

# Associations of health related behaviour, social relationships, and health status with persistent physical activity and inactivity: a study of Finnish adolescent twins

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**Objective:** To examine the association between leisure time physical activity over a three year period and health related behaviour, social relationships, and health status in late adolescence as part of a nationwide longitudinal study.

**Methods:** Five birth cohorts of adolescent twins aged 16 at baseline (n = 5028; 2311 boys and 2717 girls) participated in the study. Questionnaires on leisure time physical activity, other health related behaviour, social relationships, and health status were sent to the twins on their 16th and 17th birthdays and six months after their 18th birthday. The combined response rate to the three questionnaires was 75.8% for boys and 81.7% for girls. Those who answered in all three questionnaires that their frequency of physical activity was 4–5 times a week or more were defined as persistent exercisers, and those who exercised at most twice a month in all three were defined as persistently inactive. Logistic regression analyses were used to identify baseline variables associated with outcome measures.

**Results:** Overall, 20.4% of boys and 13.0% of girls were persistent exercisers and 6.5% of boys and 5.3% of girls were persistently inactive. In both sexes, smoking, irregular breakfast eating, attending vocational school, and poor self perceived current health were significantly associated with persistent inactivity.

**Conclusions:** Persistent physical inactivity in adolescents is associated with a less healthy lifestyle, worse educational progression, and poor self perceived health. Tailoring methods to promote physical activity may prove useful for influencing other health habits. Such programmes are indicated for vocational schools in particular.

It is well recognised that certain lifestyle habits, including low physical activity, are risk factors for many diseases. To prevent later disease, childhood physical activity should continue during adulthood. The possibility of doing so is likely to be modulated by environmental and social factors, such as sex, social class, and educational opportunities. Whereas primary preventive efforts target the lifestyle of individuals, public health policy and community interventions aim to modify social and environmental conditions to facilitate adoption of a healthy lifestyle.<sup>1</sup> The relation of lifestyle factors and social and environmental conditions to adolescent physical activity patterns is insufficiently understood.

Cross sectional studies of adolescents show that smoking is associated with low physical activity.<sup>2–6</sup> There are also associations between patterns of physical activity and type of school,<sup>7,8</sup> school grades especially physical education,<sup>9</sup> and participation in organised sport.<sup>8,9</sup> In a Danish study, high school students participated more in leisure time sport and reached higher physical performance than students from technical or vocational schools,<sup>7</sup> but according to Telama *et al*<sup>10</sup> differences in physical activity by type of school were not strong in Finland. Vilhjalmsson *et al*<sup>11</sup> found in a sample of 1131 15–16 year olds in Iceland that male sex, sociability, perceived importance of sports and health, and improvement and satisfaction with mandatory gym classes in school were all related to more involvement in leisure time physical activity, whereas hours of paid work and television viewing were related to less. Several studies,<sup>12–14</sup> but not all,<sup>15–17</sup> indicate that both parental exercise habits and encouragement influence children's exercise habits.

Longitudinal studies of physical activity show that many lifestyle, social, and environmental factors may predict consistent physical activity. These include non-smoking,<sup>2,18</sup>

lower consumption of saturated fatty acids,<sup>19</sup> higher school grades and participation in organised sports,<sup>8</sup> playing sport for school,<sup>20</sup> as well as social relationships,<sup>2</sup> parents interest in physical activity, the local environment,<sup>8</sup> and very good self assessed health.<sup>20</sup>

The purpose of this study was to examine health related behaviour, social relationships, and health status at the age of 16 in relation to persistence of physical activity and physical inactivity during the following two and a half years.

## SUBJECTS AND METHODS

Twins from consecutive birth cohorts were identified from the Central Population Registry of Finland.<sup>21</sup> Within two months of their 16th birthdays, a questionnaire about health habits and attitudes, symptoms, and relationships with parents, peers, and co-twin was mailed in 1991–1995 to twins born in 1975–1979 respectively (6130 twins in 3065 families).<sup>21</sup> Parents received a questionnaire also. Two new questionnaires were sent to all twins who replied at the age of 16. One was sent a month after their 17th birthday, and another about six months after their 18th birthday (mean response age 18.5 years). The present analysis was based on adolescents who replied to all three questionnaires. Health related behaviour, social relationships (except for the kind of school attended after compulsory education ends), and health status are based on the questionnaire answered at the age of 16. Information on the school is based on the 17 year questionnaire, because compulsory, universal schooling ends at the age of 16, after which adolescents can choose any subsequent school.

The total number of subjects answering all three questionnaires was 5028 (2311 boys and 2717 girls), with a response rate among boys of 75.8% and among girls of 81.7%. Of these,

122 twins (57 boys and 65 girls) were excluded because of incomplete answers or having an illness or handicap that could affect physical activity. All these conditions were reported by the subjects themselves or their parents, and the effect of the conditions on physical activity was assessed by the authors. The final cohort size was 4906 subjects (2254 boys and 2652 girls).

Three aspects of leisure time physical activity were assessed: the frequency of leisure time physical activity outside school with seven response alternatives (ranging from nearly daily to not at all) and the subjects' own perception of their physical fitness (very good, fairly good, satisfactory, rather poor, very poor). A third question asked about the intensity (four different degrees of sweating and breathing during exercise) of physical activity was asked only at baseline.<sup>6</sup> In an independent sample, one month test-retest correlations were greater than 0.75 for both fitness and intensity.<sup>6</sup>

Those who answered in all questionnaires that their frequency of physical activity was 4–5 times a week or more were defined as persistent exercisers, and those who exercised 1–2 times a month or less based on all three questionnaires were classified as persistently inactive. These formed the main outcome measures of stability of physical activity, and these can be considered as indicators of consistent behaviour.

Three groups of covariates were used (for detailed information, see Aarnio *et al.*<sup>6</sup>), which had previously been shown in cross sectional analyses to be related to physical activity patterns.

(1) Health related behaviours: smoking habits (non-smokers, occasional smokers, regular smokers, and quitters), alcohol consumption (non-users, users, and heavy users), use of dietary fats through a single question on the type of spread used on bread, and breakfast eating habits (every morning, 3–4 times a week, and once a week) were assessed.<sup>6</sup>

(2) Social relationships: kind of school (academically oriented high school, vocational school, others), school grade compared with class average (better, average, worse), and socioeconomic status of parents (upper level employee, lower level employee, worker, self employed, and farmer, and, if not working, unemployed or retired).

(3) Health status: own perception of current health (very good, rather good, average, poor, or very poor). Self reported symptoms were assessed by a sum score of the frequency (never or rarely, monthly, weekly, daily) of ten items (stomach pains, tension or nervousness, irritability or temper, outbursts, sleeping disorders, headaches, tremor, fatigue or weakness, dizziness, back or neck pains). Body mass index was computed as weight (kg)/height squared (m<sup>2</sup>).<sup>6</sup>

### Statistical analysis

Logistic regression analyses were used to screen which variables showed significant associations with the outcome measures, first individually and then by multivariable analysis within covariate groups (health related behaviour, social relationships, and health status). A final sex specific logistic regression was performed with those variables that remained significant in the groupwise analysis. The possible lack of statistical independence between members of a twin pair was taken into account by using logistic regression modelling with the generalised estimating equations in PROC GENMOD in SAS (SAS Institute, Cary, North Carolina, USA; version 6.12), thus providing correct confidence intervals for odds ratios. Results for variables not included in the final analysis can be found at [www.bjsportsmed.com](http://www.bjsportsmed.com).

### RESULTS

Overall, 20.4% of boys and 13.0% of girls were persistent exercisers, and 6.5% of boys and 5.3% of girls were persistently

inactive. Among boys who considered their fitness to be very good at the age of 16, 43.6% were persistent exercisers and 1.6% were persistently inactive, while correspondingly among the girls 39.7% were persistent exercisers and 1.6% persistently inactive. The intensity of physical activity at the age of 16 also correlated with persistent exercising; of boys who breathed and sweated heavily during exercise, 42.8% were persistent exercisers and 1.3% persistently inactive, and correspondingly among the girls 31.5% were persistent exercisers and 3.9% persistently inactive.

In the final logistic regression, the variables showing significant associations with persistent activity among boys (table 1) were non-smoking, regular breakfast eating, attending a gym, mother's socioeconomic status, and good perceived current health; significant associations among girls (table 2) were non-smoking, regular breakfast eating habits, non-use of spreads on bread, attending a gym, and good perceived current health.

Significant associations with persistent inactivity among boys were found for smoking, irregular breakfast habits, attending vocational school, self employed father, and poor self perceived health (table 1). Variables with significant associations among girls (table 2) similarly were smoking, poor perceived current health, and attending vocational school. For example, regular smokers had odds ratios (ORs) of 1.80 (95% confidence interval (CI) 1.09 to 2.96) (boys) and 2.50 (1.42 to 4.40) (girls) for persistent inactivity compared with non-smokers, whereas those in vocational school had ORs of 1.65 (1.04 to 2.62) (boys) and 1.83 (1.10 to 3.04) (girls) compared with gymnasium students.

### DISCUSSION

The most consistent associations of persistent exercise in this study as measured by repeated assessment on three occasions over a 30 month period in late adolescence were non-smoking, superior school achievement, self rated good health, and regular breakfast eating habits.

Although the study population comprised twins, we disregarded their twinship in the analyses of associations with physical activity patterns. The subjects were considered solely as individual adolescents drawn from the population. A strength of this study is that the questionnaire study was completed three times at the ages of 16, 17, and 18, covering a three year period. The number of subjects and the response rate were high. A relative weakness of the study is that it only covers late adolescence.

Can one generalise from a twin sample to all adolescents? As shown earlier, twins from this sample and Finnish singletons from a random population sample had very similar distributions of their responses on the intensity of physical activity.<sup>6</sup> In general, the twins reported themselves to be slightly more physically fit than the singletons.<sup>6</sup> There is some evidence that male twins, in particular, are slightly shorter and less obese than singletons at age 16,<sup>22</sup> but this difference becomes smaller by age 17.

Our results were generally similar for boys and girls. Poor health was associated with persistent exercise in both sexes, even after excluding subjects with illnesses that hindered physical ability. According to other studies, boys seemed to be more active than girls,<sup>23, 24</sup> and according to Riddoch *et al.*,<sup>24</sup> girls had healthier nutritional habits. In our study, boys were more often persistent exercisers than girls, but in health related behaviour, boys and girls seem to be alike in general with respect to patterns of exercise persistence.

Longitudinal studies of physical activity show some evidence of consolidation and tracking of physical activity, smoking behaviour, and food preference. According to Kedler *et al.*<sup>18</sup> in a seven year follow up, students identified at baseline with high physical activity remained active and similarly those

**Table 1** Multivariable logistic regression analyses of health related behaviours, social relationships, and health status variables in relation to physical activity patterns among boys at the ages of 16, 17, and 18.5 years in FinnTwin16 study

Variable	Total	Persistent exercisers			Persistently inactive		
		n (%)	OR (95% CI)	p	n (%)	OR (95% CI)	p
<b>Smoking</b>							
Regular smoker	472	21 (4.5%)	0.20 (0.11 to 0.36)	*	71 (15.0%)	1.80 (1.09 to 2.96)	*
Occasional smoker†	790	178 (22.5%)	0.87 (0.66 to 1.15)		49 (6.2%)	0.98 (0.62 to 1.53)	
Non-smoker	936	234 (25%)	1.00		50 (5.3%)	1.00	
<b>Alcohol</b>							
Heavy users	397	49 (12.3%)	1.28 (0.95 to 1.72)		NIC		
Users	1285	283 (22.0%)	0.92 (0.55 to 1.53)				
Non-users	548	113 (20.6%)	1.00				
<b>Breakfast eating</b>							
Once a week	274	13 (4.7%)	0.39 (0.23 to 0.67)	*	14 (5.1%)	2.55 (1.64 to 3.97)	*
3–4 times a week	283	25 (8.8%)	0.76 (0.50 to 1.14)		13 (4.6%)	0.94 (0.52 to 1.70)	
Every morning	1670	213 (12.6%)	1.00		60 (3.4%)	1.00	
<b>School type</b>							
Vocational school	885	107 (12.1%)	0.46 (0.34 to 0.64)	*	94 (10.6%)	1.65 (1.04 to 2.62)	*
Other alternatives‡	194	16 (8.3%)	0.40 (0.22 to 0.75)	*	24 (12.4%)	1.40 (0.67 to 2.92)	
Gymnasium	1139	318 (27.9%)	1.00		54 (4.7%)	1.00	
<b>School grade</b>							
Worse than average	62	1 (1.6%)	0.38 (0.09 to 1.53)		11 (17.7%)	1.86 (0.74 to 4.64)	
Other alternatives§	1808	353 (20%)	1.26 (0.90 to 1.76)		142 (8.0%)	0.89 (0.50 to 1.59)	
Better than average	323	88 (27.2%)	1.00		15 (4.6%)	1.00	
<b>Father's socioeconomic status</b>							
Lower level employee	308				27 (8.8%)	1.78 (0.94 to 3.36)	
Worker	690				63 (9.1%)	1.46 (0.82 to 2.58)	
Self employed	174				22 (12.6%)	2.45 (1.25 to 4.80)	*
Farmer	189				11 (8.6%)	1.06 (0.45 to 2.43)	
Upper level employee	478				7 (1.5%)	1.00	
<b>Mother's socioeconomic status</b>							
Lower level employee	1015	207 (20.4%)	0.86 (0.59 to 1.23)				
Worker	437	86 (19.7%)	1.18 (0.74 to 1.88)				
Self employed	98	19 (19.4%)	0.25 (0.08 to 0.77)	*			
Farmer	160	27 (16.9%)	0.75 (0.40 to 1.40)				
Upper level employee	308	75 (24.3%)	1.00				
<b>Own perception of current health</b>							
Poor¶	20	1 (5%)	0.27 (0.04 to 1.51)		8 (40%)	17.8 (5.64 to 56.7)	*
Rather good or average	1222	159 (13%)	0.47 (0.37 to 0.61)	*	130 (11%)	2.16 (1.41 to 3.31)	*
Very good	1011	290 (28.7%)	1.00		38 (3.8%)	1.00	
<b>Body mass index</b>							
≥26	82	11 (13.4%)	2.71 (1.13 to 6.46)		NIC		
19–25	1813	335 (18.5%)	2.40 (1.50 to 3.85)				
<18	244	27 (11.1%)	1.00				

Values are odds ratios (OR) and 95% confidence intervals (95% CI) for persistent activity and inactivity.

\*p<0.05.

†Includes quitters.

‡Other alternatives are comprehensive school, university, higher vocational school, other courses.

§Other alternatives are little bit better, average, little bit worse.

¶Two lowest classes very poor and poor are combined.

NIC, Not included in the final analyses, table includes only statistically significant variables. Results for variables not shown here can be found at [www.bjssportsmed.com](http://www.bjssportsmed.com).

with initially low physical activity remained inactive. Tracking was found to be moderate between 13 and 16, and rather high between 17 and 18.<sup>24</sup> According to Dovey *et al.*,<sup>20</sup> participation in physical activity at the age of 18 was 63% of that reported at 15. Raitakari *et al.*<sup>19</sup> found that physical activity shows significant tracking, and physical inactivity shows even better tracking. In a Finnish study of adolescents,<sup>25</sup> tracking correlations of physical activity were significant but rather low (0.50 to 0.80 among boys and 0.40 to 0.61 among girls). Physical activity during adolescence was a significant but weak predictor of physical activity nine years later.<sup>8</sup>

Our findings indicate the need to design strategies for improving different health related habits at the same time. Programmes encouraging physical activity should take into consideration musculoskeletal problems that vigorous exercise can cause.<sup>26</sup> In addition to smoking and alcohol abuse, drug abuse must be considered as a future health risk, which was not assessed in this study. At the same time, schools should recognise that there seem to be individual differences in the development of high risk behaviours, and that scholastic aptitude appears to be an indicator of risk. It is also impor-

tant to remember that being forced to exercise during childhood may have negative consequences for later activity.<sup>27</sup>

How can physical activity be promoted in adolescents? A recent consensus recommended that all children and adults should gradually build up to 30 minutes of activity of moderate intensity on most, preferably all, days of the week, with more emphasis on physical activity than exercise.<sup>28</sup> In addition, the Royal College of Physicians recognised that “the habit of taking regular recreational exercise is best started in childhood and should be continued to middle age and when possible into old age because exercise helps to make the most of diminishing physical capacity”.<sup>29</sup> Guidelines for recommendations for physical activity in adolescents appear to differ in many consensus conferences and have been criticised for being insufficiently based on scientific studies.<sup>30</sup> Schools should promote physical activity as a part of an active lifestyle. According to Kedler *et al.*,<sup>18</sup> the early consolidation of health behaviours implies that interventions should begin before sixth grade. Interventions should be tailored to young students and those in vocational schools. A review of school health promotions shows that initiatives can have a positive

**Table 2** Multivariable logistic regression analyses of health related behaviours, social relationships, and health status variables in relation to physical activity patterns among girls at the ages of 16, 17, and 18.5 years in the FinnTwin16 study

Parameter	Total	Persistent exercisers			Persistently inactive		
		n (%)	OR (95% CI)	p	n (%)	OR (95% CI)	p
Use of dietary fats							
Light, mixed, butter	776	97 (12.5%)	0.39 (0.27 to 0.55)	*	39 (5.0%)	2.55 (0.94 to 6.87)	
Margarine	1553	158 (10.2%)	0.45 (0.25 to 0.81)	*	107 (6.9%)	4.03 (1.81 to 13.7)	
Nothing	307	81 (26.4%)	1.00		5 (1.6%)	1.00	
Smoking							
Regular smoker	522	23 (4.4%)	0.52 (0.30 to 0.91)	*	68 (13.0%)	2.50 (1.42 to 4.40)	*
Occasional smoker†	988	115 (11.6%)	0.77 (0.56 to 1.07)		47 (4.8%)	1.43 (0.83 to 2.45)	
Non-smoker	1121	198 (17.7%)	1.00		38 (3.4%)	1.00	
Alcohol							
Heavy users	409	25 (6.1%)	0.84 (0.61 to 1.16)			NIC	
Users	1680	213 (12.7%)	0.44 (0.22 to 0.90)				
Non-users	552	99 (17.9%)	1.00				
Breakfast eating							
Once a week	405	36 (8.9%)	0.62 (0.40 to 0.96)	*	37 (9.1%)	1.34 (0.78 to 2.30)	
3–4 times a week	419	38 (9.1%)	0.68 (0.45 to 1.02)		30 (7.2%)	1.23 (0.73 to 2.07)	
Every morning	1820	269 (14.8%)	1.00		85 (4.7%)	1.00	
School type							
Vocational school	616	38 (6.2%)	0.46 (0.29 to 0.71)	*	52 (8.4%)	1.83 (1.10 to 3.04)	*
Other alternatives‡	271	13 (4.8%)	0.33 (0.15 to 0.72)	*	34 (12.5%)	2.40 (1.23 to 4.67)	*
Gymnasium	1744	284 (16.3%)	1.00		64 (3.7%)	1.00	
School grade							
Worse than average	37	2 (5.4%)	1.76 (0.31 to 9.94)		6 (16.2%)	1.44 (0.42 to 4.94)	
Other alternatives§	1957	194 (9.9%)	0.79 (0.58 to 1.06)		123 (6.3%)	1.17 (0.61 to 2.24)	
Better than average	601	137 (22.8%)	1.00		17 (2.8%)	1.00	
Mother's socioeconomic status							
Lower level employee	1165	155 (13.3%)	0.86 (0.58 to 1.25)				
Worker	533	53 (9.9%)	0.77 (0.48 to 1.24)				
Self employed	126	14 (11.1%)	0.81 (0.38 to 1.69)				
Farmer	155	18 (11.6%)	0.69 (0.33 to 1.44)				
Upper level employee	360	66 (18.3%)	1.00				
Father's socioeconomic status							
Lower level employee	366				19 (5.2%)	0.60 (0.28 to 1.27)	
Worker	825				55 (6.7%)	0.79 (0.44 to 1.42)	
Self employed	232				19 (8.2%)	0.95 (0.44 to 2.05)	
Farmer	201				4 (2.0%)	0.27 (0.09 to 0.84)	
Upper level employee	526				27 (5.1%)	1.00	
Own perception of current health							
Poor¶	33	1 (3%)	0.37 (0.16 to 0.83)	*	9 (27.3%)	5.66 (2.01 to 15.9)	*
Rather good or average	1676	152 (9.1%)	0.56 (0.42 to 0.73)	*	121 (7.2%)	2.22 (1.32 to 3.75)	*
Very good	934	183 (19.6%)	1.00		27 (2.9%)	1.00	
Body mass index							
26>	106				5 (4.7%)	0.69 (0.22 to 2.18)	
19–25	2092				112 (5.4%)	0.73 (0.42 to 1.27)	
<18	371				29 (7.8%)	1.00	

Values are odds ratios (OR) and 95% confidence intervals (95% CI) for persistent activity and inactivity.

\*p<0.05

†Includes quitters.

‡Other alternatives are comprehensive school, university, higher vocational school, other courses.

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¶Two lowest classes very poor and poor are combined.

NIC; not included in the final analyses; the table includes only statistically significant variables. Variables not found here can be found at [www.bjsportsmed.com](http://www.bjsportsmed.com).

### Take home message

Consistent physical inactivity in late adolescence is associated with a less healthy lifestyle, poor educational achievement, and poor self perceived health. Conversely, physical activity appears to result in a healthy lifestyle, good educational achievement, and good health. Health promotion in adolescence should address the health and wellbeing of adolescents as a whole.

impact on children's health and behaviour but do not do so consistently. Although most interventions are able to enhance children's knowledge, the goal of changing attitudes and behaviour that influence health is much harder to achieve.<sup>31</sup> However, promoting physical activity among adolescents should lead to a healthier overall lifestyle.

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