

The joint associations of occupational, commuting, and leisure-time physical activity, and the Framingham risk score on the 10-year risk of coronary heart disease

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Aims To determine joint associations of different kinds of physical activity and the Framingham risk score (FRS) with the 10-year risk of coronary heart disease (CHD) events.

Methods and results Study cohorts included 41 053 Finnish participants aged 25–64 years without history of CHD and stroke. The multivariable-adjusted 10-year hazard ratios (HRs) of coronary events associated with low, moderate, and high occupational physical activity were 1.00, 0.66, and 0.74 ($P_{\text{trend}} < 0.001$) for men, and 1.00, 0.53, and 0.58 ($P_{\text{trend}} < 0.001$) for women, respectively. The multivariable-adjusted 10-year HRs of coronary events associated with low, moderate, and high leisure-time physical activity were 1.00, 0.97, and 0.66 ($P_{\text{trend}} = 0.002$) for men, and 1.00, 0.74, and 0.54 ($P_{\text{trend}} = 0.003$) for women, respectively. Active commuting had a significant inverse association with 10-year risk of coronary events in women only. The FRS predicted 10-year risk of coronary events among both men and women. The protective effects of occupational, commuting, or leisure-time physical activity were consistent in subjects with a very low (<6%), low (6–9%), intermediate (10–19%), or high ($\geq 20\%$) risk of the FRS.

Conclusion Moderate or high levels of occupational or leisure-time physical activity among both men and women, and daily walking or cycling to and from work among women are associated with a reduced 10-year risk of CHD events. These favourable effects of physical activity on CHD risk are observed at all levels of CHD risk based on FRS assessment.

Introduction

Coronary heart disease (CHD) is the leading cause of deaths in the developed countries and in many developing nations.¹ The Framingham risk score (FRS), a combination of several risk factors, has been developed to estimate the risk of CHD events in adults without known or clinically manifested atherosclerotic CHD.² This has been thus far the most commonly used risk estimator worldwide. In 2001, the Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults has accepted that the FRS is used as an office-based approach to estimate and stratify an individual's absolute short-term risk of an initial CHD event in order to guide the initiation and intensity of additional cardiovascular testing and/or primary prevention therapy.³ The NCEP has adopted a modification of the risk prediction algorithm from the FRS to estimate 10-year risk for developing CHD.⁴

There is good evidence that regular physical activity reduces the risk of CHD.^{5–10} Most previous studies have

focused on leisure-time physical activity alone.^{5–10} The association of occupational physical activity with the risk of CHD was assessed mostly in 1970s, but the recent evidence is limited since 1990s.^{11–13} Only one study has assessed the association of daily walking or bicycling to and from work with the risk of CHD.¹⁴ Moreover, the potential joint associations of different kinds of physical activity and the FRS with the risk of CHD have not been investigated in the general population. The aim of the present study is to examine¹ the risk of CHD incidence associated with different levels of each form of physical activity (occupational, commuting, or leisure-time physical activity) and the FRS, and² the protective relationship between different levels of each form of physical activity and the risk of CHD incidence within different levels of the FRS.

Methods

Participants

Five independent cross-sectional population surveys were carried out in four geographic areas of Finland in 1972, 1977, 1982, 1987, and 1992.¹⁵ In 1972 and 1977, a randomly selected sample making up 6.6% of the population born between 1913 and 1947 was

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drawn. Since 1982, the sample has been stratified by area, gender, and 10-year age group according to the World Health Organization (WHO) MONItoring trends and determinants of Cardiovascular disease (MONICA) protocol.¹⁶ The total sample size of the five surveys was 44 906 participants, 25 to 64 years of age. The participation rate varied by year from 74–88%.¹⁵ After excluding 1552 subjects with a history of CHD or stroke at baseline, and 2301 with incomplete data on any required variables, the present analyses included 19 707 men and 21 346 women. The participants gave a verbal informed consent. The surveys were conducted according to the ethical rules of the National Public Health Institute, and the investigations were carried out in accordance with the Declaration of Helsinki.

Assessment of physical activity

Occupational, commuting, and leisure-time physical activity was assessed using a self-administered questionnaire. A detailed description of the questions has been presented elsewhere.^{17–19} The subjects reported their occupational physical activity according to the following three categories: (i) 'low' was physically very easy, sitting office work, e.g. secretary; (ii) 'moderate' was work including standing and walking, e.g. store assistant, light industrial worker; (iii) 'high' was work including walking and lifting, or heavy manual labour, e.g. industrial or farm work. Daily commuting return journey was categorized into three categories: (i) motorized transportation or no work (no walking or cycling); (ii) walking or bicycling 1–29 min/day; (iii) walking or bicycling more than 30 min/day. Self-reported leisure-time physical activity was classified into three categories: (i) 'low' was defined as almost completely inactive, such as reading, watching TV, or doing some minor physical activity but not of moderate or high level; (ii) 'moderate' was doing some physical activity more than four hours a week, such as walking, cycling, or light gardening, excluding travel to work; (iii) 'high' was performing vigorous physical activity more than three hours a week, such as running, jogging, swimming, or heavy gardening, or competitive sports several times a week.

Other assessments

Smoking, socioeconomic factors, alcohol consumption, and medical history were also assessed by using the self-administered questionnaire. Education level, measured as the total number of school years, was divided into birth cohort specific tertiles. Based on the questionnaire data, the participants were classified as non-smokers and current-smokers. Since questions on alcohol consumption were different between the first two surveys (1972 and 1977) and the latter surveys, the participants were categorized into abstainers and alcohol users. Family history of CHD was defined as a history of whose mothers or fathers were once diagnosed as myocardial infarction. Participants were asked whether they were currently using antihypertensive medication. At the study site, specially trained nurses measured height, weight, and blood pressure using the standardized protocol according to the WHO MONICA project.¹⁶ Blood pressure was measured with a standard sphygmomanometer from the right arm of the participant who was seated for 5 min before the measurement. Height was measured without shoes and weight was measured with light clothing. Body mass index (BMI) was calculated as weight in kilograms divided by the square of the height in metres. After blood pressure measurement, a venous blood specimen was drawn. Total cholesterol was determined by using Lieberman Burchard method in 1972 and 1977, and total and high-density lipoprotein (HDL) cholesterol was measured by an enzymatic method (CHOD-PAP, Boehringer MANNHEIM, Mannheim, Germany) since 1982. Because the enzymatic method gave 2.4% lower values than the Lieberman Burchard method, 1972 and 1977 values were corrected by this percentage.

The risk factors included in the FRS were age, total cholesterol, systolic blood pressure, treatment for hypertension, and cigarette

smoking. Since HDL cholesterol was measured only in the surveys of 1982, 1987, and 1992, HDL cholesterol was included in the FRS in a separate subgroup analysis. The NCEP risk algorithm score was used for men and women separately.³ The first step was to calculate the number of points for each risk factor, and the total risk scores were summed by the points for each risk factor. In present analyses, four levels of 10-year CHD risk were defined as: <6% (very low), 6–9% (low), 10–19% (intermediate), and $\geq 20\%$ (high).³ Sex-specific cut points of the FRS were 10, 12, and 15 in men and 18, 20, and 23 in women, respectively.³ According to the NCEP criteria, subjects with history of diabetes are considered CHD equivalents⁴ and included in the group with high risk of 10-year CHD risk.

Prospective follow-up

Follow-up information was based on the Finnish National Hospital Discharge Register for non-fatal outcomes (hospitalized myocardial infarctions) and the Finnish Death Register for fatal outcomes (deaths due to CHD) by using the personal identification numbers assigned to every citizen of Finland. The overall sensitivity of the diagnosis of myocardial infarction in the combined Finnish Hospital Discharge Register and the Causes of Death Register was 83%.²⁰ An incident CHD event was defined as a combination of first non-fatal myocardial infarction or coronary death without previous non-fatal event. All subjects were followed until an incident CHD event, death due to other causes, or 10 years from the baseline survey through computerized register linkage. The Eighth, Ninth, and Tenth Revisions of the International Classification of Diseases (ICD) were used to identify non-fatal myocardial infarction (410–411 and I21–I22, I24) and fatal cases of CHD (410–414 and I20–I25).

Statistical analyses

The Cox proportional hazards model was used to estimate the hazard ratios (HRs) and 95% confidence intervals (CIs) of the 10-year risk of CHD events according to¹ different levels of physical activity during work, commuting, or leisure time,² different levels of the FRS, and³ different levels of physical activity during work, commuting or leisure time and the FRS combinations. The proportional hazards assumption in the Cox model was assessed with graphical methods, and with models including time-by-covariate interactions.²¹ In general, all proportionality assumptions were appropriate. In the joint analyses, we dichotomized all three kinds of physical activity at low vs. moderate to high levels for occupational and leisure-time physical activity, and for commuting physical activity (any vs. none). Since only high level of leisure-time physical activity was associated with a low 10-year risk of incident CHD events in men, low to moderate level of leisure-time physical activity was defined as inactivity. Because the number of women in the two highest FRS groups was low, women with intermediate (10–19%) and high ($\geq 20\%$) risks were combined in the analyses. The multivariable analyses included study year, BMI, education, alcohol consumption, family history of CHD, occupational, commuting, and leisure-time physical activity, as well as the FRS. Statistical significance was considered to be $P < 0.05$. All statistical analyses were performed with SPSS for Windows 14.0 (SPSS Inc., Chicago, Ill, USA).

Results

During the 10-year follow-up period, 1141 men and 392 women had an incident CHD event. General characteristics of the study population at baseline are presented in *Table 1*. The majority of women (86%) and 46% of men had a 10-year FRS for very low CHD risk <6%; 16% of men and 2.3% of women had a 10-year FRS for high CHD risk $\geq 20\%$. Age-adjusted correlations were 0.23 in men ($P < 0.001$)

Table 1 Baseline characteristics of study subjects by sex

	Men (n = 19 707)	Women (n = 21 346)
Age (years)	43.0 (10.7) ^a	43.9 (11.0)
BMI (kg/m ²)	26.1 (3.6)	26.0 (4.7)
Diastolic blood pressure (mmHg)	88 (12)	85 (13)
Systolic blood pressure (mmHg)	143 (19)	140 (23)
Serum cholesterol (mmol/L)	6.27 (1.25)	6.15 (1.34)
HDL cholesterol (mmol/L)	1.26 (0.32)	1.52 (0.34)
Education (years)	8.9 (3.7)	9.2 (3.7)
FRS	8.9 (5.8)	10.5 (6.5)
Occupational physical activity (%)		
Low	31.9	39.5
Moderate	22.8	32.6
High	45.3	27.9
Walking or cycling to and from work (%)		
0	48.6	42.7
1–29 min/day	33.0	33.4
≥30 min/day	18.4	23.9
Leisure-time physical activity (%)		
Low	29.9	40.3
Moderate	51.2	47.6
High	18.9	12.1
Alcohol drinking (%)	66.0	32.8
Current smoking (%)	44.7	16.8
Family history of CHD (%)	24.3	26.4
Hypertension treatment (%)	7.1	10.1
FRS (%) ^b		
Very low risk	46.0	86.2
Low risk	12.2	8.2
Intermediate risk	25.5	3.3
High risk	16.3	2.3

^aMean (standard deviation).

^bDefined as very low risk of 10-year CHD risk <6%; low risk of 10-year CHD risk 6–9%; intermediate risk of 10-year CHD risk 10–19%; high risk of 10-year CHD risk 20% or more.

and 0.18 in women ($P < 0.001$) for occupational and commuting physical activity, -0.08 in men ($P < 0.001$) and -0.04 in women ($P < 0.001$) for occupational and leisure-time physical activity, and 0.04 in men ($P < 0.001$) and 0.07 in women ($P < 0.001$) for commuting and leisure-time physical activity.

In multivariable analyses, after adjustment for study year, BMI, education, alcohol consumption, family history of CHD, the other two kinds of physical activity, and the FRS, the 10-year HRs of incident CHD events associated with low, moderate, and high occupational physical activity were 1.00, 0.66, and 0.74 ($P_{\text{trend}} < 0.001$) for men, and 1.00, 0.53, and 0.58 ($P_{\text{trend}} < 0.001$) for women, respectively (Table 2). The multivariable-adjusted 10-year HRs of incident CHD events associated with low, moderate, and high leisure-time physical activity were 1.00, 0.97, and 0.66 ($P_{\text{trend}} = 0.002$) for men, and 1.00, 0.74, and 0.54 ($P_{\text{trend}} = 0.003$) for women, respectively. Active commuting had a significant inverse association with age- and study year-adjusted 10-year risk of incident CHD events in both men ($P_{\text{trend}} = 0.027$) and women ($P_{\text{trend}} < 0.001$). The inverse relationship remained significant among women ($P_{\text{trend}} < 0.001$) but not among men ($P_{\text{trend}} = 0.49$) after further adjustment for other risk factors and occupational and leisure-time physical activity.

The FRS was a highly significant predictor of an incident CHD event in both men and women. In multivariable analyses, after adjustment for study year, BMI, education, alcohol consumption, family history of CHD, occupational, commuting, and leisure-time physical activity, the 10-year HRs of incident CHD events associated with the FRS at different CHD risk levels (<6, 6–9, 10–19, and $\geq 20\%$) were 1.00, 4.80, 10.6, and 17.2 ($P_{\text{trend}} < 0.001$ for trend) for men, and 1.00, 3.62, 6.29, and 6.46 ($P_{\text{trend}} < 0.001$ for trend) for women, respectively (Table 2). When the further pooled analyses were done according to the first two surveys (1972 and 1977) and the latter surveys (1982, 1987 and 1992), the protective effects of different kinds of physical activity and the predictive value of the FRS did not change in these two different periods (data not shown).

When HDL cholesterol was included in the FRS in our surveys carried out in 1982, 1987, and 1992, the multivariable-adjusted 10-year HRs of incident CHD events associated with the FRS at different CHD risk levels (<6, 6–9, 10–19, and $\geq 20\%$) were 1.00, 5.05, 11.0, and 23.5 ($P_{\text{trend}} < 0.001$ for trend) for men, and 1.00, 4.73, 7.31, and 9.64 ($P_{\text{trend}} < 0.001$ for trend) for women, respectively (Table 3).

The joint associations of different kinds of physical activity and the FRS with the risk of incident CHD events are presented in Tables 4 and 5. Occupational or leisure-time physical activity in men appears to attenuate but does not eliminate the adverse association between the FRS and the risk of incident CHD (Table 4). In women, the protective effects of occupational, commuting, or leisure-time physical activity were consistent in subjects with a very low (<6%), low (6–9%), and intermediate to high ($\geq 10\%$) risk of the FRS (Table 5). No significant interactions between the FRS and any one of occupational ($\chi^2 = 2.32$, 3 df, $P > 0.1$ in men and $\chi^2 = 0.64$, 2 df, $P > 0.1$ in women), commuting ($\chi^2 = 3.18$, 3 df, $P > 0.1$ in men and $\chi^2 = 0.82$, 2 df, $P > 0.1$ in women), and leisure-time ($\chi^2 = 1.15$, 3 df, $P > 0.1$ in men and $\chi^2 = 1.77$, 2 df, $P > 0.1$ in women) physical activity with the risk of incident CHD events were identified in either men or women. When the analyses were restricted in the surveys of 1982, 1987, and 1992 where the measurement of HDL cholesterol was available, these protective effects of physical activity shown above did not change (data not shown).

Discussion

Moderate or high levels of occupational or leisure-time physical activity, and daily walking or cycling to and from work were significantly and independently associated with a reduced 10-year risk of incident CHD events among women. Moderate or high levels of occupational physical activity, and high level of leisure-time physical activity were also significantly and independently associated with a reduced 10-year risk of incident CHD events among men. These favourable effects of physical activity on the 10-year risk of incident CHD events were observed regardless of the CHD risk level, measured by the FRS at baseline.

Most previous studies have focused on the health effects of leisure-time physical activity alone.^{5–10} Whereas there is strong evidence that leisure-time physical activity is associated with a reduced risk of CHD among men,^{6,8,10} evidence for women is less clear,^{5,7,9,12} as part of these

Table 2 Adjusted HRs of incident CHD according to different levels of FRS, occupational, commuting, and leisure-time physical activity

	Numbers of cases	Person-years	HRs (95% CIs)		
			Model 1	Model 2	Model 3
<i>Men</i>					
Occupational physical activity					
Low	496	58 489	1.00	1.00	1.00
Moderate	169	43 490	0.68 (0.57–0.81)	0.64 (0.54–0.76)	0.66 (0.55–0.79)
High	476	85 641	0.86 (0.75–0.98)	0.73 (0.64–0.83)	0.74 (0.65–0.85)
<i>P</i> for trend			<0.001	<0.001	<0.001
Walking or cycling to and from work (min/day)					
0	628	90 347	1.00	1.00	1.00
1–29	291	62 803	0.85 (0.74–0.98)	0.83 (0.72–0.95)	0.92 (0.79–1.06)
≥30	222	34 470	0.84 (0.72–0.98)	0.87 (0.75–1.02)	0.98 (0.83–1.15)
<i>P</i> for trend			0.027	0.019	0.49
Leisure-time physical activity					
Low	421	55 211	1.00	1.00	1.00
Moderate	634	96 009	0.91 (0.81–1.03)	0.96 (0.85–1.09)	0.97 (0.86–1.10)
High	86	36 400	0.51 (0.40–0.64)	0.64 (0.51–0.82)	0.66 (0.52–0.83)
<i>P</i> for trend			<0.001	0.001	0.002
FRS					
Very low risk	76	89 608	1.00	1.00	1.00
Low risk	103	23 163	5.28 (3.92–7.10)	4.88 (3.62–6.57)	4.80 (3.57–6.47)
Intermediate risk	466	46 531	12.0 (9.40–15.3)	11.0 (8.63–14.1)	10.6 (8.29–13.5)
High risk	496	28 318	20.5 (16.1–26.1)	18.3 (14.3–23.3)	17.2 (13.4–22.1)
<i>P</i> for trend			<0.001	<0.001	<0.001
<i>Women</i>					
Occupational physical activity					
Low	245	81 787	1.00	1.00	1.00
Moderate	69	68 928	0.55 (0.42–0.73)	0.45 (0.35–0.59)	0.53 (0.40–0.70)
High	78	58 672	0.60 (0.46–0.78)	0.50 (0.38–0.65)	0.58 (0.44–0.76)
<i>P</i> for trend			<0.001	<0.001	<0.001
Walking or cycling to and from work (min/day)					
0	264	88 562	1.00	1.00	1.00 (0.13–0.90)
1–29	81	70 403	0.73 (0.57–0.95)	0.56 (0.43–0.72)	0.69 (0.53–0.90)
≥30	47	50 422	0.48 (0.35–0.66)	0.44 (0.32–0.60)	0.54 (0.39–0.75)
<i>P</i> for trend			<0.001	<0.001	<0.001
Leisure-time physical activity					
Low	223	83 796	1.00	1.00	1.00
Moderate	149	99 931	0.67 (0.55–0.83)	0.71 (0.58–0.88)	0.74 (0.60–0.92)
High	20	25 660	0.52 (0.33–0.82)	0.51 (0.32–0.81)	0.54 (0.34–0.87)
<i>P</i> for trend			<0.001	0.001	0.003
FRS					
Very low risk	190	181 494	1.00	1.00	1.00
Low risk	92	16 865	5.07 (3.95–6.51)	4.04 (3.13–5.23)	3.62 (2.79–4.68)
Intermediate risk	63	6657	8.79 (6.60–11.7)	7.31 (5.46–9.79)	6.29 (4.68–8.45)
High risk	47	4371	10.1 (7.36–13.9)	7.71 (5.55–10.7)	6.46 (4.63–9.02)
<i>P</i> for trend			<0.001	<0.001	<0.001

Model 1, adjusted for study year and age in the analyses for any one of three types of physical activity and adjusted for study year in the analysis of FRS; model 2, adjusted for study year, education, BMI, alcohol consumption, family history of CHD, and FRS (in the analyses for any one of three types of physical activity) or leisure-time physical activity (in the analysis of FRS); model 3, adjusted for study year, education, BMI, alcohol consumption, family history of CHD, occupational, commuting, and leisure-time physical activity, as well as FRS.

studies,^{7,9} but not all,^{5,12} have indicated a significant inverse association between leisure-time physical activity and the risk of CHD. Some studies have also found similar inverse associations of walking and vigorous physical activity with the risk of CHD.^{6,7,9,10} Only a few studies have assessed the association between occupational physical activity and the risk of CHD since the 1990s, and no significant association has been found.^{11–13} One study assessed the association of daily walking or bicycling to and from work with

the risk of CHD among men only, and no significant association has been found.¹⁴ The results of the present study emphasize that not only leisure-time physical activity but also occupational physical activity and activity from daily walking or cycling to work are important in the prevention of CHD. Occupational physical activity has been largely ignored in epidemiological surveys. Daily active commuting as another major source of total physical activity in some populations, such as China and Finland,²² was indirectly

Table 3 Adjusted HRs of incident CHD according to different levels of FRS^a

FRS	Numbers of participants (%)	Numbers of cases	Person-years	HRs (95% CIs) ^b	
				Model 1	Model 2
Men (n = 9510)					
Very low risk	4083 (42.9)	22	40 474	1.00	1.00
Low risk	1217 (12.8)	35	11 863	5.44 (3.19–9.27)	5.05 (2.95–8.62)
Intermediate risk	2313 (24.3)	150	21 743	12.8 (8.19–20.0)	11.0 (6.99–17.3)
High risk	1897 (19.9)	265	16 952	28.8 (18.7–44.5)	23.5 (15.0–36.6)
<i>P</i> for trend				<0.001	<0.001
Women (n = 10 505)					
Very low risk	9112 (86.7)	72	90 010	1.00	1.00
Low risk	781 (7.4)	43	7452	7.03 (4.81–10.3)	4.73 (3.18–7.06)
Intermediate risk	370 (3.6)	30	3483	10.5 (6.88–16.2)	7.31 (4.68–11.4)
High risk	242 (2.3)	26	2106	15.4 (9.86–24.2)	9.64 (5.99–15.5)
<i>P</i> for trend				<0.001	<0.001

^aThis analysis only includes surveys conducted from 1982, 1987, and 1992. FRS included HDL cholesterol also.

^bModel 1, adjusted for study year; model 2, adjusted for study year, education, BMI, alcohol consumption, family history of CHD, occupational, commuting, and leisure-time physical activity.

Table 4 Adjusted HRs of incident CHD according to joint effects of FRS, and occupational commuting, and leisure-time physical activity among men

HRs (95% CIs)	FRS			
	Very low risk	Low risk	Intermediate risk	High risk
Occupational physical activity				
Moderate or high	1.00	4.80 (3.36–6.88)	9.68 (7.20–13.0)	17.1 (12.8–23.0)
Low	1.22 (0.74–2.01)	6.03 (3.93–9.25)	15.3 (11.3–20.7)	22.3 (16.4–30.2)
Walking or cycling to and from work (min/day)				
≥ 1	1.00	5.15 (3.36–7.89)	11.2 (7.87–15.9)	20.1 (14.2–28.5)
0	1.28 (0.82–2.00)	5.73 (3.75–8.73)	12.8 (9.00–18.1)	19.1 (13.5–27.2)
Leisure-time physical activity				
High	1.00	6.35 (2.94–13.7)	12.9 (6.91–24.1)	16.5 (8.12–33.4)
Low or moderate	1.72 (0.95–3.13)	7.87 (4.39–14.1)	17.6 (10.1–30.7)	29.1 (16.7–50.6)

Multivariate models included study year, education, BMI, alcohol consumption, family history of CHD, occupational, commuting, and leisure-time physical activity.

measured by asking for the frequency and duration of walking or cycling in many Western studies. Several studies have shown that regular walking or cycling to work is related to lower levels of cardiovascular risk factors,^{17,22,23} and a reduced risk of type 2 diabetes,¹⁷ stroke,¹⁹ and mortality among general and diabetic populations.^{18,24}

The FRS has been found to predict well absolute CHD risk among whites and blacks in different settings.²⁵ In the present study, we indicated that Finnish subjects with low (6–9%), intermediate (10–19%), and high (≥20%) levels of the FRS showed a 4.8- to 17.2-fold increased risk of CHD events in men and a 3.6- to 6.5-fold increased risk in women compared with men and women with a very low (<6%) level of the FRS. A similar trend has also been found in the Lipid Research Clinics Prevalence Study.²⁶ Subjects with low, intermediate, and high levels of the FRS usually must have one or more risk factors that exceed desirable levels. It has been suggested that subjects with a low or intermediate level of the FRS should be counselled about their increased CHD risk and offered general dietary and lifestyle advice that might help them

to modify their risk and achieve very low risk status in the future, and subjects with a high level of the FRS (including also subjects with a history of diabetes or CHD) should have all CHD risk factors treated to reduce their risk of CHD and overall cardiovascular disease.²⁷

In the present study, we found that moderate or high levels of occupational physical activity and high level of leisure-time physical activity in men, and moderate or high levels of occupational or leisure-time physical activity, and daily walking or cycling to and from work in women could be the good way to attenuate the risk of 10-year CHD events in subjects with low, intermediate, and high levels of the FRS. One of the important findings from this study was that the protective effect of different kinds of physical activity was important also in women with very low level of the FRS. While no previous study has assessed if the protective effect of physical activity on CHD risk can be found in subjects at different CHD risk levels, several prospective studies have evaluated whether exercise testing is an independent predictor for mortality in asymptomatic individuals at different risk levels of the FRS. The Lipid

Table 5 Adjusted HRs of incident CHD according to joint effects of FRS, and occupational commuting, and leisure-time physical activity among women

HRs (95% CIs)	FRS		
	Very low risk	Low risk	Intermediate or high risk
Occupational physical activity			
Moderate or high	1.00	3.87 (2.54–5.89)	7.65 (5.11–11.5)
Low	1.99 (1.48–2.67)	6.82 (4.81–9.67)	11.4 (8.14–16.0)
Walking or cycling to and from work (min/day)			
≥ 1	1.00	5.03 (3.26–7.74)	8.29 (5.33–12.9)
0	1.96 (1.44–2.65)	5.94 (4.13–8.54)	10.9 (7.71–15.5)
Leisure-time physical activity			
Moderate or high	1.00	4.59 (3.14–6.70)	7.40 (5.09–10.7)
Low	1.66 (1.24–2.22)	5.05 (3.51–7.26)	9.52 (6.74–13.4)

Multivariate models included study year, education, BMI, alcohol consumption, family history of CHD, occupational, commuting, and leisure-time physical activity.

Research Clinics Prevalence Study found that exercise testing (both metabolic equivalents and heart rate recovery) was a useful adjunct for clinical risk assessment in asymptomatic women with the FRS 6–19% and men with the FRS 10–19%.²⁶ A recent analysis from the Framingham Heart Study offspring cohort demonstrated that exercise capacity during exercise treadmill testing was a significant predictor of 10-year CHD risk only in those with high ($\geq 20\%$) risk of the FRS, but not in those with low ($<10\%$) or intermediate (10–19%) levels of the FRS.²⁸ The results of our study are consistent with the recommendation from a variety of organizations, including Centers for Disease Control and Prevention and the American College of Sports Medicine²⁹ and the WHO³⁰ that every adult should have at least 30 min moderate-intensity physical activity (such as brisk walking, cycling, swimming, home repair, and yard work) on most, preferably all, days of the week. Since walking is highly accessible, readily adopted, and rarely associated with exercise-related injury, this activity is more available for elder subjects.^{6,7,9,10}

There are several strengths and limitations in our study. A large random sample of men and women was drawn from a homogeneous population. The follow-up was long and practically complete, and the number of ascertained CHD events was large. Not only leisure-time physical activity, but also occupational and commuting physical activities were included in the analysis. A limitation of our study is the self-report of physical activity, and that physical activity was recorded only once at baseline. Self-administered questionnaires are relatively crude and imprecise measures of habitual physical activity, smoking, socioeconomic factors, alcohol consumption, and medical history. Although no specific assessment of repeatability or validity of our questionnaire for physical activity has been carried out, similar questionnaires have been used in a large number of studies in Finland and other Nordic countries^{17–19,24,31,32} where the patterns of physical activity are relatively similar. The method has been working in a large number of studies that can be considered as a validation in practice. We have no data on possible changes in physical activity during the follow-up. Misclassification, particularly over-report of the amount of physical activity at baseline and

changes in the activity during the follow-up probably underestimated the association between physical activity and the outcome. HDL cholesterol was measured only in part but not all surveys. We can not completely either exclude the effects of residual confounding due to measurement error in the assessment of confounding factors, or some unmeasured dietary factors.

In conclusion, the present study demonstrates that moderate or high levels of occupational or leisure-time physical activity, and daily walking or cycling to and from work are associated with a reduced 10-year risk of incident CHD events among women. Moderate or high levels of occupational physical activity, and high level of leisure-time physical activity are associated with a reduced 10-year risk of incident CHD events among men. These protective effects of above physical activity on the 10-year risk of incident CHD events are observed at any level of the CHD risk, measured by the FRS at baseline. Thus, the cardiovascular risk scores in the future need to consider an assessment of physical activity, too.

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