

# Predicting Coronary Heart Disease and Stroke

## The FINRISK Calculator



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### ABSTRACT

The FINRISK risk calculator predicts 10-year risk for coronary heart disease, stroke incidence, and their combination. The model is based on 10-year cohort follow-up from 3 different cohorts in 1982, 1987, and 1992 from a random population sample in 3 areas in Finland. Coronary heart disease, stroke, and their combination are predicted by smoking, systolic blood pressure, total cholesterol, high-density lipoprotein cholesterol, diabetes, and family history. The Internet-based calculator is commonly used in Finland in health services to assess the need for hypertension and hypercholesterolemia treatment and is used also in patients' counseling.

The North Karelia Project, as other preventive projects, was based on the concept of some major causal risk factors. Although the main strategy of the project was the population-based approach, especially the health services were asked to detect and intervene on patients' risk factors. A heavy emphasis was put on the accumulated risk (i.e., the overall risk coming from the combination of different risk factors). In those days, the project developed and used a simple risk score, based on adding ordinal numeral scores based on several risk factors. Later on, when prospective analyses were started from the cohorts of the population surveys, various risk estimates could be analyzed and developed. The original population risk factor surveys of the North Karelia Project were developed in FINMONICA (FINnish Multinational MONItoring of trends and determinants in CArdiovascular disease) surveys in the 1980s and since 1992 in the national FINRISK studies, have been carried out every 5 years to serve national health monitoring. These large samples gave good possibilities for major follow-up and risk estimate analyses. This development and international examples made it possible to consider and develop our own risk score.

Globally, there are several risk functions and tools for cardiovascular risk prediction based on different data sources and with slightly different focus. The Framingham risk score has been used also in Finland to estimate individual risk for cardiovascular diseases [1,2]. The Danish Precard risk calculator is based on several cohort analyses and clinical trials [3]. The European SCORE risk charts were published in 2003 based on 12 European cohorts [4]. The SCORE function predicts cardiovascular mortality.

Risk functions based in data from one population often over or under estimate the real risk in another population. Therefore, we developed the FINRISK calculator based on the National FINRISK Study. The calculator can be used by Internet in Finnish, Swedish, or English language [5]. We have earlier published a risk function for coronary heart disease mortality based on smoking, diastolic blood pressure,

and serum cholesterol level [6]. Coronary heart disease, stroke, and their combination are predicted by smoking, systolic blood pressure, total cholesterol, high-density lipoprotein (HDL) cholesterol, diabetes, and family history.

### METHODS

Random population samples of individuals 30 to 64 years of age were studied in 1982, 1987, and 1992 in North Karelia, Kuopio province, and southwestern Finland. In these 3 surveys 9,391 men and 10,056 women were studied. Smoking was asked by self-reported questionnaire. A smoker was a person who had smoked at least 1 year in his or her life and had smoked in the past month. Blood pressure was measured twice from the right arm in a sitting position after 5 min rest. Total cholesterol and HDL-cholesterol were measured from venous sample in biochemical laboratory in National Public Health Institute. Measurement methods have published in detail previously [7]. Diabetes was assessed by using diagnosis information from the hospital discharge register combined with data from questionnaire asking if a doctor had diagnosed diabetes. Positive family history was asked by questionnaire if father or mother had had myocardial infarction or stroke at young age.

The risk factor survey results were linked to national hospital discharge and mortality registers. The follow-up time was 10 years. End points for coronary heart disease were myocardial infarction, unstable angina pectoris or death from coronary heart disease. Stroke included both infarctions and hemorrhage. Participant with earlier coronary heart disease or stroke were excluded from the analyses. Altogether 376 men and 152 women had coronary heart disease diagnosis, and 190 men and 119 women had stroke diagnosis.

Logistic regression analyses were performed separately for men and women and for both endpoints. One person was included only once depending on which disease came first. Total cardiovascular risk was estimated by calculating coronary heart and stroke risks together.

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**TABLE 1.** Risk factors predicting coronary heart disease or stroke during 10-year follow-up in the FINRISK survey from years 1982, 1987, and 1992

Risk Factor	Coronary Artery Disease Incidence		Stroke	
	Men	Women	Men	Women
Age, yrs	1.083 (1.069–1.098)	1.101 (1.073–1.130)	1.122 (1.099–1.147)	1.067 (1.040–1.093)
Smoking (no = 0, yes = 1)	1.87 (1.50–2.32)	2.41 (1.58–3.66)	1.65 (1.22–2.23)	1.52 (0.93–2.48)
Cholesterol, mmol/l	1.39 (1.28–1.51)	1.24 (1.10–1.40)	0.97 (0.85–1.09)	0.98 (0.85–1.14)
Systolic blood pressure, mm Hg	1.017 (1.011–1.022)	1.018 (1.010–1.025)	1.015 (1.008–1.022)	1.009 (1.001–1.018)
HDL-cholesterol, mmol/l	0.55 (0.39–0.78)	0.33 (0.20–0.54)	0.65 (0.41–1.03)	0.47 (0.27–0.82)
Diabetes (no = 0, yes = 1)	2.10 (1.50–2.95)	2.80 (1.82–4.32)	2.42 (1.62–3.61)	3.45 (2.18–5.46)
Parents had infarct or stroke (no = 0, yes = 1)	1.40 (1.07–1.74)	1.51 (1.05–2.16)	1.34 (0.77–2.24)	1.72 (1.00–2.98)

Values are odds ratio (95% confidence interval).  
HDL, high-density lipoprotein.

## RESULTS

Smoking, total cholesterol, HDL-cholesterol, systolic blood pressure, diabetes, and positive family history all predicted coronary heart disease (Table 1). Odds ratios were quite similar for men and women. Protective effect of HDL-cholesterol seems to be stronger in women than in men but the difference was within the 95% confidence interval. Logistic regression models are shown in Table 2.

Using the model 10 year risks were calculated to 50-year-old men and women using the National FINRISK Study data in 2002 (Figs. 1A and 1B). If the person had no risk factors (blood pressure  $\leq 120$  mm Hg, total cholesterol  $\leq 4.5$  mmol/l, no smoking, no diabetes) the risk to get coronary heart disease before 60 years of age was little under 1%. If a person had 1 risk factor (smoking or cholesterol  $\geq 7$  mmol/l or blood pressure  $\geq 160$  mm Hg or

diabetes), the risk was increased to about 2%; a combination of 3 risk factors increased the risk to 4% to 5%; a combination of 4 risk factors increased the risk to 8% to 10%; and person with all risk factors had 16% risk. In women, the relative risk was very similar to that of men, but the absolute level was lower 0.2% without risk factors and 7% with all risk factors.

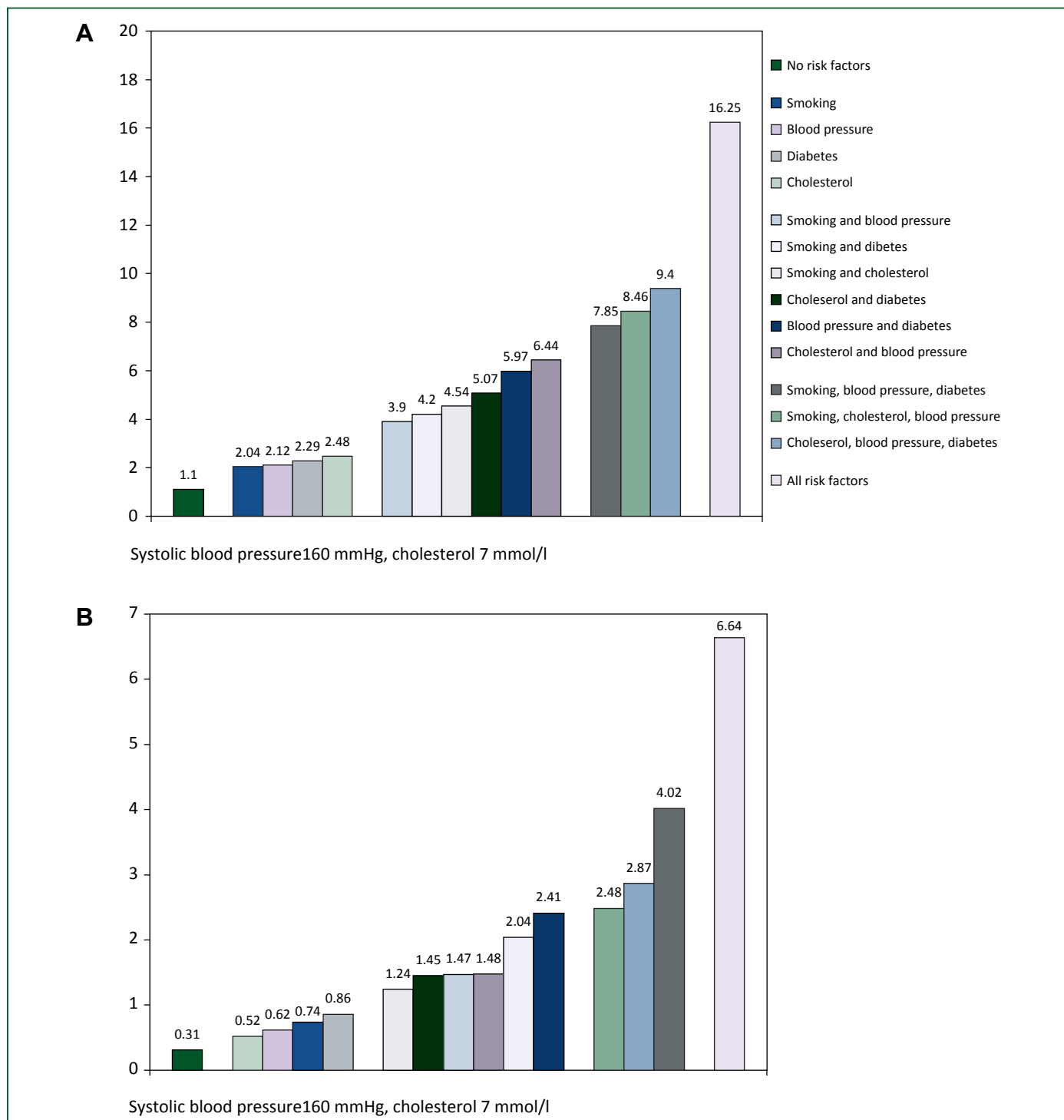
## DISCUSSION

This article presents the FINRISK 10-year risk score of acute coronary event (myocardial infarction, unstable angina pectoris, or coronary heart disease death), stroke, and their combination. The developed calculator can be used freely through the Internet in Finnish, Swedish, or English. It can and has been also adapted to health services

**TABLE 2.** Risk of the acute coronary heart disease incident, stroke risk, and cardiovascular disease (death or hospital treatment) in the next 10 years (%).

<b>Males</b>	
Risk of coronary heart disease	$(1/(1 + \exp(11.213 - 0.0802 \times \text{age} - 0.6260 \times \text{smoking} - 0.3293 \times \text{cholesterol} - 0.0166 \times \text{systolic blood pressure} + 0.5893 \times \text{HDL-cholesterol} - 0.7417 \times \text{diabetes} - 0.3138 \times \text{parents infarct}))) \times 100$
Risk of stroke	$(1/(1 + \exp(11.6994 - 0.1153 \times \text{age} - 0.4981 \times \text{smoking} - 0.0149 \times \text{systolic blood pressure} + 0.4406 \times \text{HDL-cholesterol} - 0.879 \times \text{diabetes} - 0.2933 \times \text{parents stroke}))) \times 100$
Risk of cardiovascular disease	Risk of the coronary heart disease + risk of the stroke
<b>Females</b>	
Risk of coronary heart disease	$(1/(1 + \exp(11.839 - 0.0962 \times \text{age} - 0.8776 \times \text{smoking} - 0.2119 \times \text{cholesterol} - 0.0175 \times \text{systolic blood pressure} + 1.1009 \times \text{HDL-cholesterol} - 1.0303 \times \text{diabetes} - 0.4090 \times \text{parents infarct}))) \times 100$
Risk of stroke	$(1/(1 + \exp(7.966 - 0.0633 \times \text{age} - 0.4163 \times \text{smoking} - 0.00893 \times \text{systolic blood pressure} + 0.7636 \times \text{HDL-cholesterol} - 1.2383 \times \text{diabetes} - 0.547 \times \text{parents stroke}))) \times 100$
Risk of cardiovascular disease	Risk of the coronary heart disease + risk of the stroke

Risk algorithms are from logistic regression analysis.  
HDL, high-density lipoprotein.



**FIGURE 1. Ten year risk (%) of coronary heart disease in (A) 50-year-old men and (B) 50-year-old women.**

information technology systems. The risk can then be automatically calculated once the measurements have been done. The current treatment guidelines in Finland recommend risk calculation to all men latest at 40 years of

age and to women at 50 years of age. Blood pressure and high cholesterol treatment should be based on absolute risk estimation. Personal risk estimates can be used on health counseling and in assessing the need for treatment.

Earlier used SCORE and Framingham risk functions give different absolute risks. SCORE is based on mortality statistics and gives lower estimates while the FINRISK function is based on incidence. Framingham function gives higher values mainly because it takes into account also angina pectoris. Ten percent 10-year risk in the FINRISK function is equivalent to about 5% risk in SCORE and 20% risk in Framingham function. Risk factors coefficients are quite similar in different functions but the absolute risk varies between populations. Adapting risk function from one population to another requires adjustment to the mortality or incidence level of that population. This is not needed if the risk function is based on cohorts from the same population.

Risk functions are most useful for the middle-aged population. Among younger people absolute risk is very low. For them relative risk is more useful. The FINRISK calculator gives also the risk of person of the same age and sex with average risk in that group and the ideal risk without any risk factors, which can be used in considering the risk of a young patient. Another option to estimate the risk of young people is to estimate the risk with patient's risk factors at 60 years of age. Among old people the role of risk factors may be different depending on other diseases and functional capacity.

## SUMMARY

The FINRISK calculator, based on 3 cohorts from different areas in Finland, has been a very useful tool to estimate patients' risk for coronary heart disease and stroke and is widely used in the health services in Finland.

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