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**Abstract:** Background: The positive impacts of active travel on cardiovascular health still require further research in youth populations which are increasing the risk of obesity. Purpose: The present study aimed to analyse the associations between active travel (e.g. walking/bicycling) to school and cardiovascular risk markers in children. Methods: The sample comprised 665 children (345 boys) aged 7-9 years. Height, weight, and skinfolds were collected by a trained fieldworker as well as data on cardiovascular risk markers between March 2009 and January 2010 (analysed data in 2012-2013). Information on mode and duration of travel to school was gathered by questionnaire. Outcome variables were statistically normalized and expressed as Z scores. Logistic regressions, with adjustments for confounders, were used. Results: Children who walking/bicycling to school were significantly less likely to have lower clustered CRS than their passive commuting counterparts. The final regression model also indicated that those walking or bicycling to school were more likely to have higher levels of PA than those who usually travel by motor transports; level of education of parents was also positive associated with active commuting in children. Conclusion: Findings showed an independent association between active commuting and the clustered of cardiovascular risk in children aged 7-9 yrs.

April 9th, 2014

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Dear Professor Franco,

After have been acting several times as reviewer for Preventive Medicine, our research group is pleased to submit the manuscript “**Active commuting and its associations with cardiovascular risk markers in children**” as a brief report for publication in the *Preventive Medicine*.

The manuscript is original, has been submitted solely to Preventive Medicine and it has not been previously published. The paper does not include content that is abusive, defamatory, libelous, obscene, and fraudulent, in violation of applicable laws, or which would otherwise be offensive.

All of the co-authors agree with the order of names on the title page of the manuscript and they have reviewed and approved the complete manuscript. The corresponding author would like to confirm full access to all aspects of the research and writing process, and take final responsibility for the paper.

Yours sincerely,

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## ACTIVE COMMUTING AND ITS ASSOCIATIONS WITH CARDIOVASCULAR RISK MARKERS IN CHILDREN

### ABSTRACT

**Background:** The positive impacts of active travel on cardiovascular health are well established in adults but still require further research, especially in youth populations which are increasing the risk of obesity. **Purpose:** The present study aimed to analyse the associations between active travel (e.g. walking/bicycling) to school and cardiovascular risk markers in children. **Methods:** The sample comprised 665 children (345 boys) aged 7-9 years. Height, weight, and skinfolds were collected by a trained fieldworker as well as data on cardiovascular risk markers (resting heart rate, diastolic and systolic blood pressure) between March 2009 and January 2010 (data were analysed in 2012-2013). Information on mode and duration of travel to school was gathered by questionnaire. Outcome variables were statistically normalized and expressed as *Z* scores. A cardiovascular risk score (CRS) was computed as the mean of the *Z* scores. Logistic regressions, with adjustments for confounders, were used. **Results:** Children who walking/bicycling to school were significantly less likely to have lower clustered CRS than their passive commuting counterparts. The final regression model also indicated that those walking or bicycling to school were more likely to have higher levels of PA than those who usually travel by motor transports; level of education of parents was also positive associated with active commuting in children. **Conclusion:** Findings showed an independent association between active commuting and the clustered of cardiovascular risk in children aged 7-9 yrs. These findings may be useful for policy makers and city planners when designing neighborhoods that promote PA.

**Keywords:** *Inactivity, Childhood, Obesity, Public Health, Active transportation*

33 **INTRODUCTION**

34 Active commuting, which usually means walking or cycling to school/work, could have  
35 multiple health benefits by increasing physical activity (PA) and reducing the adverse health  
36 effects of sedentary behavior caused, among other things, for motor vehicle transport (1).  
37 Among youth, rates of active commuting to school have decreased beside a context of  
38 declining levels of PA and increasing prevalence of overweight (2, 3), which suggests that  
39 these trends are probably linked. The literature indicates that possible health benefits of active  
40 commuting to school include higher rates of PA and higher cardiovascular fitness among  
41 youth, which are linked with reduced risk for metabolic and cardiovascular diseases (4).

42 In context of the preceding trends, further research is needed since an increasing risk  
43 of obesity and metabolic problems in Southern countries of Europe is evident and where data  
44 is lacking. Therefore, this study aimed to analyse the associations between active travel (e.g.  
45 walking/bicycling) to school and cardiovascular risk markers in children.

47 **METHODS**

48 *Sample*

49 The *Portuguese Prevalence Study of Obesity in Childhood* (PPSOC) was a random cross-  
50 sectional survey conducted between March 2009 and January 2010 (data were analysed in  
51 2012-2013). Details on sampling and response rates can be found elsewhere (5). A total of  
52 17,509 2-13 year old children were recruited among whom 665 children (345 boys) aged 7-9  
53 years were included in the present analyses. Ethical approval for PPSOC was given by the  
54 *Portuguese Commission for Data Protection* which requires anonymity and non-  
55 transmissibility of data (IRB). Curricular and parental informed consent was obtained prior to  
56 data collection.

58 *Anthropometry*

59 Height and weight were measured at school in the morning with participants in t-shirt and  
60 shorts and without shoes. Skinfold thicknesses (mm) (triceps, subscapular and suprailiac)  
61 were also measured by a trained research workers using a skinfolds caliper produced by  
62 Holtain Ltd, Crymych UK. Body mass index (BMI,  $\text{kg}/\text{m}^2$ ) was subsequently calculated.

### 64 ***Physical Activity (PA)***

65 PA was assessed by a questionnaire, filled out by parents who collected information of PA  
66 [i.e. outside school, in organized sports, and mode and duration of travel to/from school  
67 (walking or cycling)]. These three PA variables were converted into the same units (minutes  
68 per week) and summed into one total PA variable. Similar procedure and variables were used  
69 in recent epidemiological studies (5); in addition, similar PA instrument was previously used  
70 in Portuguese youth with good reliability (ICC: 0.92 to 0.96) (6).

### 72 ***Cardiovascular risk score (CRS)***

73 Diastolic (DBP) and systolic (SBP) blood pressure (mmHg), and resting heart rate (RHR)  
74 (beats/minute) were measured using an Omron M7 blood pressure monitor by trained research  
75 workers. Three measurements were taken for DBP, SBP and RHR, the mean of the three  
76 measurements were used in analyses. A clustered cardiovascular risk score was calculated  
77 from the above risk markers; similar procedure was used in previous epidemiological studies  
78 (7).

80 ***Parental education:*** Educational background of fathers and mothers was based on the  
81 *Portuguese Educational System* and the three educational levels were defined as: 1=Low-  
82 Education; 2=Middle-Education and 3=High-Education. Similar procedures have used in the  
83 Portuguese context (8, 9).

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2 85 ***Statistical analysis***  
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4 86 Sex-specific descriptive statistics were calculated for anthropometrical, daily PA and  
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7 87 cardiovascular risk variables. One-way analysis of variance (ANOVA) was used to test the  
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10 88 effect of sex on the above mentioned variables. All ANOVAs were followed with Bonferroni-  
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12 89 corrected *post hoc* tests.  
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14 90 Associations between active commuting and the CVR, controlling for potentially  
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17 91 confounding effects of chronological age, BMI, time spent in organized sports and, father and  
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19 92 mother education were estimated using logistic regression analysis. The complex samples  
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21 93 generalised linear models (CSGLM) procedure to produce results with robust standard errors  
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24 94 that take into account clustering of participants by school were used. Significance was set at  
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26 95 5%. SPSS 15.0 (SPSS Inc., Chicago, Illinois, USA) was used.  
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31 97 **RESULTS**  
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34 98 Characteristics of the sample are summarized in Table 1. Time spent playing sport was, on  
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36 99 average, significantly higher in males, whereas diastolic blood pressure and cardiovascular  
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39 100 risk score were higher in females.  
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44 102 [Table 1]  
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48 104 Children who walking/bicycling to school were significantly less likely to have lower  
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51 105 clustered CVR than their passive commuting counterparts, after adjustment for confounders.  
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53 106 The final regression model also indicated that those walking/bicycling to school were  
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56 107 significantly more likely to have higher levels of PA than those who usually travel by motor  
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58 108 transports; in addition, significant predictors of the active commuting were higher educational  
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109 level of fathers (odds ratio: 2.56, 95% CI 1.35 to 4.87, p<0.01) and mothers (odds ratio: 1.89,  
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2 110 95% CI 1.03 to 3.47, p<0.05).  
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## 14 115 **DISCUSSION**

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16 116 Understanding daily routine activities, such as active commuting, which may have important  
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18 117 health implications in children should be analyzed, especially in under studied populations of  
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21 118 Southern of Europe where the highest rates of obesity are prevalent. Data revealed that active  
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23 119 commuting children were significantly less likely to have lower clustered CVR than their  
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25 120 passive commuting counterparts. These results are consistent with previous research in U.S.  
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28 121 (10), the Netherlands (11), Australia (12) and Portugal (13) which suggested that active  
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30 122 commuters have higher odds to have a better cardiovascular and metabolic profile than their  
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32 123 non-active peers, independent of moderate-to-vigorous physical activity (MVPA).  
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36 124 Physical environmental factors that may influence children's mode of transport to  
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38 125 school include road and sidewalk infrastructure, traffic safety, accessibility of public  
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40 126 transportation, and weather conditions (14). Findings also revealed a positive association  
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42 127 between active commuting and PA levels in youth corroborating previous studies (3, 10).  
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44 128 Data from these studies indicate that children who use active forms of transport to school  
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46 129 accumulate approximately 20 additional minutes of MVPA per day on weekdays (3, 10) and  
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49 130 expend 33.2 to 44.2 kcal more per day than do youth who are driven to school (15).  
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53 131 In the final model, the strongest predictor of active commuting among Portuguese  
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55 132 adolescent girls was parental education. It has been suggested that mothers with higher levels  
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58 133 of education are more likely to engage in health promoting behaviours and thus present an  
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134 influential role model for children (16). In fact, family characteristics, especially parents, may  
135 play an important behavioural role, serving as models from early childhood through  
136 adolescent years (17). However, the literature on the issue of SES and active commuting is  
137 somewhat inconclusive. Some studies showed no association between family SES and  
138 children's mode of transport to school (18) while others showed a contrasting results in  
139 Australia (19) and U.S. (20) suggesting that children from low SES backgrounds are more  
140 likely than children from high SES backgrounds to actively commute to school, and may  
141 require additional research.

142           Limitations of the present study should be also recognized; firstly, this study has a  
143 cross-sectional design and, therefore, it is not possible to infer casual relationships.  
144 Furthermore, habitual PA was obtained by self-reported instrument (e.g. parental proxy),  
145 which might be inaccurate as parents are not always with their children, especially outside the  
146 domestic environment. Other limitations include the absence of blood variables, such as lipids  
147 and indicators of glucose metabolism that would allow more comprehensive examination.

## 148 149 **CONCLUSION**

150 The present study showed an independent association between active commuting and the  
151 clustered of cardiovascular risk in children aged 7-9 years. Level of education of parents was  
152 associated with active commuting in children. Both educational and environmental strategies  
153 are necessary to encourage children to walk/bike and to provide safety and pleasant physical  
154 environments for youth.

## 155 156 **ACKNOWLEDGMENT**

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1  
2 160 **Declaration of interest:** The authors report no conflicts of interest. The authors alone are  
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5 161 responsible for the content and writing of the paper.  
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4 **ACTIVE COMMUTING AND ITS ASSOCIATIONS WITH**  
5 **CARDIOVASCULAR RISK MARKERS IN CHILDREN**  
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10 **Table 1.** Descriptive characteristics of participants <sup>a</sup>.

Variable	Males (n=345)	Females (n=319)	Total sample (n=664)
Chronological age, years	8.4 (0.9)	8.6 (0.9) **	8.5 (0.9)
Weight (kg)	30.7 (6.7)	30.6 (6.5)	30.6 (6.6)
Height (m)	1.31 (0.07)	1.31 (0.7)	1.31 (0.07)
BMI <sup>b</sup>	17.70 (2.54)	17.71 (2.52)	17.69 (2.53)
active travel time to/from school (mins/wk)	17.3 (0.7)	17.3 (0.7)	17.3 (0.7)
time spent playing sport <sup>c</sup> (mins/wk)	140.2 (150.3)	109.7 (132.6) *	125.6 (142.8)
school physical activity time (mins/wk)	74.9 (30.0)	78.3 (29.3)	76.5 (29.7)
resting heart rate (beats/min)	85.7 (11.1)	89.6 (11.8) **	87.5 (11.6)
DBP <sup>d</sup> (mmHg)	58.0 (6.8)	59.8 (6.9) **	58.9 (6.8)
SBP <sup>e</sup> (mmHg)	95.3 (9.5)	95.8 (10.3)	95.5 (9.9)
cardiovascular risk score	-0.13 (0.76)	0.12 (0.81) **	-0.01 (0.80)

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12 <sup>a</sup> Data are shown as mean (SD) unless otherwise stated;

13 <sup>b</sup> Body Mass Index;

14 <sup>c</sup> Log-transformed values were used in the analysis.

15 <sup>d</sup> Diastolic blood pressure;

16 <sup>e</sup> Systolic blood pressure.

17 \*  $p < 0.05$ ; \*\*  $p < 0.01$ ;

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**Table 2.** The association between active commuting (e.g. walking or cycling vs. motor transportation) and cardiovascular risk score controlling for biological and social variables in children aged 7-9 years (n=664).

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Model <sup>a</sup>	<i>B</i>	S.E.	Active commuting		p
			<i>e<sup>B</sup></i>	95% C.I.	
1	-0.30	0.13	0.74	0.58 to 0.95	0.02
2	-0.32	0.13	0.73	0.56 to 0.94	0.02
3	-0.49	0.17	0.61	0.44 to 0.85	0.01
4	-0.43	0.17	0.65	0.47 to 0.91	0.01
5	-0.37	0.18	0.69	0.49 to 0.98	0.04

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<sup>a</sup> Model 1 = cardiovascular risk score; Model 2 = model 1 + chronological age and sex; Model 3 = model 2 + BMI; Model 4 = model 3 + daily physical activity; Model 5 = model 4 + paternal SES, and maternal SES.

April 9th, 2014

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Dear Professor Franco,

The authors are pleased to submit the manuscript “**Active commuting and its associations with cardiovascular risk markers in children**” as a brief report for publication in the *Preventive Medicine*. In addition, they would like to communicate the following ***Declaration of interest***: The authors report no conflicts of interest.

Yours sincerely,

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