

# Relation between leisure time exercise and cardiovascular risk factors among 15-year-olds in eastern Finland

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## ABSTRACT

*Study objective:* To examine the associations between frequency of leisure time exercise and cardiovascular risk factors in adolescents.

*Design:* Cross sectional survey carried out over a 3 month period in 1984.

*Setting:* All 24 schools in North Karelia province and 16 randomly selected schools in Kuopio province.

*Participants:* A total of 1142 boys and girls aged 15, randomly selected from 40 schools (16 boys and 16 girls from each), participated out of a possible total sample of 1280. Main reason for non-participation was absence from school but a small number refused to participate.

*Measurements and main results:* The investigation comprised a medical examination, including anthropometry, a self administered questionnaire checked by interview, a parental questionnaire, and a blood sample for biochemical estimations. The main findings were: (1) Leisure time exercise was inversely related to daily smoking (Spearman's  $\rho$ , boys  $-0.16$ ,  $p < 0.01$ ; girls  $-0.13$ ,  $p < 0.01$ ) but was not related to serum lipoproteins or blood pressure. The inverse association between exercise and smoking was independent of socioeconomic family background. (2) Body mass index and sexual maturation were associated with systolic blood pressure, and among boys they were inversely related to high density lipoprotein cholesterol. (3) The lack of linear trends between exercise and biological risk factors may be explained by the high prevalence of leisure time exercise in the sample (72% of boys and 71% of girls exercised at least 2–3 times per week, in addition to physical education classes at school).

*Conclusions:* Among 15-year-old eastern Finnish boys and girls, leisure time exercise is favourably associated with the main behavioural cardiovascular risk factor, smoking, but not with serum total cholesterol or blood pressure.

Appropriate, possibly daily, physical activity is recommended for children as well as for adults.<sup>1</sup> For adults, this can be justified by the consistently observed associations between increased leisure time physical activity and lower risk factors for coronary heart disease (CHD) or other chronic conditions.<sup>2</sup> The relationship of children's or adolescents' physical activity to cardiovascular risk factors is, however, less well documented. It has been suggested that exercise is favourably associated with atherosclerosis precursors,<sup>3</sup> but a recent review has not found the available evidence to be convincing.<sup>4</sup> For example, physical fitness (which is not equivalent to physical activity) was inversely related to blood pressure in US school children,<sup>5,6</sup> but an intervention study with daily exercise could show no significant effects on blood

pressure and serum lipoproteins in 10-year-old Australian children.<sup>7</sup>

There is a lack of information about the association between exercise and cardiovascular risk factors among children and adolescents, especially for European countries. The aim of the present study was to describe the associations between leisure time exercise and cardiovascular risk factors among a random sample of 15-year-old school children from eastern Finland—an area characterised by a very high incidence of cardiovascular diseases.<sup>8</sup>

## Methods

All 24 schools in the province of North Karelia and 16 randomly selected schools in the province of Kuopio

are participating in the North Karelia Youth Project in eastern Finland. For this project, 16 boys and 16 girls were randomly selected from among the 9th graders in each of the 40 schools.

The sample of the present cross sectional analysis consisted of the 1280 boys and girls aged 15 in the project. Of the boys, 91% and of the girls, 95% participated in the medical screening, which was carried out in March, April and May 1984. The main reason for non-participation was that children were absent from school, but a few children refused to participate. In addition to the physical examination the study included a self administered questionnaire for the children, checked by interview, and another questionnaire for their parents. For the present analysis, complete medical and questionnaire data were available for 1142 boys and girls aged 15. A more detailed description of the survey has been published.<sup>9</sup> Blood pressure was measured twice in the right arm, with the child in a sitting position, after 5 min rest. A standard sphygmomanometer with one cuff size, 12 × 22 cm, was used. The first and fifth Korotkoff sounds were recorded at 2 mm Hg intervals. After the first measurement, the heart rate was counted for 30 s. The blood pressure recorded here is the second measurement. All measurements were taken by the same nurse.

Height was measured to the next succeeding mm and weight to the nearest 100 g. Body mass index (BMI; kilograms, divided by height in metres squared: kg/m<sup>2</sup>) was chosen as the measure for relative weight. Children's sexual maturity was classified according to Tanner's scale.<sup>10</sup> In this analysis, only the developmental stage of pubic hair was taken into account.

Blood samples drawn after the blood pressure measurement were analysed for serum total cholesterol, high density lipoprotein (HDL) cholesterol and serum thiocyanate. The parents were asked to give the children only a light breakfast on the morning of the study. Fresh serum samples were analysed at the Biochemical Laboratory of the National Public Health Institute of Finland. For serum cholesterol concentration, the laboratory procedure was standardised with the WHO Regional Reference Centre in Prague. For determination of cholesterol, an enzymatic assay was used. For the high density lipoprotein cholesterol determination, very low density and low density lipoproteins were precipitated with dextran sulphate-magnesium chloride reagent.

Smoking was measured by 13 questions in the questionnaire. In this analysis, only the actual smoking status was taken into account, according to the following categories: daily smoking, 1–2 times a week, 1–2 times a month, less than once a month, not at all. Leisure time exercise was measured using one 5

category question. Children reported how often they exercised for at least half an hour during leisure time so that they are at least a little out of breath and sweating: daily, 2–3 times a week, once a week, 2–3 times a month, or less. For data processing, the two highest and the two lowest levels of exercise were combined into one group each. Exercise during the physical education classes at school, twice weekly (approximately 45 mins each time) for all of the subjects, was regarded as constant within the study sample and therefore not taken into account in this analysis. The children also reported how great a distance they had covered in the 12 min run of the current school year. This number was considered to reflect the subjects' aerobic fitness. Forty seven per cent (n=265) of the boys and 20% (n=113) of the girls had participated in the 12 min test and remembered the distance run. Education of the father was measured by the total number of years of full time education; income of the parents in the household was measured using a 6 category question pertaining to levels of annual gross family income.

Statistical procedures for significance testing of associations included analysis of variance (with SPSSX package), calculation of linear regression coefficients, and log-linear regression analysis for contingency tables (with GLIM package).

## Results

Of the boys, 72% and of the girls, 71% were physically highly active during their leisure time, with out of school exercise at least 2–3 times a week. Less than 10% of the subjects had leisure time exercise less than once a week (table 1). Exercise was significantly associated with only one cardiovascular risk factor. In both sexes, exercise was inversely related to daily smoking. The proportion of daily smokers doubled from the highest to the lowest level of physical activity. No significant connection was found between exercise and the biological risk factors for CHD: total serum cholesterol, HDL cholesterol, and systolic and diastolic blood pressure. Nor was exercise related to serum thiocyanate, which may be considered as a biological indicator of smoking. Aerobic fitness, in terms of the self reported distance run in 12 min, was not significantly associated with serum lipoproteins, blood pressure or smoking in either sex (data not shown). The intercorrelation between leisure time exercise and aerobic fitness was significant, but rather low (table 2).

In contrast to exercise, the indices of body mass and sexual maturation turned out to be significantly related both to HDL cholesterol and to systolic blood pressure (table 2). The association was inverse with HDL cholesterol, positive with systolic blood

Table 1 Levels of cardiovascular risk factors according to frequency of leisure time exercise among 15-year-old Finnish boys and girls

Frequency of leisure time exercise	Boys		Girls		Total cholesterol (mmol/litre; mean)		HDL cholesterol (mmol/litre; mean)		Systolic blood pressure (mm Hg; mean)		Diastolic blood pressure (mm Hg; mean)		Thiocyanate ( $\mu$ mol/litre)		Daily smoking (%)		
	n	%	n	%	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	
	2-3 times a week or more	406	72	410	71	4.47	4.87	1.29	1.45	133	124	64	67	50	42	21	11
once a week	107	19	124	21	4.46	4.81	1.30	1.43	134	124	64	65	55	46	30	20	
less than once a week	52	9	43	8	4.53	4.89	1.27	1.42	132	126	62	64	45	38	40	21	
Total, mean	565	100	577	100	4.47	4.86	1.29	1.45	133	124	64	66	51	42	25	14	
SD	—	—	—	—	0.83	0.89	0.27	0.27	13	12	12	11	30	24	—	—	
Analysis of variance/ $\chi^2$					NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	p=0.001 p=0.015

n = number of subjects; HDL = high density lipoprotein; NS = not significant

Table 2 Simple linear correlation coefficients<sup>a</sup> among 565 boys and 577 girls aged 15

		Body mass index (kg/m <sup>2</sup> )	Sexual maturity (pubic hair)	Smoking status	Years of education of father	Gross family income	12 min run distance (m)
Leisure time exercise	Boys	NS	NS	-0.16†	0.09*	0.08*	0.24†
	Girls	NS	NS	-0.13†	NS	0.09* <sup>b</sup>	0.28†
HDL cholesterol (mmol/litre)	Boys	-0.23†	-0.20†	-0.16†	NS	NS	NS
	Girls	-0.16†	NS	-0.08*	NS	NS	NS
Systolic blood pressure (mm HG)	Boys	0.30†	0.20†	-0.09*	NS	NS	NS
	Girls	0.21†	0.11*	-0.13†	-0.14†	-0.10*	NS

<sup>a</sup> Pearson correlation coefficients are given in the table, with the exception of correlations between two categorical variables, for which Spearman's  $\rho$  is indicated.

<sup>b</sup> Interrelation between smoking status and gross family income: Boys NS, girls  $r=0.08^*$

\*  $p<0.05$ ; †  $p<0.01$ ; NS = not significant

pressure, and more pronounced in boys than in girls. Body mass index and sexual maturation were not, or were only marginally, related to total cholesterol and diastolic blood pressure. No significant intercorrelation was found between exercise and body mass index or exercise and sexual maturity.

On the other hand, socioeconomic variables such as gross family income and education of the father tended to correlate with both exercise and the smoking behaviour of the adolescents (table 2). The parents' income and education may thus have confounded the observed relationship between the adolescents' exercise and smoking. To clarify this possible bias, we tested the independent character of the exercise-smoking relationship by log-linear regression analysis. First, exercise (dichotomised as once a week or less v 2-3 times a week or more), smoking (daily smokers v

others) and family income (lower half v upper half of annual gross family income) were included into the model. The inverse association of exercise and smoking remained significant in both boys ( $z$  value 3.22;  $p=0.001$ ) and girls (2.77;  $p=0.006$ ), whereas family income was not significantly related to smoking, nor were exercise and income interrelated. For boys, but not for girls, there was a significant interaction term between exercise, smoking and family income (2.87;  $p=0.004$ ), indicating that the inverse association between exercise and smoking was less pronounced among boys in the lower income group than among those in the upper income group. The proportions of male smokers were: low income-low exercise 34% ( $n=31$ ), low income-high exercise 26% (48), high income-low exercise 39% (28), high income-high exercise 11% (23). The analysis thus

showed that the association between exercise and smoking was independent of family income in both genders, and that, in addition, income modified the relationship in boys.

A second regression analysis was performed with the number of years of education of the father entered as socioeconomic stratifier. The significant relationship between exercise and smoking was confirmed as well in both boys and girls. No other associations, including the interactions, were significant (data not shown). Taken together, both log-linear regression analyses indicated that the observed association of more frequent leisure time exercise with a lower proportion of daily smokers seems to be largely independent of the socioeconomic family background of the adolescents.

### Discussion

This study among a representative sample of 15-year-old schoolchildren in eastern Finland showed that frequency of leisure time exercise is inversely related to the most important behavioural risk factor for coronary heart disease, smoking, but not significantly connected with biological risk factors such as blood pressure and serum lipoproteins. These findings thus match the situation in the female adult Finnish population,<sup>11</sup> but they do not fully confirm observations among Finnish men in whom leisure time exercise was inversely related to serum cholesterol and blood pressure as well.<sup>12</sup>

The significant association between exercise and smoking, which was independent of the socioeconomic family background of the children, may appear trivial—but it is not well documented in either adults or adolescents.<sup>13</sup> Obviously, based on the present cross sectional investigation, nothing can be said about the direction of causality of this relationship. But in itself, it suggests that the clustering of CHD risk factors, at least the behavioural ones, which is known for the adult population of the same area<sup>14</sup> and which may be increasing at present,<sup>15</sup> starts early in adolescence. Several important determinants of smoking behaviour in youth have already been described by others: the number of smokers in the family and poor school achievement are correlated with smoking,<sup>16</sup> and the smoking habit of the best friend is the strongest predictor of adolescent smoking.<sup>17</sup> With a broad set of psychosocial and environmental determinants of smoking and multivariate analysis, it was possible to explain 87% of the variance of smoking observed among young Finnish men.<sup>18</sup>

Exercise and serum thiocyanate were not associated in this study. This is not surprising, since smoking status and thiocyanate are usually not highly

correlated in youngsters ( $r=0.4$  in our study), presumably due to the large day to day variation in smoking and the small numbers of cigarettes smoked per day by teenagers.<sup>17</sup> Admittedly, this failure to confirm the inverse exercise-smoking association with an objective index of smoking is somewhat unsatisfactory, since it is known that assessment of adolescents' smoking behaviour by self report is subjected to several sources of bias.<sup>19</sup>

In our sample, exercise or fitness was unrelated to blood pressure. Here it must be noted that most of the variance in fitness during adolescence is determined by factors other than exercise, for example heredity, since in our study, as well as in those of others,<sup>20</sup> the coefficients for the correlation of exercise with endurance capacity were low (around 0.2 to 0.3). Our results are not in accordance with reports that fitness is favourably associated with blood pressure among children.<sup>5,6</sup> However, the predictive value of childhood blood pressure for adult hypertension seems to be modest.<sup>21</sup>

It has been suggested that exercise is more likely to be associated with HDL cholesterol in young adults than in children,<sup>22</sup> possibly due to the decrease in physical activity that begins after puberty.<sup>16</sup> Generally, a skewed and narrow distribution of an independent variable, eg exercise in children, will render it more difficult to describe a linear trend with a dependent variable, eg serum lipoproteins. Indeed, among our study population, the distribution of exercise seemed to be shifted towards the right, with very few physically inactive children. This might be typical for the whole age range of Finnish schoolchildren<sup>3</sup> and it is possibly one major reason why in our cross sectional data we could not repeat the observation that habitual exercise levels of adolescents predict serum lipoprotein patterns.<sup>22-24</sup> On the other hand, our findings are compatible with the inconclusive outcome of exercise intervention studies aiming at a reduction of biological CHD risk factors in children.<sup>6, 25, 26</sup>

Compared with the role of exercise, factors such as sexual maturation and the body mass index, which reflects both growth and fatness in adolescents, are more important determinants of the biological CHD risk factors. Body mass index and sexual maturation are both known to be associated with systolic, but not diastolic blood pressure;<sup>27-29</sup> and at least in boys, are known to be inversely related to HDL but not to total serum cholesterol.<sup>30, 31</sup> A detailed description of the distribution of CHD risk factors among the study sample is given elsewhere.<sup>32</sup>

Among the boys and girls in our study, smoking and HDL cholesterol were inversely related. This confirms the notion that smoking is associated with an unfavourable lipoprotein profile, at whatever age

smoking initiated during adolescence.<sup>33</sup> Three important goals have been proposed for health education in children: a healthy diet, non-smoking, and appropriate exercise. Serum lipoproteins and smoking behaviour have both been shown to respond well to health education interventions among our population of schoolchildren<sup>34 35</sup> and elsewhere.<sup>36</sup> On the other hand, there is one explanation for the fact that leisure time exercise played only a modest role as a predictor of biological CHD risk factors in this population of pupils in eastern Finland: the investigated adolescents may already get sufficient exercise from the point of view of CHD prevention. Even if we did not measure the overall physical activity in our 15-year-old subjects, apparently most of them were clearly more physically active than has been recommended for adults;<sup>1</sup> thus a large proportion of the children may get the achievable benefit that habitual physical activity conveys on CHD risk factors. It must be noted, however, that this prevalence of high levels of physical activity does not prevent Finnish children from having relatively high levels of cardiovascular risk factors in international comparisons.<sup>16 30</sup> Obviously, physical activity alone cannot counteract or outweigh the behavioural, environmental and genetic factors responsible for the high CHD mortality in eastern Finland.

Given the difficulties in measuring physical activity in children accurately,<sup>3</sup> one may regard our approach (measuring leisure time exercise in 15-year-olds with only one multiple choice question) as too crude. It was not, however, our intention to measure physical activity in Finnish adolescents precisely, but merely to classify 15-year-old boys and girls into different levels of exercise for a description of associated CHD risk factors. The same question has also consistently predicted associations of exercise with CHD risk factors among male adults of the same population.<sup>12</sup> It is further known that a simple question on the frequency of sweat inducing physical activity provides valuable information on adult exercise.<sup>37</sup>

In conclusion, high leisure time exercise was inversely related to smoking, but not related to blood pressure and serum lipoproteins in 15-year-old Finnish boys and girls. This notion may not, however, deal with all important aspects of exercise in youth. Exercise in childhood and adolescence may be more important as a determinant of adult leisure time physical activity, which is known to be beneficial, than as an indicator of CHD risk. Physical education in school may play a decisive role in motivating children to develop life long exercise habits.<sup>38</sup> During adolescence, emphasising enjoyment of the exercise itself and of the associated benefits, such as social contacts, may therefore merit more attention than the short term effects of physical activity on CHD risk factor levels.

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