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School and individual-level correlates of physical activity in children: a multilevel approach

Determinantes individuais e do contexto escolar na atividade física de crianças: um estudo multinível

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Abstract

This study aimed to assess the association between individual and school environment variables and physical activity levels in Brazilian schoolchildren with 8-12 years of age. A sample of children from 20 private and public schools (n=1,210) was selected. Total and leisure-time physical activities and active transportation to school (AT) were measured using a self-report instrument. Total and leisure-time physical inactivity (PI) were defined as <300min/week of Physical activity. Physical and social school environment features were assessed through a questionnaire. The prevalence of PI, leisure-time PI, and AT to school were 69.2%, 75.8% and 70.5%, respectively. Multilevel models showed that PI was more frequent among girls, and was negatively associated with older age and higher maternal schooling. Girls were more inactive during leisure-time. For contextual variables, greater Physical Education teacher/student ratio was associated with lower levels of both total and leisure-time PI. AT was negatively associated with higher income and positively associated with older age. Students from public schools use more AT. Based on the prevalence of PI found, strategies focused at increasing physical activity levels should be implemented immediately. Also, our findings suggest that both individual and school contextual variables were associated with levels of PI, varying between domains.

Keywords

Social Environments, Epidemiology, Physical Education, Physical Activity.

Resumo

Este estudo objetivou avaliar a associação entre variáveis individuais e do contexto escolar com os níveis de atividade física em escolares de 8 a 12 anos de idade. Uma amostra de crianças de 20 escolas públicas e privadas (n=1210) foi selecionada. Os níveis de atividade física total e no lazer e o transporte ativo para a escola foram mensurados por meio de um instrumento validado. Crianças foram consideradas inativas quando realizavam <300min/semana de atividade física. O ambiente social e físico escolar foi avaliado através de questionário. As prevalências de Inatividade Física (IF), IF no lazer e transporte ativo foram de 69,2%, 75,8% e 70,5%, respectivamente. Modelos de análise multinível mostraram que a IF total esteve associada ao sexo feminino e negativamente associada com o aumento da idade e a maior escolaridade materna. As meninas também foram mais inativas no lazer. Das variáveis contextuais, o aumento da razão Professor de Educação Física/aluno foi associado a menores níveis de IF total e de lazer. O transporte ativo à escola esteve negativamente associado com a maior renda e aumentou com o aumento da idade e em alunos de escolas públicas. Com base nos resultados, estratégias focadas no aumento dos níveis de atividade física entre as crianças devem ser implementadas imediatamente. Ainda, nossos achados sugerem que tanto variáveis individuais como contextuais estão associadas com os níveis de inatividade física, variando entre seus domínios.

Palavras-chave

Ambientes Sociais; Epidemiologia; Educação Física; Atividade Física.

INTRODUCTION

Physical activity practice in childhood and adolescence provides both short- and long-term benefits for physical and mental health [1,2]. Global recommendations to promote regular physical activity (PA), including aerobic, strength, and flexibility exercises have been established [3]. However, around 4/5 of the adolescents aged 13-15 years of age are not meeting these recommendations [4]. Further, there is evidence that some indicators of PA, such as participation in physical education (PE) classes, are decreasing over time [5]. Therefore, increasing PA levels of adolescents worldwide has become an important public health priority.

The understanding of factors that affect PA behaviours is important in developing interventions. Previous research has primarily focused on identifying individual level correlates of PA[6,7], and there is evidence that correlates vary according to the domains of PA investigated[8-10]. However, studies focusing solely on individual correlates fail to account for the multiple levels of influence on behaviour, such as those presented in the ecological model [8].

For youth, most of physical activities occur at home, school, and neighbourhoods. Therefore, it is likely that factors of these levels may interact with individual characteristics influencing PA patterns. Because most children attend school and spend a considerable amount of the day at school, contextual factors, such as school structure and environment, might play a role. School structures, such as large school campuses, school buildings, and play areas (per enrolled student) have been associated with higher levels of PA among youth and the availability of school play equipment, facilities, and after-school programs, fields, and courts are important correlates of PA[11].

This study examines individual and school-related contextual correlates of PA in a representative sample of schoolchildren from the city of Pelotas, Brazil.

METHODS

This cross-sectional study was performed in Pelotas, a southern Brazilian city. The city has approximately 320,000 inhabitants of which 26,000 are children aged 8-12 years. A two-stage cluster sample design was adopted. There are 25 private and 91 public schools in Pelotas that serve children within this age range. To ensure proportionality, five private and 15 public schools were randomly selected, using a probability proportional to school size. In each school, five classrooms, from 2nd to 6th grade were randomly selected and all children enrolled in these classes were initially eligible for the study. Physically and/or mentally disabled children were not included. More details about the methodology of this study are available elsewhere[12].

The research team visited the schools in 2010 to carry out data collection. Schools were visited as many times as needed so that the children absenteeism was restricted to no more than 10%. Data collection included a questionnaire sent to parents via children, an interview with children, anthropometric measurements and an assessment of the schools' social and physical environment.

Information on lifestyle was collected using a previously validated PA questionnaire [13]. The questionnaire addressed commuting to-and-from school and leisure-time physical activities. It comprised questions on transport-related PA and a box with a list of leisure-time activities. Active transportation to school was

considered when child reported going to school walking or by cycling. Level of total and leisure-time PA was classified as insufficient if students participated in less than 300 min/week of PA.

Socioeconomic data were obtained from parents. Maternal education level was evaluated in years of formal education and categorized in four groups (up to 4 years; 5 to 8; 9 to 11; and 12 or more years). Family income was collected in Brazilian Reals (BRL). Information on number of people living in the house was also collected. Per capita family income was obtained dividing the income of the family by the number of people living in their house and then, was divided into quartiles. Height was measured to the nearest 0.1 cm with a portable stadiometer, and weight was measured in light clothing and no shoes on to the nearest 0.1 kg on a digital scale. Body Mass Index (BMI) was calculated as weight (kg) divided by squared height (m^2). Participants were classified as normal, overweight or obese according to sex- and age-specific BMI cut-off points[14].

Structure of PE class and availability of physical structures to practice sports in schools was evaluated using a questionnaire completed by PE teachers. The questionnaire included closed questions about the number of PE teachers in the school, indoor facilities (courts and gyms), and other equipment that could be used during activities. The questionnaire was pre-tested with professionals that were not included in the sample. No alterations were performed in the final version. PE teacher/student ratio was obtained dividing the number of PE teacher of the school by the total number of students in the school and categorized into tertiles. The variable *Physical Structure* was obtained by Principal Component Analysis (PCA) performed with the following data obtained by questionnaire:: 1) number of courts; 2) number of sports markings in the courts; 3) presence of indoor courts; 4) condition of the courts reported by the PE teacher; 5) number of different equipments for sports practice (balls for different sports, volleyball nets, basketball table, equipment for gymnastics and athletics); 6) availability of the school structure for sports practice after school. The scores obtained from PCA were categorized into tertiles.

The social environment was assessed by a questionnaire based on the *National Survey of Students' Health* (PeNSE)[15] administered to school coordinators. It contains questions addressing topics about violence, alcohol, drugs, and tobacco. To summarize information collected, PCA analysis was performed to create two variables: 1) Violence; and 2) Alcohol/Drugs and Tobacco. The variable *Violence* considered data about school security, presence and type of fencing around the school, need for police security, occurrence of acts of violence – physical, verbal, bullying - and vandalism between students or against the school population or structure, existence of gangs and episodes involving fire arms. The variable *alcohol/drugs/tobacco* took in account the existence of episodes of use of these substances in the ambient of school by students, teachers and staff, the presence of these themes in the school curriculum and the existence of policies against tobacco use in the school. For both variables, schools were divided into tertiles with the scores obtained in PCA, sorted from less to more prone conditions for sports practice.

Data were entered twice in an EpiData (The EpiData Association, Odense, Denmark) database with automatic checks for consistency and range. Data analyses were carried out in Stata 11.0 (StataCorp, College Station, TX, USA). Descriptive statistics were used to characterize the sample by outcomes and independent variables. Multilevel Logistic Regression analysis using scheme of mixed

effects was used in order to assess the association of independent variables with the outcomes considering two levels of organization: Level 1 – Individual-level variables and; Level 2 – School-Level Variables. The odds ratio and 95% confidence intervals were estimated. Model selection was carried out using deviance-based significance testing. The final models were adjusted from both individual and contextual level variables. To be included in the final model, variables should present a p value ≤0.250 after adjustments.

The project was approved by the Human Ethics Research Committee of Federal University of Pelotas and by the Education Departments. All children received a letter, explaining parents the aims of the study, ensuring confidentiality and requesting their authorization.

RESULTS

Table 1 shows the descriptive analysis of the sample. The prevalence of physical inactivity (69.2%), leisure-time physical inactivity (75.8%), and active transportation to school (70.5%) are displayed. Girls presented a greater prevalence of physical inactivity and leisure-time physical inactivity, but no differences were found in active transportation (Figure 1).

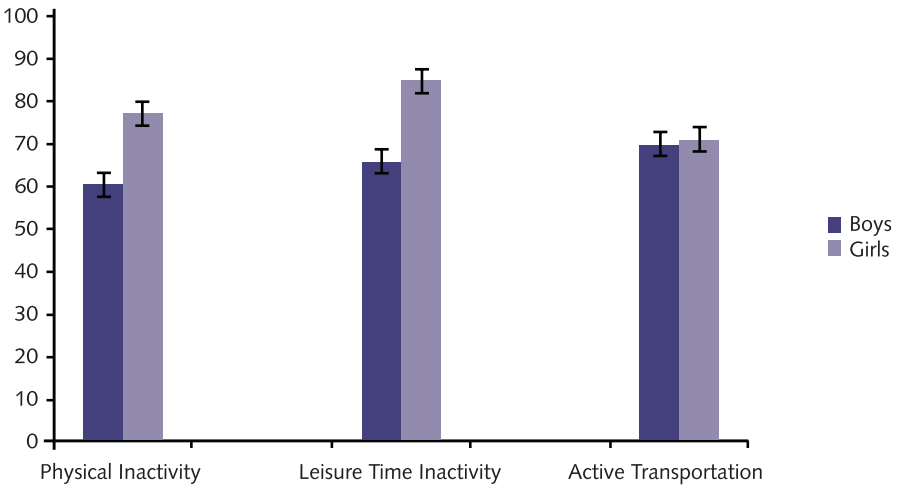

Figure 1 – Percentage of physical inactivity according to sex in Brazilian schoolchildren (8-12 years). Pelotas, Brazil.

The results of factors associated with physical inactivity are shown in Table 2. The model including individual and contextual level variables revealed that girls are less active [OR 2.30 (1.75-3.02)]. It was also found that older children [OR 0.53 (0.31-0.88)] and children from mothers with lower education [OR 0.58 (0.35-0.97)] presented a protective effect to this outcome. For school-level variables, PE teacher/student ratio was associated with physical inactivity. Students from schools with more PE teachers per student were negatively associated with physical inactivity [OR 0.58 (0.40-0.84)].

Gender was also associated with physical inactivity in leisure time (Table 3). Girls were more prone to physical inactivity in leisure-time [OR 2.96 (2.18-4.01] than boys. In addition, greater PE teacher/student ratio had a protective effect for this outcome [OR 0.41 (0.27-0.62)].

Table 1 – Description of the sample by individual and contextual variables. Pelotas, Brazil.

Variables	N	%	95% CI
Individual Level			
Physical inactivity (<300 min/wk)	767	69.2	66.4 – 71.9
Leisure-time physical inactivity (<300 min/wk)	800	75.8	73.2 – 78.3
Active transportation to school	834	70.5	67.8 – 73.1
Sex			
- Male	574	47.4	44.6 – 50.3
- Female	637	52.6	49.7 – 55.4
Age			
- 8 years	182	15.0	13.1 – 17.2
- 9 years	312	25.8	23.3 – 28.3
- 10 years	295	24.4	22.0 – 29.9
- 11 years	259	21.4	19.1 – 23.8
- 12 years	163	13.5	11.6 – 15.5
Maternal schooling			
- ≥12 years	137	11.7	10.0 – 13.7
- 9 to 11 years	365	31.0	28.4 – 33.8
- 5 to 8 years	248	21.1	18.8 – 23.5
- Up to 4 years	426	36.2	33.5 – 39.0
Per capita family income			
- 1st quartile	260	25.1	22.5 – 27.9
- 2nd quartile	271	26.2	23.5 – 28.9
- 3rd quartile	258	24.9	22.3 – 27.7
- 4th quartile	247	23.8	21.3 – 26.6
Body mass index			
- Normal	787	65.4	62.6 – 68.1
- Overweight/Obese	417	34.6	31.9 – 37.4
Contextual Level			
Structure			
Physical Education teacher/student ratio			
- 1st tertile	567	46.8	44.0 – 49.7
- 2nd tertile	376	31.1	28.5 – 33.8
- 3rd tertile	268	22.1	19.8 – 24.6
Physical Structure*			
- 1st tertile	444	36.7	33.9 – 39.4
- 2nd tertile	376	31.1	28.5 – 33.8
- 3rd tertile	391	32.3	29.7 – 35.0
Social Environment			
School Type			
- Private	253	20.9	18.6 – 23.3
- Public	958	79.1	76.7 – 81.4
Alcohol/drugs/tobacco *			
- 1st tertile	558	46.1	43.2 – 48.9
- 2nd tertile	474	39.1	36.4 – 42.0
- 3rd tertile	179	14.8	12.8 – 16.9
Violence*			
- 1st tertile	417	34.4	31.8 – 37.2
- 2nd tertile	426	35.2	32.5 – 37.9
- 3rd tertile	368	30.4	27.8 – 33.1

* Variables obtained by PCA analysis.

Table 4 illustrates the results of multilevel analysis for active transportation. Older children were more likely to use active means of transport to school [OR 2.82 (1.38-5.74)] than younger children and children from families with greater per capita income were negatively associated with active transportation [OR 0.40 (0.21-0.75)]. Schools with better condition for sports practice showed a protec-

tive effect for active transportation in crude analysis but this association was not observed after controlling for confounders (individual level variables and type of school). Children from public schools were more active during transportation compared to children from private schools [OR 14.41 (3.49-59.50)]. None of the variables generated by PCA analysis (violence, alcohol/drugs/tobacco, physical structure) were associated with the three outcomes used in this study.

Table 2 – Association of individual and contextual characteristics with physical inactivity in school-children (8-12 years). Pelotas, Brazil. Multilevel Logistic Regression.

Variables *Fixed effects*	Empty Model	Crude analysis	Individual Level	Individual + Contextual level
Individual Level		OR (95% CI)	OR (95% CI)	OR (95% CI)
Sex				
- Male		1.00	1.00	1.00
- Female		2.27 (1.74-2.96)	2.29 (1.74-3.00)	2.30 (1.75-3.02)
Age				
- 8 years		1.00	1.00	1.00
- 9 years		0.84 (0.53-1.33)	0.83 (0.52-1.34)	0.81 (0.50-1.30)
- 10 years		0.77 (0.48-1.21)	0.73 (0.45-1.17)	0.70 (0.43-1.12)
- 11 years		0.54 (0.34-0.86)	0.52 (0.32-0.83)	0.51 (0.32-0.82)
- 12 years		0.55 (0.34-0.91)	0.52 (0.31-0.88)	0.53 (0.31-0.88)
Mother's schooling				
- ≥12 years		1.00	1.00	1.00
- 9 to 11 years		0.64 (0.39-1.06)	0.68 (0.41-1.14)	0.68 (0.41-1.12)
- 5 to 8 years		0.72 (0.42-1.23)	0.73 (0.42-1.27)	0.73 (0.43-1.25)
- Up to 4 years		0.59 (0.35-1.00)	0.58 (0.34-0.99)	0.58 (0.35-0.97)
Per capita familiar income				
- 1st quartile		1.00	-	-
- 2nd quartile		1.09 (0.74-1.61)		
- 3rd quartile		1.34 (0.89-2.03)		
- 4th quartile		1.15 (0.73-1.83)		
Children BMI				
- Normal		1.00	-	-
- Overweight/Obese		0.86 (0.66-1.13)		
Contextual Level				
Structure				
Teacher/student ratio				
- 1st tertile		1.00	-	1.00
- 2nd tertile		0.63 (0.43-0.93)		0.55 (0.40-0.77)
- 3rd tertile		0.53 (0.35-0.79)		0.58 (0.40-0.84)
Physical Structure				
- 1st tertile		1.00	-	-
- 2nd tertile		0.94 (0.58-1.52)		
- 3rd tertile		1.30 (0.80-1.09)		
Social Environment				
School Type				
- Private		1.00	-	-
- Public		0.67 (0.42-1.06)		
Alcohol/drugs/tobacco use				
- 1st tertile		1.00	-	-
- 2nd tertile		0.89 (0.57-1.38)		
- 3rd tertile		1.15 (0.64-2.06)		
Violence occurrence				
- 1st tertile		1.00	-	-
- 2nd tertile		0.93 (0.56-1.52)		
- 3rd tertile		1.08 (0.65-1.79)		
Random Effects				
School Level Variance	0.123		0.096	0.006

Table 3 – Association of individual and contextual characteristics with leisure-time physical inactivity in schoolchildren (8-12 years). Pelotas, Brazil. Multilevel Logistic Regression.

Variables *Fixed effects*	Empty Model	Crude analysis	Individual Level	Individual + Contextual level
Individual Level		OR (95% CI)	OR (95% CI)	OR (95% CI)
Sex				
- Male		1.00	1.00	1.00
- Female		2.96 (2.18-4.02)	2.29 (1.74-3.00)	2.96 (2.18-4.01)
Age				
- 8 years		1.00	-	-
- 9 years		0.76 (0.47-1.25)		
- 10 years		0.90 (0.54-1.48)		
- 11 years		0.77 (0.47-1.28)		
- 12 years		0.63 (0.37-1.09)		
Mother's schooling				
- ≥12 years		1.00	-	-
- 9 to 11 years		0.64 (0.37-1.11)		
- 5 to 8 years		0.73 (0.40-1.32)		
- Up to 4 years		0.78 (0.44-1.40)		
Per capita familiar income				
- 1st quartile		1.00	-	-
- 2nd quartile		1.06 (0.69-1.63)		
- 3rd quartile		1.48 (0.93-2.35)		
- 4th quartile		1.12 (0.68-1.84)		
Children BMI				
- Normal		1.00	-	-
- Overweight/Obese		0.94 (0.69-1.27)		
Contextual Level				
Structure				
Teacher/student ratio				
- 1st tertile		1.00	-	1.00
- 2nd tertile		0.56 (0.38-0.82)		0.51 (0.34-0.75)
- 3rd tertile		0.40 (0.27-0.61)		0.41 (0.27-0.62)
Physical Structure				
- 1st tertile		1.00	-	-
- 2nd tertile		0.99 (0.57-1.73)		
- 3rd tertile		1.31 (0.75-2.29)		
Social Environment				
School Type				
- Private		1.00	-	-
- Public		0.80 (0.46-1.37)		
Alcohol/drugs/tobacco use		1.00	-	-
- 1st tertile		0.92 (0.55-1.54)		
- 2nd tertile		1.05 (0.53-2.08)		
- 3rd tertile				
Violence occurrence				
- 1st tertile		1.00	-	-
- 2nd tertile		0.69 (0.40-1.20)		
- 3rd tertile		0.79 (0.45-1.39)		
Random Effects				
School-Level Variance	0.172		0.179	0.032

Table 4 – Association of individual and contextual characteristics with active transportation to school in children (8-12 years). Pelotas, Brazil. Multilevel Logistic Regression.

Variables Fixed effects	Empty Model	Crude analysis	Individual Level	Individual + Contextual level
Individual Level		OR (95% CI)	OR (95% CI)	OR (95% CI)
Sex				
- Male		1.00	-	-
- Female		1.18 (0.86-1.63)		
Age				
- 8 years		1.00	1.00	1.00
- 9 years		1.62 (0.98-2.69)	1.26 (0.73-2.17)	1.26 (0.73-2.17)
- 10 years		1.76 (1.06-2.93)	1.24 (0.72-2.17)	1.24 (0.72-2.17)
- 11 years		1.55 (0.92-2.62)	1.27 (0.71-2.25)	1.27 (0.71-2.25)
- 12 years		2.85 (1.53-5.31)	2.82 (1.38-5.74)	2.82 (1.38-5.74)
Mother's schooling				
- ≥12 years		1.00	-	-
- 9 to 11 years		1.23 (0.70-2.16)		
- 5 to 8 years		1.17 (0.63-2.15)		
- Up to 4 years		1.60 (0.86-3.00)		
Per capita familiar income				
- 1st quartile		1.00	1.00	1.00
- 2nd quartile		0.94 (0.54-1.64)	0.99 (0.56-1.74)	0.99 (0.56-1.74)
- 3rd quartile		0.53 (0.31-0.91)	0.54 (0.32-0.93)	0.54 (0.32-0.93)
- 4th quartile		0.38 (0.20-0.70)	0.40 (0.21-0.75)	0.40 (0.21-0.75)
Children BMI				
- Normal		1.00	-	-
- Overweight/Obese		0.88 (0.63-1.23)		
Contextual Level				
Structure				
Teacher/student ratio				
- 1st tertile		1.00	-	-
- 2nd tertile		0.77 (0.12-5.06)		
- 3rd tertile		1.83 (0.26-12.91)		
Physical Structure				
- 1st tertile		1.00	-	1.00
- 2nd tertile		0.65 (0.13-3.32)		1.09 (0.36-3.30)
- 3rd tertile		0.11 (0.02-0.52)		1.12 (0.28-4.57)
Social Environment				
School Type				
- Private		1.00		1.00
- Public		27.29 (9.33-79.77)		14.41 (3.49-59.50)
Alcohol/drugs/tobacco use		1.00	-	-
- 1st tertile		2.20 (0.37-13.09)		
- 2nd tertile		1.39 (0.14-13.53)		
- 3rd tertile				
Violence occurrence				
- 1st tertile		1.00	-	-
- 2nd tertile		0.93 (0.14-5.71)		
- 3rd tertile		0.26 (0.04-1.79)		
Random Effects				
School-Level Variance	3.134		2.044	0.833

DISCUSSION

In this study, individual and contextual correlates were identified for PA in Brazilian youth. Individual correlates, including sex (male), age (older), and mother's income (higher), and contextual correlates, including PE teacher/student ratio (higher), were associated with overall physical activity. PA in the context of leisure-time and active transportation, however, varied. Leisure-time PA was predicted by sex and PE teacher/student ratio, while active transportation was predicted by age, income, and school type. These variations suggest that there are fundamental differences by context of PA among youth in Brazil. Further, once youth PA is a function of different variables, the current study provides evidence that some contextual factors are associated with PA beyond individual-level demographic variables.

The PE teacher/student ratio was the only school-related variable found to be associated with overall and leisure-time PA. An increased PE teacher/student ratio was associated with a decrease in the odds of total and leisure-time inactivity. This is in accordance with findings from previous studies, which have suggested that the presence of supervisors can stimulate the practice of PA during the school day and it could have a positive effect in the learning process of children[16-18]. In opposite to previous reports, our study suggests an effect of PE teacher/student ratio on non-school related PA. However, since this study included all leisure-time activities inside and outside of school, the evidence is inconclusive. Although research is limited in this area, one recent study found that activity during PE classes could have an effect on PA inside and outside of school separately[19]. Collectively, these findings imply that a variable that specifically measures PA outside of school and another that measures PA during school need to be tested for an association with PE teacher/student ratio. Findings from these future studies may provide more evidence for the importance of PE class in Brazilian schools.

Physical structure of the schools has been found to impact PA; however, in this study, there was only an association with active transportation. Specific aspects of physical structures, including access to amenities[20], size of play area[21], access to school fields in extra times[19], and other physical characteristics such as the presence of gymnasium[22] have been found to increase levels of PA during school hours. Nevertheless, in our study, the variable built to represent school physical structure was not associated with leisure-time or overall PA. Even though in agreement with another study's findings[23], it may imply that either the variable used in this study did not accurately capture the physical structure of the school, which influences leisure-time physical activity or overall physical activity, or in reality, there is no influence from the school environment on PA in Brazilian schoolchildren. Additional studies looking at other specific physical characteristics of schools may be benefited if developing a more accurate measurement tool.

The discrepancy in leisure-time PA across gender may be related to activities offered during PE and the overall physical structure of the school. Gender was a significant determinant of behaviour for overall and leisure-time PA. Girls were half as likely to participate in PA and three times less likely to engage in leisure-time PA than boys. This may be related to the fact that boys are generally more likely to be motivated to engage in sporting activities while girls often need to be prompted to participate in structured, less competitive physical activities. Currently in Brazil, PE classes are not considered a priority course subject, causing

substantial declines in class time devoted to PA, availability of equipment, and teacher motivation to teach health and PA-related concepts. This has resulted in PE becoming a time for students to practice sport or to participate in free-play, which is more compatible with boys PA preferences than girls. In terms of physical structure, schools that have higher availability of facilities, equipment, and space to be active may increase the opportunities for girls to participate. Space to be active may be an important factor since it allows for more than one type of activity to be occurring at the same time; thus, possibly increasing participation in activity for both girls and boys [24].

It is likely that gender differences in overall physical activity decline with increasing age. In this study, findings that older age (11-12) protects against overall physical inactivity were analogous to findings from another study that suggests that the gender association for physical inactivity disappears at the age of 10[6]. This is likely due to increased independence from parents and increased physical activity outside of school, including active transportation. In this study, older schoolchildren (age 12) were almost three times more likely to participate in active transportation than younger schoolchildren (8 years) and there was no gender association. In previous studies, boys have been found to be more likely to actively commute than girls[9]. This discrepancy suggests that, in this study, age was more influential than gender for active transportation.

In addition to this data, attending public schools was strongly associated with active transportation to school in comparison with attending private school. Part of this association can be explained by SES, which is directly influenced by access to assets such as car and private school buses[25]. However, the association between attending public school and active transportation remained significant even after adjusting by SES and age. Generally, parents who enrol their children in private school are able to strategically choose the school according to quality and philosophy of education and the physical structure offered to the students. On the other hand, children attending public schools are enrolled according to the proximity of the school to the children's homes. Thus, children from public schools have a greater chance to study closer to their homes and it is reasonable to conclude that they use more active commuting to school than those from private schools because of this proximity.

Some strengths of this study should be highlighted such as the multilevel approach used in the statistical analysis. This approach has been largely used to analyse the simultaneous effects of group- and individual-level variables on individual-level outcomes[26], avoiding the possibility to find incorrect and potentially misleading results that could be found using a single-level analysis. In addition, the sampling method and the use of a validated instrument to measure the level of PA provide internal validity to the study. On the other hand, the instrument used in the analysis of physical and social environments of the schools was developed to be used in a recent Brazilian National School Survey (PeNSE)[15], but it is not yet validated. Although it is preferable that information collected by questionnaires are collected from children than from parents, some non-differential measurement error can be expected through the use of these instruments. Another limitation is that other environments that could act more strongly in the habit of doing physical activity such as home and neighbourhood were not evaluated.

In conclusion, these findings showed that both individual and school context variables were associated with levels of physical activity, varying between domains.

In addition, in terms of contextual variables, the presence of physical education teachers appears to play a more important role in physical activity promotion in comparison with physical and social environment of the schools. To understand the influence of contextual variables in levels of PA in children, future studies should be also focused on home and neighbourhood characteristics. For research purposes, it would be important for these studies to incorporate objective information about the built environment and to use check-lists and satellite images to audit environments.

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