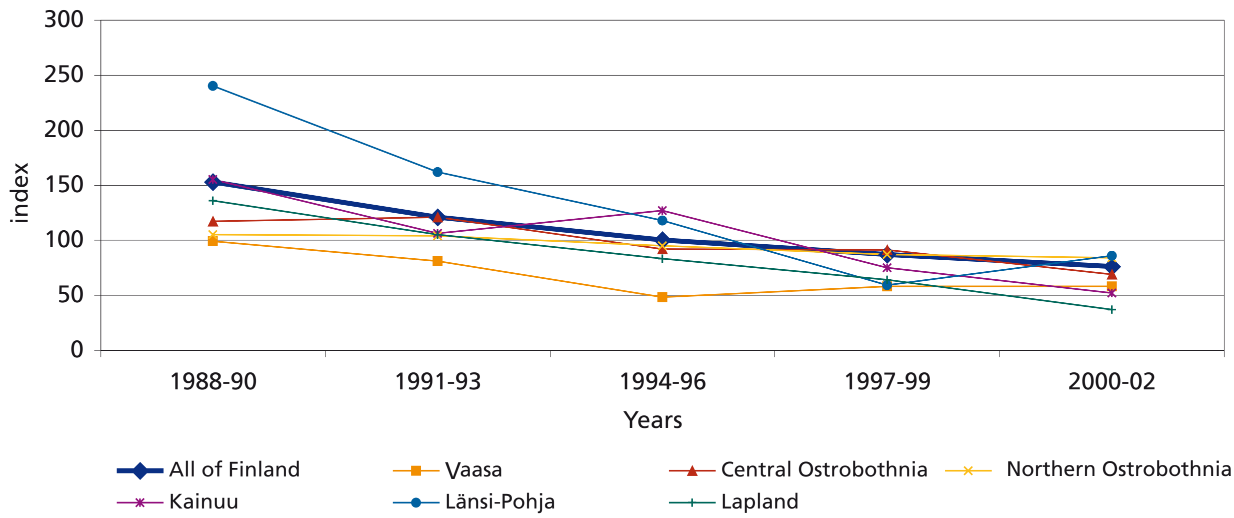


FIGURE 11. Change in the index describing the number of the first lower limb amputations among people with diabetes in the hospital districts of Vaasa, Central Ostrobothnia, Northern Ostrobothnia, Kainuu, Länsi-Pohja and Lapland in the years 1988–2002. The amputations have been standardised for age and gender and they have been proportioned to the number of people with diabetes in each hospital district. The number of amputations in all of Finland in 1994–1996 = 100.

The number of amputations in proportion to the number of people with diabetes fell between the first (1988–1990) and the last (2000–2002) period under study everywhere in Finland. Towards the end of the period under review, the index rose slightly in the hospital districts of Helsinki, Päijät-Häme, Southern Karelia, Southern Savo, Northern Savo, Central Finland and Länsi-Pohja.

During the last period under review in 2000–2002, the lowest index (35) was recorded in the hospital district of Lapland and the highest index (106) in Southern Savo.

The steepest fall in the index in relation to the initial value, 75 per cent, was also recorded in Lapland. Measured in per cent, the smallest change (21%) took place in the index for Northern Ostrobothnia, but this is partly explained by the low level of the initial index (the lowest value after Vaasa).

Figure 12 and Table 9 show how the index describing the number of amputations changed in all hospital districts during the period under study. In other words, they combine the data of Figures 8–11. Figure 12 illustrates the distinct downward trend, as well as the clearly narrower regional variation, that can be seen in indices for the whole country.

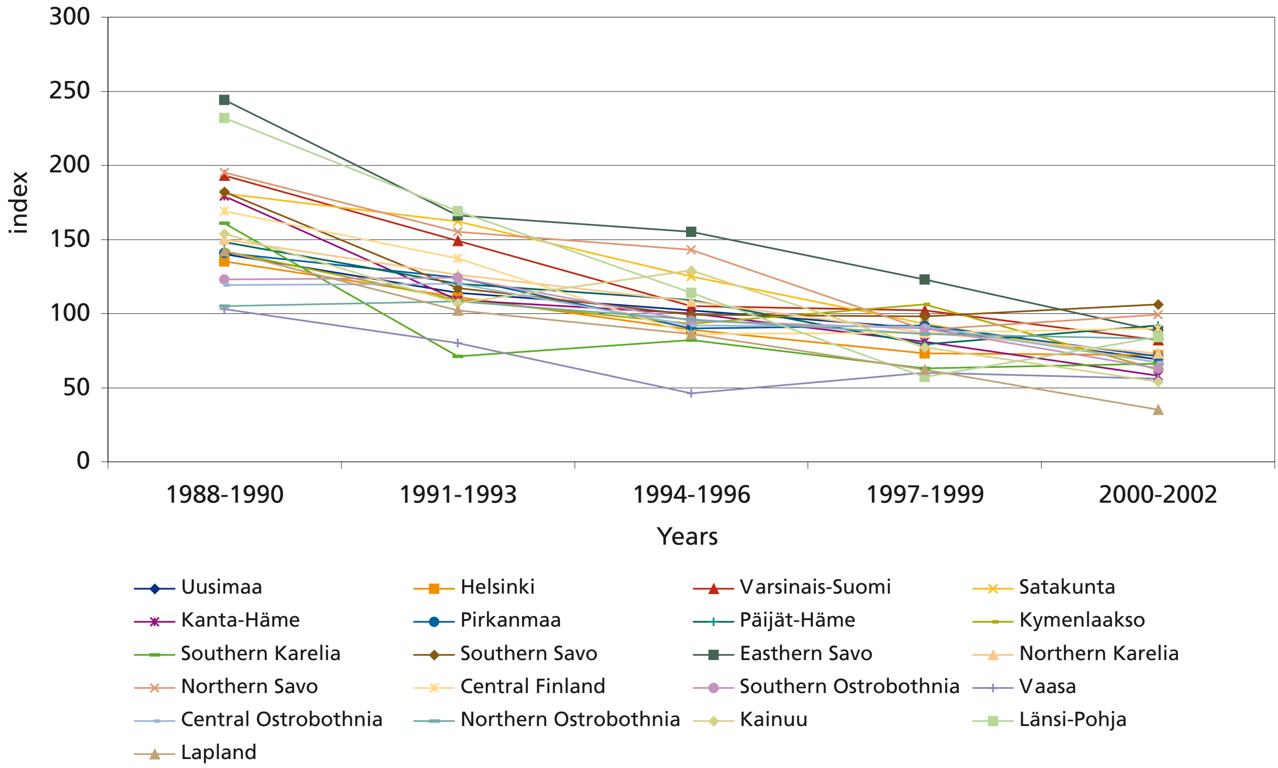


FIGURE 12. Change in the index describing the number of the first lower limb amputations among people with diabetes in all hospital districts in the years 1988–2002. The amputations have been standardised for age and gender and they have been proportioned to the number of people with diabetes in each hospital district. The number of amputations in all of Finland in 1994–1996 = 100. See Appended Table 4.

TABLE 9. Indices describing the number of the first lower limb amputations among people with diabetes in all hospital districts in the years 1988–2002. The amputations have been standardised for age and gender and they have been proportioned to the number of people with diabetes in each hospital district. The number of amputations in all of Finland in 1994–1996 = 100.

Hospital district	1988-1990	1991-1993	1994-1996	1997-1999	2000-2002
Uusimaa	142	112	103	91	70
Helsinki	131	110	89	72	74
Varsinais-Suomi	190	148	105	104	83
Satakunta	179	161	125	93	66
Kanta-Häme	178	103	102	83	59
Pirkanmaa	143	124	90	93	73
Päijät-Häme	147	118	105	77	95
Kymenlaakso	139	108	92	108	64
Southern Karelia	158	71	83	65	68
Southern Savo	179	107	101	99	110
Eastern Savo	243	160	149	125	89
Northern Karelia	151	124	107	87	75
Northern Savo	190	151	144	87	103
Central Finland	166	137	85	88	92
Southern-Ostrobothnia	122	124	98	91	65
Vaasa	99	81	48	58	58
Central-Ostrobothnia	117	121	92	91	69
Northern-Ostrobothnia	105	104	95	87	84
Kainuu	155	106	127	75	52
Länsi-Pohja	240	162	118	59	86
Lapland	136	105	83	64	37
All of Finland	**153**	**121**	**100**	**87**	**76**

Amputation levels

Lower limb amputations can be divided into different levels in two ways: either amputations below/above the knee or minor/major amputations. In this study, minor amputations referred to amputations in the areas of the toes, feet and ankles, while major amputations referred to amputations in the areas of the legs and thighs. The division into minor and major amputations is essential because there is a marked difference in the inconvenience caused to the patient and in the costs of care between these two categories. For this reason, studies on lower limb amputations often focus only on major amputations (49, 50).

In this study the amputation level developed positively between the years 1988 and 2002 so that the number of the first major amputations performed for persons with diabetes (the patient may have previously had a minor amputation) decreased, and the number of the first minor amputations (the patient may have previously had a major amputation) increased. The number of major amputations fell by 32 per cent between the years 1988 and 2002 (Table 10).

TABLE 10. The first minor and major amputations of lower limbs among persons with diabetes, and the ratio between these two types of amputations in 1988–2002.
N.B. This may not necessarily be the first amputation for the person during this period (see text).

Year	Number of minor amputations	Number of major amputations	Ratio between minor and major amputations
1988	271	657	0,41
1989	261	597	0.44
1990	268	604	0.44
1991	259	581	0.45
1992	298	579	0.51
1993	332	546	0.61
1994	314	520	0.60
1995	315	528	0.60
1996	359	496	0.72
1997	353	464	0.76
1998	353	476	0.74
1999	422	498	0.85
2000	401	459	0.87
2001	411	453	0.91
2002	419	448	0.94

Persons who underwent their first minor amputation were significantly younger (mean age 69 years) than those who had their first major amputation (74 years). The difference was statistically significant ($p<0.001$).

The difference in the incidence of the first major amputations between women and men with diabetes disappeared between 1988 and 2002. In 1999–2002, the incidence was nearly the same for both genders (Figure 13).

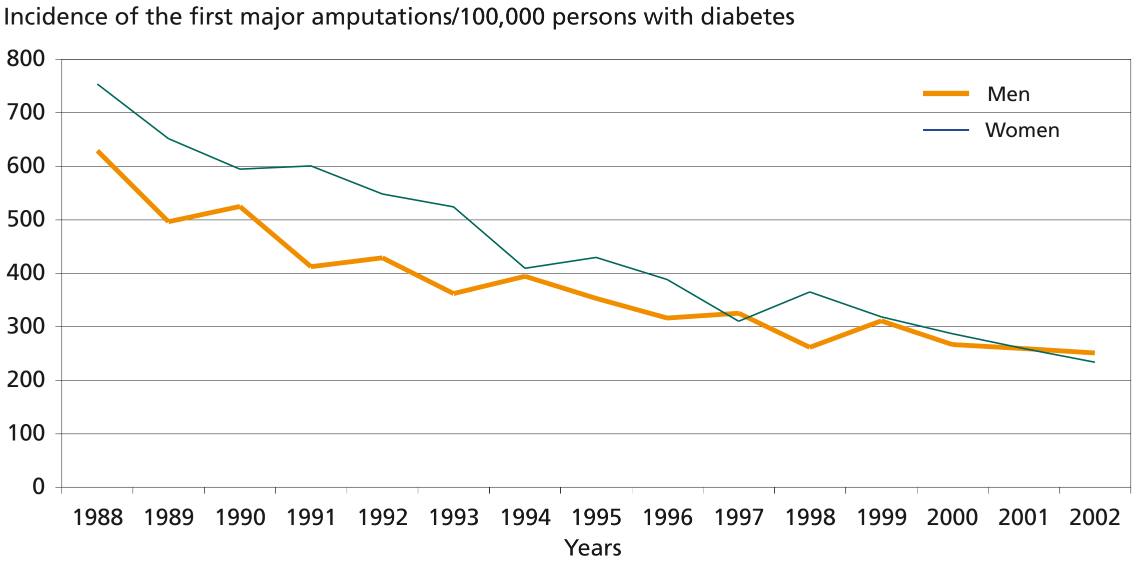


FIGURE 13. Incidence of the first major amputations among persons with diabetes for 100,000 cases of diabetes, by gender, in 1988–2002.

The narrowing of variation between hospital districts during the period under study was at least as clear in the case of the index for major amputations as it was in the index describing the number of all amputations (Figure 14, Table 11). Similarly, the falling trend of the indices was clearly visible. The lowest index for the first major amputations in 2000–2002 was recorded in the hospital districts of Southern Ostrobothnia and Lapland.

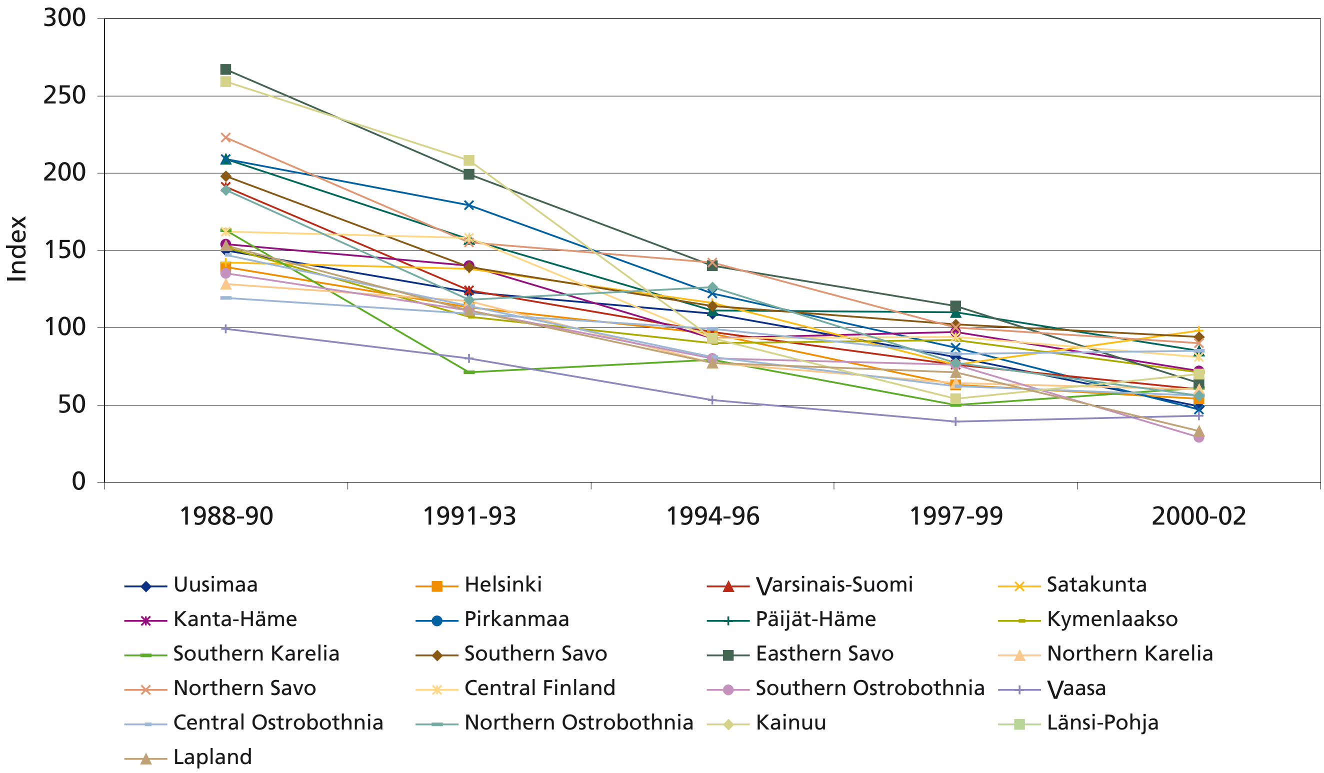


FIGURE 14. Change in the index describing the number of the first major amputations among people with diabetes in all hospital districts in 1988–2002. The amputations have been standardised for age and gender and they have been proportioned to the number of people with diabetes in each hospital district. The number of major amputations in all of Finland in 1994–1996 = 100.

TABLE 11. Index describing the number of the first major amputations among people with diabetes in all hospital districts in the years 1988–2002. The amputations have been standardised for age and gender and they have been proportioned to the number of people with diabetes in each hospital district. The number of amputations in all of Finland in 1994–1996 = 100.

Hospital district	1988-1990	1991-1993	1994-1996	1997-1999	2000-2002
Uusimaa	151	122	110	82	50
Helsinki	133	111	95	63	55
Varsinais-Suomi	206	155	110	111	87
Satakunta	205	178	124	87	47
Kanta-Häme	193	114	99	76	61
Pirkanmaa	156	139	92	98	73
Päijät-Häme	143	134	113	73	100
Kymenlaakso	149	106	89	92	72
Southern Karelia	156	73	79	51	62
Southern Savo	200	128	114	102	96
Eastern Savo	268	193	135	114	63
Northern Karelia	126	115	79	64	60
Northern Savo	218	155	143	98	92
Central Finland	159	155	91	95	82
Southern Ostrobothnia	136	108	82	76	30
Vaasa	91	80	55	40	45
Central Ostrobothnia	143	116	80	63	57
Northern Ostrobothnia	118	103	98	82	86
Kainuu	193	115	129	73	54
Länsi-Pohja	265	197	96	55	72
Lapland	151	114	73	72	34
All of Finland	**163**	**128**	**100**	**82**	**67**

Procedures involving arteries of the lower limbs

Various factors contribute to the reduction in lower limb amputations among people with diabetes: vascular procedures carried out to save blood circulation in lower limbs; control of all known risk factors affecting the development of atherosclerosis (smoking, hypertension, disorders in lipid metabolism, etc.); and the monitoring of feet and legs and the timely and careful treatment of any problems detected (e.g. ulcers) in this connection. Studies indicate that in 71–85 per cent of amputations among people with diabetes, the condition was accelerated by an ulcer in the lower limb leading to a severe infection or to necrosis (48, 51).

Percutaneous transluminal angioplasty (PTA) of the lower limbs is a procedure involving a low risk of complications; its results can be compared to those of vascular surgery among both people with diabetes and other people (52). If PTA is not possible, vascular surgery should be considered in order to avoid amputation.

In our study we were not able to determine the number of all vascular procedures performed on the lower limbs of persons with diabetes. The hospital discharge register data reveal only a small percentage of PTA procedures since they are usually performed in the outpatient ward, and so far the hospital discharge registers only encompass care given in the inpatient ward. In consequence, in this study vascular procedures refer mainly to vascular surgery.

According to the findings of this study, out of all lower limb amputations carried out during the period under study (1988–2002), 54–60 per cent were performed for persons with diabetes, but out of all vascular procedures on the lower limbs carried out during the same period, only 15–28 per cent were performed for persons with diabetes. In 2002, the share was 26 per cent. During the period under study, a total of 8,943 vascular procedures were performed for 6,710 people. Of these people, 6,537 had diabetes at the time of the procedure and 173 persons had prediabetes. A vascular procedure alone without a lower limb amputation during the period under study was performed for 4,370 persons with diabetes. This was 67 per cent of all people with diabetes who underwent a vascular procedure. Amputation without a vascular procedure was performed for 8,730 people, which is 79 per cent of all people with diabetes who underwent an amputation on their lower limbs. A major lower limb amputation without a vascular procedure was performed for 6,352 persons with diabetes during 1988–2002.

When the indexed numbers of lower limb amputations are compared to the indices of vascular procedures in hospital districts (Figure 15, Table 12), the trends were different. A clear rise in the indices was visible during the first few years of the study period. A distinct turn took place during 1997–1999, when the number of vascular procedures and the subsequent comparative indices began to decline. An explanation for this may be the separation of thorax surgery as a speciality of its own in 1998. In consequence, indications for bypass operations on lower limbs have perhaps become more precise because surgeons doing heart bypass operations no longer perform bypass operations on lower limbs. PTAs on lower limbs may also have replaced some operations (only a small percentage of PTAs can be seen in this material).

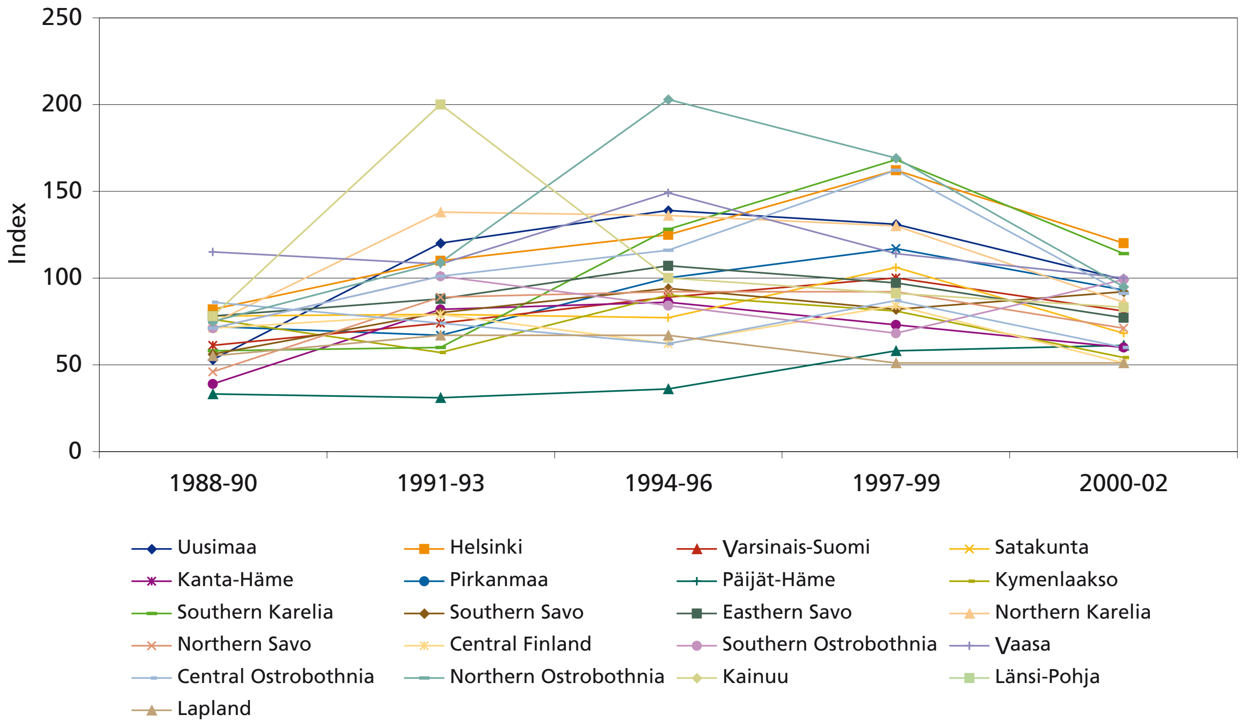


FIGURE 15. Change in the index describing the number of the first vascular procedures on the lower limbs among people with diabetes in all hospital districts in 1988–2002. The vascular procedures have been standardised for age and gender and they have been proportioned to the number of people with diabetes in each hospital district. The number of vascular procedures in all of Finland in 1994–1996 = 100.

TABLE 12. Comparative indices for the first vascular procedures performed on the lower limbs of people with diabetes in all hospital districts in the years 1988–2002. The vascular procedures have been standardised for age and gender and they have been proportioned to the number of people with diabetes in each hospital district. The number of vascular procedures in all of Finland in 1994–1996 = 100.

Hospital district	1988-1990	1991-1993	1994-1996	1997-1999	2000-2002
Uusimaa	53	120	139	131	99
Helsinki	82	110	125	162	120
Varsinais-Suomi	33	31	36	58	61
Satakunta	72	67	100	117	93
Kanta-Häme	61	74	89	100	81
Pirkanmaa	39	82	86	73	60
Päijät-Häme	78	79	77	106	68
Kymenlaakso	76	57	90	81	54
Southern Karelia	58	60	128	168	114
Southern Savo	56	80	94	82	92
Eastern Savo	78	88	107	97	77
Northern Karelia	74	138	136	130	86
Northern Savo	46	89	92	92	71
Central Finland	71	79	62	84	51
Southern Ostrobothnia	71	101	84	68	99
Vaasa	115	108	149	114	100
Central Ostrobothnia	86	74	62	87	60
Northern Ostrobothnia	71	101	116	162	91
Kainuu	75	109	203	169	95
Länsi-Pohja	78	200	100	91	83
Lapland	55	67	67	51	51
All of Finland	**64**	**88**	**100**	**108**	**82**

Among vascular procedures, only the incidence of infrapopliteal (extending below the knee) bypass operations has been found to correlate inversely with the incidence of major amputations in the Finnish population in the years 1993–1994. In other words, infrapopliteal bypass operations may reduce the number of amputations (49).

However, this study revealed that in 1997–2002, the incidence of all first vascular surgical procedures (codes PDE, PDF, PDH, PDU, PEE, PEF, PEH, PEN, PEQ, PEU, PFE, PFH, PFN, PFQ, PFU, PGH), standardised for age and gender, correlated inversely with the corresponding incidence of the first major amputations in the fourteen hospital districts that had the greatest numbers of people with diabetes (correlation coefficient -0.771 and p<0.001). The correlation was even clearer in terms of the incidence of infrapopliteal (located in the area of the knee or lower) procedures of vascular surgery (codes PFE, PFH, PFN, PFQ, PFU) (correlation coefficient -0.793 and p<0.001).

Discussion

Many studies have been conducted on lower limb amputations among persons with diabetes, but comparison of their findings is difficult because the materials have been compiled and treated in different ways, the ethnic target groups differ, and care practices differ. An amputation performed above the ankle means a marked fall in the quality of life of a person with diabetes and usually causes permanent costs of different types. Prevention of all amputations will become even more important as the number of persons with diabetes increases and the age structure of the population changes. Accordingly, the goal is to achieve as nonradical amputations (minor ones) as possible if the patient has been able to get around independently. There is a greater tendency to perform a major amputation for permanently bedridden patients, to spare them from any subsequent amputation.

In a study that encompassed all people with diabetes in the Netherlands (53) in the years 1991–2000, the mean age of all patients at the time of their amputation was 72 years (SD 12), or the same as in this material. No significant change was detected in the mean age in either country during the period under study.

The absolute numbers of amputations among women and men showed a similar trend in both studies; in other words, amputations among men increased and among women decreased. At least a partial explanation to this trend in this study is the decrease in the relative share of women (Table 2).

The decrease in the incidence of amputations among people with diabetes in the Netherlands between 1991 (550 per 100,000 persons with diabetes) and 2001 (363 per 100,000 persons with diabetes) is smaller (34%) than the decrease among Finns with diabetes during the same period (40%). The incidence figures are not comparable because the population in the Dutch study also includes people who control their diabetes by means of their diet.

The ratio between minor and major amputations did not change among Dutch people with diabetes between 1991 and 2000. For instance, the share of leg and thigh amputations remained nearly the same, or 49 per cent, throughout the period under review. Thus, major amputations accounted for a slightly smaller percentage of all amputations among Dutch people with diabetes than they did among Finns with diabetes in 2002 (52%).

There is only one previous Finnish study of amputations among people with diabetes: The study population consisted of inhabitants in the Province of Kuopio in 1978–1984 (38). The material included persons with diabetes irrespective of whether they controlled their diabetes by means of diet, oral medication or insulin. The proportion of people who controlled their diabetes by means of dietary changes (33%) in the Kuopio region was estimated on the basis of an earlier study; the number of people on drug therapy was obtained from the KELA register. The study compared amputations associated with diabetes (amputations caused by traumas and tumours were excluded) against amputations performed for people who did not have diabetes. The mean age of men with diabetes at the time of their first amputation was 67 years (SD 10) and the mean age of women was 74 years (SD 9). In this respect, the results were nearly the same as in this study. The incidence of amputations standardised for age among people with diabetes in the Province of Kuopio was 239 per 100,000 persons with diabetes for women and 349 per 100,000 for men. Not only the standardisation for age, but also the inclusion of people who control their diabetes by means of dietary changes caused a difference between that study and the present study. If we estimate the share of people who control their diabetes through diet at 30 per cent (36) and if we use this figure to calculate the number of all people with diabetes (both women and men) in this study in 2002, the incidence of amputations among women becomes 224 per 100,000 persons with diabetes and among men 313 per 100,000 persons with diabetes. Although these figures cannot be compared directly with the findings in the Kuopio study, it can be seen that they are of the same order of magnitude.

The goal set in the St Vincent declaration in 1989 was to cut the number of lower limb amputations among people with diabetes by 50 per cent within the next five years (54). In Finland, the number of all amputations performed for people with diabetes fell by 40 per cent from 1988 to 2002, when adjusted for the number of people with diabetes. The corresponding fall in incidence was 60 per cent. Thus the goals set in the St Vincent declaration have not been fully met as quickly as had been hoped.

The DEHKO Programme (5) for 2000–2010 sets the objective of reducing leg amputations among people with diabetes by half. Between 2000 and 2002, the incidence of lower limb amputations, adjusted for the population with diabetes, fell by 12 per cent in the whole of Finland (Appended Table 1). If the same trend continues, the total reduction by 2010 would be 60 per cent, i.e. the objective would be met.

To some extent, leg amputations can be avoided by means of vascular procedures, but since the underlying disease is progressive and since surgical procedures, in particular, involve complications, attention must be paid to the patient's overall situation when planning operations.

A study conducted at the HUCH (Helsinki University Central Hospital) (55) analysed 511 infrapopliteal bypass operations. According to the findings, a previous myocardial infarction, angina pectoris or stroke had a major negative effect on postoperative cardiac or cerebrovascular complications.

In consequence, the researchers propose that the contraindications for the vascular surgery in question should include severe coronary heart disease, an earlier stroke, and renal insufficiency requiring prolonged dialysis, because these patients have a high risk of postoperative death or leg amputation. In our research material, 915 diabetic people who had experienced a myocardial and/or cerebral infarction had also undergone some vascular surgical procedure.

The strong inverse correlation detected in this study between vascular surgical procedures and the incidence of amputations indicates that vascular surgery is an important factor in the prevention of amputations among people with diabetes. However, it is not possible to estimate its share when compared to primary prevention (optimal control of the blood glucose level, lipid values and blood pressure, etc.). Correct timing of vascular surgical procedures and charting of the overall situation of a person with diabetes are important when targeting limited resources so that persons with diabetes gain the optimal benefit from these procedures.

Consideration of the age and gender structure, and of the number of people with diabetes in each hospital district, revealed differences among hospital districts as concerns both lower limb amputations and the vascular procedures that may prevent these amputations. The number of lower limb amputations adjusted for the number of people with diabetes showed a positive trend during the period under study, but again there were differences between hospital districts in the way the incidence of these amputations had been reduced.

Myocardial infarctions

Diabetes is one of the most important independent risk factors for coronary heart disease (19). The same known risk factors (e.g. hypertension, disorders of lipid metabolism and smoking) affect the development of the disease irrespective of whether the person has diabetes or not. Persons with type 1 and type 2 diabetes differ from each other with respect to their lipid metabolism. Persons with type 1 diabetes even have a blood lipid composition that prevents atherosclerosis. Typically they have normal LDL and high HDL cholesterol values (56), and in their case the development of coronary heart disease is associated with the degree of nephropathy (kidney damage) (57). For persons with type 2 diabetes, the principal lipoprotein irregularities are low HDL cholesterol and high triglyceride values (58), which explain their markedly higher risk of myocardial infarction.

In this study, the following hospital discharge register codes were classified as myocardial infarctions: ICD-9 classification, 4100 and 4109; ICD-10 classification, I21 and I22. Myocardial infarctions were classified as two different disease events if there was an interval of at least 28 days between the first days of the two admissions, or between the admission and death caused by myocardial infarction. The day when the patient was admitted for care determined the year in which the infarction was recorded.

The study did not include the myocardial infarctions (in total 8,740) that had occurred before the first diabetes entry for the patient. In other words, the patient's diabetes had not yet been diagnosed, the diabetes had not broken out, or it was controlled by means of diet and the hospital discharge register contained no entry of it as a secondary diagnosis. Among these patients, the myocardial infarctions (in total 2,930) that had occurred after the first diabetes entry were, however, included in the material. The 2,518 persons with diabetes whose home municipality was not known or who lived abroad were included in the material for the whole of Finland.

During the period under study 1988–2002, persons with diabetes had a total of 67,476 myocardial infarctions (after the first diabetes entry). Of these, 29,727 (44%) led to death. Out of all infarctions, the first ones recorded during this period numbered 48,007 (71%). Of the first infarctions, 21,003 (44%) led to death. Recurring infarctions numbered 19,469 (29% of all) among a total of 12,142 patients, of whom 8,883 had two infarctions and 2,168 had three infarctions during the period under review. In other words, 45 per cent of patients who survived their first infarctions had a new infarction later.

The mean age of persons with diabetes who had their first myocardial infarction during the period 1990–2002 was 76.5 years for women and 69.0 years for men. [The difference between women and men was statistically significant ($p<0.001$)]. Between 1990 and 2002, the mean age of women and men at the time of their first myocardial infarction increased by 2.2 years and 1.6 years, respectively.

The share of myocardial infarctions leading to death was 51 per cent among both women and men with diabetes in 1990. By 2002, this share had fallen to 37 per cent among men and 38 per cent among women (Table 13).

TABLE 13. Annual numbers of myocardial infarctions among all people with diabetes, among women and men separately, and infarctions leading to death, by gender.

Year	Number of myocardial infarctions Men	Men who died myocardial infarctions	%	Number of myocardial infarction Women	Women who died myocardial infarctions	%	myocardial infarctions total
1988	1,236	401	32	2,005	713	36	3,241
1989	1,463	543	37	2,358	971	41	3,821
1990	1,779	905	51	2,620	1,322	51	4,399
1991	1,814	908	50	2,618	1,322	51	4,432
1992	2,027	967	48	2,653	1,318	50	4,680
1993	1,990	993	50	2,714	1,311	48	4,704
1994	1,858	868	47	2,565	1,245	49	4,423
1995	2,060	975	47	2,507	1,268	51	4,567
1996	1,983	920	46	2,266	1,125	50	4,249
1997	2,032	916	45	2,365	1,076	46	4,397
1998	2,068	916	44	2,452	1,063	43	4,520
1999	2,202	939	43	2,266	981	43	4,468
2000	2,427	898	37	2,561	1,015	40	4,988
2001	2,516	897	36	2,746	1,007	37	5,262
2002	2,596	935	36	2,729	1,009	37	5,325
Total	**30,051**	**12,981**		**37,425**	**16,746**		**67,476**

When deaths caused by myocardial infarction were standardised for age and compared between women and men with diabetes, it was discovered that, after standardisation for age, women had higher mortality figures, but the difference disappeared by the year 2002 (Figure 16). In standardisation for age, myocardial infarction mortality in the whole of Finland in 1994 is given the value of 100. 1994 was selected as the reference year because it is located mid-way between the beginning and end of the review period.

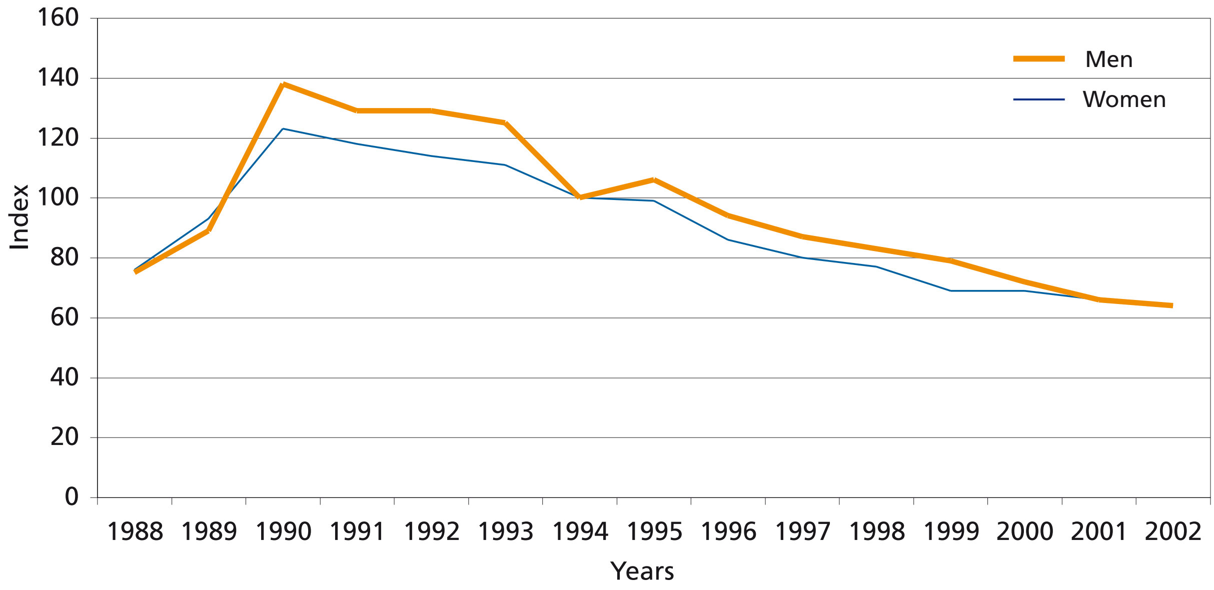


FIGURE 16. Index describing deaths caused by myocardial infarctions among women and men with diabetes in 1988–2002 (the whole of Finland in 1994 = 100).

The share of people with diabetes among all myocardial infarctions recorded in the hospital discharge register system (fatal myocardial infarctions outside hospital were not recorded for people who did not have diabetes) increased by about 6 percentage points between 1990 and 2000. The reason may be the increase in the number of persons with diabetes and/or a more rapid rise in the incidence of myocardial infarctions among the rest of the population than among persons with diabetes. Thereafter, the share of persons with diabetes among all myocardial infarctions fell slightly (Table 14). In 2002, persons with diabetes accounted for one quarter of all myocardial infarctions. Women with diabetes accounted for a higher percentage of all infarctions among women than did men with diabetes for all infarctions among men, although this difference became smaller during the period under study.

TABLE 14. Percentages of people with diabetes, and women and men separately, among all myocardial infarctions treated in hospital in 1988–2002.

Year	People with diabetes out of all infarctions (%)	Men with diabetes out of all infarctions among men (%)	Women with diabetes out of all infarctions among women (%)
1988	16.4	11.7	22.1
1989	19.5	14.0	26.0
1990	20.7	15.1	27.3
1991	21.5	15.6	28.5
1992	22.5	17.7	28.2
1993	22.8	17.1	29.5
1994	22.8	17.6	28.9
1995	23.2	19.0	28.5
1996	22.2	18.6	26.6
1997	24.0	20.0	29.1
1998	24.3	20.0	29.4
1999	24.4	21.2	28.5
2000	26.5	23.7	29.7
2001	25.8	22.6	29.5
2002	25.9	23.2	29.1

Table 15 shows the number of the first myocardial infarctions among men and women with diabetes, by age group. The incidence of myocardial infarctions per 100,000 persons with diabetes, by age group and gender, is shown in Figures 17 and 18. For women, most of the first myocardial infarctions occurred at the age of 75 years or older, whereas for men the number of myocardial infarctions was almost the same in the age groups 65–74 years and 75 years or older (Table 14).

The number of myocardial infarctions among men and women with diabetes, by age group, is shown in Table 15, and the incidence per 100,000 persons with diabetes, by age group and gender, is shown in Figures 17 and 18.

TABLE 15. The first myocardial infarctions among women and men, by age group, in 1988–2002.

Men Year	Age group 0-24	25-54	55-64	65-74	75+	Total
1988	2	118	282	378	312	1,092
1989	-	130	276	431	356	1,193
1990	1	168	326	495	468	1,458
1991	-	151	298	512	460	1,421
1992	-	153	305	540	496	1,494
1993	1	175	326	550	452	1,504
1994	-	136	307	476	465	1,384
1995	-	160	299	541	500	1,500
1996	-	147	273	528	455	1,403
1997	-	163	286	504	514	1,467
1998	-	171	277	517	521	1,486
1999	-	173	265	554	549	1,541
2000	-	206	311	545	567	1,629
2001	-	147	314	542	588	1,591
2002	-	169	342	517	642	1,670
Total	4	2,367	4,487	7,630	7,345	21,833

Women Year	Age group 0-24	25-54	55-64	65-74	75+	Total
1988	-	53	167	555	912	1,687
1989	-	48	130	558	1,089	1,825
1990	1	48	146	579	1,193	1,967
1991	-	41	119	563	1,226	1,949
1992	-	49	138	522	1,153	1,862
1993	1	37	138	534	1,217	1,927
1994	-	34	122	462	1,131	1,749
1995	-	50	114	461	1,104	1,729
1996	-	50	100	394	1,005	1,549
1997	-	41	90	397	1,115	1,643
1998	-	45	90	442	1,065	1,642
1999	-	48	88	335	1,045	1,516
2000	-	58	95	397	1,094	1,644
2001	-	42	101	349	1,274	1,766
2002	-	46	97	345	1,173	1,661
Total	2	690	1,735	6,893	16,796	26,116

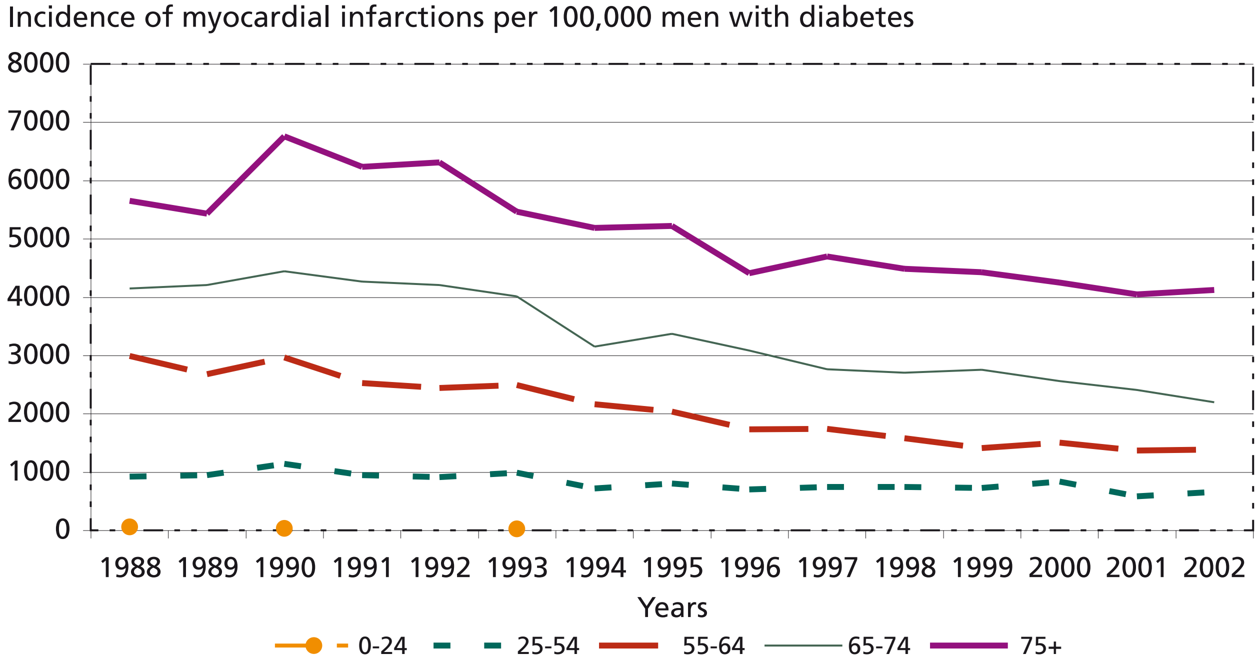


FIGURE 17. The incidence of the first myocardial infarctions among men with diabetes, by age group, per 100,000 men with diabetes in 1988–2002.

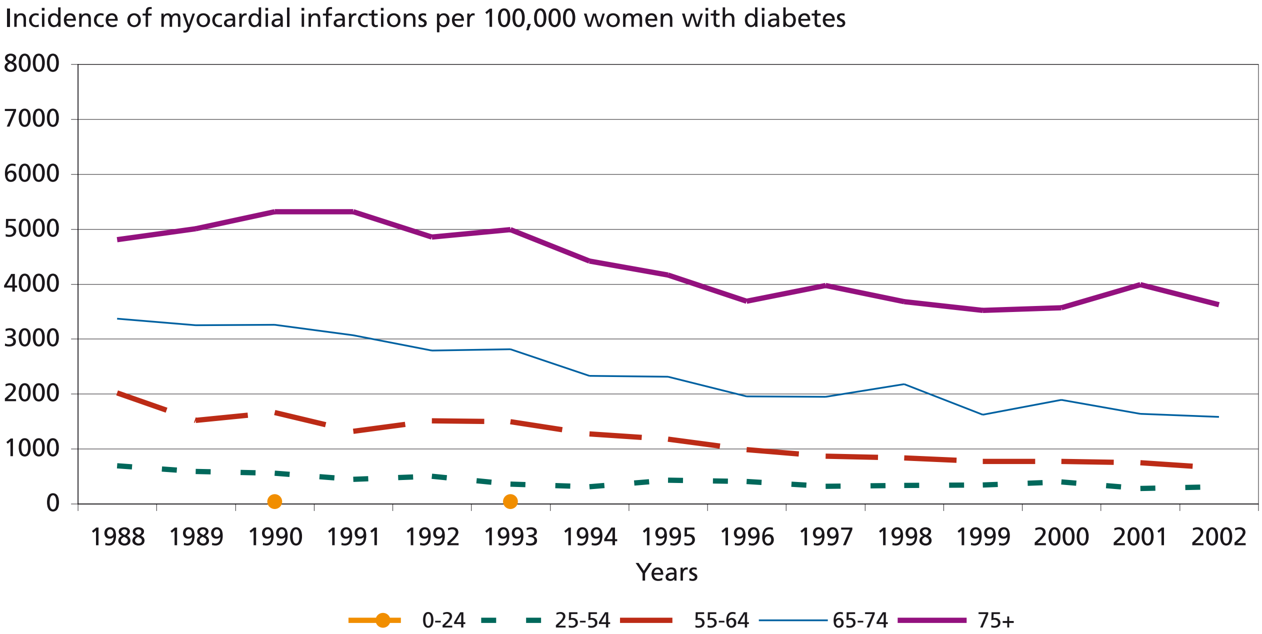


FIGURE 18. The incidence of the first myocardial infarctions among women with diabetes, by age group, per 100,000 men with diabetes in 1988–2002.

When seen against the number of people with diabetes, the decrease in the incidence of myocardial infarctions was greater among women than among men, and the greatest in the age group 55–64 years for both genders. In this age group, the decrease in the incidence of the first infarction among women was as much as 61 per cent between the years 1990 and 2002. For men, the decrease during those years was also considerable, or 55 per cent (Figures 17 and 18).

When standardised for age and adjusted for the number of people with diabetes, the incidence of the first myocardial infarctions between the years 1990 and 2002 decreased by 40 per cent among women and by 46 per cent among men (Figure 19).

During the period under study, the decrease in the incidence of the first myocardial infarctions among men with diabetes, standardised for age, was 4.6 per cent annually. This was a statistically significant trend ($p<0.0001$; the 95 per cent confidence interval was 3.7–5.2%). The corresponding change among women with diabetes was 4.0 per cent, which was also statistically significant ($p<0.0001$; 95 per cent confidence interval 3.3–4.8%).

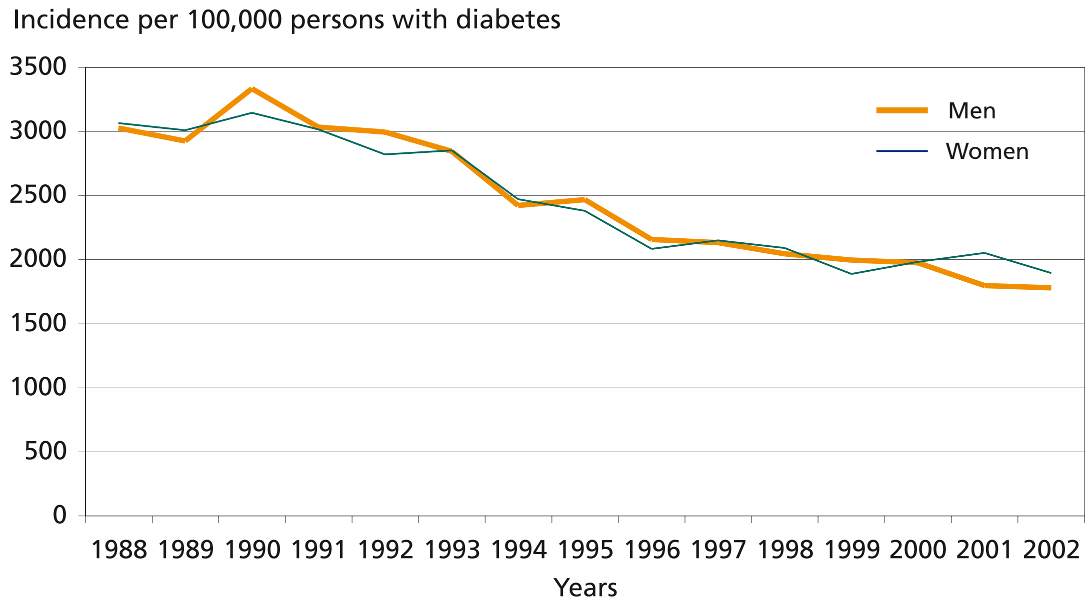


FIGURE 19. Change in the incidence of the first myocardial infarction, standardised for age and proportioned to the number of people with diabetes, in 1988–2002, by gender.

When the figures were standardised for age and gender and examined by hospital district, the first myocardial infarctions among people with diabetes showed the same trend as lower limb amputations. Differences between hospital districts in the myocardial infarction index diminished by 69 per cent between the beginning of the period under study and 2002 (Figure 20, Table 16). The decrease in infarctions (a falling trend) can also be seen fairly clearly although there may have been considerable annual variations within individual hospital districts (Figure 20).

The development of the index describing the number of myocardial infarctions in hospital districts is illustrated in Figures 21–24. The hospital districts have been grouped so that there are 5–6 districts per Figure. The order follows the numbering given when statistics were compiled (1–21).

The highest myocardial infarction indices during the period 2000–2002 were observed for Kainuu, Eastern Savo, Southern Savo and Länsi-Pohja. The lowest figures were recorded in Kymenlaakso, Southern Karelia, Päijät-Häme and Southern Ostrobothnia (Table 16). However, once the figures describing the incidence of the first myocardial infarctions had been standardised for age and gender, no statistically significant differences were found when each hospital district was compared against the rest of Finland during the period 2000–2002.

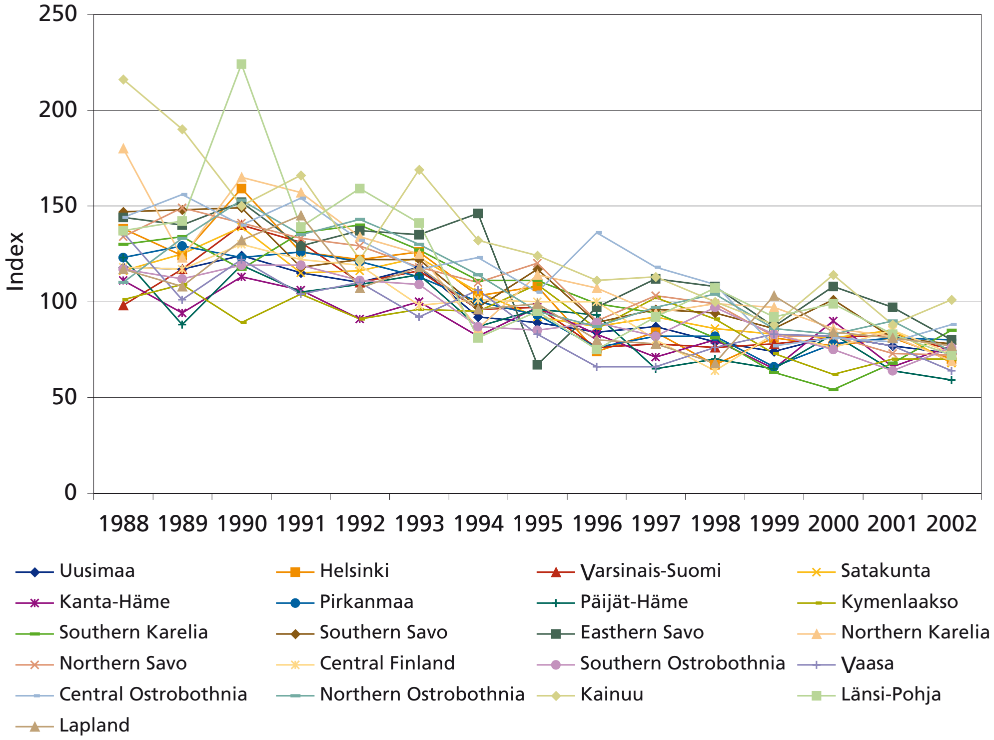


FIGURE 20. Change in the index describing the number of the first myocardial infarctions among people with diabetes in all hospital districts in the years 1988–2002. The myocardial infarctions have been standardised for age and gender and proportioned to the number of people with diabetes in each hospital district. Number of myocardial infarctions in all of Finland in 1994 = 100. See Appended Table 5.

TABLE 16. Indices describing the number of the first myocardial infarctions among people with diabetes in all hospital districts in the years 1988–2002. The myocardial infarctions have been standardised for age and gender and proportioned to the number of people with diabetes in each hospital district. Number of myocardial infarctions in all of Finland in 1994 = 100.

Hospital district	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Uusimaa	118	117	124	115	110	118	92	89	84	87	79	74	82	77	74
Helsinki	138	124	159	126	122	126	103	108	74	84	67	81	77	81	70
Varsinais-Suomi	98	117	140	131	110	116	96	97	76	78	76	78	81	83	75
Satakunta	116	125	139	115	116	123	105	92	87	92	86	83	81	85	68
Kanta-Häme	111	94	113	106	91	100	82	97	83	71	80	65	90	66	77
Pirkanmaa	123	129	123	126	121	113	100	93	76	82	82	66	78	81	80
Päijät-Häme	123	88	119	105	109	114	87	96	93	65	70	65	83	64	59
Kymenlaakso	101	109	89	104	91	96	95	109	86	102	91	73	62	70	70
Southern Karelia	130	134	117	136	140	127	111	111	99	94	81	63	54	68	85
Southern Savo	147	148	149	118	122	122	97	117	89	96	94	86	101	81	78
Eastern Savo	144	140	152	129	137	135	146	67	97	112	108	87	108	97	80
Northern Karelia	180	123	165	157	134	125	86	114	107	94	99	97	86	82	69
Northern Savo	134	149	141	133	129	118	110	120	90	103	99	82	82	73	72
Central Finland	118	117	130	122	119	98	101	100	100	80	64	83	76	85	73
Southern Ostrobothnia	117	112	119	119	111	109	87	85	89	82	97	83	75	64	76
Vaasa	136	101	122	104	110	92	106	83	66	66	76	83	82	77	64
Central Ostrobothnia	144	156	140	154	132	117	123	105	136	118	109	77	81	79	88
Northern Ostrobothnia	110	133	153	135	143	130	114	95	87	97	104	86	83	90	74
Kainuu	216	190	150	166	122	169	132	124	111	113	100	88	114	88	101
Länsi-Pohja	137	142	224	139	159	141	81	95	75	92	107	92	99	83	72
Lapland	117	108	132	145	107	118	96	99	80	78	68	103	84	81	77
All of Finland	**126**	**123**	**134**	**125**	**119**	**117**	**100**	**99**	**86**	**87**	**85**	**79**	**81**	**79**	**75**

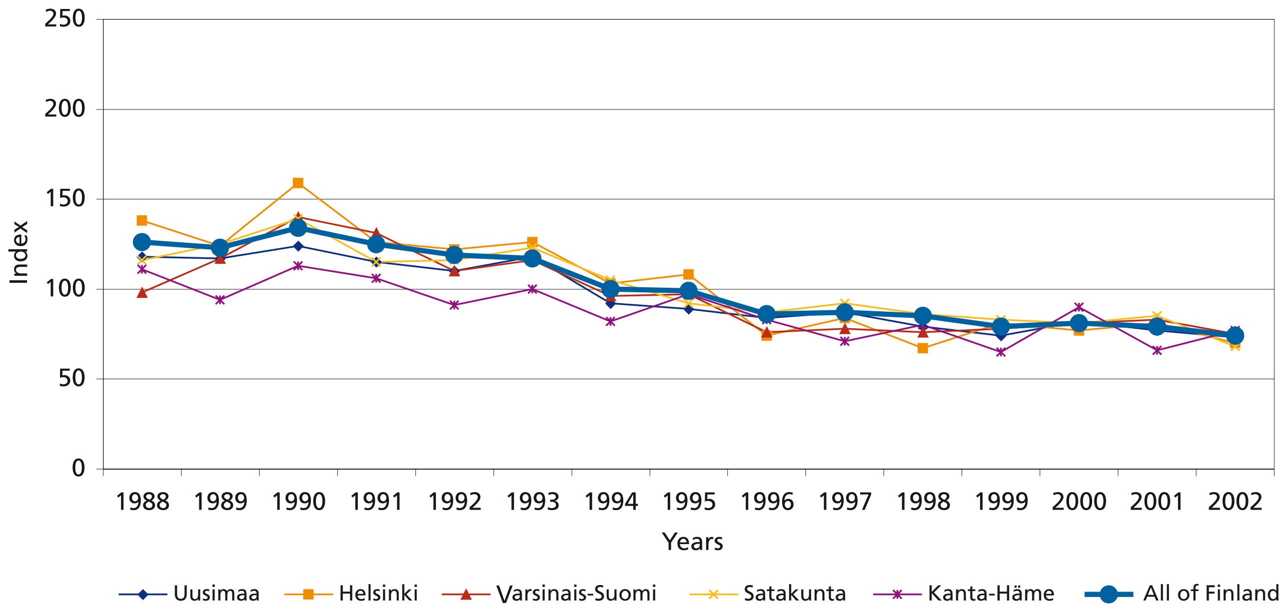


FIGURE 21. Change in the index describing the number of the first myocardial infarctions among people with diabetes in the hospital districts of Uusimaa, Helsinki, Varsinais-Suomi, Statakunta and Kanta-Häme in the years 1988–2002. The myocardial infarctions have been standardised for age and gender and proportioned to the number of people with diabetes in each hospital district. Number of myocardial infarctions in all of Finland in 1994 = 100.

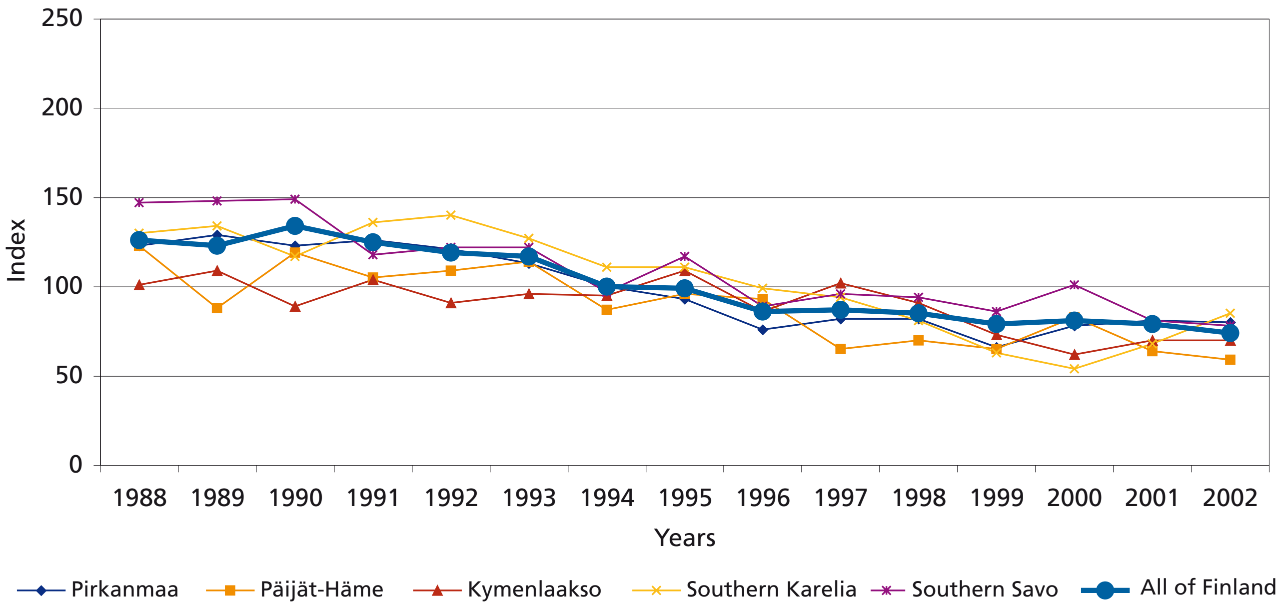


FIGURE 22. Change in the index describing the number of the first myocardial infarctions among people with diabetes in the hospital districts of Pirkanmaa, Päijät-Häme, Kymenlaakso, Southern Karelia and Southern Savo in the years 1988–2002. The myocardial infarctions have been standardised for age and gender and proportioned to the number of people with diabetes in each hospital district. Number of myocardial infarctions in all of Finland in 1994 = 100.

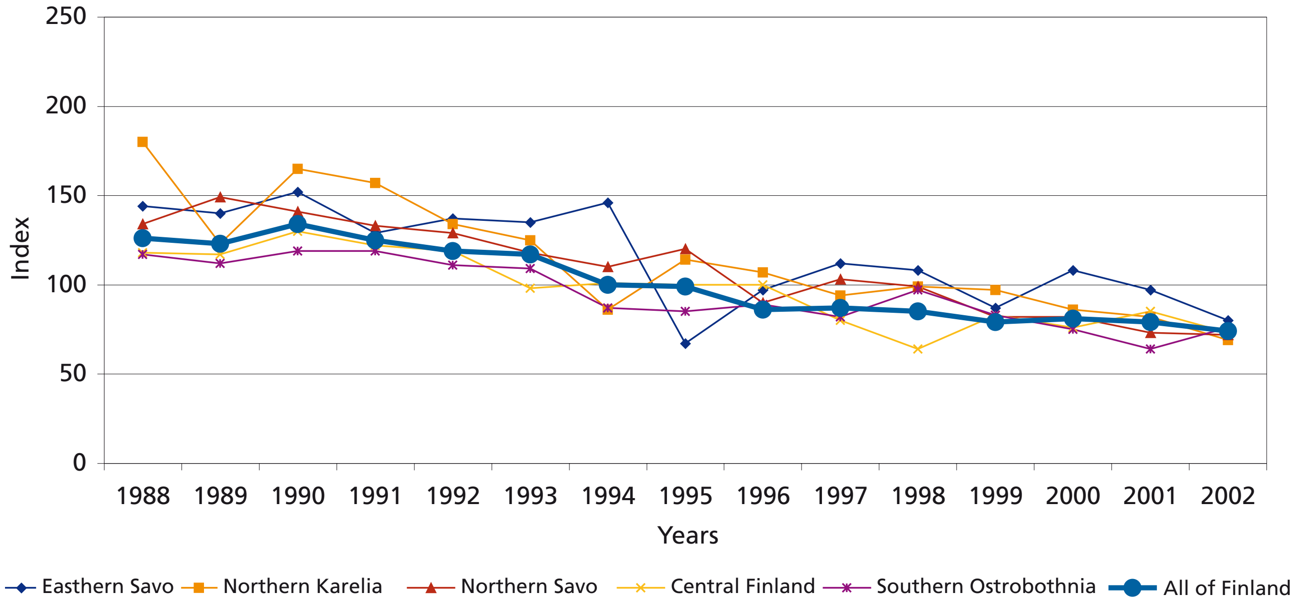


FIGURE 23. Change in the index describing the number of the first myocardial infarctions among people with diabetes in the hospital districts of Eastern Savo, Northern Karelia, Northern Savo, Central Finland and Southern Ostrobothnia in the years 1988–2002. The myocardial infarctions have been standardised for age and gender and proportioned to the number of people with diabetes in each hospital district. Number of myocardial infarctions in all of Finland in 1994 = 100.

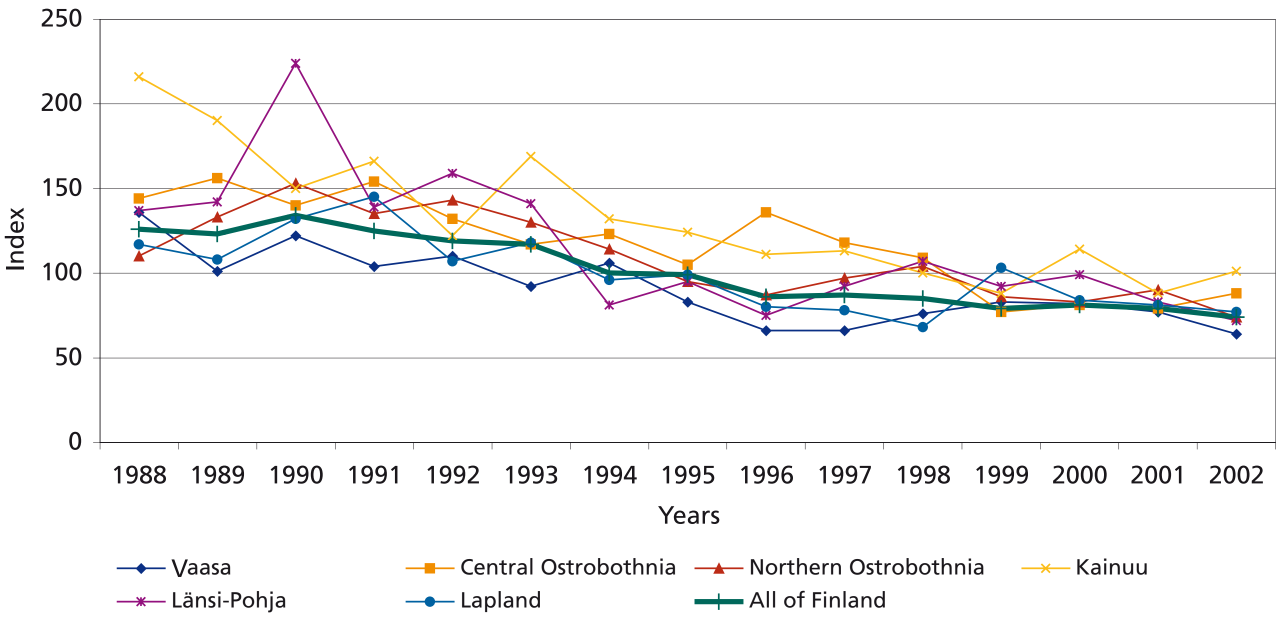


FIGURE 24. Change in the index describing the number of the first myocardial infarctions among people with diabetes in the hospital districts of Vaasa, Central Ostrobothnia, Northern Ostrobothnia, Kainuu, Länsi-Pohja and Lapland in the years 1988–2002. The myocardial infarctions have been standardised for age and gender and proportioned to the number of people with diabetes in each hospital district. Number of myocardial infarctions in all of Finland in 1994 = 100.

Discussion

Examination of the number of fatal myocardial infarctions in 1988 and 1990 (Table 13) reveals that over two times more men with diabetes had died of myocardial infarction in 1990 than in 1988. Also for women, the figure was nearly two times higher than in 1988. The main reason for this is probably that the material does not include 2,433 persons with diabetes who had died in 1988 and 1989. These people were found in the mortality register of Statistics Finland (Table 32) but their data were not in the KELA registers or in the Hilmo register. An explanation for this may be that medication for diabetes had been started while the patient was in institutional care. In such cases, the patient would not receive refunds from KELA and there would be no entry of the medication in the KELA files. The persons may have been in hospital care, but diabetes was not entered as a secondary diagnosis.

The incidence of myocardial infarctions decreased in all age groups during the period under study, but the decrease was the greatest in the age group 55–64 years for both women and men with diabetes. In general, women with diabetes had their first myocardial infarction at a later age than men. In the whole population, men's coronary heart disease mostly appears as a myocardial infarction, whereas among women the most common form of the disease is angina pectoris (59).

Altogether 45 per cent of people who had already had a myocardial infarction had another one during the period under study. This figure is as high as the one obtained in a Finnish study conducted among people with type 2 diabetes. In that study, the recurrence of a myocardial infarction during a follow-up period of seven years was 45 per cent among people who had already had a myocardial infarction (60).

The number of fatal myocardial infarctions fell significantly among both women (13%) and men (14%) with diabetes. This is partly explained by the advances made in the treatment of myocardial infarction, but possibly also by new, more sensitive diagnostics for myocardial infarctions, which mean that such infarctions are diagnosed better.

The number of myocardial infarctions among people with type 1 diabetes was so small annually that the figures showed wide random variation. For this reason, the myocardial infarctions of both type 1 and type 2 diabetes have been treated together.

Women and men with diabetes had different patterns of myocardial infarctions. Myocardial infarctions occurred at a later age among women than men, and women with diabetes accounted for a higher percentage of all cases of myocardial infarction among women than men with diabetes among all men. In fact, it has been shown that women with type 2 diabetes have a considerably elevated risk of contracting a myocardial infarction when compared to men with type 2 diabetes (61). The risk was only partly explained by the fact that women had a greater burden of the known risk factors (hypertension, low HDL cholesterol and high triglycerides).

The share of persons with diabetes among all infarction patients treated in hospital rose to 25 per cent, and the share of men with diabetes among all male infarction patients increased significantly in relation to women. This is explained, at least partly, by the increase in the relative share of men.

In the case of myocardial infarction, changes in morbidity are always the sum of many factors. These factors also include random variation, which would have a smaller role if myocardial infarctions were also studied in time series of three years. However, this is too long a period to follow trends when the topic is the most common complication among people with diabetes, even though it is not worth making annual comparisons between hospital districts, owing to the wide variation involved. At the national level, improvements made in the prevention and care of myocardial infarctions among people with diabetes were seen in three ways during the period under review: the differences between hospital districts became smaller; the relative number of myocardial infarctions decreased; and fewer deaths were caused by myocardial infarctions.

Cerebral infarctions

Diabetes is an independent risk factor of ischemic cerebral infarctions (62). The ischemic cerebral infarction of persons with diabetes differs from other cerebral infarctions in that the infarction is more often an atherothrombotic and lacunar infarction, and patients more often have a simultaneous ischemic heart disease and hyperlipidemia (63).

According to the Framingham study, men with type 2 diabetes run a 2.6 times higher risk and women with type 2 diabetes run a 3.8 times higher risk of a cerebral infarction than diabetes-free persons of the corresponding age and gender (64).

Cerebral infarction is a disease for which a person may receive hospital care more than once; the diagnosis entered into the hospital discharge register is always cerebral infarction. It is not possible to distinguish between an old and a new cerebral infarction merely on the basis of data in the hospital discharge register. In this study, patients were included in the analysis of the number of cerebral infarctions only once (the year of the first admission); in other words, the study focused on the first cerebral infarction that the patient had had in 1988–2002.

The study did not include cerebral infarctions (in total 5,574) that had occurred before the first diabetes entry had been made for the patient, i.e. diabetes had not yet been diagnosed, it had not surfaced or it was controlled by means of diet and diabetes had not been entered into the hospital discharge register as a secondary diagnosis.

TABLE 17. The numbers of first cerebral infarctions in 1988–2002 by gender and for all people with diabetes, and the first cerebral infarctions leading to death among men and women with diabetes.

Year	First cerebral infarctions among men with diabetes	Men with diabetes who died of their first cerebral	%	First cerebral infarctions among women	Women with diabetes who died of their first cerebral	%	First cerebral infarctions among people with diabetes, total
1988	881	135	15	1,385	274	20	2,266
1989	748	123	16	1,402	365	26	2,150
1990	787	187	24	1,475	453	31	2,262
1991	835	210	25	1,439	432	30	2,274
1992	887	194	22	1,369	373	27	2,256
1993	914	190	21	1,428	373	26	2,342
1994	923	173	19	1,463	384	26	2,386
1995	994	180	18	1,402	366	26	2,396
1996	1,037	188	18	1,341	332	25	2,378
1997	971	165	17	1,325	302	23	2,296
1998	1,023	165	16	1,301	318	24	2,324
1999	1,043	173	17	1,241	304	25	2,284
2000	1,006	148	15	1,236	309	25	2,242
2001	1,058	152	14	1,229	287	23	2,287
2002	1,051	147	14	1,116	264	24	2,167
Total	**14,158**	**2,530**		**20,152**	**5,136**		**34,310**

TABLE 18. The first cerebral infarctions among men and women with diabetes, by age group, in 1988–2002

Men Year	Age group 0-24	25-54	55-64	65-74	75+	Total
1988	1	82	222	308	268	881
1989	-	81	168	242	257	748
1990	-	66	135	317	269	787
1991	-	78	150	297	310	835
1992	-	76	190	338	283	887
1993	-	83	198	303	330	914
1994	-	82	198	330	313	923
1995	-	89	172	407	326	994
1996	1	86	214	383	353	1,037
1997	-	97	178	383	313	971
1998	1	91	163	388	380	1,023
1999	-	108	192	373	370	1,043
2000	-	84	189	346	387	1,006
2001	-	107	189	355	407	1,058
2002	-	79	196	379	397	1,051
Total	3	1,289	2,754	5,149	4,963	14,158

Naiset Year	Age group 0-24	25-54	55-64	65-74	,75+,	Total
1988	-	27	121	485	752	1,385
1989	-	28	91	429	854	1,402
1990	1	19	111	432	912	1,475
1991	-	20	114	395	910	1,439
1992	-	17	98	357	897	1,369
1993	-	27	87	409	905	1,428
1994	-	29	111	368	955	1,463
1995	-	43	100	406	853	1,402
1996	-	29	81	355	876	1,341
1997	-	30	81	354	860	1,325
1998	-	22	72	297	910	1,301
1999	-	31	68	285	857	1,241
2000		37	56	291	852	1,236
2001	1	31	79	246	872	1,229
2002	-	27	56	250	783	1,116
Total	2	417	1,326	5,359	13,048	20,152

During the period 1988–2002, the first cerebral infarctions among people with diabetes totalled 34,310. Of them, altogether 7,666 (22%) had led to death. Women's first cerebral infarctions numbered 20,152 and men's 14,158. The share of fatal cerebral infarctions out of all first cerebral infarctions among people with diabetes fell by 10 per cent for men and by 7 per cent for women between 1990 and 2002, as did the absolute numbers of fatal first cerebral infarctions for both genders during the same period (Table 17).

The mean age of women who suffered a cerebral infarction was 76.7 years (SD 9), while the mean age for men was 69.7 years (SD 10.3). The median ages for women and men were 78 years and 71 years, respectively. Between 1990 and 2002, the mean age of women at the time of their first cerebral infarction rose by 1.8 years, while the mean age for men rose by 0.6 years.

The majority (65%) of first cerebral infarctions among women occurred at the age of 75 years or older. For men, the greatest share of first cerebral infarctions (36%) was recorded in the age group 65–74 years, but the share was nearly as high (35%) in the age group of 75 years or older (Table 18).

Figures 25 and 26 illustrate the incidence of cerebral infarctions among men and women with diabetes, by age group per 100,000 persons with diabetes of the same age.

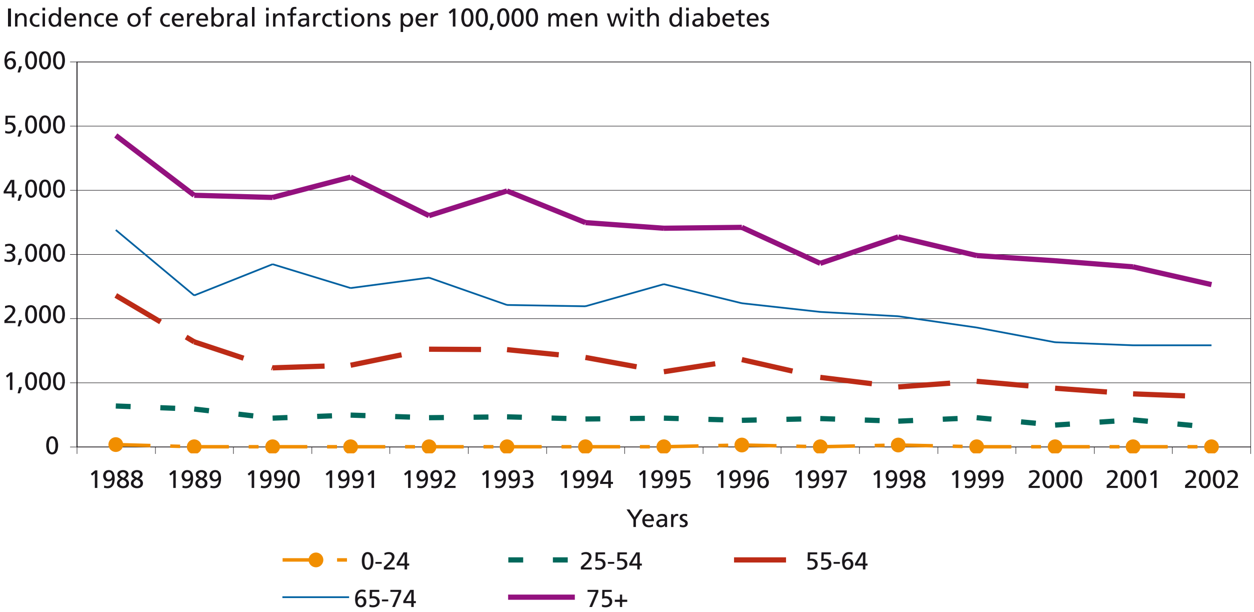


FIGURE 25. The incidence of the first cerebral infarctions among men with diabetes, by age group, per 100,000 men with diabetes in 1988–2002.

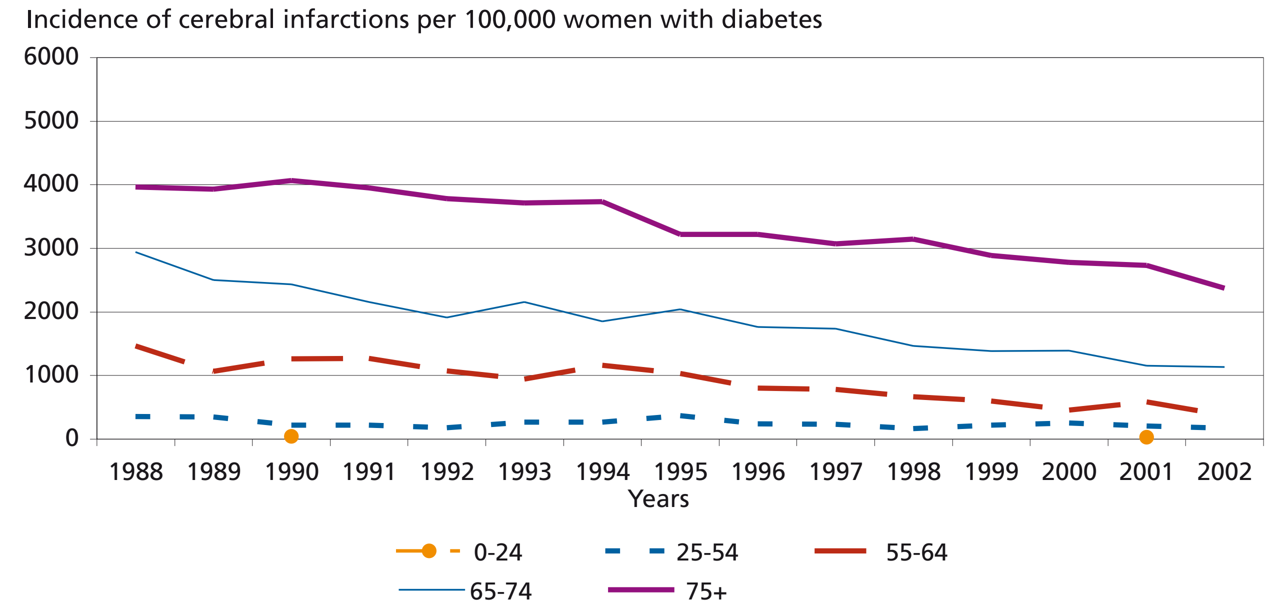


FIGURE 26. The incidence of the first cerebral infarctions among women with diabetes, by age group, per 100,000 men with diabetes in 1988–2002.

The incidence of the first cerebral infarctions per 100,000 person with diabetes of the corresponding age fell in all age groups, but among women the greatest decrease (70%) occurred in the age group 55–64 years, whereas among men, the greatest decrease (44%) was recorded in the age group 65–74 years.

Standardised for age, the number of deaths caused by the first cerebral infarction fell among people with diabetes between the years 1990 and 2002. The index describing mortality fell by 61% among women and by 65% among men (Figure 27).

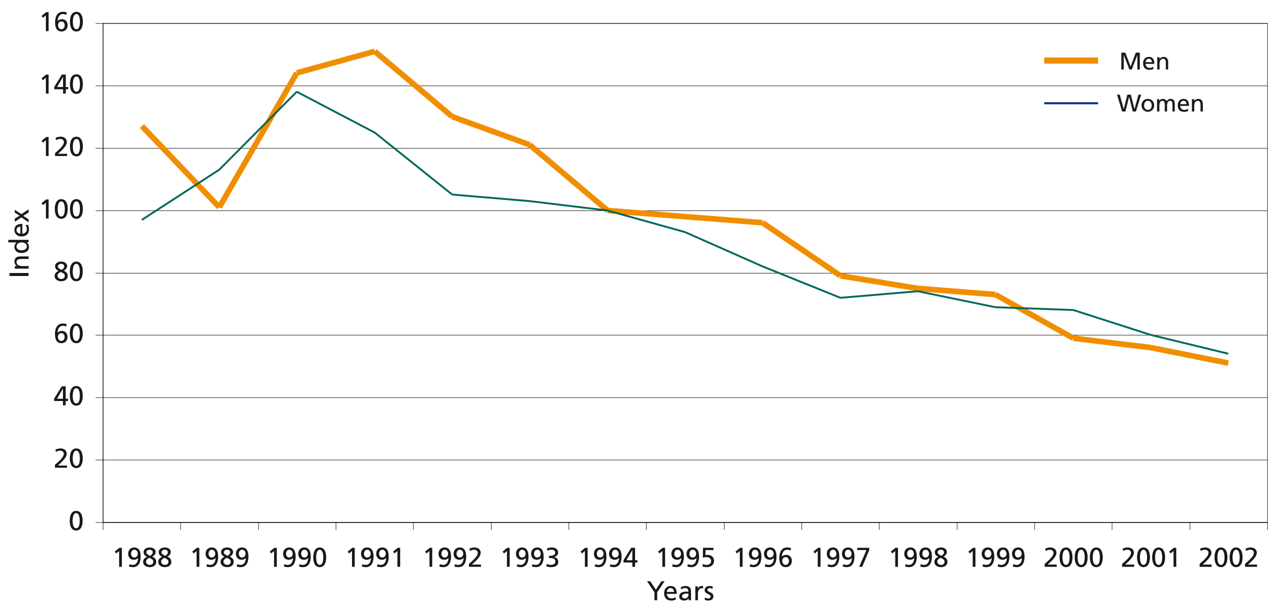


FIGURE 27. Deaths caused by the first cerebral infarctions among people with diabetes, standardised for age, in 1988–2002 (all of Finland in 1994 = 100).

The share of persons with diabetes out of all cerebral infarction patients recorded through the hospital discharge register system fell among women but rose among men. The figures do not include cerebral infarctions leading to death outside hospital (Table 19).

TABLE 19. The percentages for women and men with diabetes, both separately and together, out of all first cerebral infarctions treated in hospital in 1988–2002.

	Men	Women	Men+ Women
1988	15.6	21.4	18.7
1989	16.2	24.7	20.9
1990	18.4	28.0	23.7
1991	19.1	27.1	23.4
1992	20.1	26.8	23.7
1993	20.4	25.9	23.5
1994	20.0	27.2	23.9
1995	21.3	25.8	23.7
1996	22.8	24.9	23.9
1997	21.2	25.2	23.3
1998	22.3	24.3	23.3
1999	22.4	23.7	23.1
2000	21.9	23.8	22.9
2001	22.6	23.0	22.8
2002	23.2	21.7	22.4

The differences between hospital districts in cerebral infarction indices diminished from 1990 to 2002 (Figure 28 and Table 20). Figure 28 also illustrates the reduction in the number of cerebral infarctions and the role of random variation for each hospital district. Inspection of the cerebral infarction indices over the last three years reveals that the highest indices occurred in Uusimaa, Kymenlaakso, Eastern Savo and Southern Savo. The lowest indices were in Päijät-Häme, Vaasa, Central Ostrobothnia and Lapland. However, when the incidence of the first cerebral infarctions was standardised for age and gender, only the index in Southern Savo was statistically significantly ($p<0.05$) greater than indices in the rest of the country during the period 2000–2002.

The trend for cerebral infarctions in individual hospital districts is illustrated in Figures 29–32. The hospital districts have been grouped so that there are 5–6 districts per Figure. The order follows the numbering given when statistics were compiled (1–21).

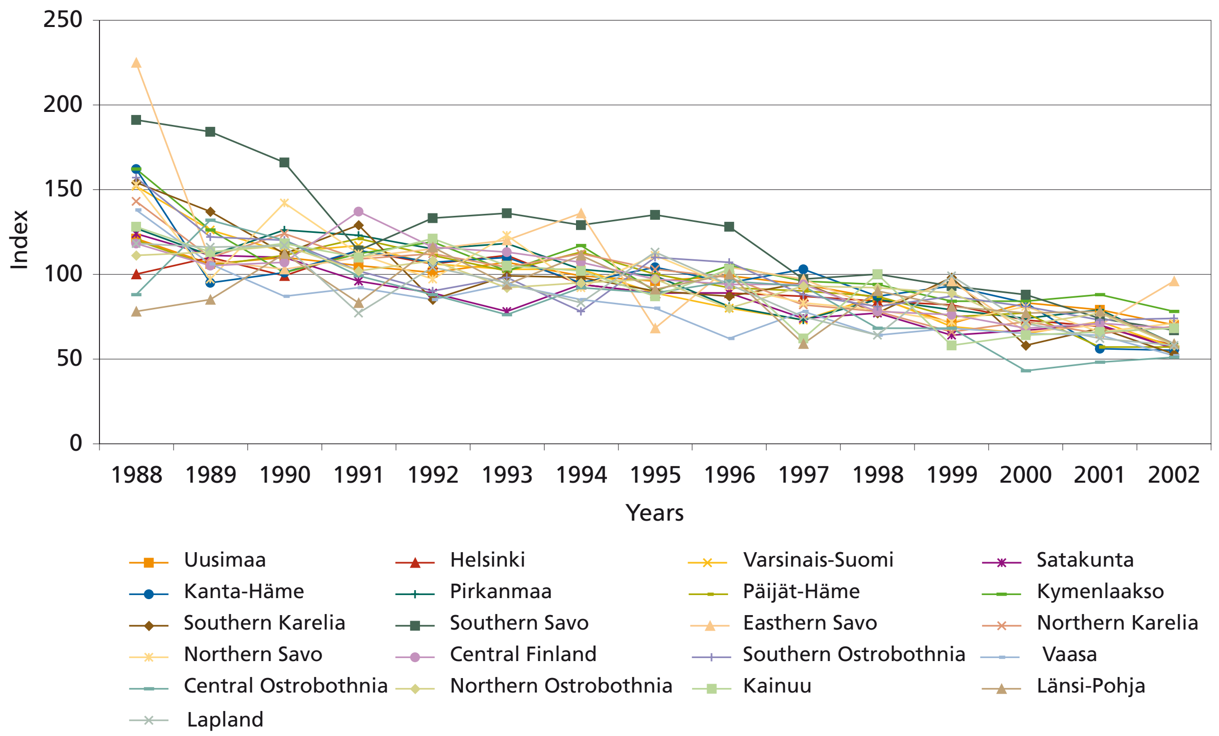


FIGURE 28. Change in the index describing the number of the first cerebral infarctions among people with diabetes in all hospital districts in the years 1988–2002. The cerebral infarctions have been standardised for age and gender and they have been proportioned to the number of people with diabetes in each hospital district. Number of cerebral infarctions in all of Finland in 1994 = 100. See Appended Table 6.

TABLE 20. Indices describing the number of the first cerebral infarctions among people with diabetes in all hospital districts in the years 1988–2002. The cerebral infarctions have been standardised for age and gender and they have been proportioned to the number of people with diabetes in each hospital district. Number of cerebral infarctions in all of Finland in 1994 = 100.

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Uusimaa	121	106	110	105	101	107	99	96	99	94	86	71	83	79	70
Helsinki	100	110	99	114	106	111	94	89	89	87	84	82	73	69	58
Varsinais-Suomi	152	126	113	117	106	103	103	89	80	73	87	69	65	72	57
Satakunta	124	111	110	96	89	78	94	89	89	74	77	64	67	70	56
Kanta-Häme	162	95	101	114	107	110	95	104	95	103	87	93	83	56	55
Pirkanmaa	127	111	126	123	115	118	103	99	81	73	85	79	74	79	59
Päijät-Häme	120	105	111	121	111	102	113	100	92	90	87	75	77	57	57
Kymenlaakso	162	126	101	112	119	102	117	90	105	96	94	84	84	88	78
Southern Karelia	154	137	112	129	85	99	98	90	87	95	77	98	58	68	53
Southern Savo	191	184	166	114	133	136	129	135	128	97	100	93	88	74	67
Eastern Savo	225	108	103	110	115	120	136	68	104	97	80	96	66	70	96
Northern Karelia	143	110	124	109	112	104	112	103	98	82	78	66	72	65	69
Northern Savo	153	97	142	112	97	123	92	111	93	83	79	72	81	66	71
Central Finland	118	105	107	137	116	113	107	97	94	94	78	76	68	71	68
Southern Ostrobothnia	157	122	120	102	90	98	78	110	107	88	81	87	81	73	74
Vaasa	138	106	87	92	85	94	85	80	62	78	64	68	65	64	52
Central Ostrobothnia	88	132	120	99	88	76	92	89	96	93	68	68	43	48	51
Northern Ostrobothnia	111	113	117	102	108	92	95	97	80	93	92	89	70	77	58
Kainuu	128	113	118	110	121	105	102	87	103	62	100	58	64	66	68
Länsi-Pohja	78	85	112	83	116	94	111	91	100	59	90	81	77	78	59
Lapland	118	116	117	77	104	95	83	113	94	75	64	99	71	62	58
All of Finland	**134**	**114**	**114**	**110**	**105**	**105**	**100**	**97**	**92**	**85**	**83**	**78**	**73**	**71**	**63**

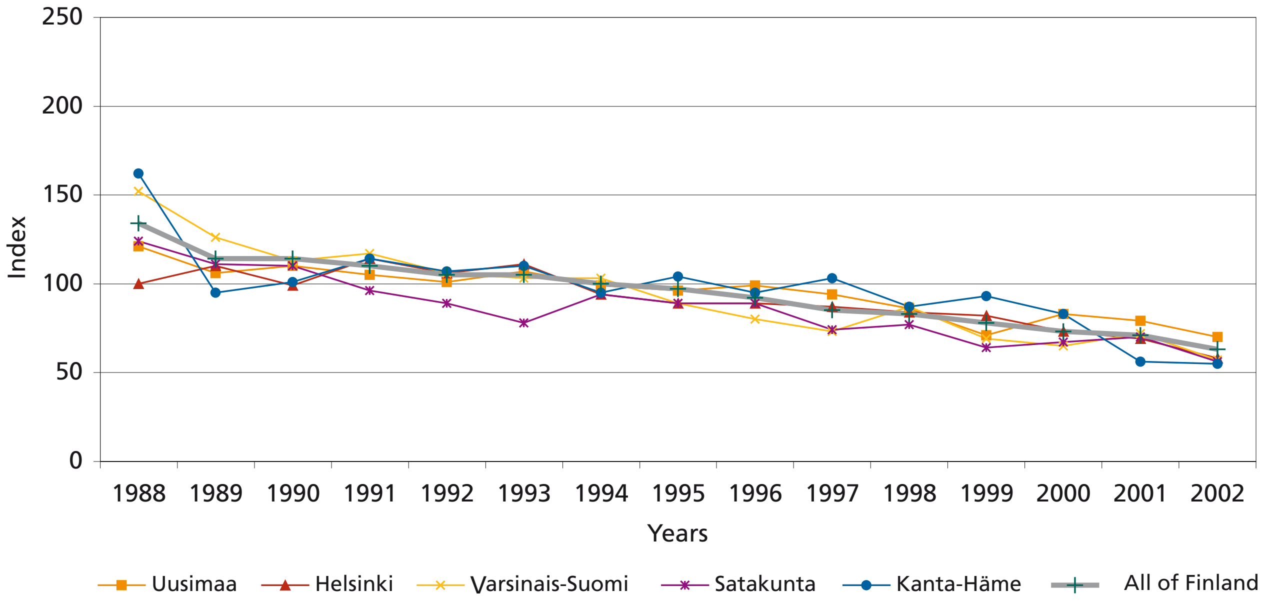


FIGURE 29. Change in the index describing the number of the first cerebral infarctions among people with diabetes in the hospital districts of Uusimaa, Helsinki, Varsinais-Suomi, Statakunta and Kanta-Häme in the years 1988–2002. The cerebral infarctions have been standardised for age and gender and proportioned to the number of people with diabetes in each hospital district. Number of cerebral infarctions in all of Finland in 1994 = 100.

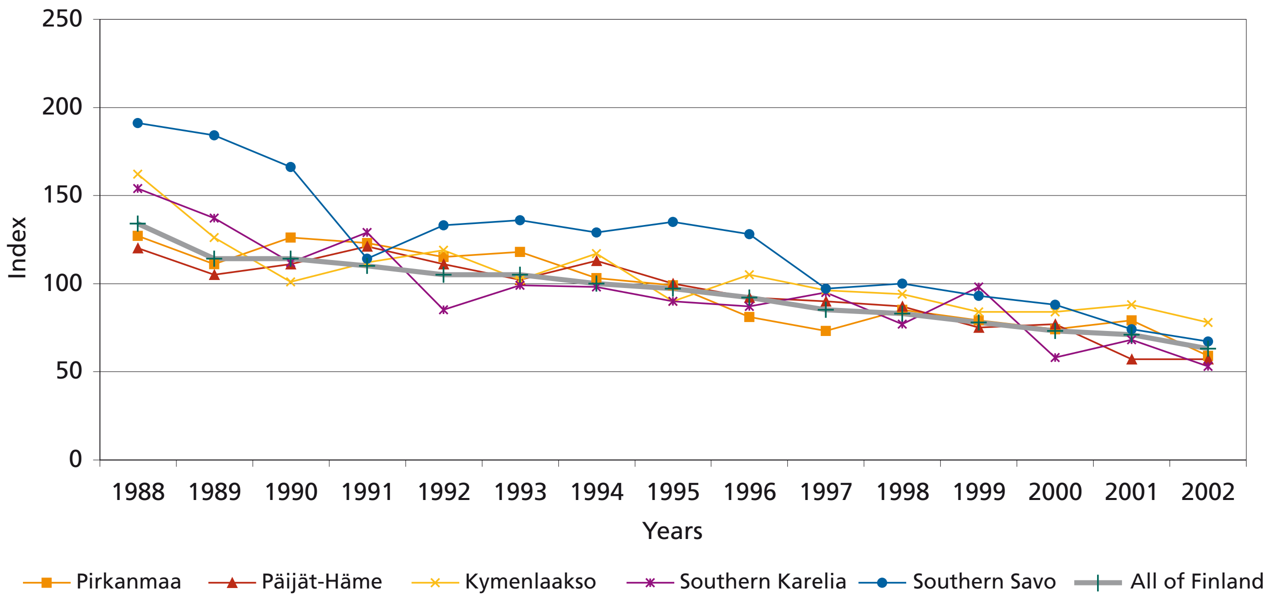


FIGURE 30. Change in the index describing the number of the first cerebral infarctions among people with diabetes in the hospital districts of Pirkanmaa, Päijät-Häme, Kymenlaakso, Southern Karelia and Southern Savo in the years 1988–2002. The cerebral infarctions have been standardised for age and gender and proportioned to the number of people with diabetes in each hospital district. Number of cerebral infarctions in all of Finland in 1994 = 100.

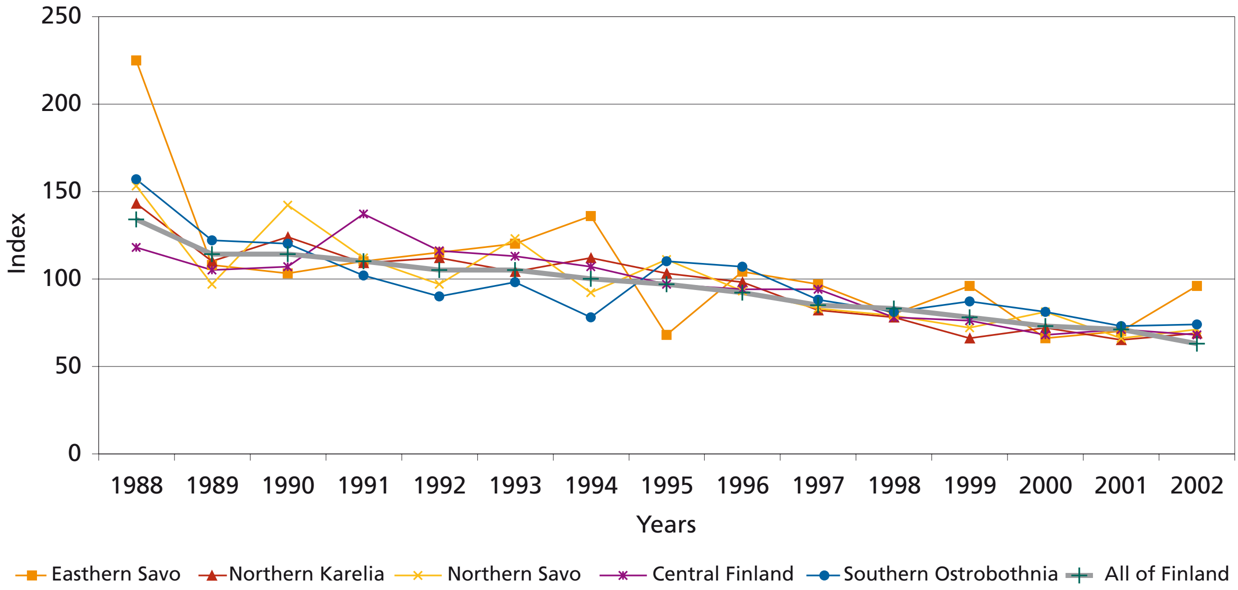


FIGURE 31. Change in the index describing the number of the first cerebral infarctions among people with diabetes in the hospital districts of Eastern Savo, Northern Karelia, Northern Savo, Central Finland and Southern Ostrobothnia in the years 1988–2002. The cerebral infarctions have been standardised for age and gender and proportioned to the number of people with diabetes in each hospital district. Number of cerebral infarctions in all of Finland in 1994 = 100.

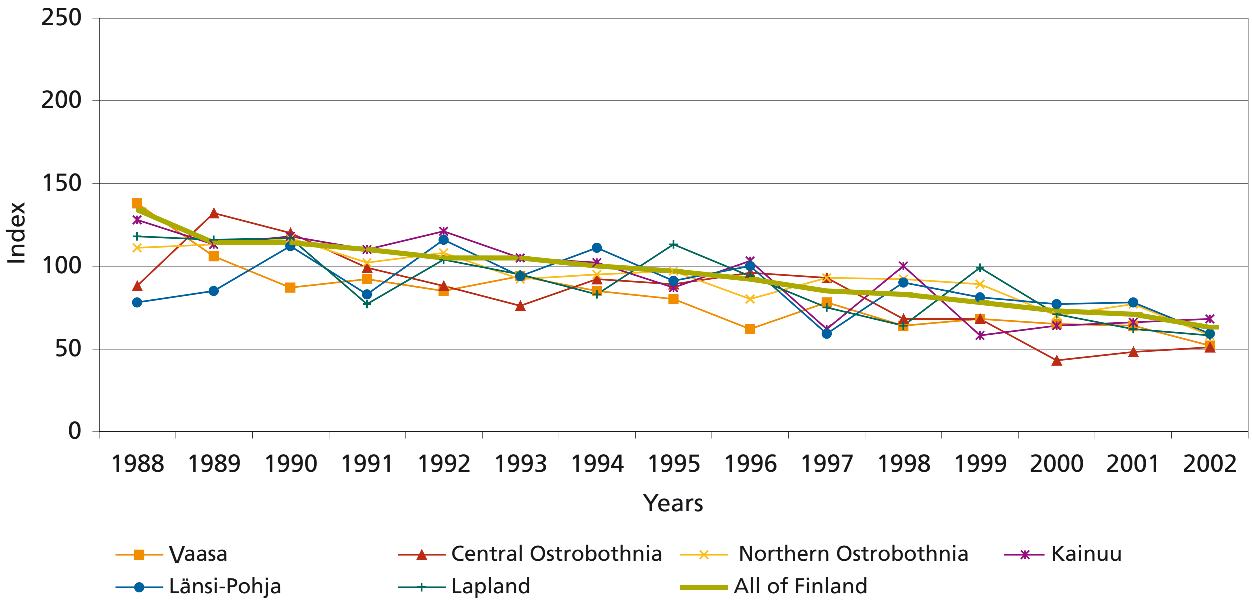


FIGURE 32. Change in the index describing the number of the first cerebral infarctions among people with diabetes in the hospital districts of Vaasa, Central Ostrobothnia, Northern Ostrobothnia, Kainuu, Länsi-Pohja and Lapland in the years 1988–2002. The cerebral infarctions have been standardised for age and gender and proportioned to the number of people with diabetes in each hospital district. Number of cerebral infarctions in all of Finland in 1994 = 100.

Discussion

When the numbers of fatal cerebral infarctions among people with diabetes are examined for the years 1988, 1989 and 1990 (Table 17), it can be seen that over 50 per cent more men with diabetes died of a cerebral infarction in 1990 than in the previous year, and that 65 per cent more women with diabetes died of a cerebral infarction in 1990 than in 1988. The underlying reason is probably the same as for myocardial infarctions, i.e. relatively more persons with diabetes who had died of a cerebral infarction are not included in the material for the years 1988 and 1989 than for other years (Table 32). Thus, these shortcomings in the material for the early years (1988 and 1989) must be taken into account when analysing the findings.

The annual number of cerebral infarctions among people with type 1 diabetes was so small that all people with diabetes have been grouped together. The incidence of the first cerebral infarctions fell during the period under study in all age groups of people with diabetes, but the change was clearly more pronounced for women in all age groups except that of 25–54 years (Figures 25 and 26). The decrease in incidence among women of 55–64 years of age was 70 per cent from the year 1990, or nearly double the figure for men of the same age. For both women and men, the difference between the age groups of 75 years or older and 65–74 years in the incidence of cerebral infarctions grew wider between the years 1990 and 2002.

The number of the first cerebral infarctions that led to death among people with diabetes were reduced by 61 per cent among women and by 64 per cent among men between the years 1990 and 2002 (change in the index standardised for age). Thus, the change was really substantial. A similar trend has been discovered in the incidence of the first strokes and in mortality caused by strokes within 28 days for the whole of the Finnish population between the years 1991 and 2002 (66).

There were major differences between the ages at which men and women with diabetes had their first cerebral infarctions. Women's age was clearly higher and the women's average age at the time of the first cerebral infarction rose markedly more than the average age of men.

The share of persons with diabetes out of all first cerebral infarctions treated in hospital (for the whole population) fell for women but rose for men. At least a partial explanation may be the relatively sharper increase in the number of men with diabetes.

Random variation in the number of the first cerebral infarctions in each hospital district was visible after standardisation, especially as concerns smaller hospital districts. However, Figure 28 shows a positive, or clearly falling, trend in cerebral infarction indices standardised for age and gender. The differences between hospital districts have also become narrower.

Renal and ophthalmic diseases caused by diabetes

Certain complications caused by diabetes, such as renal diseases and ophthalmic diseases, are known as specific complications. These would in theory serve as good indicators of the quality of care, because the patient's glycemic control plays a greater role in the emergence of these diseases than in the emergence of non-specific complications. However, most of these complications are treated in hospital outpatient wards (patients are not referred to inpatient wards), and therefore the frequency of these complications cannot be determined on the basis of the hospital discharge register. Following the start of the Benchmarking project in 1997, STAKES has collected diagnostic data on outpatient visits; year by year this information has become more comprehensive. In future it will therefore be possible to obtain much more information about the occurrence of renal and ophthalmic problems among people with diabetes, starting from the phase when these problems require a specialist's evaluation/care.

The problem is that the ICD-10 codes in use are by nature unspecific, such as renal complications of type 1 diabetes (E10.2). Using this diagnosis, it is not possible to compare the severity of different patients' complications. The ICD-10 diagnosis N08.3, glomerular disorders in diabetes mellitus, was relatively rare as the primary or secondary diagnosis during 1988–2002 (Table 21). This makes it more difficult to make comparisons between hospital districts. Kidney transplants among people with diabetes are nearly always caused by advanced glomerular disorders; however, the procedure is rare (Table 22).

TABLE 21. Admissions because of renal complications among people with diabetes in 1988–2002.

Year	Renal complications in diabetes mellitus	Glomerular disorders in diabetes mellitus
1988	2,489	182
1989	2,319	236
1990	2,346	274
1991	2,338	313
1992	2,403	418
1993	2,782	405
1994	2,604	340
1995	2,879	324
1996	2,665	1,567
1997	2,557	1,584
1998	2,667	1,602
1999	2,429	1,533
2000	2,515	1,749
2001	2,661	1,778
2002	2,632	1,865
Total	**38,286**	**14,170**

TABLE 22. Kidney transplants performed for persons with diabetes in 1988–2002.

Year	
1988	18
1989	42
1990	57
1991	31
1992	48
1993	52
1994	61
1995	54
1996	49
1997	44
1998	79
1999	54
2000	70
2001	61
2002	59
Total	**779**

Among ophthalmic complications, the following are unspecific diagnoses: diabetic background retinopathy, unspecified retinal disorder, cataract, ophthalmic complications and other retinal disorder. For them, diagnostics and follow-up are mostly done in the outpatient ward. More accurate and more severe complications include diabetic maculopathy, severe background retinopathy, advanced diabetic ophthalmic disorder and its sequelae, vitreous hemorrhage, and traction detachment of retina. These complications are also followed and treated in the outpatient ward; it is therefore not possible to use them as reliable indicators for comparisons between hospital districts. The small annual number of admissions is another factor preventing regional comparisons (Table 23).

TABLE 23. Admissions for ophthalmic complications among people with diabetes in 1988–2002.

Year	• Diabetic background retinopathy • Unspecified retinal disorder • Diabetic cataract • Type 2 diabetes with ophthalmic complications • Other retinal disorder in diseases classified elsewhere	• Diabetic maculopathy • Severe diabetic background retinopathy • Advanced diabetic ophthalmic disorder • Sequelae of diabetic ophthalmic disorder • Vitreous hemorrhage • Vitreous hemorrhage in diseases classified elsewhere • Traction detachment of retina
1988	1,536	378
1989	1,398	346
1990	1,368	410
1991	1,388	538
1992	1,248	527
1993	1,352	564
1994	1,290	619
1995	1,068	648
1996	1,396	573
1997	1,117	524
1998	1,095	587
1999	1,188	700
2000	1,078	642
2001	1,013	593
2002	1,029	634
Total	**18,564**	**8,283**

Mortality among persons with diabetes

Mortality among persons with diabetes is higher than that among the rest of the population. However, there is variation depending on factors such as the gender, type of diabetes and home country (66).

The standardised mortality ratio (SMR) of people with type 1 diabetes is generally higher than that of people with type 2 diabetes (66, 67). In 1995, the prognosis of persons with type 1 diabetes was better in Finland than in Estonia or Lithuania (68).

Diseases of the circulatory system are the most common cause of death among people with diabetes, whether type 1 or type 2 (66).

Table 24 shows deaths between 1988 and 2002 among people with diabetes included in this material. Missing figures at the beginning of the period under study indicate that it was not possible to divide people into diabetes types in those years, owing to lacking data.

Deaths and causes of death classified according to the type of diabetes should therefore be examined from the year 1994 onwards (the prescription register of KELA was put to use in 1994).

The last three columns show indices where the number of persons with diabetes who died in 1994 is given the value 100 and other years are compared to that (direct standardisation for age and gender). On the basis of the standardised indices, the mortality ratio of people with type 1 diabetes fell by 12 per cent and that of people with type 2 diabetes by 24 per cent between the years 1994 and 2002.

TABLE 24. Deaths among persons with diabetes in 1988–2002.

Year	Type 1	Type 2	Diabetes type uncertain	Total	Index type 1	Index type 2	Index all together
1988	-	-	4,378	4,378	-	-	76
1989	-	1	5,530	5,531	-	-	85
1990	-	6,178	1,990	8,168	-	127	120
1991	-	6,208	2,001	8,209	-	122	114
1992	-	6,321	2,075	8,396	-	119	112
1993	-	6,575	2,259	8,834	-	119	113
1994	135	6,006	2,259	8,400	100	100	100
1995	191	6,005	2,671	8,867	134	94	101
1996	173	5,980	2,503	8,656	115	89	95
1997	173	6,160	2,353	8,686	110	86	91
1998	164	6,434	2,279	8,877	98	85	89
1999	170	6,643	2,189	9,002	95	84	87
2000	172	6,853	2,176	9,201	95	81	85
2001	144	6,874	2,014	9,032	75	77	79
2002	180	7,251	2,057	9,488	88	76	79
Total	1,502	83,489	38,734	123,725			

The number of deaths among persons with diabetes type 1 in 1994–2002 was so small that random variation becomes a major factor in the figures. The median age of death for people with type 1 diabetes varied during the period under study and was 49 years in 2002 (Table 25).

In 2002, there was no statistically significant difference ($p = 0.48$) between the mean ages of death among women and men with type 1 diabetes (49 and 50 years) (Table 25). In the same year, the mean age of death for women with type 2 diabetes was 81 years; for men with type 2 diabetes it was 74 years. The difference was statistically significant ($p<0.0001$) (Table 26).

The change in the median age of death for people with type 1 diabetes between the years 1994 and 2002 was not statistically significant for either gender, nor for both genders together. For both men and women with type 2 diabetes, the median age of death rose by one year (Table 25). Both changes were statistically significant ($p<0.0001$).

TABLE 25. Annual ages of death, persons with type 1 diabetes in 1994–2002.

Year	Number men	Median men	Mean men	Number women	Median women	Mean women	Number total	Median total
1994	100	47	46	35	48	49	135	48
1995	144	47	48	47	44	45	191	46
1996	116	47	46	57	45	46	173	46
1997	122	48	47	51	42	43	173	46
1998	106	47	47	58	43	44	164	46
1999	123	48	48	47	50	49	170	48
2000	118	47	47	47	49	49	172	47
2001	102	47	46	46	53	49	144	47
2002	136	49	50	44	50	49	180	49

TABLE 26. Annual ages of death, persons with type 2 diabetes in 1990–2002.

Year	Number men	Median men	Mean men	Number women	Median women	Mean women	Number total	Median total
1990	2,225	73	73	3,953	79	79	6,178	78
1991	2,304	73	72	3,904	80	79	6,208	78
1992	2,440	73	73	3,881	80	79	6,321	78
1993	2,597	73	72	3,978	80	79	6,575	78
1994	2,361	74	73	3,645	81	80	6,006	78
1995	2,457	74	73	3,548	81	80	6,005	79
1996	2,451	74	73	3,529	82	81	5,980	79
1997	2,600	74	73	3,560	81	80	6,160	79
1998	2,839	75	74	3,595	82	80	6,434	79
1999	2,957	75	74	3,686	82	81	6,643	79
2000	3,073	74	74	3,780	82	81	6,853	79
2001	3,065	75	74	3,809	82	81	6,874	79
2002	3,331	75	74	3,920	82	81	7,251	79

The median time of living with the disease (time from the start of diabetes medication to death) varied between 22 and 26 years for men and between 25 and 35 years for women with type 1 diabetes (Table 27).

TABLE 27. Duration of type 1 diabetes before death in 1994–2002.

Year	Number men	Median men	Number men	Median women	Number total	Median total
1994	100	25	35	28	135	25
1995	144	24	47	29	191	25
1996	116	22	57	29	173	24
1997	122	24	51	25	173	25
1998	106	26	58	28	164	27
1999	123	24	47	30	170	27
2000	118	26	54	31	172	27
2001	102	23	42	35	144	26
2002	136	26	44	26	180	26

The standardised mortality ratio (SMR) among people with diabetes is the ratio between the observed and expected mortality; it describes the mortality of the diabetic population under study in relation to the rest of the population. If the SMR is over 100, it shows that the group in question has excess mortality when compared to the basic population.

The annual SMR values of people with type 1 diabetes showed the effect of random variation, but a falling trend was evident for both diabetes types; in other words, the difference in mortality between people with diabetes and the rest of the population became narrower in 1994–2002 (Table 28).

There was a clear difference in the SMR between people with type 1 and type 2 diabetes. No corresponding difference existed between women and men in the whole diabetic population (Table 29).

The annual change in mortality, standardised for age, among men with diabetes was -3.6 per cent, which is statistically significant ($p<0.0001$; 95 per cent confidence interval -3.2–4.1%). For women, the corresponding change in mortality was -4.0 per cent, which is also statistically significant ($p<0.0001$; 95 per cent confidence interval -3.4–4.5%).

TABLE 28. Standardised mortality ratios (SMR) between observed deaths and expected deaths among people with type 1 or type 2 diabetes, including confidence intervals.

Year	Type 1 diabetes SMR	Confidence interval	Type 2 diabetes SMR	Confidence interval
1994	348	292 - 412	196	191 - 201
1995	467	403 - 538	183	179 - 188
1996	401	343 - 465	175	170 - 179
1997	382	327 - 443	173	169 - 177
1998	347	296 - 405	174	170 - 179
1999	344	294 - 400	173	169 - 177
2000	332	285 - 386	172	168 - 176
2001	270	228 - 318	167	163 - 171
2002	327	281 - 378	166	162 - 170

TABLE 29. Standardised mortality ratios (SMR) between observed deaths and expected deaths among men, women and all people with diabetes, including confidence intervals, in 1990–2002.

Year	SMR men	Confidence interval	SMR women	Confidence interval	SMR all	Confidence interval
1990	216	208 - 223	245	238 - 252	233	228 - 238
1991	216	209 - 224	239	233 - 246	230	225 - 235
1992	214	206 - 221	232	225 - 238	224	219 - 229
1993	215	208 - 222	224	218 - 230	221	216 - 225
1994	204	198 - 221	217	211 - 223	212	207 - 216
1995	208	202 - 215	215	209 - 221	212	208 - 217
1996	193	187 - 200	207	202 - 213	201	197 - 206
1997	193	187 - 200	201	195 - 206	197	193 - 202
1998	195	189 - 201	200	194 - 206	198	194 - 202
1999	193	187 - 199	197	191 - 202	195	191 - 199
2000	194	188 - 200	194	189 - 199	194	190 - 198
2001	185	179 - 191	186	181 - 191	185	182 - 189
2002	186	181 - 192	184	179 - 190	185	182 - 189

The recorded cause of death was chosen as the cause of death among people with diabetes in this material, provided that the cause had been mentioned. If the recorded cause of death was diabetes (E10–E14 or a diagnosis starting with 250), then the list showing the underlying cause of death, the direct cause of death, a secondary cause of death or a contributing cause of death (if given) was followed for as long as necessary in order to find a more specific cause of death than diabetes.

Tables 30 and 31 show the causes of death among people with diabetes, divided into main groups in accordance with classifications in ICD-9 and ICD-10. The tables show that diseases of the circulatory system were the most common cause of death among people with type 1 diabetes. Next came external causes of injury, poisoning and diseases. Diseases of the circulatory system were also the most common cause of death among people with type 2 diabetes; next came tumours and diseases of the respiratory system.

The data obtained from the register of Statistics Finland did not show the cause of death for one person with type 1 diabetes and for 43 persons with type 2 diabetes.

TABLE 30. Causes of death among people with type 1 diabetes, by disease class.

Disease class	ICD-9 Number	ICD-10 Number	Total
Infectious and parasitic diseases	5	28	33
Neoplasms	17	97	114
Diseases of the blood and blood-forming organs			
Endocrine and metabolic diseases and disorders	-	-	-
involving the nutritional and immune systems	22	92	114
Mental disorders	11	47	58
Diseases of the nervous system and sensory organs (ICD-10 classes G00-H95)	3	19	22
Diseases of the circulatory system	169	545	714
Diseases of the respiratory system	26	64	90
Diseases of the digestive system	32	65	97
Diseases of the genitourinary system	-	1	1
Diseases involving pregnancy, childbirth and the puerperium	-	4	4
Diseases of the skin and subcutaneous tissue	1	31	32
Diseases of the musculoskeletal system	-	-	-
Congenital malformations	-	-	-
Diseases and mortality originating in the perinatal period	-	1	1
Symptoms and incompletely defined cases	3	17	20
Injury and poisoning	1	2	3
External causes of injury, poisoning and diseases	21	177	198
Total	**311**	**1,190**	**1,501**

TABLE 31. Causes of death among people with type 2 diabetes, by disease class.

Disease class	ICD-9 Number	ICD-10 Number	Total
Infectious and parasitic diseases	451	493	944
Neoplasms	5,196	7,658	12,854
Diseases of the blood and blood-forming organs	31	40	71
Endocrine and metabolic diseases and disorders			
involving the nutritional and immune systems	248	946	1,194
Mental disorders	842	2,077	2,919
Diseases of the nervous system and sensory organs (ICD-10 classes G00-H95)	279	770	1,049
Diseases of the circulatory system	24,030	26,610	50,640
Diseases of the respiratory system	2,793	3,768	6,561
Diseases of the digestive system	1,263	1,659	2,922
Diseases of the genitourinary system	33	41	74
Diseases involving pregnancy, childbirth and the puerperium	123	168	291
Diseases of the skin and subcutaneous tissue	794	895	1,689
Diseases of the musculoskeletal system	-	-	-
Congenital malformations	-	-	-
Diseases and mortality originating in the perinatal period	22	21	43
Symptoms and incompletely defined cases	74	91	165
Injury and poisoning	2	1	3
External causes of injury, poisoning and diseases	342	1,685	2,027
Total	36,523	46,923	83,446

Tables 32 and 33 show the ten most common single causes of death among people with type 1 and type 2 diabetes (at the three-character level). Myocardial infarction and ischemic heart diseases account for more than half of all causes of death in both types of diabetes.

TABLE 32. The most common causes of death among people with type 1 diabetes in 1988–2002 (n = 1,502).

Cause of death	Number	Percentage of deaths
Myocardial infarction	318	35
Ischemic heart disease	200	22
Diabetes mellitus	86	9
Consequences of alcohol	69	8
Pneumonia	58	6
Suicide	51	6
Intracerebral hemorrhage	45	5
(Other) diseases of pancreas	40	4
Cerebral infarction	29	3
Renal disease	18	1

TABLE 33. The most common causes of death among people with type 2 diabetes in 1988–2002 (n = 83,489).

Cause of death	Number	Percentage of deaths
Myocardial infarction	20,785	42
Ischemic heart disease	11,416	23
Cerebral infarction	7,197	14
Dementia	2,710	5
Pneumonia	2,670	5
Bronchitis	2,093	4
Lung cancer	1,867	4
Cerebrovascular disease or its sequelae	1,692	3
Cancer of pancreas	1,453	3
Cardiac insufficiency	1,376	3

Discussion

No corresponding study on the mortality of the entire diabetic population has been conducted before in Finland.

The positive finding was that the difference in mortality between people with diabetes and the rest of the population became narrower and that for both genders, the annual change in standardised mortality was statistically significant.

The median age of death among people with type 2 diabetes rose by one year between the years 1994 and 2002. The difference in the median age of death between the two types of diabetes was about 30 years in 2002; the median age of death among people with type 1 diabetes was 49 years. The most common causes of death were the same for both types of diabetes: myocardial infarction and ischemic heart disease. The same observation was made in the WHO multinational study, in which Europe was represented by the UK, Switzerland, Germany and Poland. The age of death among people with type 1 diabetes was also roughly the same or slightly higher in the WHO study, but the age of death among people with type 2 diabetes was 20–25 years higher in Finland than in London, Berlin, Switzerland, etc. However, the WHO study followed only a small sample of each country's diabetic population and the follow-up extended up to 1988 (67).

In the WHO study, the SMR figures for people with diabetes varied greatly from one country to the next, but in the main the SMR was higher among people with type 1 diabetes than among people with type 2 diabetes, with the exception of men with type 1 diabetes in London. Among European countries, women with type 1 diabetes had the highest SMR in Switzerland (742) while men with type 1 diabetes had the highest SMR in Berlin (682). The lowest SMR was recorded in London (188 for men and 338 for women). For both men and women with type 2 diabetes, the highest SMR was observed in Switzerland (342 and 382) and the lowest in London (225 for men and 230 for women).

The SMR figures obtained for the countries included in the WHO study and the SMR figures obtained in this study cannot be compared with each other because mortality has been proportioned to the population of each country. However, a higher SMR for type 1 diabetes than for type 2 diabetes was a common feature shared by both studies.

Figures 3 and 4 illustrate changes in the age structure of persons with diabetes and the associated change in mortality among the older age brackets. A completely new age group, 75–79 years, appeared among people with type 1 diabetes between the years 1996 and 2002. At the same time, the number of people who were 70–74 years of age nearly quadrupled. The number of people with type 2 diabetes who were over 85 years of age increased by 36 per cent during the same period (9,089 persons in 2002).

RELIABILITY OF REGISTERS

To obtain a comprehensive picture of the number of persons with diabetes in Finland by means of registers, the best sources are the register of medications eligible for special reimbursement and the prescription register of KELA. However, people who control their diabetes by means of changes in diet cannot be found through KELA. In addition, there are persons in permanent institutional care using diabetes medication who cannot be found in KELA's files, as well as persons with diabetes who, for some reason or another, have not wanted KELA's reimbursements for medication or who have not used the drug therapy prescribed for them. However, these people can be found in the hospital discharge register of STAKES if they have been treated in hospital and the diabetes diagnosis has been entered into the hospital discharge register.

Thus these registers complement each other and data from both registers are needed to obtain reliable register study data.

Altogether 3,634 patients, or one per cent of the original material, had to be discarded because of inadequate/faulty information. The reliability of data from the hospital discharge register improved significantly in the 1990s; especially the amount of missing data has diminished (69).

The mortality register of Statistics Finland contained a total of 5,481 patients who had diabetes as one of their causes of death but who were not found in the files of KELA or STAKES. Of these people, 2,433 or 44 per cent had died in 1988 or 1989 (Table 34). They may have had diabetes controlled through diet, or no application for reimbursement for their medication had been filed with KELA and they had had no treatment in hospital where they would have been diagnosed as having diabetes.

TABLE 34. Patients with diabetes in the mortality register who were not found in the KELA registers or in the Hilmo register.

Year	Total number	Cause of death myocardial infarction	Cause of death cerebral infarction
1988	1,434	582	160
1989	999	415	124
1990	357	119	35
1991	309	108	34
1992	334	116	31
1993	285	105	31
1994	253	91	24
1995	204	78	15
1996	162	60	14
1997	200	49	18
1998	177	45	15
1999	148	45	16
2000	181	44	19
2001	222	49	23
2002	216	74	18

The reliability of entries in the STAKES hospital discharge register as concerns diagnosed myocardial infarctions proved to be good when data in the Hilmo register were compared with the population-based FINMONICA/FINAMI myocardial infarction registers.

By contrast, the hospital discharge register is not a very reliable source for the type of diabetes. Among all patients found in the register (210,002), "other diabetes" or "unspecified diabetes" had been selected as the diagnosis once or more often for altogether 20,872 patients (10% of the entire material). However, most of these patients (16,029) also had hospital admissions where some other diabetes type had been selected as the diagnosis.

Many persons with diabetes (61%) had two or more hospital admissions; of them, 119,370 patients (57%) had been classified in two or more different ways during different admissions. The diabetes type obtained from the Hilmo register can be regarded as the most reliable one when the patient had more than one admission and the same type of diabetes had been entered into the register each time. In this way, 11,874 patients (6%) were classified as having type 1 diabetes and 75,838 patients (36%) were classified as having type 2 diabetes (Appended Table 2). The result is completely different from the result obtained in a previous diabetes study based on the hospital discharge register (35) in which 85.8 per cent of patients with diabetes had only been given one diabetes type code. However, in that study it is not said how many of the patients had had only one admission during the period under review, which was shorter than in this study (the years 1988–1992).

It was to be expected that the diabetic populations in the Hilmo and KELA registers are not identical because not all people with diabetes in Finland could have had hospital care between the years 1988 and 2002. However, it was surprising that Hilmo contained over 47,000 patients who were not in the KELA registers. Nor had diabetes been entered as a secondary diagnosis into the hospital discharge register in a consistent manner. Instead, the mortality register of Statistics Finland, the visual impairment register or the register of births contained only a small number of persons with diabetes who had not been registered with KELA and/or Hilmo.

Contrary to preconceptions, the number of times diabetes is entered as a secondary diagnosis into the hospital discharge register when diabetes itself or its complication is not the reason for treatment has become less common. In 1996, out of all admissions of people with diabetes (people who take diabetes medication as shown by the KELA file), 10 per cent did not include diabetes as the patient's secondary diagnosis even though the patient had the disease. By the year 2002, the percentage of such admissions had doubled, to 20 per cent (Table 35). Among the various fields of medicine in 2002, it was the most common not to enter diabetes into the hospital discharge register during admissions for surgery (9,678); next came general medicine and internal diseases.

Among hospital districts in 2002, the highest number of admissions where no diabetes diagnosis had been entered was found in the hospital district of Northern Ostrobothnia. As a disease, diabetes has a complicating effect on most treatments; it is therefore justified always to enter it into the hospital discharge register.

TABLE 35. Admissions (number) where the diagnosis of diabetes had not been entered in 1988–2002.

Year	Admissions where the diabetes diagnosis is missing	All admissions of people with diabetes	Percentage of missing diagnoses
1988	4,186	90,927	5
1989	5,503	101,751	5
1990	7,897	107,921	7
1991	7,914	112,138	7
1992	8,621	117,576	7
1993	9,342	127,415	7
1994	10,680	135,759	8
1995	12,652	140,656	9
1996	15,950	154,583	10
1997	18,878	157,506	12
1998	21,868	161,824	14
1999	24,295	154,736	16
2000	26,874	171,112	16
2001	29,718	174,126	17
2002	36,159	181,231	20
Total	**240,537**	**2,089,261**	

SUMMARY

The goal of the study was to create an up-to-date picture of people with diabetes, of the complications of diabetes, and of the reliability of diabetes data in registers. These goals were attained reasonably well. The register data available for the study gave new information on the regional distribution of diabetes and some of its complications, and on the age structure, gender distribution and mortality of people with diabetes. Previous studies (11) had already indicated the trend corroborated by this study, too; namely, the sharp increase in the incidence of type 2 diabetes and the occurrence of type 2 diabetes among ever younger age groups. This trend gives reason for concern and places requirements for more effective measures to prevent the disease.

The increase in obesity among the Finnish population is one probable explanation for the rise in the number of people with type 2 diabetes, but improved diagnostics and the more active approach to this disease taken by the health care system have increased the number of people who take diabetes medication registered by KELA.

The number of persons with diabetes is also increasing because these persons live longer than before, and the excess mortality compared to the rest of the population is decreasing.

The data in the registers used are not reliable as concerns the type of diabetes, and there are shortcomings in the comprehensiveness of the data. However, the comprehensiveness and reliability of the data could be improved considerably by combining the data of three national registers. By means of data compiled by KELA, it was also possible to search the Hilmo register for the end-point events of those persons with diabetes whose hospital discharge register data did not show diabetes as a secondary diagnosis.

Determination of the type of diabetes by means of the register data obtained proved to be problematic because when an effort was made to ensure the reliability of the division, a large number of patients were left in the group "diabetes type uncertain", especially during the initial years of the period under study. We strove to achieve an accurate definition of the diabetes type so that we would have been able to follow the numbers of complications by the main type (type 1 and 2). However, in most cases the numbers of the end-point events for persons with type 1 diabetes proved to be so small that it made little sense to examine them as a group of their own. For this reason, analysis of the material by type of diabetes is to some extent limited.

The goals of the study included finding answers to the following questions: "Is the information obtained from national registers suitable to describe the quality of diabetes care throughout Finland?" and "Do hospital districts constitute suitable regions for reviewing the occurrence of complications of diabetes?" On the basis of the study, the answer to both questions is yes. Among the end-point events of cardiovascular diseases associated with diabetes, myocardial infarction, cerebral infarction and amputation of lower limbs were clear-cut diagnoses whose incidence was high enough to enable examination by hospital district. Clear regional differences were found, although towards the end of the period under review these differences were not statistically significant, except in two cases. The differences were greater at the beginning but evened out during the period under study. A definite trend that was detected was the fall in the incidence of myocardial and cerebral infarctions and amputations when these were proportioned to the number of people with diabetes in each region. In some hospital districts, this trend was clearly more positive than the average for the whole country. By analysing these differences, the districts with less positive figures can study whether the keys to good care practices could be discovered in another hospital district.

A good outcome of care naturally depends on the entire chain of care provided for patients with diabetes but, especially in care for people with type 2 diabetes, the basic health care is an important

factor. Specialised health care can, however, influence the basic health care through its own actions (e.g. training, regional care guidelines).

By contrast, retinopathy and nephropathy – the two specific complications of diabetes that can be diagnosed the most reliably – are not suited for use as indicators that are collected from the hospital discharge register because they are mainly followed and treated in outpatient care (outpatient wards and health-care centres). However, a system of data collection encompassing diagnoses in outpatient care is being started. Therefore, the suitability of the incidence of the specific complications of diabetes as indicators can be reassessed in future.

Diagnoses of retinopathy and nephropathy do not reveal the severity of the complication; for this reason, differences in recording practices may have the greatest effect in regional comparisons. The two other questions that the study was expected to answer were: “Is the information on the incidence of complications of diabetes, analysed periodically from the Hilmo register, suited for use as a constant indicator of care quality?” and “How often should this analysis be made when considering the incidence of various complications?”

When end-point events such as myocardial infarctions, cerebral infarctions and lower limb amputations are selected as indicators of good diabetes care, the period of analysis should be longer than one year. At the annual level, random variation plays such a major role – especially in smaller hospital districts – that comparisons had to be made, in particular with regard to amputations of lower limbs, in periods encompassing three years. Even though the incidence of myocardial infarctions and cerebral infarctions was greater than that of lower limb amputations, they also showed evidence of random variation at the annual level. On the basis of the material, it can be recommended that the regional analysis of these indicators should in future be carried out at intervals of three years. The eligibility of indicators and long-term trends of changes should be analysed once every ten years.

The special refund entitlement register kept by KELA includes the ICD-10 code of the person’s diabetes type since the year 2000. These data will facilitate the determination of people’s diabetes types in future analyses. The data also enable comparison against the diabetes type entered into the Hilmo register. Valuable additional information would be obtained by following indicators by diabetes type, but the number of people with type 1 diabetes is too small to enable regional comparisons of end-point events.

The changes detected can be explained not only by the development of care practices but also by any changes that may have occurred in the clinical picture and determination of diabetes. If type 2 diabetes is diagnosed at an earlier stage than before, this brings “healthier” persons into the diabetes population and the opportunities for preventing complications will improve. The follow-up period of 15 years used in our study showed the dramatic increase in the Finnish diabetic population. When this trend is combined with the ageing of people with diabetes, care for diabetes, and the prevention of this disease and its complications, will face ever greater challenges.

CONCLUSIONS

The building of study material on the basis of register data has proved very time-consuming, because certain basic data for diabetes research are not directly available from registers. Determination of the diabetes type had to be done by means of complicated chains of deduction. The diabetes type recorded in KELA's special refund entitlement register since 2000 is a major improvement in the registration of diabetes data. Care for diabetes is organised increasingly often as outpatient care; for this reason, the hospital discharge register at present is not comprehensive enough as a source of information on care for diabetes or its complications. The reform of data collection in outpatient care, launched at STAKES, will partly solve this problem. In this study, there were 118,340 persons with diabetes whose data were only found in KELA's special refund entitlement register and prescription register; this is 36 per cent of the entire population identified as having diabetes. Similarly, the data of 47,602 persons with diabetes were only found in the hospital discharge register; this is 14 per cent of the total number of people identified as having diabetes. On the basis of these figures, it is clear that data from both the hospital discharge register and the refund entitlement register are needed when compiling a register for the follow-up of complications. The data in the prescription register, collected since its establishment in 1994, made it much easier to classify the study population into diabetes types 1 and 2. In consequence, separate analysis of changes among people with type 1 and type 2 diabetes should only be started from the year 1994.

The Finnish registers containing data on health care constitute a valuable source of information, and even with certain shortcomings they can be considered comprehensive and reliable. By combining data in the various registers, it is possible to obtain a comprehensive picture of our major public health problems. This picture then helps in the planning and development of care.

The research material now created is unique in its scope. Therefore, any errors that may have been made when recording data or any other minor shortcomings do not change the final outcome. Our intention is that the data now collected will be utilised in many ways in future.

In order to ensure the quality of care for diabetes, regional analysis of the incidence of complications should be carried out once every three years. This requires combination of data available in the hospital discharge register, in the registers of medications and in the mortality register.

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APPENDIX

APPENDED TABLE 1. Indices describing the numbers of people with type 1 diabetes, by hospital district (direct standardisation for age and gender). Total number of people with type 1 diabetes in Finland in 1994 = 100.

Hospital district	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	Change 1988-02
All of Finland	78	82	85	90	93	97	100	103	107	111	115	120	124	129	133	55
01 Uusimaa	85	87	90	94	97	101	104	108	111	113	118	121	125	129	133	48
02 Helsinki	78	79	81	84	86	88	95	98	101	106	109	113	119	126	127	49
03 Varsinais-Suomi	82	84	89	93	95	97	100	103	107	110	115	120	124	128	132	50
04 Satakunta	77	82	86	89	93	96	100	102	109	111	116	123	128	133	141	64
05 Kanta-Häme	91	97	97	102	105	111	113	119	125	128	131	136	143	146	152	61
06 Pirkanmaa	80	84	87	91	95	98	102	105	110	115	119	121	124	130	133	53
07 Päijät-Häme	72	76	78	82	85	89	91	94	97	100	104	110	114	119	124	52
08 Kymenlaakso	84	86	91	96	102	107	109	113	115	120	123	127	129	131	137	53
09 Southern Karjala	86	88	91	97	100	101	104	110	114	120	123	129	131	136	140	54
10 Southern Savo	76	79	83	88	92	98	101	105	111	119	127	130	139	143	148	72
11 Eastern Savo	83	91	98	104	106	114	116	119	125	129	132	137	141	147	151	68
12 Northern Karelia	89	95	99	102	109	114	119	120	125	132	139	144	147	151	154	65
13 Northern Savo	74	77	82	87	92	97	99	101	103	106	110	117	123	129	133	59
14 Central Finland	84	88	93	97	100	103	107	111	116	120	125	128	133	136	142	58
15 Southern Ostrobothnia	68	73	77	81	84	90	95	99	101	105	111	116	121	126	130	62
16 Vaasa	75	81	83	87	89	93	96	99	105	110	114	118	121	125	130	55
17 Central Ostrobothnia	75	79	82	88	91	95	98	104	110	112	116	122	127	134	132	57
18 Northern Ostrobothnia	68	73	78	83	86	90	93	97	100	103	107	113	118	126	131	63
19 Kainuu	67	70	75	80	84	90	93	93	99	101	104	112	120	123	129	62
20 Länsi-Pohja	57	61	65	71	75	78	82	86	88	94	100	102	104	109	114	57
21 Lapland	58	61	64	68	70	78	80	84	89	92	96	102	106	112	119	61
22 Åland	77	80	81	84	86	87	90	92	96	102	108	113	117	116	124	47

APPENDED TABLE 2. Indices describing the numbers of people with type 2 diabetes, by hospital district (direct standardisation for age and gender). Total number of people with type 2 diabetes in Finland in 1994 = 100.

Hospital district	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
All of Finland	42	50	57	66	76	87	100	109	118	126	133	141	150	159	168
01 Uusimaa	40	47	53	61	71	82	98	107	114	121	129	136	144	154	162
02 Helsinki	38	45	50	57	65	75	95	104	113	120	128	136	145	154	164
03 Varsinais-Suomi	39	45	53	61	72	83	96	104	111	117	124	132	139	146	154
04 Satakunta	43	50	57	65	74	84	97	105	114	123	128	136	144	153	160
05 Kanta-Häme	41	47	54	63	73	85	96	105	115	123	131	137	145	155	167
06 Pirkanmaa	40	46	54	64	73	84	96	105	115	123	132	141	150	157	166
07 Päijät-Häme	49	56	63	71	79	87	97	103	112	120	126	135	145	152	163
08 Kymenlaakso	45	52	58	66	75	85	98	105	113	122	130	138	145	153	163
09 Southern Karjala	49	57	64	75	87	100	112	120	127	139	146	155	168	176	184
10 Southern Savo	39	47	55	65	74	85	101	113	124	134	139	146	154	165	175
11 Eastern Savo	50	59	68	80	89	101	115	125	138	148	152	164	173	184	197
12 Northern Karelia	43	51	58	67	79	92	103	112	124	132	141	148	158	165	176
13 Northern Savo	46	53	59	70	81	91	103	113	122	132	141	147	156	167	179
14 Central Finland	43	50	55	61	69	78	91	101	111	120	129	136	146	157	169
15 Southern Ostrobothnia	47	58	67	79	92	107	120	129	141	150	160	166	174	182	192
16 Vaasa	29	36	43	52	61	68	77	85	93	100	107	115	122	131	139
17 Central Ostrobothnia	46	56	64	75	86	102	116	130	139	146	153	164	172	182	189
18 Northern Ostrobothnia	59	71	79	90	101	114	126	136	146	156	161	167	175	185	195
19 Kainuu	55	67	73	82	90	104	112	120	130	137	141	147	157	169	178
20 Länsi-Pohja	45	55	58	66	75	86	98	109	118	126	132	139	148	158	168
21 Lapland	39	49	56	66	77	87	100	112	123	133	140	148	157	164	172
22 Åland	28	32	35	40	44	48	59	61	65	67	74	78	88	93	101

APPENDED TABLE 3. Incidence of the first lower-limb amputations among persons with diabetes per 100,000 persons with diabetes in 1988–2002.

	Men	Women	All
1988	898.5	943.0	924.0
1989	659.0	799.7	738.9
1990	734.5	704.2	717.5
1991	576.9	708.0	649.3
1992	595.3	673.4	637.8
1993	560.8	664.5	616.6
1994	577.4	512.5	542.9
1995	520.1	539.8	530.5
1996	542.0	475.9	507.7
1997	489.8	441.2	464.9
1998	428.7	467.5	448.3
1999	512.2	434.5	473.4
2000	462.5	402.3	432.8
2001	424.4	386.2	405.7
2002	447.1	322.0	386.5

APPENDED TABLE 4. The first amputations among persons with diabetes, as standardised indices by hospital district.

Hospital district	1988-1990	1991-1993	1994-1996	1997-1999	2000-2002
Uusimaa	142	112	103	91	70
Helsinki	131	110	89	72	74
Varsinais-Suomi	190	148	105	104	83
Satakunta	179	161	125	93	66
Kanta-Häme	178	103	102	83	59
Pirkanmaa	143	124	90	93	73
Päijät-Häme	147	118	105	77	95
Kymenlaakso	139	108	92	108	64
Southern Karelia	158	71	83	65	68
Southern Savo	179	107	101	99	110
Eastern Savo	243	160	149	125	89
Northern Karelia	151	124	107	87	75
Northern Savo	190	151	144	87	103
Central Finland	166	137	85	88	92
Southern Ostrobothnia	122	124	98	91	65
Vaasa	99	81	48	58	58
Central Ostrobothnia	117	121	92	91	69
Northern Ostrobothnia	105	104	95	87	84
Kainuu	155	106	127	75	52
Länsi-Pohja	240	162	118	59	86
Lapland	136	105	83	64	37
All of Finland	**153**	**121**	**100**	**87**	**76**

APPENDED TABLE 5. The first myocardial infarctions among persons with diabetes, as standardised indices by hospital district.

Hospital district	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Uusimaa	118	117	124	115	110	118	92	89	84	87	79	74	82	77	73
Helsinki	138	124	159	126	122	126	103	108	74	84	67	81	77	81	70
Varsinais-Suomi	98	117	140	131	110	116	96	97	76	78	76	78	81	83	75
Satakunta	116	125	139	115	116	123	105	92	87	92	86	83	81	85	68
Kanta-Häme	111	94	113	106	91	100	82	97	83	71	80	65	90	66	77
Pirkanmaa	123	129	123	126	121	113	100	93	76	82	82	66	78	81	80
Päijät-Häme	123	88	119	105	109	114	87	96	93	65	70	65	83	64	59
Kymenlaakso	101	109	89	104	91	96	95	109	86	102	91	73	62	70	70
Southern Karelia	130	134	117	136	140	127	111	111	99	94	81	63	54	68	85
Southern Savo	147	148	149	118	122	122	97	117	89	96	94	86	101	81	78
Eastern Savo	144	140	152	129	137	135	146	67	97	112	108	87	108	97	80
Northern Karelia	180	123	165	157	134	125	86	114	107	94	99	97	86	82	69
Northern Savo	134	149	141	133	129	118	110	120	90	103	99	82	82	73	72
Central Finland	118	117	130	122	119	98	101	100	100	80	64	83	76	85	73
Southern Ostrobothnia	117	112	119	119	111	109	87	85	89	82	97	83	75	64	76
Vaasa	136	101	122	104	110	92	106	83	66	66	76	83	82	77	64
Central Ostrobothnia	144	156	140	154	132	117	123	105	136	118	109	77	81	79	88
Northern Ostrobothnia	110	133	153	135	143	130	114	95	87	97	104	86	83	90	74
Kainuu	216	190	150	166	122	169	132	124	111	113	100	88	114	88	101
Länsi-Pohja	137	142	224	139	159	141	81	95	75	92	107	92	99	83	72
Lapland	117	108	132	145	107	118	96	99	80	78	68	103	84	81	77
All of Finland	**126**	**123**	**134**	**125**	**119**	**117**	**100**	**99**	**86**	**87**	**85**	**79**	**81**	**79**	**74**

APPENDED TABLE 6. The first cerebral infarctions among persons with diabetes, as standardised indices by hospital district.

Hospital district	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Uusimaa	121	106	110	105	101	107	99	96	99	94	86	71	83	79	70
Helsinki	100	110	99	114	106	111	94	89	89	87	84	82	73	69	58
Varsinais-Suomi	152	126	113	117	106	103	103	89	80	73	87	69	65	72	57
Satakunta	124	111	110	96	89	78	94	89	89	74	77	64	67	70	56
Kanta-Häme	162	95	101	114	107	110	95	104	95	103	87	93	83	56	55
Pirkanmaa	127	111	126	123	115	118	103	99	81	73	85	79	74	79	59
Päijät-Häme	120	105	111	121	111	102	113	100	92	90	87	75	77	57	57
Kymenlaakso	162	126	101	112	119	102	117	90	105	96	94	84	84	88	78
Southern Karelia	154	137	112	129	85	99	98	90	87	95	77	98	58	68	53
Southern Savo	191	184	166	114	133	136	129	135	128	97	100	93	88	74	67
Eastern Savo	225	108	103	110	115	120	136	68	104	97	80	96	66	70	96
Northern Karelia	143	110	124	109	112	104	112	103	98	82	78	66	72	65	69
Northern Savo	153	97	142	112	97	123	92	111	93	83	79	72	81	66	71
Central Finland	118	105	107	137	116	113	107	97	94	94	78	76	68	71	68
Southern Ostrobothnia	157	122	120	102	90	98	78	110	107	88	81	87	81	73	74
Vaasa	138	106	87	92	85	94	85	80	62	78	64	68	65	64	52
Central Ostrobothnia	88	132	120	99	88	76	92	89	96	93	68	68	43	48	51
Northern Ostrobothnia	111	113	117	102	108	92	95	97	80	93	92	89	70	77	58
Kainuu	128	113	118	110	121	105	102	87	103	62	100	58	64	66	68
Länsi-Pohja	78	85	112	83	116	94	111	91	100	59	90	81	77	78	59
Lapland	118	116	117	77	104	95	83	113	94	75	64	99	71	62	58
All of Finland	**134**	**114**	**114**	**110**	**105**	**105**	**100**	**97**	**92**	**85**	**83**	**78**	**73**	**71**	**63**

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