Changes in premature deaths in Finland: successful long-term prevention of cardiovascular diseases

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This article describes the long-term consequences of successful cardiovascular disease (CVD) prevention and its influence on premature mortality in Finland, with special reference to North Karelia. Active community-based CVD prevention began in 1972 in the province of North Karelia (population, 180 000). Since 1977, active preventive work has been carried out nationwide, taking advantage of the experience from North Karelia, which continued as a demonstration area for integrated prevention of noncommunicable diseases. Comprehensive community-based interventions as part of WHO Interhealth and CINDI programmes in North Karelia and nationwide aimed at changing the target risk factors and health behaviours (serum cholesterol, blood pressure, smoking, diet) at the population level. Age-adjusted mortality rates for CVD, coronary heart disease (CHD), cerebrovascular disease, all cancers, lung cancer, accidents and violence, and all causes in the population aged 35–64 years from the pre-programme period (1969–71) to 1995 were the main measures of the outcome.

Among men there was a great reduction in deaths from CHD, CVD, cancer, and all causes in the whole country. From 1969–71 to 1995 the age-standardized CHD mortality (per 100 000) decreased in North Karelia by 73% (from 672 to 185) and nationwide by 65% (from 465 to 165). The reduction in CVD mortality was of the same magnitude. Among men, CHD mortality decreased in the 1970s, as did lung cancer mortality in the 1980s and 1990s, significantly more in North Karelia than in all of Finland. Among women there was a great reduction in CVD (including CHD and stroke) mortality and all-causes mortality, but only a small reduction in cancer mortality. These results show that a major reduction in CVD mortality among the working-age population can take place in association with active reduction of major risk factors, with a favourable impact on cancer and all-causes mortality.

Background

Owing to exceptionally high cardiovascular disease (CVD) mortality rates, especially from coronary heart disease (CHD), in the eastern regions of Finland (*1–3*), the North Karelia project was launched in 1972 as an intensive preventive programme to reduce this heavy burden of CVD (*4*). During the original project period (1972–77), the activities were carried out in the province of North Karelia (pilot area), which continued to serve as a national demonstration area, these experiences being the basis for national CVD prevention. The main objective at the outset was to achieve a substantial decline in CHD mortality, especially among middle-aged men. When the project joined the WHO Country Integrated Noncommunicable Diseases Intervention (CINDI) and Interhealth programmes, there was a greater emphasis on more integrated approaches for noncommunicable disease (NCD) prevention.

A public health strategy was developed to reduce the population levels of the main CVD risk factors (elevated serum cholesterol, hypertension, and smoking). Great emphasis was put on promoting cholesterol-lowering dietary changes. A comprehensive community-level approach was adopted, involving the health and other services, voluntary organizations, local media, businesses, and public policy. On the national level, expert guidelines were issued, the involvement of industry was promoted, and public policy was enacted (e.g. antismoking legislation). Details of the implementation of the project (*5*) and descriptions about the national

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activities to promote cholesterol-lowering dietary changes and to fight smoking have been published (*6*, *7*).

The project was evaluated using carefully standardized surveys of cross-sectional population samples. These were carried out every five years in North Karelia, in the initial reference area (Kuopio province) and then in other parts of the country for nationwide monitoring (*5*). The previously published 20-year risk-factor changes show, among middle-aged men (30–59 years), a major reduction in the population levels of the target risk factors (*8*). The results also show that during the original project period (1972–77) these reductions were significantly greater in North Karelia than in the reference area. When the surveys showed some levelling-off in the risk-factor trends of 1982–87, new intensive activities were started in North Karelia and nationwide to further promote cholesterol-lowering dietary changes. This coincided with further international expert recommendations, and increasing interest from and collaboration with the food industry.

Earlier publications from the North Karelia project reported a major decline in CHD mortality, which was significantly greater in North Karelia than in the reference province of Kuopio in the 1970s (*9*), but stabilized in the early 1980s (*10*). The present paper describes the latest findings in mortality trends in North Karelia and nationwide, in the context of the long-term potential of successful CVD prevention.

Materials and methods

The mortality data for North Karelia and all of Finland were obtained from Statistics Finland, an organization which reviews the diagnoses made by local doctors on individual death certificates in accordance with the eighth revision of the International Classification of Diseases (ICD) from 1969 to 1986, and the ninth revision thereafter. The following ICD codes were used for the mortality categories: diseases of the circulatory system 390–459, ischaemic heart disease 410–414, cerebrovascular disease 430–438, all neoplasms 140–239, and lung cancer 162 (includes also malignant neoplasm of trachea and bronchus).

The mortality rates were calculated on the basis of population data from the national population registry. Age adjustment was done using World Standard Population (35–44 years (*12*), 45–54 years (*11*), 55–64 years (*8*)) as the standard. The mortality trends and changes for North Karelia and Finland and the 95% confidence intervals were calculated using linear regression, where the logarithms of the mortality rates were used as dependent variables and the year, area and year–area interaction as independent variables. Differences between the trends were evaluated by testing the differences between regression coefficients in the usual manner. Statistical computations were carried out using SAS statistical software (version 6).

National trends and figures are given for descriptive purposes, but when compared with North Karelia, the tests were done to determine the difference between North Karelia and the rest of Finland. Because North Karelia has only 3.5% of the total population, its impact on national figures is very small.

Results

There was a remarkable decline in CVD and cancer mortality among the male population aged 35–64 years in North Karelia and nationwide after the pre-programme period (1968–71). CHD mortality was analysed for three periods: 1969–78, 1979–85 and 1986–95. During the first period the decline was significantly greater in North Karelia than nationwide (annually, −2.9% vs −1.0%; $P = 0.007$). During the second period (i.e. after the original North Karelia project), the decline levelled off in North Karelia but increased nationwide (annually, −0.2% vs. −3.5%). Since 1986, there has been a sharp decline in North Karelia and the nationwide decline accelerated (annually, −8.0% vs −6.5%) (Fig. 1).

Trends in cancer mortality among the male population show some differences. The decrease in cancer mortality, especially in the most common form (lung cancer) among men, was similar in North Karelia and all Finland in the 1970s, but thereafter the decline was much more in North Karelia than nationwide. The annual decline in lung cancer mortality during the period 1980–95 was −7.3% in North Karelia and −4.8% nationwide ($P = 0.017$) (Fig. 2).

Tables 1 and 2 show the age-adjusted mortality rates among the 35–64-year-old male and female population nationwide and in North Karelia in 1969–71 (pre-programme period) and 1993–95. Before the start of the programme the mortality in Finnish males was exceptionally high; the approximate male/female ratio was 5 for CHD, 2 for cancer, and 3 for total mortality. The mortality rates in North Karelia were generally higher than nationwide, except for women's cancer and accidents and violent deaths.

From 1969–71 to 1993–95 a substantial decline was seen in all major causes of mortality except for accidents and violent causes and cancers among females. The decline in CVD mortality (over 60%) was due to decreased mortality from both ischaemic

Fig. 1. **Age-adjusted mortality rates of coronary heart disease in North Karelia and the whole of Finland among males aged 35–64 years from 1969 to 1995.** Figures in parentheses are 95% confidence intervals.

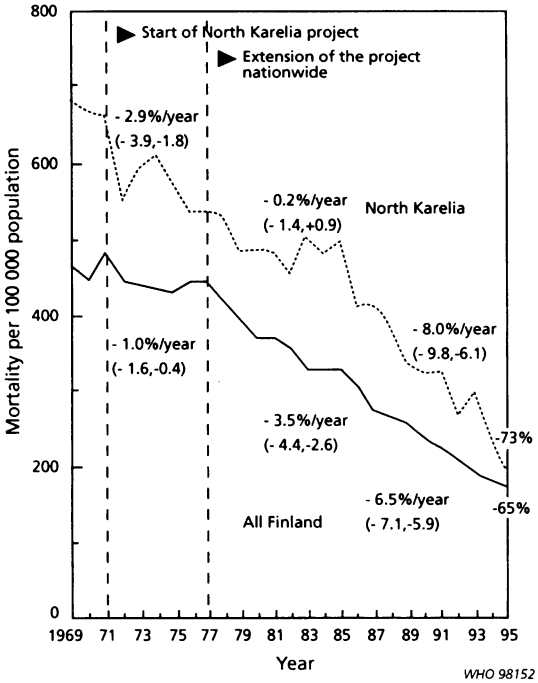
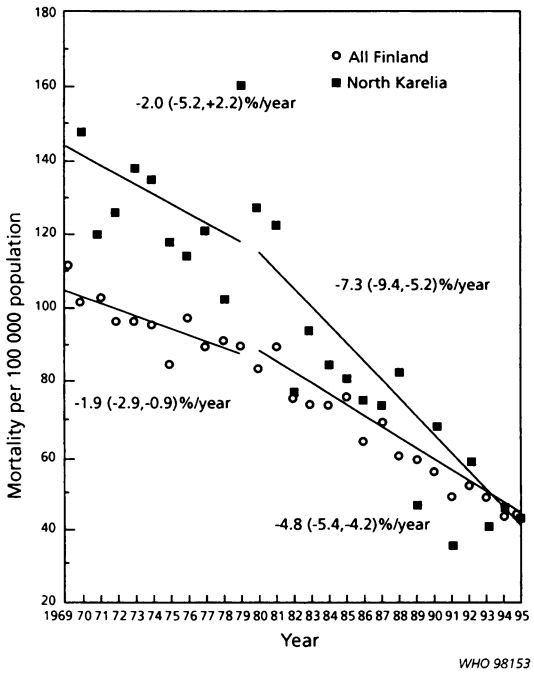


Fig. 2. **Age-adjusted mortality rates of lung cancer in North Karelia and the whole of Finland among males aged 35–64 years from 1969 to 1995 (subperiods 1969–78, 1979–85 and 1986–95).** Figures in parentheses are 95% confidence intervals.



heart disease and cerebrovascular disease. Generally the declines for this whole period were of the same order of magnitude in both areas. Lung cancer mortality among men declined significantly more ($P < 0.001$) in North Karelia (−71.4%) than nationwide (−57.1%). The general decline in accidents and violent deaths was much smaller than that of the main chronic diseases. The declines in CVD mortality were generally of the same magnitude among both men and women, but women experienced a much lower decline in cancer.

If data for the last year of follow-up (1995) are used, the decline in CVD mortality in men from the pre-programme period was −68% in North Karelia and −61% nationwide. The respective figures for CHD mortality were −72.5% and −64.5%. At the outset (1969–71) there was a large and significant difference in CHD mortality rates between North Karelia (672; 95% confidence interval (CI), 620–724) and nationwide (465; 95% CI, 456–474). This difference became statistically insignificant by 1995: for North Karelia 185 (95% CI, 140–230) and nationwide 165 (95% CI, 157–173).

Fig. 3 shows the decline in CHD mortality in North Karelia by 10-year age groups. The relative decline was clearly greater among the younger age groups, especially in men. In the youngest male age group (35–44 years), the decline in CHD mortality was 87%. Fig. 4 presents the cumulative percentage decline in male CHD mortality in North Karelia and nationwide from the pre-programme period (1969–71), initially showing a greater decline in North Karelia, with the nationwide figures eventually catching up. North Karelia then saw another decline larger than that of the nationwide sample.

Table 3 shows the average annual number of deaths from all causes and from cardiovascular diseases in North Karelia and nationwide in 1969–71 and in 1995. In this 24-year period there were 3102 fewer deaths annually nationwide and 250 fewer in North Karelia among men aged 35–74 years. For women the respective figures were 3284 and 191. Most of this decline was due to reductions in cardiovascular deaths. Life expectancy at birth rose nationally from 66.4/74.6 years (males/females) in 1971 to 72.8/80.2 years in 1995.

Table 1: **Age-adjusted annual mortality rates in 1969–71 and in 1993–95 in Finland as a whole and in North Karelia and respective changes among the 35–64-year-old male population**

Mortality	Mortality rate (per 100 000 population)	
	Finland	North Karelia
All causes:		
1969–71	1272 (1257, 1287)[a]	1509 (1431, 1587)[a]
1993–95	700 (690, 710)	833 (779, 887)
% change	−45.0	−44.8
Cardiovascular diseases:		
1969–71	647 (637, 657)	855 (796, 914)
1993–95	261 (255, 267)	338 (303, 373)
% change	−59.7	−60.5
Coronary heart disease:		
1969–71	465 (456, 474)	672 (620, 724)
1993–95	175 (170, 180)	237 (208, 266)
% change	−62.4	−64.7
Cerebrovascular disease:		
1969–71	93 (89, 97)	90 (71, 109)
1993–95	40 (38, 42)	47 (34, 60)
% change	−57.0	−47.8
Cancer:		
1969–71	248 (242, 254)	271 (238, 304)
1993–95	149 (145, 153)	153 (130, 176)
% change	−39.9	−43.5
Lung cancer:		
1969–71	105 (101, 109)	147 (123, 171)
1993–95	45 (43, 47)	42 (30, 54)
% change	−57.1	−71.4
Accidents and violent causes:		
1969–71	201 (195, 207)	227 (196, 258)
1993–95	173 (168, 178)	203 (176, 230)
% change	−13.9	−10.6

[a] Figures in parentheses are 95% confidence intervals.

Fig. 3. **Percentage decline in the age-adjusted mortality rate of coronary heart disease in North Karelia from 1969–71 to 1993–95, by sex and 10-year age groups.**

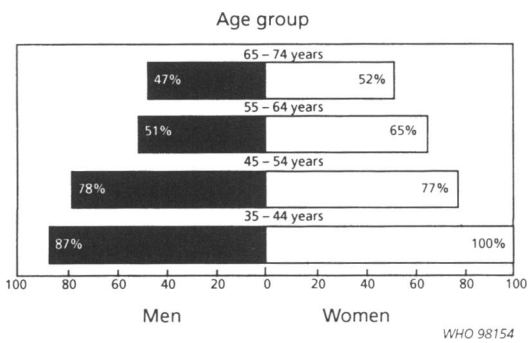


Table 2: **Age-adjusted mean annual mortality rates (per 100 000 population) in 1969–71 and in 1993–95 in Finland as a whole and in North Karelia and respective changes among the 35–64-year-old female population**

Mortality	Mortality rate (per 100 000 population)	
	Finland	North Karelia
All causes:		
1969–71	475 (467, 483)[a]	501 (459, 543)[a]
1993–95	280 (274, 286)	311 (277, 345)
% change	−41.1	−37.9
Cardiovascular diseases:		
1969–71	205 (200, 210)	262 (232, 292)
1993–95	65 (62, 68)	93 (75, 111)
% change	−68.3	−64.5
Coronary heart disease:		
1969–71	82 (79, 85)	118 (98, 138)
1993–95	28 (26, 30)	37 (26, 48)
% change	−65.9	−68.6
Cerebrovascular disease:		
1969–71	69 (66, 72)	65 (50, 80)
1993–95	23 (21, 25)	32 (21, 43)
% change	−66.7	−50.8
Cancer:		
1969–71	141 (137, 145)	121 (100, 142)
1993–95	119 (115, 123)	118 (97, 139)
% change	−15.6	−2.5
Accidents and violent causes:		
1969–71	41 (38, 44)	31 (20, 42)
1993–95	44 (42, 46)	44 (31, 57)
% change	+7.3	+41.9

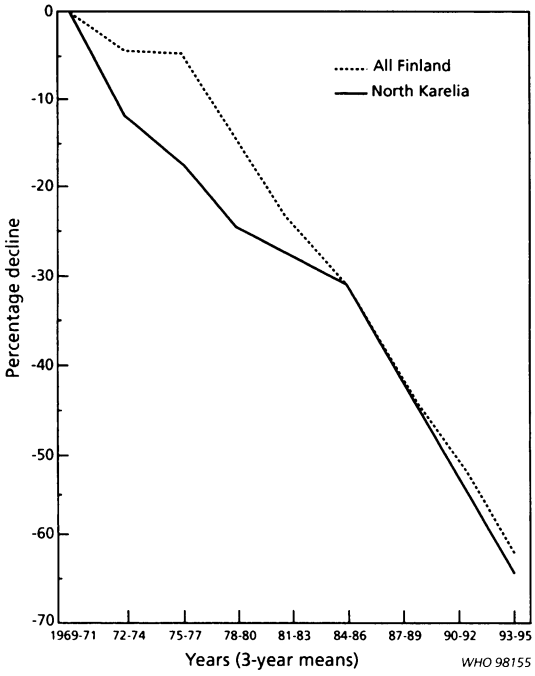
[a] Figures in parentheses are 95% confidence intervals.

Discussion

The findings show a marked decline in the mortality rate of the middle-aged population. The decline in CHD mortality started in North Karelia soon after the intervention began. In the 1970s there was a significantly sharper decrease in North Karelia than nationwide, which corresponds with the clearly greater reduction in the risk factors there during that period. While thereafter the trend levelled off in North Karelia, there was soon a sharper decline nationwide. Recently North Karelia has seen another sharp decline, the male CHD mortality rate in 1995 being 73% lower than the pre-programme (1969–71) rate. The decrease in cerebrovascular disease mortality has been nearly of the same magnitude as that for CHD mortality. The trend in CVD mortality among women too was similar.

Cancer mortality among men also decreased considerably; the change was less favourable among

Fig. 4. **Percentage decline in age-adjusted coronary mortality of 35–64-year-old males in North Karelia and the whole of Finland from 1969–71 to 1993–95 by 3-year periods.**



women, partly due to their increased smoking compared with a major decrease among men. During the 1980s the decline in male cancer mortality was more pronounced in North Karelia than nationwide, which was related to the longer time-lag needed for cancer prevention than for CVD prevention. The 24-year decline in lung cancer mortality among men was significantly greater in North Karelia than nationwide (71% vs. 57%), and was nearly as large as the decline in cardiovascular diseases.

Mortality data based on routine sources may be assumed to be valid for the middle-aged population. The observed reduction in myocardial infarction and cerebrovascular stroke rates in North Karelia has been validated by specific disease registers operating in the area (*11–13*). For site-specific cancers the number of deaths in North Karelia is small. The reduction in lung cancer mortality, however, was significantly greater in North Karelia than in all Finland, which accords with the smoking figures. The proportion of male smokers has declined nationwide since the early 1960s, but in the 1970s the decrease was considerably greater in North Karelia than in the reference area (*14*). Allowing for a relatively long incubation period, the impressive downward trend of lung cancer mortality in North Karelia, particularly during the 1980s, is in good agreement with the smoking trends.

Changes in violent deaths were generally quite small. Among women the numbers were especially low in North Karelia at the outset. Generally, traffic accident mortality decreased, while alcohol-related accident mortality increased along with the overall rise in alcohol consumption. It is worth mentioning that a prospective study of the 1972 population sample found that serum cholesterol level was not associated with the risk of violent death, while smoking and alcohol consumption were positively associated with it (*15*).

Thus, there has been a remarkable decline in mortality among the middle-aged population in association with the reduction in the population levels of the target risk factors. This has particularly concerned cardiovascular diseases in both sexes, and

Table 3: **Average annual number of deaths from all causes and from cardiovascular diseases (CVD) in North Karelia and in Finland as a whole in 1969–71 and in 1995 among men and women, by age group**

	No. of deaths in men from:				No. of deaths in women from:			
	All causes		CVD		All causes		CVD	
	35–64 years	65–74 years	35–64 years	65–74 years	35–64 years	65–74 years	35–64 years	65–74 years
North Karelia								
1969–71	479	313	273	185	184	264	99	169
1995	277	265	97	119	112	145	33	67
Difference	202	48	176	66	72	119	66	102
Finland								
1969–71	9617	6831	4910	3820	4407	5835	1957	3561
1995	6886	6460	2471	3230	2834	4124	630	1917
Difference	2731	371	2439	590	1573	1711	1327	1644

cancer among men. More than 5000 premature deaths have been prevented in North Karelia and 60000 nationwide. The differences in the numbers of deaths presented in Table 3 give a conservative estimate of the "lives saved" because these figures do not take into account the considerable ageing of the population.

A separate analysis has shown that the observed reductions in the population risk-factor levels can explain most of the decline in CHD mortality (*16*). Of all risk factors, the reductions in serum cholesterol levels had the greatest impact. When we look at the three subperiods, the previously published risk-factor trends (*8*) are in general agreement with the coronary mortality development, i.e. they show a sharp decline in North Karelia in the 1970s, a levelling off in the 1980s, and another sharp decline in 1982–92. In similar analyses, stroke was related to the same risk factors, but hypertension was much more important than cholesterol or smoking. Risk-factor changes, especially the decrease in blood pressures, explained much of the decline in strokes (*17*). It is thus likely that most of the remarkable decline in CVD and cancer rates was due to the reduction achieved in target risk factors, i.e. to primary prevention. Concurrent improvements in therapy have obviously contributed to these favourable developments. Future analyses will shed more light on the nature of the disease change process in the population.

The experience in North Karelia and Finland as a whole is a major demonstration that premature mortality from the modern epidemics of CVD and cancer can be greatly reduced. Finland started from a very high level of CVD mortality, and more progress can still be achieved. As the cardiovascular disease burden in the country has shifted towards the older population, the future challenge is to improve the cardiovascular health in this age group. At the same time, further progress is needed to prevent the risk factors from developing and to ensure heart-healthy lifestyles in childhood.

We have shown that prevention leads to a major reduction in CVD mortality among the working-age population, with a favourable impact on mortality from all causes. Active international collaboration related to WHO programmes, such as Interhealth, CINDI and CARMEN, will ultimately show to what extent this experience can be repeated in different cultural settings.

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Résumé

Evolution des décès prématurés en Finlande: succès de la prévention à long terme des maladies cardio-vasculaires

Les taux de mortalité par maladie cardio-vasculaire (MCV) étaient très élevés au début des années 70 en Finlande, en particulier dans la région orientale. Le projet de Carélie du Nord a été lancé en 1972, avec l'aide de l'OMS, pour réduire ce lourd fardeau. Des interventions complètes en communauté, fondées sur des théories épidémiologiques et comportementales pertinentes, ont été exécutées dans la province de Carélie du Nord depuis 1972. Après 1977, cette expérience a débouché sur une action nationale de prévention associant les services de santé et bien d'autres secteurs de la société, la Carélie du Nord restant une zone pilote. Les résultats publiés précédemment, fondés sur des enquêtes répétées et soigneusement normalisées portant sur des échantillons représentatifs de la population, ont fait apparaître des réductions sensibles des facteurs de risque cibles (tabagisme, cholestérolémie, hypertension) dans la population active des deux sexes, à l'exception du tabagisme chez les femmes. Ces réductions se sont produites d'abord en Carélie du Nord, puis dans toute la Finlande.

Le présent article examine les dernières tendances de la mortalité par MCV en Carélie du Nord et dans l'ensemble de la Finlande, par suite d'une action préventive à long terme réussie. Chez les hommes, on a constaté en Finlande une nette réduction de la mortalité par MCV, cardiopathie coronarienne (CC), cancer et pour toutes les causes. De 1969–71 à 1995, la mortalité par CC standardisée selon l'âge (pour 100000) a diminué en Carélie du Nord de 73% (de 672 à 185) et au niveau national de 65% (de 465 à 165). La réduction de la mortalité par MCV était du même ordre. Toujours chez les hommes, la mortalité par CC dans les années 70 a diminué beaucoup plus en Carélie du Nord que dans toute la Finlande, de même que la mortalité par cancer du poumon dans les années 80 et 90. Chez les femmes, on a constaté une nette réduction de la mortalité par MCV (y compris par CC et ictus) et de la mortalité pour toutes les causes, mais seulement une faible baisse de la mortalité par cancer.

L'expérience menée en Carélie du Nord et dans l'ensemble de la Finlande prouve que l'épidémie moderne de MCV peut être sensiblement réduite et montre comment une action préventive intégrée peut aussi faire baisser nettement la mortalité par cancer et la mortalité

globale. Il est probable que la diminution considérable des taux de MCV et de cancer s'explique en grande partie par la réduction des facteurs de risque cibles, c'est-à-dire par la prévention primaire. La Finlande est partie d'un taux très élevé de mortalité par MCV et davantage de progrès peuvent encore être accomplis.

Nous avons montré que la prévention permet de réduire considérablement la mortalité par MCV dans la population active et qu'elle a un impact favorable sur la mortalité toutes causes confondues. Une collaboration internationale active, dans le cadre de programmes de l'OMS tels que INTERSANTE, CINDI et CARMEN, montrera en fin de compte jusqu'à quel point cette expérience peut être répétée dans des contextes culturels différents.

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