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Characteristics of the schools' surrounding environment, distance from home and active commuting in adolescents from Curitiba, Brazil

Características do ambiente no entorno de escolas, distância da residência e deslocamento ativo em adolescentes de Curitiba, Brasil

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ABSTRACT: ***Introduction:*** Active commuting to school could help increasing physical activity levels among adolescents. However, there is limited understanding on how the relationship between the environment in school surroundings, as well the distance to school, could affect this behavior. ***Aim:*** To analyze the characteristics of the environment and distance between house and school with objective measures and their association with active commuting between adolescents of Curitiba, Brazil. ***Methods:*** 493 adolescents were interviewed and 124 schools evaluated. The study variables included the schools' surroundings accessibility characteristics obtained through systematic observation, and the distance between home to school was determined through Geographic Information Systems (GIS) data. ***Results:*** The presence of "safety signs" was inversely associated with active commuting (PR = 0.78; 95%CI 0.67–0.91; p = 0.003), as well distance 1,501–3,000 m (PR = 0.53; 95%CI 0.40 – 0.71; p < 0.001) and ≥ 3,501 m (PR 0.29; 95%CI 0.18 – 0.45; p < 0.001). Overall, schools' surroundings showed walking friendly characteristics. ***Conclusion:*** Traffic safety and distance to school were associated with active commuting to school among the study participants. Policies aiming at integrating access to school and traffic safety could help to promoting active commuting among adolescents.

Keywords: Exercise. Transportation. Geographic information systems. Schools. Adolescent.

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RESUMO: ***Introdução:*** A prática de deslocamento ativo para a escola pode ser uma maneira de aumentar a atividade física entre os adolescentes, no entanto pouco se sabe sobre o ambiente no entorno das escolas, bem como a distância até a escola pode afetar esse comportamento. ***Objetivo:*** Analisar a associação entre as características do ambiente no entorno da escola, a distância da residência e o deslocamento ativo de adolescentes de Curitiba, Brasil. ***Métodos:*** Quatrocentos e noventa e três adolescentes foram entrevistados e 124 escolas foram avaliadas. As variáveis do estudo incluíram as características de acessibilidade no entorno da escola por observação sistemática e a distância da residência até a escola por Sistemas de Informações Geográficas (SIG). ***Resultados:*** A presença de "placas de segurança" (RP = 0,78; IC95% 0,66 – 0,91; p = 0,003) apresentou associação inversa ao deslocamento ativo dos adolescentes, bem como as distâncias 1.500–3.500 m (RP = 0,53; IC95% 0,40 – 0,71; p < 0,001) e ≥ 3.501 m (RP = 0,29; IC95% 0,18 – 0,45; p < 0,001). No geral, o entorno das escolas se mostrou favorável à caminhada. ***Conclusão:*** A segurança no trânsito e a distância entre a escola e a residência associaram-se com o deslocamento ativo entre adolescentes do estudo. Políticas que integrem acesso a escolas próximas à residência e segurança no trânsito podem contribuir para o incentivo ao deslocamento ativo até a escola entre adolescentes.

Palavras-chave: Exercício. Transportes. Sistemas de informação geográfica. Instituições acadêmicas. Adolescente.

INTRODUCTION

Active commuting to school is an important means of promoting physical activity for adolescents[1] and health promotion[2]. This behavior is extremely relevant, since eight out of ten adolescents do not meet the recommended levels of physical activity[3,4]. Thus, actions such as walking and/or cycling to school can contribute to increasing the time spent in active behaviors[5].

In some Brazilian cities, active commuting is carried out by less than half of adolescents. In Florianópolis, for example, only 41% actively commute to school[6]. On the other hand, in Pernambuco, 43% of adolescents were considered physically inactive when commuting to school[7], which exposes a variation in this prevalence between the regions of Brazil[6-9].

Some programs to encourage active commuting, such as *Caminho da Escola*[10], *Bicicleta na Escola*[11] and the *Bicicleta no seu Bairro*[12] projects have been implemented to encourage walking and/or cycling among children and adolescents. However, the success of these programs still depends on the presence of attributes of the built environment, such as bike paths and bike lanes, sidewalks in good condition, and road signs, especially in the streets surrounding schools[13-15]. Furthermore, the distance to services and leisure spaces in the community, in addition to the distance traveled by teenagers to school[13-15], are factors related to the chosen mode of commuting.

Most studies that have sought to understand the relationship between these factors of the neighborhood's built environment and active commuting were conducted in

high-income countries with environmental and social characteristics that are different from Brazil[16]. For example, Brazilian cities have been affected by the sharp increase in private motorized transport, by the increase in public transport fares[17], and by the precarious or lack of bicycling infrastructure[18]. In addition, the majority of available studies use only the perceptions of environmental attributes and distance to school, which do not permit the verification of factors of the built environment that can contribute positively or negatively with the outcome, making the findings inconsistent. Thus, the objective of this study was to analyze the association between characteristics of the environment around the school, distance from the residence, and the active commuting of adolescents from Curitiba, Brazil.

METHODS

DESIGN, CHARACTERISTICS OF THE STUDY AND ETHICAL ASPECTS

The study had a cross-sectional design through a household survey[18] and an observational study conducted in the city of Curitiba, Paraná. The city has 1,851,215 inhabitants[20] and is mainly recognized for its urban planning and green areas[21]. The data of the present study are part of an international multicentric project called International Physical Activity and the Environment Network (IPEN), which is carried out in 19 countries, with similar data collection protocol and measures[22]. In Brazil, data collection was performed in the city of Curitiba, Paraná, between the months of August 2013 and May 2014. The project was approved by the Research Ethics Committee (CEP) of the Pontifícia Universidade Católica do Paraná (PUC-PR).

SELECTION OF LOCATIONS

Altogether, there were 2,395 census sectors in Curitiba[23], and it was considered the primary sampling unit. To maximize the variability of the data, the extremes of walkability and neighborhood income[24] were selected according to data from the Brazilian Institute of Geography and Statistics (*Instituto Brasileiro de Geografia e Estatística* - IBGE)[23]. Walkability represents characteristics of the environment that can favor the practice of physical activity, defined by the sum of at least three attributes: residential density, street connectivity and mixed land use[25]. The variables were ordered in deciles and the combinations of the extremes called quadrants were defined: low income and low walkability; low income and high walkability; high income and low walkability; and high income and high walkability. In order to obtain a spatially representative sample, eight census sectors in each quadrant were intentionally selected, totaling the 32 necessary for the study.

SELECTION OF RESIDENCES AND PARTICIPANTS

To select the residences, blocks were considered secondary sampling units. The enrollment process was carried out on all of the blocks, and the first was located at the southwest end of the sector. The residences were approached from the upper left side of the block (all houses present, one by one in a clockwise direction). In case of refusal or if a teenager did not reside there, the next house on the left was visited. In each household, an adolescent and a guardian were selected. The criteria for the selection of adolescents were: female - the youngest and male - the oldest, thus allowing for equal selection between the sexes. If the adolescent refused, another member of the same residence could be invited to the study voluntarily. The minimum sample for the project was 300 adolescents[22].

Adolescents aged between 12 and 17 years old, living in the city of Curitiba, Paraná, were considered eligible, specifically in the selected census sectors, for at least one year. Furthermore, the teenager had tto study at a school located in the city of Curitiba and not have any physical and/or cognitive limitations that would make physical activity impossible.

HOUSEHOLD SURVEY

The household survey was conducted in two stages. First, an invitation was made for the adolescent and their guardian to participate, and the interview was scheduled. Second, the interviews (guardians and adolescents) were carried out on the days and times previously scheduled. For the guardians, a questionnaire was applied with 215 questions involving environmental characteristics, physical activity and demographic information. For the adolescents, the questionnaire had 285 questions about environment, physical activity, psychosocial aspects, sedentary behavior, occupation, school and sociodemographic information. All interviews were conducted by members of the Research Group on Physical Activity and Quality of Life (*Grupo de Pesquisa em Atividade Física e Qualidade de Vida* - GPAQ), who received 12-hour theoretical and practical training on the selection criteria, how to approach to residences, how to fill out the forms, how to apply the questionnaire, how to ask the questions, and the appropriate answers. A trial was carried out to simulate the data collection process and to solidify the procedures.

IDENTIFICATION OF SCHOOLS AND THE ASSESSMENT TOOL

The evaluation of the school environment occurred simultaneously with the household survey. The collection took place between the months of August 2013 and May 2014 in public and private schools in the city of Curitiba, Paraná. From the information obtained in the questionnaires in the household survey, the schools in which the adolescents studied were identified, namely: the name of the school, the managing body, address and telephone

number. At the time, the city had 1,034 schools (212 municipal, 167 state and 655 private)[26]. For access to the institutions, the Municipal Education Secretariat (*Secretaria Municipal de Educação* - SME) and the Paraná State Education Secretariat (*Secretaria Estadual de Educação do Paraná* - SEED) were contacted, requesting permission for the research. In addition to the authorization of the secretariats, the school principals had to sign the Informed Consent Form (ICF). All schools selected in the study were located in the city of Curitiba, and offered elementary and/or high school education and included Physical Education in the curriculum. Schools that did not complete all stages of the assessment were excluded.

The school environment and its surroundings were assessed through systematic observation with the School Audit Tool instrument, developed by Jones et al.[27] in the United Kingdom and adapted to the Brazilian context. Characteristics related to the practice of physical activity were observed and divided into four sections:

- Access to school;
- Area surrounding the school;
- Aesthetics and;
- School grounds.

The variables of this study are contained in section B of this instrument, and were composed of 14 items. The evaluations were carried out by four independent researchers, who underwent an eight-hour theoretical-practical training.

INDEPENDENT VARIABLES

Characteristics of the environment around the school

The environment around the school was characterized by the structures present in the streets around the space where the school is physically located[27]. These structures were independently assessed in the section *"area around the school"* (bike paths, bike lanes, sidewalk on both sides, sidewalk on one side, crosswalk, traffic lights or speed reducers, school signs, traffic signs and route signs for cyclists): "no" for not present and "yes" for present. For analysis purposes, the sidewalk variable was added and categorized as "no" for not present and "yes" for present. Thus, it is possible to understand how each variable is related to the outcome. Also, based on the sum of the individual items around the school, a general score was computed, divided into tertiles, and later classified as "low", "medium" and "high".

DISTANCE FROM HOME

The geocoding of the participants occurred based on the self-reported information of the street, such as street name, house number and postal code (CEP). To compose the

distance variable, the geographic locations of the residence and the school were considered. Thus, calculating the shortest distance between them through the network of city streets was performed using the command "*Network analyst> Route*" in ArcGIS 10.0. ESRI® software[28]. As there is no pre-established cutoff point to quantify the distances, the categorization of the variable was performed based on the findings in the literature. As such, three categories were assigned in this study: ≤ 1,500 m; 1,501– 3,500 m; and ≥ 3,501 m[15].

DEPENDENT VARIABLE

The practice of active commuting to school was assessed by the question "In a normal school week, how many days and how much time during the day do you use the following means of commuting (to and from school)?", considering active commuting: walking, riding a bicycle or using skates to go to and/or from school. For analysis purposes, this variable was dichotomized into: "Do not", for those who did not actively commuting during the week, and "Do", for those who did it ≥ 1 time per week. This classification is commonly used in the literature[13,29].

COVARIABLES

The adolescent's sex ("male"; "female") was observed, and the age was classified into three age groups ("12–13 years", "14–15 years" and "16–17 years"). Socioeconomic status was assessed with the questionnaire from the Brazilian Association of Research Companies (*Associação Brasileira de Empresas de Pesquisa* - ABEP)[30], which was later classified into seven levels. For the analysis, the participants were classified into three categories: "high" (class A), "medium" (class B) and "low" (class C + D + E). Vehicle ownership was assessed according to the number of vehicles present in the residence: "no", when there were no vehicles, and "yes", for ≥ 1 vehicle. The type of school administration was classified as "public" or "private".

DATA ANALYSIS

The frequency distribution and χ^2 test for heterogeneity, linear trend and Fisher's exact test were used to describe the characteristics of the sample. Poisson regression was used to test the crude association between the characteristics of the environment around the school, the distance from the residence and active commuting. In the adjusted analysis, the potential covariates identified in the crude analysis, with $p < 0.05$, were inserted in the final model. The analyzes were performed using Statistical Package for the Social Science (SPSS) 20.0 and STATA 12.0 statistical software, with the significance level maintained at 5%.

RESULTS

Of the 930 adolescents eligible to participate in the project, 493 actually made up the final sample, with a refusal rate of 53.0%, distributed similarly between sex and neighborhood income. One hundred and sixty-three schools were identified, of which ten (6.1%) were ineligible and 29 (17.8%) refused to participate in the study. There was less refusal among public schools than among private schools (public 5.5% versus private 12.9%). The distribution of participants was balanced in terms of sex (girls = 51.2%), but the sample was predominantly composed of adolescents aged 12–13 years (43.1%), of the average socioeconomic level (65.2%), from public schools (70.6%) and who owned at least one car at home (81.0%). At least three in four schools had at least one bus stop (84.8%), sidewalks (99.0%), pedestrian crossings (75.2%), speed reducers (80.4%), road signs (90.4%) and safety signs (96.3%). Approximately one in ten schools had bicycle paths (12.0%), bicycle lanes (1.5%) and signposting routes for cyclists (11.3%). Most participants lived less than 1,500 m from the school (55.9%) (Table 1).

Among adolescents who live up to 1,500m from school, the proportion of those who actively commute to school is higher among those enrolled in a public school (public 59.7% versus private 13.6%). Walking is more common among adolescents from public and private schools at distances <1,500 m (59.1 and 13.6%, respectively). In relation to the use of bicycles, for trips to public schools, they were more used in distances <1,500 m (1.5%), while for trips to private schools, the distances they were used was > 3,501 m (2.5%) (Figure 1).

The unadjusted analyzes indicated that the female sex (PR = 0.84; 95%CI 0.73 - 0.97; p = 0.024) and car ownership (PR = 0.70; 95%CI 0.60 - 0, 81; p <0.001) were inversely associated with active commuting, while the 14–15 age group (PR = 1.19; 95%CI 1.00 - 1.41; p = 0.044), the average socioeconomic levels (PR = 1.98; 95%CI 1.42 - 2.76; p <0.001) and low (PR = 2.78; 95%CI 2.00 - 3.86; p <0.001) and enrollment in a public school (PR = 2.40; 95%CI 1.79 - 3.23; p <0.001) were positively associated with the outcome (Table 2). Furthermore, the presence of bus stops (PR = 0.80; 95%CI 0.65 - 0.98; p = 0.039) and the distances between home and school of 1,500– 3,500 m (PR = 0.48; 95%CI 0.35 - 0.64; p <0.001) and ≥ 3,501 m (PR = 0.24; 95%CI 0.15 - 0.39; p <0.001) showed an inverse association with active displacement. In the adjusted analyzes, the presence of safety signs (RP = 0.78; 95%CI 0.66 - 0.91; p = 0.003) and the distances of 1500–3,500 m (RP = 0.53; 95%CI 0.40 - 0.71; p <0.001) and ≥ 3,501m (PR= 0.29; 95%CI 0.18 - 0.45; p <0.001) remained associated with the outcome (Table 3).

DISCUSSION

This is the first study conducted in Brazil that explored the association between the characteristics of the environment around the school, assessed through systematic observation[27],

Table 1. Descriptive analysis of the characteristics of the environment around the school, the distance from home, and the active commuting of adolescents from Curitiba, Brazil. 2014 (n = 493).

Individual variables		Active commuting†						
		Does not		Does		p*	Total	
		N	%	n	%		n	%
Sex	Male	78	41.9	161	53.0	0.018[h]	239	48.8
	Female	108	58.1	143	47.0		251	51.2
Age range (years)	12–13	89	47.8	122	40.1	0.448[t]	211	43.1
	14–15	52	28.0	115	37.8		167	34.1
	16–17	45	24.2	67	22.0		112	22.9
Socioeconomic status	High	51	27.4	23	7.6	< 0.001[t]	74	15.1
	Average	122	65.6	197	65.0		319	65.2
	Low	13	7.0	83	27.4		96	19.6
Car ownership	No	17	9.1	76	25.0	< 0.001[h]	93	19.0
	Yes	169	90.9	228	75.0		397	81.0
Type of school	Private	99	53.5	45	14.8	< 0.001[h]	144	29.4
	Public	86	46.5	259	85.2		345	70.6
Characteristics of the environment around the school								
Bus stop	No	13	9.4	49	18.2	0.018[h]	62	15.2
	Yes	126	90.6	220	81.8		346	84.8
Bike paths	No	113	81.3	246	91.4	0.003[h]	359	88.0
	Yes	26	18.7	23	8.6		49	12.0
Bike lanes	No	135	97.1	267	99.3	0.186[f]	402	98.5
	Yes	4	2.9	2	0.7		6	1.5
Sidewalks	No	3	2.2	1	0.4	0.117[f]	4	1.0
	Yes	136	97.8	268	99.6		404	99.0
Crosswalks	No	24	17.3	77	28.6	0.012[h]	101	24.8
	Yes	115	82.7	192	71.4		307	75.2
Speed reducers	No	20	14.4	60	22.3	0.056[h]	80	19.6
	Yes	119	85.6	209	77.7		328	80.4
School signage	No	11	7.9	28	10.4	0.417[h]	39	9.6
	Yes	128	92.1	241	89.6		369	90.4
Traffic signs	No	3	2.2	12	4.5	0.282[f]	15	3.7
	Yes	136	97.8	257	95.5		393	96.3
Route signage for bikers	No	114	82.0	248	92.2	0.002[h]	362	88.7
	Yes	25	18.0	21	7.8		46	11.3
General score	Low	43	30.9	109	40.5	< 0.002[t]	152	37.3
	Average	71	51.1	141	52.4		212	52.0
	High	25	18.0	19	7.1		44	10.8
Distance from residence (meters)	≤ 1,500	22	15.9	205	76.5	<0.001[t]	227	55.9
	1,501–3,500	61	44.2	47	17.5		108	26.6
	≥ 3,501	55	39.9	16	6.0		71	17.5

†walking, using a bicycle or skating to go to and/or from school ≥1 time/week; [h]test χ^2 for heterogeneity; [t]χ^2 test for linear trend; [f]Fisher's exact test; *p <0.05.

and the distance from home, assessed by Geographic Information System (GIS)[31], with the active commuting of adolescents. The combination of methods made it possible to identify quantitative and qualitative attributes of the environment built around schools and the possible routes between homes and schools, which contributes to the understanding of how people choose their mode of transport, and are relevant and innovative factors of the study.

Active commuting to school was reported by 62% of adolescents in the sample, with a higher proportion among those enrolled in public schools (public 59.7% versus

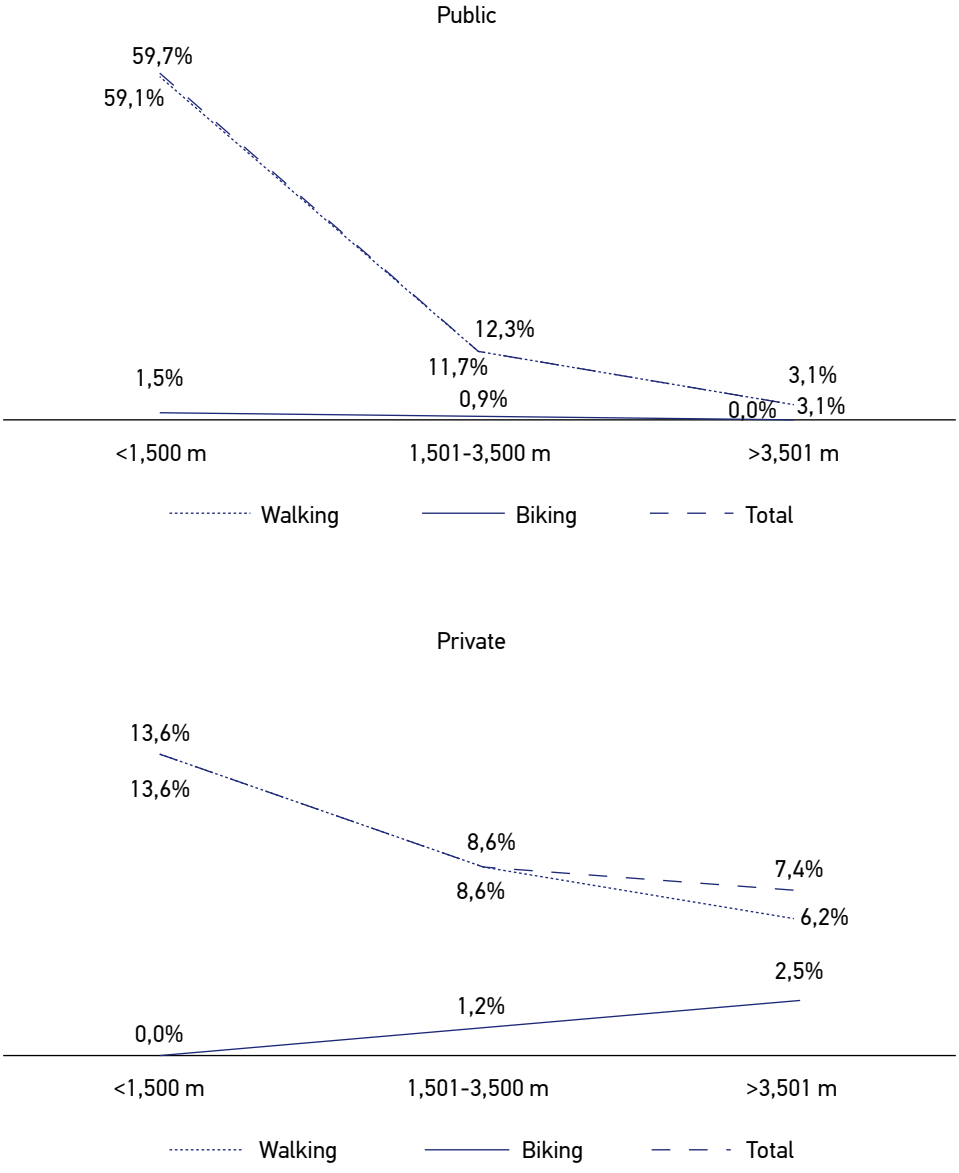

Figure 1. Proportion of adolescents who actively commute to public and private schools, according to distance from home. Curitiba, Brazil. 2014 (n = 493).

private 13.6%), especially when homes are located at a distance up to 1,500 m from the institution. This data can be justified by the enrollment procedure adopted by the State Department of Education (*Secretaria Estadual de Educação* - SEED), which prioritizes the enrollment of students in public institutions close to their homes, while private institutions do not follow this criterion[32]. However, the farthest distance observed in this study was 22,400 m, suggesting that enrollment in the education system does not necessarily follow the distance to the school as suggested by SEED. As for the type of active commuting, while walking is a popular way to get to school, the use of bicycles in Brazil is less common among teenagers, mainly because there is no culture linked to the use, little or no infrastructure in the neighborhood and around schools, in addition to topographic variations[33].

Individual characteristics may be one of the factors that justify the choice of active commuting, since the outcome, in the present study, is less frequent among girls and those whose family owns at least one car. In the study by Rech et al.[34], 56.8% of girls were active commuters to school. The same pattern was observed in the study by Silva et al.[29], in which 48.6% of the adolescents actively commuted to school in some way. This relationship could be explained by psychological and socio-cultural factors of greater overprotection by parents or guardians in relation to girls, especially when the educational level of parents or guardians is medium-low[34,35] . Furthermore, a family's purchasing power can

Table 2. Crude Poisson regression analysis between covariates and active commuting of adolescents from Curitiba, Brazil. 2014 (n = 493).

Covariates		Active commuting†		
		PR	95%CI	p*
Sex	Male	1		
	Female	0.84	0.73 – 0.97	0.024
Age range (years)	12–13	1		
	14–15	1.19	1.00 – 1.41	0.044
	16–17	1.03	0.82 – 1.28	0.761
Socioeconomic status	High	1		
	Average	1.98	1.42 – 2.76	< 0.001
	Low	2.78	2.00 – 3.86	< 0.001
Car ownership	No	1		
	Yes	0.70	0.60 – 0.81	< 0.001
Type of school	Private	1		
	Public	2.40	1.79 – 3.23	< 0.001

†Walking, riding a bicycle or skates to go to and/or from school ≥1 time/week; PR: prevalence ratio; 95%CI: 95% confidence interval; *p <0.05

interfere in the mode of transport due to the convenience and the perception of safety. Ownership of cars can influence this transport choice, giving preference to car commuting instead of traveling on foot[35-37].

Table 3. Crude and adjusted Poisson regression analysis between the characteristics of the environment around the school, the distance from the residence and the active commuting of adolescents from Curitiba, Brazil. 2014 (n = 493).

Characteristics of the environment around the school		Active commuting†					
		Crude			Adjusted‡		
		PR	95%CI	p*	RP	95%CI	p*
Bus stop	No	1			1		
	Yes	0.80	0.65 – 0.98	0.039	0.95	0.80 – 1.13	0.612
Bike paths	No	1			1		
	Yes	0.68	0.41 – 1.12	0.135	0.80	0.56 – 1.13	0.202
Bike lanes	No	1			1		
	Yes	0.50	0.18 – 1.33	0.162	0.49	0.17 – 1.40	0.181
Sidewalks	No	1			1		
	Yes	0.82	0.65 – 1.02	0.083	0.95	0.80 – 1.14	0.619
Speed reducers	No	1			1		
	Yes	0.84	0.66 – 1.07	0.180	1.02	0.82 – 1.26	0.816
School signage	No	1			1		
	Yes	0.90	0.66 – 1.24	0.548	0.90	0.68 – 1.18	0.444
Traffic signs	No	1			1		
	Yes	0.81	0.57 – 1.16	0.259	0.78	0.66 – 0.91	0.003
Route signage for bikers	No	1			1		
	Yes	0.66	0.40 – 1.09	0.107	0.80	0.56 – 1.12	0.196
Overall score	Low	1			1		
	Medium	0.92	0.73 – 1.16	0.521	1.01	0.84 – 1.20	0.897
	High	0.60	0.35 – 1.02	0.064	0.76	0.51 – 1.12	0.175
Distance from residence (meters)	≤ 1,500	1			1		
	1,501–3,500	0.48	0.35 – 0.64	<0.001	0.53	0.40 – 0.70	< 0.001
	≥ 3,501	0.24	0.15 – 0.39	<0.001	0.29	0.18 – 0.45	< 0.001

†Walking, riding a bicycle or skating to go to and/or from school ≥ 1 time/week; ‡Adjusted for covariates: sex, age group, socioeconomic status, car ownership and type of school; PR: prevalence ratio; 95%CI: 95% confidence interval; *p <0.05.

The presence of safety signs was inversely associated with active commuting (PR = 0.78; 95%CI 0.66 - 0.91). This result is in contradiction with the literature, in which the presence of signing tends to provide a greater perception of safety and increase the chances of active commuting[16]. The findings can be explained, in part, by the fact that, in developing countries such as Brazil, in the busiest places - with regard to traffic or flow of motor vehicles -, there is a greater amount of signage, which aim at greater movement control and the reduction of possible accidents[16,38]. This can inhibit active commuting, considering the large flow of cars and the negative perception of safety, especially by parents or guardians[39-41].

In fact, the findings of the present study demonstrated an inverse association between greater distances, such as 1,501–3,500 m (PR = 0.53; 95%CI 0.40 - 0.70) and ≥ 3,501 m (PR = 0.29; 95%CI 0.18 - 0.45), and active commuting to school. The results suggest a consistency with the literature that analyzed the distance traveled from the residence to the school, both for perceived measures[41,42] and for objective measures[8]. A study carried out in Belgium by D'Haese et al.[13] pointed out that distances of up to 1,500 m between home and school are suitable for walking, and distances of up to 3,000 m are suitable for cycling. A study carried out in Ireland by Nelson et al.[14] demonstrated that distances above 4,000 m are characterized as a barrier to active commuting, reinforcing that the proximity of the home can stimulate this practice[1,15,43,44], provided that factors such as perceived safety of adolescents and parents or guardians, in addition to the presence of attributes (walkability, density and accessibility), are linked[16,38]. In Brazil, Silva et al.[8] identified that the main barrier to active commuting was the distance to school. Thus, the results seem to strengthen the importance of policies that integrate access to school and traffic safety. It is also important to highlight that these commuting alternatives have direct implications for the education and health of the population, as well as for the economy and sustainability of cities[45,46].

Some limitations must be considered for the proper interpretation of the results of this study. Active commuting was self-reported, which prevents a more accurate estimation of the behavior[47]. The evaluation of the schools' surroundings was restricted to the streets around the block where the institution was located, which does not allow to extrapolate the characteristics to other streets in the community environment. The sample of schools is not representative of the city, and their selection was associated with the institutions in which the adolescents were enrolled. Although the shortest distance through the network of streets, between the residence and the school of the adolescents was measured using GIS, this does not reflect the real route taken by them, like, for example, data provided by Global Positioning System (GPS)[48]. Therefore, in the present study, it was not possible to assess the "quality" of the total area that covers the path that the teenager frequently used or was exposed to, for example, areas of sausage buffer of 25 or 75 m of street segments or sidewalk[49]. Finally, the cross-sectional design limits the causal interpretation between the variables.

CONCLUSION

The presence of safety signs and the distance between home and school showed an inverse association with active commuting among adolescents from public and private schools in Curitiba, Paraná. The findings indicate that traffic safety and proximity to home can contribute to active commuting to school. Policies that integrate access to schools close to home and traffic safety can contribute to encouraging active commuting to school among teenagers, and also involve the perceptions of teenagers and their parents or guardians. It is necessary, then, to provide improvements in the conditions of the neighborhood and surrounding schools for the development of effective interventions[50].

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