



Active behaviors, BMI and parental perceptions of neighborhood environments in girls aged 7-9 years

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ACTIVE BEHAVIORS, BMI and PARENTAL PERCEPTIONS OF NEIGHBORHOOD ENVIRONMENTS IN GIRLS AGED 7-9 YEARS

ABSTRACT

Background: Habitual PA may be influenced by a broader range of neighborhood, school, community, and family factors. Young people, particularly girls, tend to show lower habitual PA than boys and should be a target for prevention strategies aimed at healthy lifestyles. The purpose of this study was twofold: 1) to determine which neighborhood perceived attributes are related to active behaviors; 2) to analyze which neighborhood perceived attributes are related to BMI of children.

Methods: The sample comprised 1825 girls aged 7-9 years. Height and weight were measured, and Body Mass Index (BMI) was calculated subsequently. Participants were classified as normal weight or overweight/obese (Cole et al., 2000). Environmental variables and physical activities were assessed by questionnaire filled by their parents - the Environmental Module of the International Physical Activity Prevalence Study (IPS, 2002) was used. Multiple linear regressions, with adjustments for parental education, were used.

Results: Data revealed that neighbors with recreational facilities and infrastructure for walking and cycling were predictors of active behaviors; neighborhood safety was an additional related factor of habitual PA. On the other hand, neighbors with better access to destinations and with interesting things to look at while walking are significantly associated with lower BMI in Portuguese children.

Conclusion: The study found some significant relationships between parental perceptions of the environment and BMI and habitual PA of Portuguese girls, especially related to security for walking and unpleasant neighborhood, and access to destinations.

Keywords: *Built environment, Childhood, Active behaviour, Public Health*

INTRODUCTION

The prevalence of overweight and obesity in young people has substantially increased in many countries during the past decades (Gupta and others, 2013; Lobstein, 2010). The aetiology of obesity is complex and believed to be linked with environment factors that contribute to the decreasing adoption of active behaviours (SB). Because children have less autonomy than adults, these neighborhood environmental characteristics, as well as their parents' perceptions of these characteristics, may have particular impact on their physical activity (de Vet and others, 2011). While positive associations have been identified (Davison and Lawson, 2006; Ferreira and others, 2007) there are conflicting evidence and conclusions being drawn about the potential impact of the built environment on young people's behavior (Giles-Corti and King, 2009; Sallis and Glanz, 2006).

Effectiveness of interventions or prevention strategies strongly depends upon an understanding of the causes and correlates of obesity and active behaviours. On one hand, technological changes such as the use of electronic games and other devices and television viewing have led to an increase of opportunities to undertake convenient and attractive SB as part of a contemporary lifestyle which are strongly correlated to weight gain in children (Drenowatz and others, 2013). On the other hand, the interaction of environmental, social, and educational factors play an important role on leisure activity choices, and it has been responsible of perpetuating specific stereotypes among youth (Ramirez and others, 2011). Thus, the need to increase/promote physical activity levels among young people, particularly girls who tend to show lower habitual PA than boys, has been consistently emphasized as a public health priority (Bailey and others, 2013; Cumming and Riddoch, 2008). However, it is important to know parental perceptions of their neighborhood doing the role that parents have in children's behaviors.

Given that the available information about the relationship of these constructs in Southern European communities is relatively limited, and it achieves greater insight since

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3 youth from those countries have the highest prevalence of overweight/obesity. In addition,
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5 there is age-related decline of active behaviors throughout the life span, and the transition
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7 from the childhood to adolescence seems to be a critical period to be studied. Therefore, the
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9 aim of the present study was twofold: 1) to determine which neighborhood perceived
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11 attributes are related to active behaviors; 2) to analyze which neighborhood perceived
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13 attributes are related to BMI after controlling for potential socio-demographic and lifestyle
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15 confounding factors in a sample of children.
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20 **METHODS**

21 *Participants*

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23 The *Portuguese Prevalence Study of Obesity in Childhood* (PPSOC) was a random cross-
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25 sectional survey conducted in mainland schools in Portugal between March 2009 and January
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27 2010. Details on sampling and response rates can be found elsewhere (Jago and others, 2012).
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29 Sampling was based on a sex and age-specific proportionate stratified random design with
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31 district as the primary sampling unit. A total of 17,509 2-13 year old children were recruited
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33 among whom 1,825 female children aged 7-9 were included in the present analyses. Ethical
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35 approval for PPSOC was given by *Direcção Geral de Inovação e Desenvolvimento*.
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37 *Curricular* (DGIDC) and parental informed consent was obtained prior to data collection.
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44 *Anthropometry*

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46 Height and weight were measured at school in the morning using a portable Seca 217
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48 stadiometer and portable Seca 770 scales to the nearest 0.1 cm and 0.1 kg, respectively, with
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50 participants in t-shirt and shorts. Body mass index (BMI, kg/m²) was calculated and
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52 categorized using age and sex-adjusted cut-off points (Cole and others, 2000). The sample
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54 was divided into two weight-status groups, normal weight and overweight/obese.
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Environmental neighborhood perceptions

Parental perceptions of their local neighborhoods were assessed by a questionnaire using the Environmental Module of the International Physical Activity Prevalence Study (IPS, 2002). This questionnaire has been previously used in Portuguese youth (Mota and others, 2005; Santos and others, 2009) showing good reliability (Intra-class correlation coefficients ranging from 0.36 to 0.79) (Mota and others, 2005). The questionnaire was designed to be a brief assessment of variables believed to be related to the activity-friendliness of neighborhoods. Neighborhood environmental variables assessed included 1) access to destination (two questions); 2) connectivity of the street network (one question); 3) infrastructure for walking and cycling (one question); 4) neighborhood safety (two questions); 5) social environment (one question); 6) aesthetics (one question); and 7) recreation facilities (one question). A four-point scale assessed each question: strongly disagree, somewhat disagree, somewhat agree, and strongly agree. However, for statistical analysis, a dichotomous variable was constructed. Responses to items were collapsed in two categories: 1) “somewhat agree” and “strongly agree,” and 2) “strongly disagree” and “somewhat disagree.”

Habitual Physical Activity (PA)

PA was assessed by a questionnaire which collected information of PA time outside school and minutes per week spent in organized sports outside of school; mode and duration of travel to/from school (walking or cycling) was also assessed. The three PA variables (physical activity at school, time spent walking or cycling to and from school, and time spent playing sports outside of school) were converted into the same units (minutes per week) and summed into one total physical activity variable. Similar procedure and variables were used in recent epidemiological studies (Jago and others, 2012); in addition, similar PA instrument was previously used in Portuguese youth with good reliability (ICC: 0.92 to 0.96) (Mota and Esculcas, 2002).

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5 **Parental education:** Educational background of fathers and mothers were used as a proxy for
6 socio-economic status. It was based on the *Portuguese Educational System* [(1) 9 years or less
7 – sub-secondary; (2) 10–12 years–secondary, and (3) higher education)]. The three
8 educational levels were defined as, respectively: 1 = Low Education; 2 = Middle Education
9 and 3 = High Education. Similar procedures have used in the Portuguese context (Machado-
10 Rodrigues and others, 2012b; Mota and others, 2011).
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20 **Statistical analysis**

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22 Age-specific descriptive statistics were calculated for height, weight, BMI and total
23 minutes of habitual PA. One-way analysis of variance (ANOVA) was used to test the effect of
24 age on the above mentioned variables. All ANOVAs were followed with Bonferroni-
25 corrected *post hoc* tests.
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32 Associations between weight status and habitual PA with the perceptions of
33 neighborhood environments, controlling for potentially confounding effects of chronological
34 age, BMI, time spent in organized sports and, father and mother education were estimated
35 using multiple linear regression analysis. The complex samples generalised linear models
36 (CSGLM) procedure to produce results with robust standard errors that take into account
37 clustering of participants by school were used. Significance was set at 5%. SPSS 15.0 (SPSS
38 Inc., Chicago, Illinois, USA) was used.
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49 **RESULTS**

50 Characteristics of the sample by age are summarized in Table 1. The mean age of girls was
51 8.48 (± 0.87) years and about 69% of girls were categorized as normal weight, 23% as
52 overweight, and 8% as obese. As expected, chronological age had a significant effect on body
53 size; 9 years-old girls were, on average, 6.0 cm taller and 3.9 kg heavier than 8 years-old
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3 counterparts who were 5.0 cm taller and 3.1 Kg heavier than 7 years-old girls. In addition,
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5 data revealed that older girls had significantly more time devoted in organized sports than
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7 their younger peers.
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12 [Table 1]
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16 Associations between weight status and habitual PA with the perceptions of neighborhood
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18 environments, controlling for the afore-mentioned confounding effects are presented in Table
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20 2 and 3. There was an inverse association between parents who agreed that “Many stores are
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22 within easy walking distance of my home” and BMI of female children.
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27 [Table 2]
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32 On the other hand, data revealed that female parents who agreed that “there is so much traffic
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34 on the streets that it makes it unpleasant to walk in the neighborhood” trend to have less active
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36 children; in addition, there was a positive association between higher level of children PA and
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38 the parental perception of “It is easy to walk to a transit stop (bus, trolley) from my home”
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40 and “I see many people being physically active in my neighborhood”. Finally, security for
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42 walking (e.g. “The crime rate in my neighborhood makes it unsafe or unpleasant to walk in
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44 my neighborhood”) was significantly related with both habitual PA and BMI of children.
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53 **DISCUSSION**

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55 Understanding physical environmental factors that may influence children’s lifestyle should
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57 be analyzed, especially in under studied populations of Southern of Europe where the highest
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3 rates of obesity are prevalent. The present study examined the associations between features
4 of the built environment and weight status and active behaviour of Portuguese children. Data
5 revealed that neighbors with recreational facilities and infrastructure for walking and cycling
6 were predictors of active behaviors; neighborhood safety was an additional related factor of
7 habitual PA. On the other hand, neighbors with better access to destinations and with
8 interesting things to look at while walking are significantly associated with lower BMI in
9 Portuguese children.
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19 Previous studies of youth examining perceived safety of parks have shown a negative
20 association between low safety and PA in girls (Sallis and others, 2002). In addition, data
21 from Portuguese studies (Loureiro and others, 2010) revealed that perceptions of the
22 neighborhood being unsafe for children to play and having no place to spend leisure time
23 were associated with lower levels of exercise among youth. The literature suggests that
24 parents' concern about safety in parks (e.g. 'stranger danger' and bullying) deters them from
25 allowing their children to visit parks alone (Carver and others, 2008). Therefore, it is possible
26 that in neighborhoods where crime or violence is prevalent, where parks are not perceived to
27 be safe or where a park is on a busy road, independently mobile adolescents constrain their
28 outdoor physical activities.
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41 Interactions among several environmental factors may underlie why Portuguese girls
42 of the present study were more likely to be involved in active activities. A key factor may be
43 linked to living in a place with good connectivity or having good public services in their
44 neighborhood, but also linked to the opportunity to spend time outdoor. Since time spent
45 outdoors is positively related to physical activity in youth (Sallis and others, 2000), perceived
46 safety of the environment may be a more important factor; female youth living in high-crime
47 neighbourhoods of the North of Portugal were less active outdoors (Mota and others, 2007).
48 Despite of findings of the present study did not revealed an association between the rate crime
49 and the levels of habitual PA (e.g. with a marginal significance level, Table 3), it shows that
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3 female parents who agreed that “there is so much traffic on the streets that it makes it
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5 unpleasant to walk in the neighborhood” trend to have less active children. Similar results
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7 were found in US (Carroll-Scott and others, 2013), Canadian (Veugelers and others, 2008),
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9 and Australian (Giles-Corti and King, 2009) people, revealing that youth resided in less dense
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11 and safer neighbourhoods have more likely to be physically active, which increased the
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13 likelihood of being healthy.
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16 Parental attitudes towards physical activity may be an additional factor that moderates
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18 the relationship between higher level of children PA and the parental perception of “people
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20 being physically active in my neighborhood”. In fact, the literature have consistently
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22 supported associations between equipment at home, family physical activity rules and
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24 parental sports participation and sports participation among adolescents which were partly
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26 mediated by attitude and intention (van der Horst and others, 2010). Complementary data
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28 from Portuguese youth have been also identified those factors as significant determinants of
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30 physically active behaviours (Seabra, 2004). This indicates that, at least in part, the influence
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32 of the family environment on children’s sport participation operates via children’s physical
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34 activity attitudes, beliefs, perceived behavioral control and enjoyment. Therefore, this is quite
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36 important from several perspectives. First, youth involved in sport have higher levels of
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38 moderate-to-vigorous PA (MVPA) (Machado-Rodrigues and others, 2012a) and regular
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40 participation in MVPA has health, fitness and behavioral benefits - weight control, less
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42 adiposity, increased bone mineral content, improved aerobic capacity and muscular strength
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44 and endurance, self-concept, among others (Cumming and Riddoch, 2008; Strong and others,
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46 2005). On the other hand, participation in sports during adolescence tends to track at higher
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48 levels than other indicators of physical activity so that youth who are active in sport during
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50 adolescence are more likely to be physically active in young adulthood (Malina, 2001;
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52 Malina, 2009).
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3 The present research revealed that neighbors with recreational facilities and
4 infrastructure for walking and cycling were important predictors of active behaviors. The
5 available studies also suggest that young people who live in pedestrian-friendly or high-
6 walkable neighborhoods are more likely to walk to school (Kerr and others, 2006). Transport
7 to school may be an additional factor that moderates the relationship between habitual PA and
8 built environment. In an earlier study of adolescents from the Portuguese Midlands, a greater
9 percentage of urban than rural youth walked to school, while a greater percentage of rural
10 than urban youth used public transport (Coelho e Silva and others, 2003). It is not clear,
11 however, whether mode of transport significantly affects the habitual PA of Portuguese youth.
12 On the other hand, most studies of youth to date have examined specific aspects of the
13 neighborhood rather than an overall walkability index per se. For example, a number of
14 studies involving children and adolescents have found that, irrespective of sex, active
15 transportation to and from school was significantly more likely in neighborhoods with better
16 street connectivity, mixed land use and/or higher population densities (Braza and others,
17 2004). However, further research is needed to help clarify these relationships, particularly by
18 using both objective measures of the neighborhood and PA.
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38 No association between neighborhood aesthetics and habitual physical activity was
39 found in the present study; previous research examining that relationship in youth have
40 reported positive (McGinn and others, 2007; Mota and others, 2005), negative (Hume and
41 others, 2009), and null (Jago and others, 2006) associations. Thus, as suggested by our
42 findings, there is not a clear and consistent effect of aesthetics on physical activity within
43 youth. Youth living in aesthetically unpleasant neighborhoods may become immune to its
44 aesthetic features, and such features of the environment may not be responsible for deterring
45 physical activity (Davison and Lawson, 2006) but might be related to healthy nutritional
46 habits. Neighborhood aesthetics was significantly related with lower BMI in the present
47 sample of Portuguese youth corroborating other studies (Carroll-Scott and others, 2013)
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3 which have reported that youth living in more affluent neighborhoods reported more frequent
4 healthy eating and less unhealthy eating. In fact, the literature have reported a significantly
5 association between healthy behaviors and built, social, and socioeconomic environment
6 assets (access to parks, social ties, affluence), and unhealthy behaviors with built environment
7 inhibitors (access to fast food outlets) (Carroll-Scott and others, 2013), suggesting
8 neighborhood environments are an important level at which to intervene to prevent childhood
9 obesity and its adverse consequences.
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18 In summary, social and cultural features of communities may influence access to
19 recreational facilities and in turn to sports and other healthy behaviours. Young people living
20 in neighbourhoods with good access to shops tended to have healthier diets and were less
21 likely to be overweight (Veugelers and others, 2008). In addition, open public spaces in more
22 deprived neighbourhoods had fewer activities and safety features (Badland and others, 2010).
23 This was especially relevant as participation in organized sport is related to MVPA, and
24 consequently has the potential for health, fitness and behavioral benefits during youth and
25 also for transfer to adult physical activity (Machado-Rodrigues, 2013). The major strengths of
26 this study are the large population sample and particularly the demographic features of those
27 Southern European participants with high rates of overweight. Limitations of the present
28 study should be also recognized; firstly, this study has a cross-sectional design and, therefore,
29 it is not possible to infer casual relationships. Furthermore, habitual PA was obtained by self-
30 reported instrument (e.g. parental proxy), which might be inaccurate as parents are not always
31 with their children, and is reliant on accurate recall. Finally, features of neighborhood
32 environment were also assessed by self-report measures which should be replaced by
33 objective tools in the future.
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56 CONCLUSION

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3 The study found some significant relationships between parental perceptions of the
4 environment and BMI and habitual PA of Portuguese girls, especially related to security for
5 walking and unpleasant neighborhood, and access to destinations.
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10 11 12 **ACKNOWLEDGMENT**

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Table 1. Descriptive characteristics of participants ^a.

Variable	7 years-old (n=604)	8 years-old (n=611)	9 years-old (n=671)	Girls [total sample] (n=1886)	ANOVA
Chronological age, years					
Weight (kg)	27.0 (5.5)	30.1 (5.8)	34.0 (7.8)	30.5 (7.1)	b, c, d
Height (m)	1.25 (0.05)	1.30 (0.06)	1.36 (0.7)	1.30 (0.8)	b, c, d
BMI	17.16 (2.51)	17.71 (2.55)	18.29 (3.09)	17.74 (2.78)	b, c, d
active travel time to/from school (mins/wk)	11.7 (9.6)	11.6 (9.3)	12.8 (11.7)	12.1 (10.3)	
time spent playing sport (mins/wk)	87.7 (118.8)	97.3 (117.6)	108.8 (145.6)	98.3 (128.8)	d
school physical activity time (mins/wk)	87.9 (48.6)	87.9 (47.8)	84.6 (47.3)	86.7 (47.9)	

^a Data are shown as mean (SD) unless otherwise stated.

^b statistical differences between 7 years-old and 8 years-old age-groups ($p < 0.01$).

^c statistical differences between 8 years-old and 9 years-old age-groups. ($p < 0.01$).

^d statistical differences between 7 years-old and 9 years-old age-groups. ($p < 0.01$).

Table 2. Associations between children's BMI and parental perceptions of neighborhood environments after controlling for chronological age, time spent in organized sport, and parental education.

Scale composition	Item	BMI				
		Unstandardized coefficients		95% CI for Beta	Standardized Beta coefficient	p
		Beta	St. error			
Access to destinations	Many stores are within easy walking distance of my home.	-0.37	0.15	-0.657 to -0.085	0.065	0.01
	It is easy to walk to a transit stop (bus, trolley) from my home.	-0.02	0.14	-0.295 to 0.261	-0.003	0.91
Connectivity of the street network	There are many four-way intersections in my neighborhood.	-0.27	0.17	-0.596 to 0.065	-0.040	0.12
Infrastructure for walking and cycling	There are sidewalks on most of the streets in my neighborhood.	-0.01	0.17	-0.340 to 0.314	-0.002	0.94
Neighborhood safety	There is so much traffic on the streets that it makes it difficult or unpleasant to walk in my neighborhood.	0.24	0.15	-0.059 to 0.545	0.039	0.12
	The crime rate in my neighborhood makes it unsafe or unpleasant to walk in my neighborhood.	0.15	0.15	-0.132 to 0.437	0.026	0.29
Social environment	I see many people being physically active in my neighborhood.	-0.09	0.15	-0.378 to 0.207	-0.014	0.57
Aesthetics	There are many interesting things to look at while walking in my neighborhood.	0.32	0.14	0.052 to 0.587	0.057	0.02
Recreation facilities	My neighborhood has several public recreation facilities, such as parks, walking trails, bike paths, recreation centers, playgrounds, public swimming pools, etc.	-0.05	0.15	-0.347 to 0.251	-0.009	0.75

Table 3. Associations between children's habitual PA and parental perceptions of neighborhood environments after controlling for chronological age, BMI and parental education.

Scale composition	Item	Habitual PA				
		Unstandardized coefficients		95% CI for Beta	Standardized Beta coefficient	p
		Beta	St. error			
Access to destinations	Many stores are within easy walking distance of my home.	0.52	7.05	-13.299 to 14.335	0.002	0.94
	It is easy to walk to a transit stop (bus, trolley) from my home.	1.20	6.84	-12.204 to 14.608	0.004	0.86
Connectivity of the street network	There are many four-way intersections in my neighborhood.	11.20	8.13	-4.748 to 27.149	0.035	0.17
Infrastructure for walking and cycling	There are sidewalks on most of the streets in my neighborhood.	17.44	8.03	1.689 to 33.195	0.054	0.03
Neighborhood safety	There is so much traffic on the streets that it makes it difficult or unpleasant to walk in my neighborhood.	-24.40	7.41	-38.926 to -9.879	-0.080	0.00
	The crime rate in my neighborhood makes it unsafe or unpleasant to walk in my neighborhood.	13.18	6.99	-0.538 to 26.890	0.046	0.06
Social environment	I see many people being physically active in my neighborhood.	24.77	7.19	10.670 to 38.868	-0.084	0.00
Aesthetics	There are many interesting things to look at while walking in my neighborhood.	11.13	6.58	-1.772 to 24.030	0.041	0.09
Recreation facilities	My neighborhood has several public recreation facilities, such as parks, walking trails, bike paths, recreation centers, playgrounds, public swimming pools, etc.	18.18	7.34	3.786 to 32.567	-0.067	0.01