

Changes in CVD Incidence and Mortality Rates, and Life Expectancy

North Karelia and National



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ABSTRACT

During the last 40 years, Finland has experienced a remarkable decline in coronary heart disease and stroke mortality. The latest coronary heart disease mortality figures in the working-age population are <20% of the top figures in the early 1970s. Equal declines can be seen in men and in women, and the improvement extends to elderly populations as well. However, due to the very high historic levels, Finland still continues to have clearly higher cardiovascular mortality than, for example, the Mediterranean countries. Parallel to the decline in cardiovascular mortality, the life expectancy of Finns has increased by 11.6 years in men and by 9.2 years in women. The probability for a 30-year-old man to die of cardiovascular disease has dropped from about 30% in 1970 to 7% in 2013, and for a 30-year-old woman, the corresponding probability has dropped from 13% to about 2%.

Like many other Western countries, Finland experienced a steep increase in cardiovascular mortality after the Second World War. This development peaked in about 1970. Since then, the mortality rates have been declining remarkably rapidly. These changes are best known for coronary heart disease (CHD) mortality, which is described for the working-age population in [Figure 1](#). In the last available year, 2013, the CHD mortality among working-age men and women was <20% of the top figures. However, due to the very high starting level, the CHD mortality rates in Finland are still fairly high compared with most other Western countries, especially to the Mediterranean countries such as Italy and Spain. Substantial geographical differences in cardiovascular and total mortality within Finland have been known since the 1940s [1]. The mortality rates in eastern Finland, including North Karelia, have been clearly higher than in the southwestern parts of the country.

The aims of the present review were to describe the changes in incidence, mortality and 28-day case fatality of CHD and stroke events in North Karelia and in whole Finland from the early 1970s to the latest available year, 2013. We also describe changes in life expectancy of the Finnish population during the same period of time.

METHODS

The present report is based on record linkage of the country-wide and comprehensive Finnish health care registers and the population census data obtained from Statistics Finland. All deaths in Finland are recorded

in the Causes-of-Death Register, which includes the underlying cause of death and, if relevant, direct cause of death and up to 3 contributing causes of death. The doctor in charge of treatment during the last illness assigns the causes of death using the *International Classification of Diseases (ICD)* codes. The 10th revision of the *ICD (ICD-10)* has been in use since the beginning of 1996. Autopsies are relatively common in out-of-hospital or otherwise unexpected deaths. All hospitalizations are recorded in the National Hospital Discharge Register, where the main cause of hospitalization and up to 3 contributing causes are recorded using the *ICD* codes. The Causes-of-Death Register and the Hospital Discharge Register can be linked together on the basis of the individual ID code, unique to every resident of Finland. This has been done in the cardiovascular disease register of the National Institute for Health and Welfare (THL), which is the source of the cardiovascular event data presented in this review. The register is publicly available [2].

The trends in cardiovascular disease events in North Karelia and certain other geographical areas in Finland have also been monitored using specific acute myocardial infarction (AMI) and stroke registers, such as the FINMONICA AMI register [3] and the FINMONICA stroke register [4]. After the end of the World Health Organization's MONICA (Multinational Monitoring of Trends and Determinants in Cardiovascular Disease) project these were continued as FINAMI and FIN-STROKE registers [5,6]. Our validation studies comparing these specific AMI and stroke registers with

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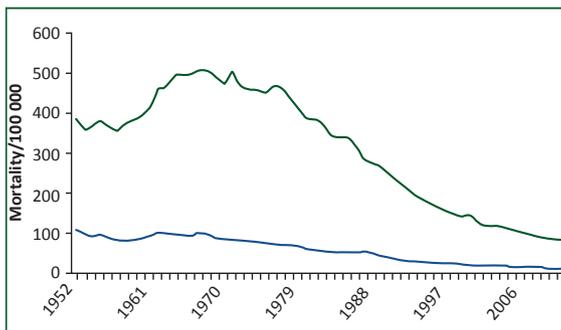


FIGURE 1. Age-standardized coronary heart disease mortality (per 100,000 persons) during 1953 to 2013 in Finland among men (green line) and women (blue line) ages 35 to 64 years.

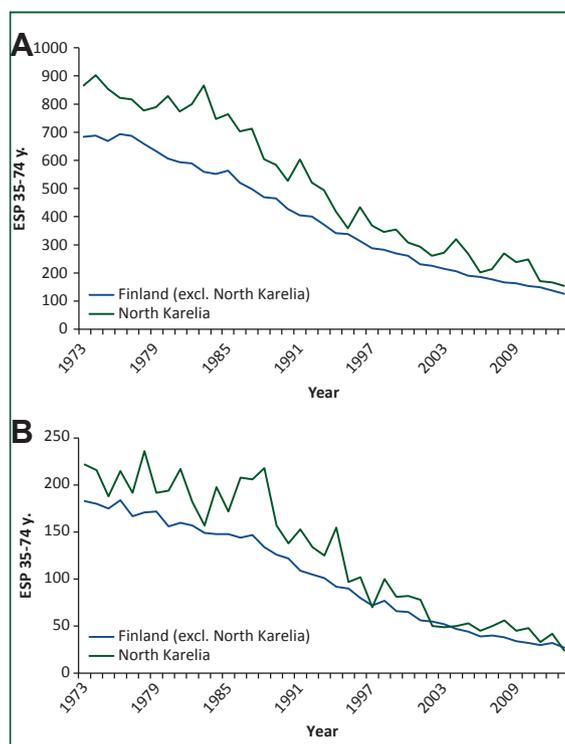


FIGURE 2. Age-standardized trends in coronary heart disease mortality in North Karelia (green line) and in the rest of Finland (blue line) among men (A) and women (B) ages 35 to 74 years. The average annual decline was 4.5% both in North Karelia and in the rest of Finland among men. Among women, the corresponding average annual declines were 5.2% and 5.1%. The *ICD-10* codes I20 to I25 and corresponding *ICD-9* and *ICD-8* codes as the underlying cause of death were taken as coronary deaths in this analysis. ESP, European standard population; *ICD*, *International Classification of Diseases*.

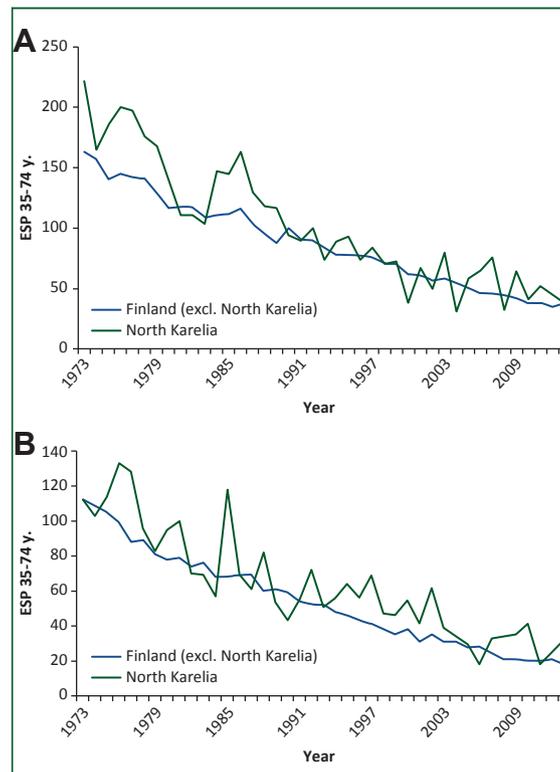


FIGURE 3. Age-standardized trends in stroke mortality in North Karelia (green line) and in the rest of Finland (blue line) among men (A) and women (B) ages 35 to 84 years. The average annual decline was 4.1% in North Karelia and 3.7% in the rest of Finland among men. Among women, the corresponding average annual declines were 3.8% and 4.5%. The *ICD-10* codes I60 to I69 and corresponding *ICD-9* and *ICD-8* codes as the underlying cause of death were taken as stroke deaths in this analysis. Abbreviations as in Figure 2.

data obtained from the country-wide health care registers show that the administrative health care registers are reliable and valid data sources for cardiovascular events in Finland [7,8].

TRENDS IN CARDIOVASCULAR EVENT RATES

CHD and stroke mortality

From 1973 to 2013, the age-standardized average annual decline in CHD mortality among men ages 35 to 74 years in North Karelia was 4.5% (95% confidence interval [CI]: 4.1% to 4.8%; $p < 0.0001$); in other parts of Finland, it was exactly the same, 4.5% (95% CI: 4.3% to 4.7%; $p < 0.0001$) (Fig. 2). In total, the decline was 81% in North Karelia and 80% in the rest of the country, as calculated from the mean rates in 1973 to 1975 and 2011 to 2013. Corresponding data in women showed the average annual decline of 5.2% (95% CI: 4.6% to 5.8%;

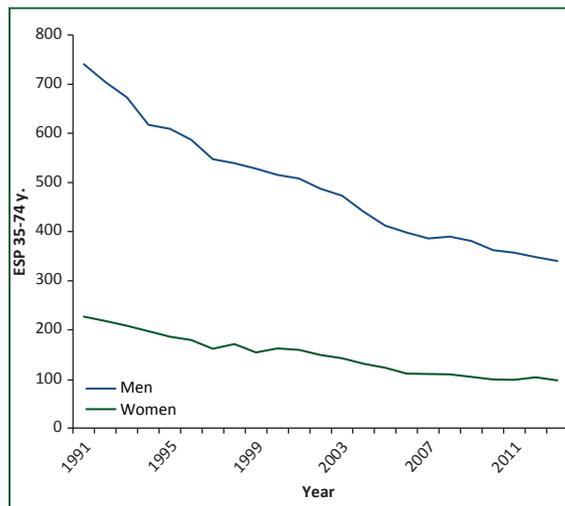


FIGURE 4. The age-standardized incidence of first ever coronary heart disease events in all of Finland among men (blue line) and women (green line) ages 35 to 74 years during the 23-year period 1991 to 2013. For nonfatal events, the *ICD-10* codes I20.0, I21, and I22 (or the corresponding *ICD-9* codes) as the primary cause for hospitalization were used in this analysis. For fatal events, the *ICD-10* codes I20 to I25, I46, R96, and R99 or the corresponding *ICD-9* codes as the underlying or direct cause of death were used. The average annual decline was 3.5% in men and 4.1% in women. Abbreviations as in Figure 2.

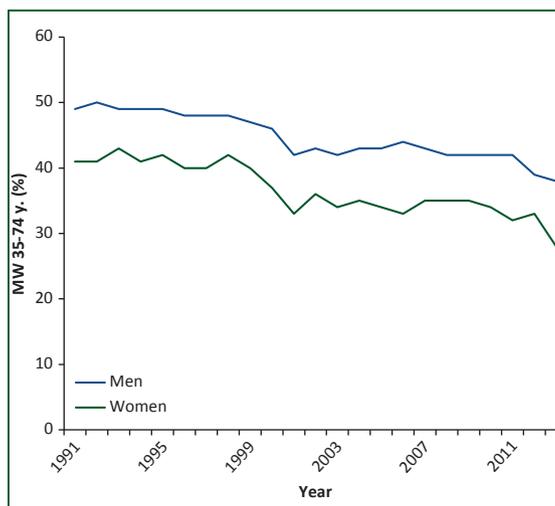


FIGURE 6. The age-standardized 28-day case fatality of acute coronary events, including out-of-hospital coronary deaths, in Finland among men (blue line) and women (green line) ages 35 to 74 years during the 23-year period 1991 to 2013. The last year was cut at November 30, 2013, to enable the 28-day follow-up for all included events. Deaths within the 28-day period with 1 of the *ICD-10* codes I20 to I24, I46, R96, or R99 or the corresponding *ICD-9* codes as the underlying or direct cause of death were considered as fatal events. The average annual decline was 2.0% among men and 2.7% among women. *ICD*, *International Classification of Diseases*; *MW*, *MONICA weights*.

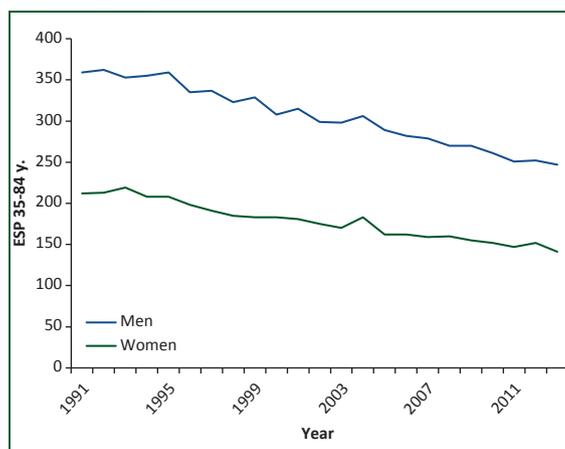


FIGURE 5. The age-standardized incidence of first ever stroke events in all of Finland among men (blue line) and women (green line) ages 35 to 84 years during the 23-year period 1991 to 2013. *ICD-10* codes I60 to I64 and the corresponding *ICD-9* codes as the primary cause for hospitalization or as the underlying or direct cause of death were included in this analysis. The average annual decline was 1.8% in men and 1.9% in women. Abbreviations as in Figure 2.

$p < 0.0001$) in North Karelia and 5.1% (95% CI: 4.7% to 5.4%; $p < 0.0001$) in other parts of Finland. In total, the decline in women was 84% in North Karelia and 83% in other parts of Finland.

The average annual declines in age-standardized stroke mortality in the age group 35 to 84 years were 4.1% (95% CI: 3.5% to 4.6%; $p < 0.0001$) in North Karelia and 3.7% (95% CI: 3.6% to 3.9%; $p < 0.0001$) in the rest of Finland (Fig. 3). Among women, the corresponding declines in stroke mortality were 3.8% (95% CI: 3.1% to 4.4%; $p < 0.0001$) and 4.5% (95% CI: 4.3% to 4.6%; $p < 0.0001$). In total, the declines in stroke mortality during the 40-year period 1973 to 2013 were 76%, both in North Karelia and in other parts of Finland among men. Among women, the corresponding declines were 77% in both areas.

Incidence of first CHD and stroke events

Data on incidence of first CHD and stroke events were available from 1991 onward. In the whole of Finland, the age-standardized incidence of first CHD events among men ages 35 to 74 years declined on average by 3.5% (95% CI: 3.3% to 3.7%; $p < 0.0001$) per year and among women by 4.1% (95% CI: 3.5% to 4.4%; $p < 0.0001$) per year

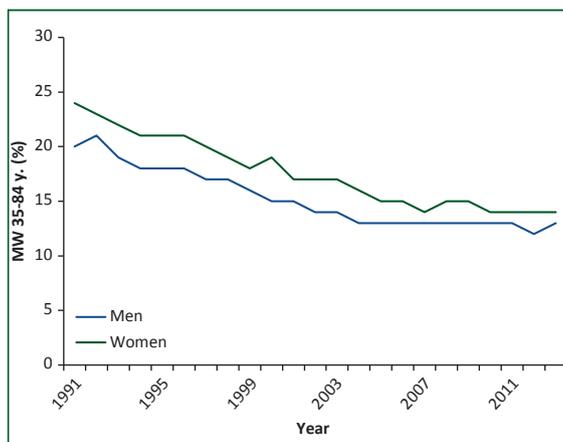


FIGURE 7. The age-standardized 28-day case fatality of acute stroke events in Finland among men (blue line) and women (green line) ages 35 to 84 years during the 23-year period 1991 to 2013. The last year was cut at November 30, 2013, to enable the 28-day follow-up for all included events. Hospitalizations and deaths with the *ICD-10* codes I60 to I64 or the corresponding *ICD-9* codes were included in this analysis. Deaths within the 28-day period with 1 of the *ICD-10* codes I60 to I64 or the corresponding *ICD-9* codes as the underlying or direct cause of death were considered as fatal events. The average annual decline was 2.7% among men and 3.2% among women. Abbreviations as in Figure 6.

(Fig. 4). Corresponding average annual declines in the age-standardized incidence of first stroke events in persons ages 35 to 84 years were 1.8% (95% CI: 1.7% to 2.0%; $p < 0.0001$) among men and 1.9% (95% CI: 1.7% to 2.1%; $p < 0.0001$) among women (Fig. 5).

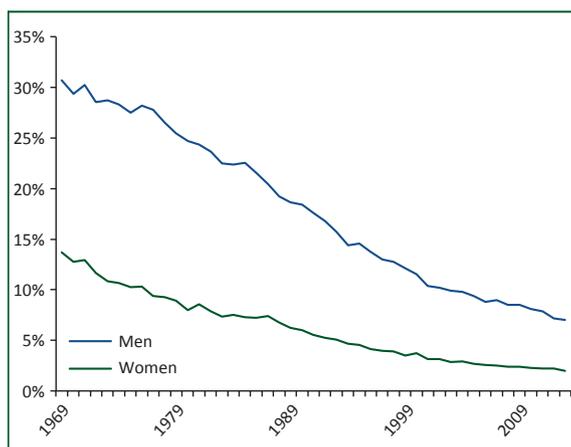


FIGURE 8. The probability of a 30-year old man (blue line) or woman (green line) to die from cardiovascular disease before his/her 70th birthday in Finland during the period 1969 to 2013.

Trends in 28-day case fatality of CHD and stroke events

The age-standardized 28-day case fatality of CHD events, including out-of-hospital coronary deaths, declined during the period 1991 to 2013 in parallel manner in men and women ages 35 to 74 years and remained consistently higher in men (Fig. 6). Before the mid-1990s, the case fatality changes were modest, but thereafter the level has declined more clearly. On average, the declines were 2.0% (95% CI: 1.7% to 2.2%; $p < 0.0001$) and 2.7% (95% CI: 2.3% to 3.0%; $p < 0.0001$) per year among men and women, respectively (Fig. 6). The corresponding declines in the 28-day case fatality of stroke in persons ages 35 to 84 years were 2.7% (95% CI: 2.3% to 3.0%; $p < 0.0001$) per year in men and 3.2% (95% CI: 2.9% to 3.5%; $p < 0.0001$) per year in women (Fig. 7).

CHANGES IN LIFE EXPECTANCY

During the last 40 years, the life expectancy of a newborn boy has lengthened by 11.6 years and of a newborn girl by 9.2 years [9]. It can be estimated that the declined cardiovascular mortality has contributed in boys about 5 years and in girls about 4.5 years to the lengthening of the life expectancy. The probability of a man or a woman age 30 to die of cardiovascular disease before his or her 70th birthday declined from about 30% in 1970 to about 7% in 2013 among men and from about 13% to 2% among women (Fig. 8).

SUMMARY

After the start of the North Karelia Project, North Karelia and, since 1977, the whole of Finland have experienced a remarkable decline in CHD and stroke mortality. These declines have been similar in both sexes and have extended to the elderly population as well [10]. Our earlier studies show that all socioeconomic groups have benefitted from the favorable development, although substantial socioeconomic differences still exist [11,12]. Most of the decline seems to be due to the reduced incidence of first events and thus due to primary prevention, but declined case fatality has definitely contributed as well, especially after the mid-1990s. This is obviously due to improved treatment, but the cases may also have become less severe [13]. Our modelled forecast suggests that the favorable development is likely to continue also in the future [14]. In parallel to the decline in cardiovascular mortality, the life expectancy of Finns has lengthened. A substantial part of the improved life expectancy is likely to be due to the decline in cardiovascular mortality.

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