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Physical fitness in relation to transport to school in adolescents. The Danish Youth and Sports Study.

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Abstract

Physical activity is associated with beneficial effects on a range of health outcomes, with beneficial effects on these outcomes being related to the relationship between physical activity and different aspects of fitness. In many Western countries there are concerns about declining levels of physical activity in school-aged children. Active transport is one way to increase physical activity in children, but few studies have evaluated whether active transport in school-aged children and adolescents has beneficial effects on fitness, and if so whether different modes of transport affect different aspects of fitness. In this study we examined the association of active transport with different aspects of fitness in a representative Danish sample of 545 boys and 704 girls, 15-19 years of age. Physical fitness was assessed through a number of field tests, including a maximal cycle test, dynamic and static strength in different muscle groups, muscle endurance, flexibility and agility. Transport to school was reported as mode of transport and distance traveled. Almost two-thirds of the population cycled to school. Cyclists had higher aerobic power than both walkers and passive travelers (4.6-5.9%). Isometric muscle endurance (10-16%), dynamic muscle endurance in the abdominal muscles (10%) and flexibility (6%) were also higher in cyclists compared to walkers and passive travelers. Other fitness measures did not differ between those who did and did not cycle to school. Mode of travel was not related to leisure time sports participation. Our findings suggest that commuter bicycling may be a way to improve health in adolescents.

Keywords: active transport, adolescents, bicycling, physical fitness

Introduction

Physical activity is associated with beneficial effects on a range of health outcomes, with beneficial effects on these outcomes being related to the relationship between physical activity and different aspects of fitness (Andersen et al. 2006). However, in many Western countries there are concerns about declining levels of physical activity and hence fitness in school-aged children (Wedderkopp et al. 2004). Active transport, such as walking or bicycling to school, has been suggested as one way to increase physical activity in children (Tudor-Loche et al. 2001). Recent studies using objective measurement of physical activity have consistently shown that children and adolescents who walk or cycle to school engage in more physical activity than those who travel by other means (Cooper et al. 2003; Cooper et al. 2005; Sirard et al. 2005; Tudor-Locke et al. 2003) and that this increased activity may exceed that due to the journey itself. To date, no experimental studies have been conducted to investigate how this increased activity may arise, and it is possible that it is the naturally more active children who use active travel to school, although studies where weekend and weekday physical activity have been compared find this not to be the case (Cooper et al 2003, Cooper et al 2005). An alternative explanation may be that the freedom gained through active travel to school allows children to engage in other activities around the school day (Cooper and Page2006).

Whatever the underlying mechanisms linking active transport to greater physical activity in children, it is unclear whether this extra activity is sufficient to result in higher levels of fitness. To date only one study has reported an association between active commuting to school and fitness in children, where cycling, but not walking, was associated with higher cardiovascular fitness levels (Cooper et al. 2006). Cooper et al. suggested that the intensity of bicycling was higher than the intensity of walking, and that a 10-15 minute bout of bicycling twice a day could be enough to increase aerobic power (Cooper et al. 2006) but this remains to be confirmed experimentally. In that study, fitness was assessed as maximal power output in a progressive cycle test, raising the possibility that commuter cyclists may have higher work efficiency, i.e. they would perform better in a cycle test even with the same oxygen uptake. Additionally, due to limitations in the accelerometer technology used to measure physical activity during cycling, that previous study was unable to determine whether those children who regularly cycled to school had greater aerobic power because they were generally more active and as part of this also tended to cycle to school (Cooper et al. 2006). If this was the case, one might expect a non-specific association of bicycling to school with all types of fitness (e.g. muscle endurance, muscle strength, flexibility and agility), not just aerobic power. A specific association with aerobic power and muscle endurance fitness in the muscles used in bicycling (both of which could be attributed to the bicycling *per se*) would be supportive of bicycling having a direct effect.

If commuter bicycling can improve fitness in young people this would potentially have important public health implications (Eisenmann et al. 2005; Wedderkopp et al. 2003). Evidence of this association is currently limited since it has only recently been realized that active commuting to school may be associated with increased physical activity and fitness in young people. Further investigation of this association is required, but is potentially difficult due to the limited prevalence of commuter cycling to school in many Western countries and the difficulty of carrying out accurate assessments of fitness within a substantial cohort. Measures of travel mode to school and of a range of fitness outcomes were, however, collected within a substantial representative sample of Danish adolescents in the Danish Youth and Sports Study during the mid-1980's. At that time no investigation of potential associations between fitness and travel mode were carried out, and we have re-analysed data from this cohort to investigate this association. The aim of the present study was thus to investigate the associations between different types of fitness and transport mode to school in adolescents.

Methods

Study participants

Study subjects were 545 boys and 704 girls, 15-19 years of age, randomly selected from school children in Denmark in 1983. Subjects were attending 54 classes in 18 high schools, nine trade schools and nine vocational schools selected according to geographical area and population density to be representative of Danish adolescents. In Denmark high-school/upper-secondary school children can select to attend high school that tend to focus on preparing students for further usually University education, trade schools that prepare students for unskilled trades and vocational schools that prepare students for skilled trades. The testing was considered part of the physical education lessons, and all students took part. Eleven students did not answer the question about traveling mode and were excluded from this analysis.

Measurements

All measurements were administered by physical education teachers who were trained by the principal investigator of this study. Questionnaires were used to determine socio-demographic characteristics, mode of transport to school and levels of physical activity. Physical activity was assessed by questions reporting type and quantity of organized sport activities in clubs and at the schools, of unorganized sports activities, and as other physical activities including physical labor, walking, bicycling, and dance. Transport to school was assessed as mode of transport. Mode was separated into different types of passive transport (motorcycle, car, bus, train), walking and bicycling. Students answered three questions if they used a range of different modes of transport: the dominant mode (1st question), the second choice and the third choice, and the dominant mode was used in all analyses. There were three questions for summer transport and three for winter, but only summer questions were used in this analysis, because all data were collected in September.

All measurements on the whole sample were collected at the same time as completion of the questionnaire. Height and weight were measured to the nearest 1 cm and 0.5 kg, and body mass index (BMI) calculated as weight (kg) divided by height^2 (metres). Five types of fitness were assessed; aerobic power, muscle endurance (3 tests), functional strength (2 tests), flexibility, and agility/functional strength. Most tests have been used in other test batteries and have demonstrated high reproducibility (r>0.9; see review of Safrit) (Safrit1990). Tests are described in detail elsewhere (Andersen et al. 1987; Andersen and Schelin1994).

<u>Aerobic power</u> was measured in a progressive cycle ergometer test. Maximal power output was used to calculate aerobic fitness. Subjects exercised for 7 minutes at an initial workload of 69 watts for females and 103 watts for males on a mechanically braked cycle ergometer at 70 rpm. Thereafter, the intensity was increased by 35 watts every 2 minutes until exhaustion. Maximal power output (MPO) was calculated as the power output on the final completed workload plus the duration of the last unfinished workload that the subject completed (i.e. 35 watts divided by the percentage of the 2 minutes cycled during the final stage).

Steady state oxygen uptake during the initial workload and maximal oxygen uptake (VO_{2max}) was measured in a randomly selected sub-group of 287 participants (126 males, 161 females) in order to convert the MPO to VO_{2max}. In these subjects VO_{2max} was measured a second time within a month of the first test and a calibration curve was calculated by linear regression (Andersen et al. 1987):

Boys: VO_{2max}=0.71+(MPO*0.010); Girls: VO_{2max}=1.01+(MPO*0.007).

Reproducibility in 35 subjects was r=0.95, and correlation to direct measurement of VO_{2max} in 287 subjects was r=0.90, p<0.001.

Muscle endurance. Dynamic muscle endurance in trunk flexors was measured by sit-ups. The subject was lying face up on the floor with vertical upper leg and fixed horizontal lower leg. Hands were crossed behind the neck. From the lying position, students were instructed to bring their right elbow to touch their left knee and then to return to the lying position, before the same movement was performed to the other side. Sit-ups were performed in a rhythm of 24 lifts per minute following a metronome until exhaustion. Isometric muscle endurance in the trunk extensors was assessed by the time the subject was able to keep the upper body hanging in a horizontal position, lying on a bench face down with fixed legs supported to the hip (Biering-Sorensen test (Biering-Sørensen1984)). Elbows were kept horizontally with fingers beside ears. Elbow flexor dynamic muscle endurance was measured by the number of times a 5 kg weight was lifted to the rhythm of a metronome. The subject was lying face down on a table supported to the shoulder. The arm was stretch downward and the elbow supported. With a 5 kg dumbbell in the hand, the elbow was bent to 90^0 35 times per minute until exhaustion.

Functional strength of the leg extensors was measured as the elevation of the center of gravity in a Sargent jump. A meter tape was attached to the mid of the body and went underneath a tape on the floor, where it was able to slide easily during the jump. The subject was standing on the floor, and the meter tape was read before the jump. After the landing at the same spot, the meter tape was read again. Counter movement in the knee extensors and arm swing were allowed. The best of 3 trials was recorded. Functional strength in the dominant arm was determined by throwing a 4 kg iron ball from a sitting position on the ground with a fixed upper body. The length of the throw was measured and the best of 3 trials recorded.

Flexibility was measured by a modified “sit and reach”. A meter stick was positioned on the floor (50 cm mark at feet level and 0 cm mark approximately at knee level). The feet were bent to a 90^0 position and the subjects stretched their hands slowly towards their feet as far as possible, the distance reached was assessed by the marked cm. Students were instructed to hold this position for at least 2 seconds, and the best of 3 trials was recorded.

Agility/functional strength. Two lines, at a distance of 10 meters, were drawn and 2 cones were placed at the distant line. The subject ran as fast as possible from the start line, picked up one cone at the distant line, returned to the start line and placed the cone on this line, before repeating the same run and retrieve with the second cone. The agility measure was the time to complete this 40 meters run with correct placement of the cones.

A priori we anticipated that bicycling would have a direct effect on aerobic power and muscle endurance in the trunk muscles (most Danes use racing bikes where the upper body is bent forward), but would have little effect on the other types of fitness. Muscle tension during bicycling is low compared to maximal tension, and a training effect on maximal strength should not be expected.

SPSS. version 13 was used for statistical analysis. Oneway ANOVA with Tukey posthoc test was used to compare means, and interaction between sex and traveling mode was tested using univariate general linear model.

Results

Mean (SD) height, weight and BMI for males was 179.2 cm (6.5 cm), 66.9 kg (8.0 kg) and 20.7 kg·m^{-2} (2.0 kg·m^{-2}) respectively, and in the females was 168.1 cm (6.5 cm), 58.5 kg (8.0 kg), and 20.1 kg·m^{-2} (2.2 kg·m^{-2}). There were no differences in height, weight and BMI between adolescents using different traveling modes in their commuting to school in this study population (all p-values >0.1).

Distribution of traveling modes in males and females is shown in table 1. Over 60% of both males and females bicycled to school as their dominant mode of transport. There was statistical evidence of a sex difference in distributions of mode of transport to school, which was largely driven by males being more likely to use passive modes of transport and females being more likely to walk. The percentage participating in any sports activities did not vary by gender ($p = 0.582$) or by mode of transport to school ($p = 0.065$). Males spent more time in leisure sports than females (5.40 vs 3.58 hours per week (h·w^{-1}), $p < 0.001$). Mean hours spent in sports activities per week did not vary by mode of transport ($p = 0.147$). In males, those using passive transportation spent 5.6 h·w^{-1} in sports activities and walkers and bicyclists both spent 5.3 h·w^{-1}. In girls, both passive travelers and walkers spent 3.8 h·w^{-1} in sports activities and bicyclists spent 3.5 h·w^{-1}.

Insert Table 1 here

Table 2 shows the mean levels of different measures of fitness by mode of transport in males and females. Adolescents cycling to school had higher aerobic power than those who walked or used passive transport. Statistics presented in table 2 are from a general linear model where transport is treated as a linear variable in the order: passive, walking and bicycling. A oneway ANOVA analysis and Tukey posthoc test in boys and girls, separately, showed a consistent pattern of higher aerobic power in cyclists, but not in walkers, both compared to passive transport. In boys, maximal work capacity was 5.9% higher, and in girls it was 4.6% higher in cyclists compared to passive transport. Theoretically, this difference could be explained by a better work efficiency during bicycling in the adolescents who cycled to school, i.e. they used less oxygen to perform the same amount of work. However, the difference in work capacity did reflect differences in maximal oxygen uptake. Oxygen uptake was measured directly in 126 boys and 161 girls. No difference was found between bicycling commuters and the others in VO_2 during cycling on a submaximal workload of 103 watts for the boys (1.55 ml $O_2 \cdot min^{-1} \cdot kg^{-1}$ for walkers and passive transport and 1.57 ml $O_2 \cdot min^{-1} \cdot kg^{-1}$ for cyclists), and 69 watts for the girls (1.17 and 1.16 ml O_2 $min^{-1} \cdot kg^{-1}$, respectively). Maximal oxygen uptake (ml $O_2 \cdot kg^{-1} \cdot min^{-1}$) in the subgroup with direct measurement of VO_{2max} was 4.7% higher in bicycling commuters compared to all others (53.2 vs 49.8) in boys, and 1.7% (40.5 vs 39.8 ml $O_2 \cdot min^{-1} \cdot kg^{-1}$) in girls, respectively.

Isometric muscle endurance was also higher in cyclists (10-16%), dynamic muscle endurance in the abdominal muscles was 10% higher, and flexibility was 6% higher in cyclists compared to passive travelers. However, no other fitness measures differed between those who did and did not cycle to school.

Insert Table 2 here

There was no interaction between sex and travel mode and we therefore calculated sex-adjusted differences in all fitness parameters with passive transport as the reference group (table 3). The only difference found between passive transport and walking was in the arm flexion dynamic test, where individuals who used passive transport scored better. Bicyclists performed better than passive transport users in aerobic fitness, situps, static back strength and sit and reach, but no differences were found in Sargent jump, iron ball throw, arm flexion dynamic test and the shuttle run test.

Insert Table 3 here

Discussion

The main findings in this study were that children who bicycled to school had higher aerobic power, muscle endurance (situps and static back strength) and flexibility (sit and reach) than children who walked or were driven to school. Other types of fitness such as arm extensor strength, arm flexion, agility and explosive power in the leg muscles did not differ between commuter groups. No difference was found in leisure sports participation by mode of transport. To some extent the difference between travel groups was specific to the types of fitness that we anticipated would be affected by bicycling and was not seen in types of fitness and muscle groups that one would not expect to be affected by bicycling. The better performance in the sit and reach test (flexibility) is an exception from this pattern. These observations provide some evidence that regular bicycling to school *per se* may relate to greater aerobic power and endurance in trunk muscles than either walking or passive transport.

Study strengths and limitations

The main limitation of this study is its cross sectional design, and consequently the inability to demonstrate a causal relationship between commuter cycling to school and fitness. However this study has a number of strengths and provides an important opportunity to further investigate the association between commuter cycling and fitness in young people. Firstly, there are few studies where a range of fitness outcomes have been measured in a large sample using different modes of transportation. Although the data used in this investigation date from the mid-1980's, transportation habits have not changed substantially in Denmark since this date. For example, more recent data in 15 year old Danish children showed that 65% bicycled to school in 1998 (Cooper et al. 2006). We can see no plausible biological reasons why the associations that we have found in this study would not be generalizable to contemporary Danish adolescents or indeed to other populations of adolescents. The results from this study offer a powerful incentive to countries where cycling rates are low and declining to promote greater use as a mode of transport. A second strength of this study was having directly measured VO_{2max} in a large subgroup, which made it possible to exclude the suggestion that a better work efficiency caused an artefactually higher maximal power output in those who cycled to school. Finally, the study was an unselected population sample of females and males from a range of socioeconomic backgrounds, with no selection on the basis of mode of transport or physical fitness (all participants completed the fitness tests). The fact that there was no difference between transport groups in sports participation point against any possibility that we somehow managed only to select bicyclists who were generally physically active.

Potential health benefits of bicycling

Active commuting has been promoted as a potential source of moderate physical activity in both children and adults. In adults, bicycling to work has been associated with an approximately 30% lower risk of all-cause mortality in both men and women after adjustment for other risk factors and general level of physical activity (Andersen et al. 2000; Matthews et al. 2007). Furthermore, bicycling in adults has been shown to be associated with heart rates that are consistent with an aerobic benefit, which is not the case for regular walking (Hendriksen et al. 2000; Vuori et al. 1994). However, the benefit of bicycling in children and adolescents is less clear. To our knowledge only one previous study has examined this issue and it found, consistent with our study, that bicycling as a mode of transport to school was associated with increased aerobic fitness in individuals aged 9 and 15 years (Cooper et al. 2005). Other aspects of fitness were not examined in that study. Thus, our study adds to the scant evidence of a specific benefit for adolescents of bicycling to school, a benefit that appears to be greater than that achieved from walking. In both the previous study (Cooper et al. 2005) and our own study aerobic power was assessed by a progressive cycle test and it could be argued that association of bicycling to school with aerobic power assessed by a cycle test in both of these studies reflects familiarity with the cycle and better work efficiency during the test because of this. However, we found no difference in work efficiency by mode of transport in our study, which suggests this is an unlikely explanation for the findings in these two studies. The specific associations with other forms of fitness (in addition to aerobic fitness) that we *a priori* specified would be expected from bicycling and that were tested in our study also argue against the notion that familiarity with a bike produced the aerobic fitness association.

Bicycling to school is rare in most Western countries (Center for Disease Control (CDC)2000; Cooper et al. 2003), with Denmark and Holland being notable exceptions. This low level of bicycling in most countries is likely to be attributable to a number of social, environmental, and personal factors, including high traffic volume, poor provision for cyclists, and parental fears regarding child safety (Center for Disease Control (CDC)2000; Lawlor et al. 2003; Timperio et al. 2005). Denmark is a country with a tradition of bicycling, where many of these issues have been addressed. Provision of bicycle racks, protected and well maintained bicycle lanes, priority given to bicyclist over other traffic, clear route marking, and a culture in which bicycling is encouraged have led to a high proportion of adults and children regularly bicycling. Whilst climate has also been suggested as a further factor related to levels of bicycling this seems unlikely given that levels of bicycling in the city of Malmø, Sweden, a city 10 miles from Copenhagen and with the same climate and environment, but lacking the structural support of bicyclists, has very low levels of bicycling.

Perspectives

If other studies confirm our findings and do indeed support a specific fitness benefit of bicycling and if further studies also suggest that bicycling has specific health benefits, this should provide an impetus for the necessary social, environmental and individual changes needed to promote safe bicycling in school aged children.

It might be argued that since a high proportion of children in Denmark already cycle to school any initiatives to try and increase this further in Denmark are unlikely to be successful and the absolute health gain might be limited. However, our results are important both for providing further incentive to maintain levels of bicycling in Denmark, and for providing evidence to support increased bicycling in other countries.

Reference List

1. Andersen LB, Harro M, Sardinha LB, Froberg K, Ekelund U, Brage S, Anderssen SA (2006). Physical activity and clustered cardiovascular risk in children: a cross-sectional study (The European Youth Heart Study). Lancet 368: 299-304.

2. Andersen LB, Henckel P, Saltin B (1987). Maximal oxygen uptake in Danish adolescents 16-19 years of age. Eur J Appl Physiol 56: 74-82.

3. Andersen LB, Schelin B (1994). Physical activity and performance in a random sample of adolescents attending school in Denmark. Scand J Med Sci Sports 4: 13-18.

4. Andersen LB, Schnohr P, Schroll M, Hein HO (2000). All-cause mortality associated with physical activity during leisure time, work, sports, and cycling to work. Arch Intern Med 160: 1621-1628.

5. Biering-Sørensen F (1984). A one-year prospective study of low back trouble in a general population. The prognostic value of low back history and physical measurements. Dan Med Bul 31: 362-375.

6. Center for Disease Control (CDC) (2000). Barriers to children walking and biking to school – the United States, 1999. JAMA 288: 1343-1344.

7. Cooper AR, Andersen LB, Wedderkopp N, Page AS, Froberg K (2005). Physical activity levels of children who walk, cycle, or are driven to school. Am J Prev Med 29: 179-184.

8. Cooper AR, Page AS (2006). Childhood obesity, physical activity and the environment. Cameron N, Norgan NG, Ellison TH. Childhood Obesity: Contemporary Issues. Taylor & Francis. 119-134.

9. Cooper AR, Page AS, Foster LJ, Qahwaji D (2003). Commuting to school: are children who walk more physically active? Am J Prev Med 25: 273-276.

10. Cooper AR, Wedderkopp N, Wang H, Andersen LB, Froberg K, Page AS (2006). Active travel to school and cardiovascular fitness in Danish children and adolescents. Med Sci Sports Exerc 38: 1724-1731.

11. Eisenmann JC, Katzmarzyk PT, Perusse L, Tremblay A, Despres JP, Bouchard C (2005). Aerobic fitness, body mass index, and CVD risk factors among adolescents: the Quebec family study. Int J Obes (Lond) 29: 1077-1083.

12. Hendriksen IJM, Zuiderveld B, Kemper HCG, Bezemer PD (2000). Effect of commuter cycling on physical performance of male and female employees. Med Sci Sports Exerc 32: 504-510.

13. Lawlor DA, Ness AR, Cope AM, Davis A, Insall P, Riddoch C (2003). The challenges of evaluating environmental interventions to increase population levels of physical activity: the case of the UK National Cycle Network. J Epidemiol Community Health 57: 96-101.

14. Matthews CE, Jurj AL, Shu XO, Li HL, Yang G, Li Q, Gao YT, Zheng W (2007). Influence of exercise, walking, cycling, and overall nonexercise physical activity on mortality in Chinese women. Am J Epidemiol 165: 1343-1350.

15. Safrit MJ (1990). The validity and reliability of fitness tests for children. Pediatr Exerc Sci 2: 9-28.

16. Sirard JR, Riner WF, Jr., McIver KL, Pate RR (2005). Physical activity and active commuting to elementary school. Med Sci Sports Exerc 37: 2062-2069.

17. Timperio A, Salmon J, Telford A, Crawford D (2005). Perceptions of local neighbourhood environments and their relationship to childhood overweight and obesity. Int J Obes (Lond) 29: 170-175.

18. Tudor-Loche C, Ainsworth BE, Popkin BM (2001). Active commuting to school. An overlooked source of childrens physical activity? Sports Med 31: 309-313.

19. Tudor-Locke C, Ainsworth BE, Adair LS, Popkin BM (2003). Objective physical activity of filipino youth stratified for commuting mode to school. Med Sci Sports Exerc 35: 465-471.

20. Vuori IM, Oja P, Paronen O (1994). Physically active commuting to work--testing its potential for exercise promotion. Med Sci Sports Exerc 26: 844-850.

21. Wedderkopp N, Froberg K, Hansen HS, Andersen LB (2004). Secular trends in physical fitness and fatness in Danish 9-year old girls and boys. Odense School child Study and Danish substudy of The European Youth Heart Study. Scand J Med Sci Sports Exerc 14: 1-6.

22. Wedderkopp N, Froberg K, Hansen HS, Riddoch C, Andersen LB (2003). Cardiovascular risk factors cluster in children and adolescents with low physical fitness. Pediatr Exerc Sci 15: 419-422.

Table 1. Percentage of subjects participating in leisure time sports by gender and mode of transport to school.

	Males					**Females**				
	No sport		**Leisure sport**		**All**	**No sport**		**Leisure sport**		**All**
	N (%)	$H \cdot w^{-1}$	N (%)	$H \cdot w^{-1}$	N (%)	N (%)	$H \cdot w^{-1}$	N (%)	$H \cdot w^{-1}$	N(%)
Cycling	71 (55.0%)	0.9	262 (63.0%)	6.5	333 (61.1%)	104 (61.5%)	0.9	351 (65.6%)	4.3	455 (64.6%)
Walking	17 (13.2%)	0.9	41 (9.9%)	7.1	58 (10.6%)	24 (14.2%)	0.9	80 (15.0%)	4.7	104 (14.8%)
Train/bus	29 (22.5%)	0.8	76 (18.3%)	7.7	105 (19.3%)	29 (17.2%)	0.7	84 (15.7%)	4.6	113 (16.1%)
Car/mc	12 (9.3%)	0.7	37 (8.9%)	6.6	49 (9.0%)	12 (7.1%)	0.6	20 (3.7%)	6.4	32 (4.5.%)

Hours of sports per week ($H \cdot w^{-1}$) includes physical education lessons. There were differences in travel modes between genders (p=0.002), but no difference in sports participation between travel modes or genders.

Table 2. Descriptive statistics for physical fitness measures by travel mode in boys and girls.

	Males								Females								P for Transport
	Bicycle		Walking		Train/bus		Car/mc		Bicycle		Walking		Train/bus		Car/mc		
	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	
Aerobic power (ml $kg^{-1} \cdot min^{-1}$)	52.0	(7.3)	49.9	(6.5)	48.8	(6.7)	49.8	(8.2)	41.1	(5.6)	40.0	(5.1)	39.3	(5.2)	39.5	(4.6)	< 0.001
Sargent jump (m)	0.53	(0.08)	0.52	(0.09)	0.52	(0.08)	0.49	(0.07)	0.42	(0.08)	0.41	(0.07)	0.42	(0.08)	0.42	(0.06)	= 0.401
Iron ball throw (m)	3.00	(0.66)	2.94	(0.67)	2.84	(0.51)	3.14	(0.85)	2.09	(0.40)	2.13	(0.46)	2.10	(0.41)	2.02	(0.48)	= 0.290
Situps (n)	33	(17)	29	(17)	30	(15)	27	(15)	24	(13)	21	(11)	22	(11)	20	(11)	= 0.005
Static back strength (sec)	143	(50)	140	(53)	130	(50)	128	(59)	154	(66)	146	(66)	137	(56)	120	(66)	< 0.001
Arm flexion dynamic test (n)	62	(36)	56	(31)	68	(49)	62	(31)	29	(22)	25	(15)	27	(14)	34	(42)	= 0.191
Sit and reach (cm)	50	(11)	50	(12)	48	(11)	47	(11)	57	(9)	55	(10)	53	(10)	52	(10)	< 0.001
Shuttle run (sec)	10.6	(1.0)	10.7	(0.9)	10.6	(1.0)	11.0	(1.6)	11.8	(1.0)	12.0	(1.0)	11.7	(1.0)	11.7	(1.0)	= 0.277

There was no interaction between traveling mode and sex, and statistics was calculated adjusted for sex. 'mc' is motorcycle or moped.

Table 3. Detailed information on absolute differences in fitness measures between passive transport and the two active types of traveling.

	Walking vs passive (95% CI)	P value	Cycling vs passive (95% CI)	P value	Males vs females (95% CI)	P value
Aerobic power (ml min-1 kg-1)	0.83 (-0.46-2.11)	=0.206	2.34 (1.45-3.24)	<0.001	10.49 (9.73-11.24)	<0.001
Sargent jump (m)	-0.005 (-0.021-0.011)	=0.538	0.004 (-0.007-0.016)	=0.435	0.107 (0.097-0.116)	<0.001
Iron ball throw (m)	0.04 (-0.07-0.15)	=0.453	0.04 (-0.04-0.11)	=0.345	0.88 (0.82-0.94)	<0.001
Situps (n)	-0.18 (-3.18-2.81)	=0.904	2.97 (0.84-5.09)	=0.006	8.60 (6.82-10.37)	<0.001
Static back strength (sec)	10.70 (-1.53-22.94)	=0.086	17.63 (9.03-26.22)	<0.001	-8.48 (-15.65—1.31)	=0.020
Arm flexion dynamic test (n)	-6.47 (-12.59—0.35)	=0.038	-2.13 (-6.44-2.17)	=0.331	34.17 (30.56-37.76)	<0.001
Sit and reach (cm)	1.91 (-0.13-3.96)	=0.067	3.14 (1.72-4.57)	<0.001	-5.77 (-6.97—4.56)	<0.001
Shuttle run (sec)	0.15 (-0.06-0.36)	=0.171	-0.01 (-0.16-0.14)	=0.875	-1.18 (-1.31—1.06)	<0.001

Since there was no difference in fitness between train/bus and car/motorcycle these two categories were merged. Differences are sex adjusted and shown with 95% confidence intervals (95% CI), and p values are for whole group adjusted for sex. Sex differences are shown to the right.