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REPORTS IN PUBLIC HEALTH

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ARTICLE

Characteristics of the environmental microscale and walking and bicycling for transportation among adults in Curitiba, Paraná State, Brazil

Características da microescala do ambiente, caminhada e uso de bicicleta no deslocamento em adultos de Curitiba, Paraná, Brasil

Características de una microescala ambiental y pasear, montar en bicicleta, como forma de transporte en una población adulta de Curitiba, Estado de Paraná, Brasil

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doi: 10.1590/0102-311Xe00203116

Abstract

The aim of this study was to analyze the association between the characteristics of the built and social and environmental microscale and walking and bicycling for transportation in adults in Curitiba, Paraná State, Brazil. A cross-sectional study was performed in 2009 with a household survey that included 1,419 adults. Objective evaluation of environment was performed on the resident's street segments, using an instrument for systematic observation consisting of six dimensions: "land use", "public transportation", "streetscape", "conditions and aesthetics", "places for walking and bicycling", and "social environment". The score for each dimension was obtained as the sum of positive items related to physical activity. The items for "public transportation" (≥ 1 items) and "places for walking and bicycling on the streets" (≥ 3 items) were dichotomized, while the scores for the other items were classified in tertiles. Walking and bicycling for transportation were assessed with the International Physical Activity Questionnaire *(IPAQ). The data were analyzed using multilevel Poisson regression. Medium "streetscape" score was inversely associated with walking ≥ 150min/week (PR = 0.60; 95%CI: 0.40-0.91; VPC = 12%) and bicycling (PR = 0.54; 95%CI: 0.29-0.99; VPC = 60%). In conclusion, only "streetscape" was associated with walking and bicycling for transportation in adults.*

Controlled Environment; Motor Activity; Walking; Bicycling

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Introduction

Physical inactivity is a leading cause of death worldwide, with serious health problems, notably in low and middle-income countries [1]. This can be partly attributed to the increase in motor vehicles, chaotic urbanization, and precarious public safety and security that affect the way people commute on a daily basis [2,3,4]. These and other characteristics have been widely studied at different scales of influence by the built environment in cities (micro, meso, and macro), especially the scales related to transportation-related physical activity [4,5,6,7]. Such characteristics include land use, street layout, presence and quality of sidewalks and bike lanes, access to public transportation, aesthetics, and public safety and security [4,6,7,8].

Evidence points to an association between variables in the perceived [5,9,10] and built environment [5,9,11,12] and transportation-related physical activity. Other studies have shown the positive effect of environmental changes on commuting behavior [12,13,14,15]. However, a large share of the evidence comes from studies in high-income countries, which may not represent the urban and sociocultural characteristics of lower-income countries like those of Latin America [3,6,7].

In Brazil, different methodologies have been used to explore the association between variables from the built environment, such as "walkability" and transportation-related physical activity in adults [3,7,16,17,18,19], while several characteristics vary according to the neighborhood's socioeconomic level [20,21]. However, a recent review failed to identify studies that used systematic observation of environment for this evaluation in adults [19]. Thus, the lack of precise and detailed information on the variables in the built and social microscale raises an important question for investigation in Brazilian cities [8,22].

Certain objective measures can thus contribute to a better understanding of the relationship between cities' structure and physically active commuting [23,24]. Data from the environmental microscale allow a detailed description of conditions in the quality of sidewalks, aesthetics, access to public transportation, lighting, and others that can be modified at low cost and in less time when compared to macroscale attributes, generally identified through geoprocessing data [5,8].

Streetscape auditing is thus a potential option for obtaining microscale data, due to its low costs and the potential for producing precise details on urban variables [5,8]. The objectivity of the measures requires clear protocols, comprehensive auditing items, and the possibility of capturing the environment's characteristics, which are dynamic, portraying the population's daily reality and potentially affecting individual choices as to mode of transportation [25,26]. The aim of this study was thus to analyze the association between the characteristics of the built and social environmental microscale and walking and bicycling as modes of transportation for adults in Curitiba, Paraná State, Brazil.

Material and methods

Study design, location, and ethical issues

This was a cross-sectional observational study using a household survey. The data are part of a research project in Curitiba, capital of Paraná State, in 2009. The project's principal objective was to assess the health characteristics, leisure-time habits, and physical activities of adults residing near the city's parks. The study was approved by the Institutional Review Board of the Federal University of Pelotas (case review 005/2008).

Selection of sites and households

In order to enhance the variability of socioeconomic status and characteristics of the built environment, eight urban parks were selected with different structures for physical activities, located in different areas of the city. The neighborhoods were classified in four groups: (1) high environmental quality and high socioeconomic status, (2) high environmental quality and low socioeconomic status, (3) low environmental quality and high socioeconomic status, and (4) low environmental quality and low socioeconomic status. Further details on the classification and selection criteria for the sites have been published elsewhere [27,28].

The households were selected from a 500-meter buffer around each of the eight parks, generated with the ArcGIS software (http://www.esri.com/software/arcgis/index.html). This distance has been adopted in similar studies [23] and considers a walking distance of five to 10 minutes from home to the park [27]. All street segments inside this radius (n = 1,899) were assessed to identify those with eligible households. One household was selected per segment, based on a random numbers table generated with the EpiInfo software (Centers for Disease Control and Prevention, Atlanta, USA). In all, 1,538 street segments with households were tallied. However, 361 (29%) did not have happen to have households and were thus excluded from the analysis.

Selection of participants and data collection

One resident per household was randomly selected based on the inclusion criteria of adult age (≥ 18 years), no physical limitations, and having lived in the neighborhood for at least a year. Interviews were conducted in 95% of the eligible segments (n = 1,461), and in 5% of the remaining segments there were no eligible residents. The refusal rate was 8% (n = 121), and quality control was performed in 13% of the interviews via telephone contact to verify the date and time of the interview and to confirm some key study variables.

Dependent variables

Walking and bicycling for transportation during a normal week were assessed with the *International Physical Activity Questionnaire* (IPAQ), long version [29]. Variables were calculated as the ratio between weekly frequency and mean daily amount for each activity. Based on the literature [23], walking was operationalized as two different outcomes according to weekly amount ("≥ 10min/week" and "≥ 150min/week"), while bicycling was categorized as ≥ 10min/week.

Independent variables

Objective evaluation of the environment used an instrument for systematic observation of the streetscape. The *Inventory for the Evaluation of the Community Environment Related to Physical Activity* (ICAF in Portuguese) was translated from the *Active Neighborhood Checklist* [26] and adapted to the Brazilian context, showing an inter-evaluator agreement of 85-98% [30].

The items comprise the community environmental microscale, and the instrument consists of various characteristics, grouped in six dimensions: land use, public transportation, streetscape, conditions and aesthetics, places for walking and cycling, and social environment. A total of 105 items were assessed, and variables were grouped according to the dimensions of the built and social environment suggested in the original instrument, which considers the quantity, variety, and quality of the attributes related to physical activities [30].

In the "land use" dimension, we evaluated occupation of the lots (45 items), "public transportation" included taxi stands, bus stops, and Bus Rapid Transit on one or both sides of the street segment (3 items). "Streetscape" assessed structures for slowing traffic or facilitating safe street crossings for pedestrians, such as speed limits and pedestrian lanes and signs (14 items). The "conditions and aesthetics" dimension included public improvements on the street segment, trash cans, and benches, versus signs of vandalism and graffiti (14 items). The dimension "places for walking and cycling" identified characteristics of the street and sidewalk that could hinder or facilitate walking or bicycling, such as obstacles, marked lanes, and signs, plus width of the sidewalks (sidewalks: 10 items; streets: 5 items). Finally, the "social environment" dimension assessed positive aspects like police presence, people engaged in physical activities and/or conversing on the streets, versus negative characteristics such as people arguing or fighting, stray dogs and other animals, panhandlers, illegal parking attendants, and drunkards (12 items). The presence of items with a potential negative association with walking and cycling was recoded from "1" to "0" (e.g., dead-end streets, etc.)

In order to characterize the environment of the street segments, the attributes for each dimension were tallied and classified at three levels of quality by tertiles: low (1st tertile), medium (2nd tertile), and high (3rd tertile). However, the items public transportation and places for walking and bicycling on streets

showed low frequency of attributes, so we opted to analyze them dichotomously (0 items versus ≥ 1 items and 0-2 items versus ≥ 3 items, respectively).

- **Individual variables**

Based on the conceptual model proposed by Saelens et al. [9], some individual variables were identified that might confound the association between the variables in the built and social environment and the target outcomes: sex, age bracket, marital status, socioeconomic status, nutritional status, self-rated health, self-rated quality of life, perceived crime in the neighborhood, number of motor vehicles in the household, and use of public transportation. For example, female gender is positively associated with walking ≥ 10min/week, but inversely associated with bicycling as transportation [23]. Meanwhile, vehicle ownership is inversely associated with the three outcomes analyzed in the current study [23]. These and other variables were identified, measured, and tested as possible covariates. The description of these measures and the way they are categorized are discussed next.

Sex (male, female) was recorded, age bracket was classified in three categories (18-39.9 years, 40-59.9 years, ≥ 60 years), and marital status categorized as single or married. Socioeconomic status was assessed using the questionnaire of the Brazilian Association of Market Research Companies (ABEP) [31], and individuals were classified in three levels: low (classes C, D, and E), medium (class B), and high (class A).

Nutritional status was obtained from self-reported weight and height, and participants were classified as "normal weight" and "excess weight", according to body mass index. Self-rated health and quality of life were assessed with the *World Health Organization Quality of Life* (WHOQOL) scale, with answers according to a five-point Likert scale [32]. Self-rated health was assessed with the question, "Are you satisfied with your health?" (very dissatisfied, dissatisfied, neither satisfied nor dissatisfied, satisfied, very satisfied). For analytical purposes, the first three categories were grouped and operationalized as "negative self-rated health" and the other two as "positive self-rated health". Self-rated quality of life was assessed with the question, "How do you rate your quality of life?" (very bad, bad, neither bad nor good, good, and very good). The first three categories were operationalized as "negative self-rated quality of life" and the other two as "positive self-rated quality of life". Finally, perceived crime was assessed with the question, "Are there many crimes in your neighborhood?", with the dichotomous (no, yes) answer from the *Neighborhood Environment Walkability Scale* (NEWS) [33].

The number of motor vehicles in the household was assessed with the ABEP questionnaire [31] and operationalized in three categories (0, 1, and ≥ 2). Use of public transportation was assessed with the question: "How many days a week do you use the city's public transportation?" (0 to 7 days), and the variable was operationalized in three categories (0 days, 1-2 days/week, and ≥ 3 days/week). The principal means of daily transportation was assessed to characterize the participants, who could choose one of eight possible answers: car, public bus, walking, motorcycle, bicycle, private (company) bus, taxi, and other.

Data analysis

Multilevel Poisson regression was used to test the association between the variables of the built and social environment and walking and bicycling for transportation. Since the study design took into account the sample selection considering the eight parks as the primary sampling units, multilevel random intercept modeling was used to consider the cluster effect between the sampling units. The variance partition coefficient (VPC) was calculated for each combination of outcome and exposure, indicating the values of the constant and the proportion of variance attributed to the place level and the variation between individuals from the same location.

We first tested the association between the individual variables and the study's dependent variables. This allowed identifying variables that were potentially associated with each outcome ($p < 0.20$) and that could be kept for analysis in the adjusted model. To construct the final multilevel regression model, we analyzed the association between the characteristics of the built and social environment and the transportation variables, adjusted for individual variables that presented $p < 0.20$. The analyses were performed with the Stata 12.0 software (StataCorp LP, College Station, USA), using the xtmepoisson command, with significance kept at 5%.

Results

Of the 1,461 interviewees, 42 were excluded due to lack of complete data on some target variable, resulting in a final sample of 1,419 individuals (Table 1). The majority of the participants were female (63.6%), 40-59 years of age (45.8%), married (57.4%), with medium socioeconomic status (49.8%), with normal nutritional status (51.7%), and with positive self-rated health (71.6%) and quality of life (73.9%), and with low perception of crimes in neighborhood (53.3%). In addition, 62.4% of the participants reported using public transportation and 76.2% had at least one motor vehicle in the household. The principal means of daily transportation was by car (46.7%), followed by public bus (34.3%) and walking (12.9%) (Table 1).

As for the variables in the built and social environment, the highest proportion of participants lived on street segments with medium-quality land use (41.2%), public transportation (84.5%), low-quality streetscape (60.4%), low aesthetic quality (44.7%), few favorable items on places for walking and bicycling on the streets (0-2 items: 79.6%), and medium quality of the social environment (40.5%). In addition, 69.1% of participants spent less time walking for transportation (≥ 10min/week), while 20.3% walked for transportation at the recommended levels (150min/week), and only 9% reported bicycling for transportation at low levels (≥ 10min/week) (Table 1).

Table 2 shows the association between individual variables and walking and bicycling. Socioeconomic status ($p < 0.05$) and number of motor vehicles ($p < 0.001$) were inversely associated with walking ≥ 10min/week, while weekly use of public transportation was positively associated ($p < 0.001$) and married marital status was inversely and potentially associated with this outcome ($p < 0.20$). Socioeconomic status, number of motor vehicles, and rate of weekly use of public transportation were associated with walking ≥ 150min/week ($p < 0.001$), while age bracket and marital status were potentially associated with this outcome ($p < 0.20$). Sex, age bracket, self-rated health, perceived crime in the neighborhood, and rate of weekly use of public transportation showed significant association with bicycling ($p < 0.05$), while self-rated quality of life and number of motor vehicles in the household were potentially associated with this outcome ($p < 0.20$).

In the bivariate association between the environmental variables and the outcomes (Table 3), medium streetscape was inversely associated with walking ≥ 150min/week (prevalence ratio – PR = 0.62; 95%CI: 0.41-0.92) and bicycling (PR = 0.53; 95%CI: 0.29-0.97). No significant values were observed in the test for trend among the categories of target variables.

After adjusting for possible confounding (Table 4), medium streetscape was associated with walking ≥ 150min/week (PR = 0.60; 95%CI: 0.40-0.91; VPC = 12%) and bicycling (PR = 0.54; 95%CI: 0.29-0.99; VPC = 60%). No significant values were found for the test for trend between target variables.

Discussion

This is the first study in Brazil to explore the association between characteristics of the built and social environment, obtained by systematic and direct observation of the environment, and walking and bicycling for transportation in adults. The methodology allowed a geographic representation of the places in neighborhoods with different environmental and social attributes for physical activity, besides obtaining and objectively measuring quantitative and qualitative attributes of the built and social environment that are not possible to identify in data obtained with geoprocessing or perception of the environment [24]. These are thus the current study's strengths and innovative characteristics. Streetscape was the only score inversely associated with walking greater than 150 min/week and bicycling.

A recent study in Recife, Pernambuco State, Brazil [30], evaluated the same attributes of the built and social environment around schools and found that public transportation, social environment, and overall environmental score were related to active commuting to school by preschool children (3-5 years). Two studies tested the association between the environment's characteristics (by systematic observation) and walking and bicycling in adults [8,25]. However, these studies were done in cities in the United States, where the characteristics of the environment differ greatly in comparison to Brazilian cities [34]. For example, a multicenter study in 14 cities in 10 countries showed that the density of street intersections and mixed land use were greater in Curitiba, than in cities in New Zealand and the United States [34]. These variables, among others, are important predictors of walking and bicycling for transportation [5,9,34].

Table 1

Description of individual and environmental variables, transportation-related physical activity, and means of transportation in adults. Curitiba, Paraná State, Brazil, 2009 (N = 1,419).

Categories	n	%
Individual variables		
Gender		
Male	517	36.4
Female	902	63.6
Age bracket (years) [5 missing]		
18-39	587	41.5
40-59	647	45.8
≥ 60	180	12.7
Marital status		
Single	604	42.6
Married	815	57.4
Socioeconomic status [8 missing]		
Low	532	37.7
Medium	702	49.8
High	177	12.5
Nutritional status [4 missing]		
Normal	731	51.7
Excess weight	684	48.3
Self-rated health		
Negative	403	28.4
Positive	1,016	71.6
Self-rated quality of life		
Negative	370	26.1
Positive	1,049	73.9
Perceived crime in neighborhood [1 missing]		
No	756	53.3
Yes	662	46.7
Number of motor vehicles in household [6 missing]		
0	336	23.8
1	669	47.3
≥ 2	408	28.9
Use of public transportation (days/week)		
0	533	37.6
1-2	422	29.7
≥ 3	464	32.7
Environmental variables		
Land use [1 missing]		
Low	483	34.1
Medium	584	41.2
High (3rd tertile)	351	24.8
Public transportation		
0 items	220	15.5
≥ 1 items	1,199	84.5
Streetscape [1 missing]		
Low	857	60.4
Medium	219	15.4
High (3rd tertile)	342	24.1

(continues)

Table 1 (continued)

Description of individual and environmental variables, transportation-related physical activity, and means of transportation in adults. Curitiba, Paraná State, Brazil, 2009 (N = 1,419).

Categories	n	%
Environmental variables		
Conditions and aesthetics		
Low	635	44.7
Medium	364	25.7
High (3rd tertile)	420	29.6
Places for walking and bicycling		
Sidewalks		
Low	494	34.8
Medium	485	34.2
High (3rd tertile)	440	31.0
Streets		
0-2 items	1,130	79.6
≥ 3 items	289	20.4
Social environment		
Low	492	34.7
Medium	575	40.5
High (3rd tertile)	352	24.8
Transportation-related physical activity		
Walking I [2 missing]		
0-9min/week	438	30.9
≥ 10min/week	979	69.1
Walking II [2 missing]		
0-149min/week	1,130	79.7
≥ 150min/week	287	20.3
Bicycling [1 missing]		
0-9min/week	1,290	91.0
≥ 10min/week	128	9.0
Main mode of transportation [13 missing]		
Car	657	46.7
Public bus	482	34.3
Walking	181	12.9
Motorcycle	33	2.3
Bicycle	31	2.2
Private bus (company)	14	1.0
Taxi	2	0.1
Other	6	0.4

Medium streetscape reduced by 41% and 46%, respectively, the likelihood of walking ≥ 150 min/week and bicycling. These results differ from a study in the US cities of Seattle, San Diego, Baltimore, and Washington DC, where the overall streetscape score was positively associated with weekly frequency of active commuting (walking + bicycling) [34]. The inverse association shown in the current study may have several explanations. First, the majority of the streets in the selected neighborhoods show low commercial density, so residents do not need to walk or pedal to local shops on a daily basis [9]. In fact, in Curitiba a positive association was found between the proportion of business districts close to the household and walking for transportation [23]. Second, proximity to parks may be associated with use of these places for leisure-time physical exercise only [27,35], and not for transportation. Third, since parks may pose natural barriers to "short" errands on foot or bicycle to neighborhood

Table 2

Multilevel bivariate association between individual variables and walking and bicycling for transportation in adults. Curitiba, Paraná State, Brazil, 2009 (N = 1,419)

	Walking I ≥ 10min/week		Walking II ≥ 150min/week		Bicycling ≥ 10min/week	
	PR	95%CI	PR	95%CI	PR	95%CI
Gender						
Female	1.00	*	1.00	*	1.00	**
Male	0.93	0.82-1.07	0.98	0.77-1.25	4.45	3.03-6.55
Age bracket (years)						
18-39	1.00	*	1.00	***	1.00	**
40-59	0.99	0.86-1.14	1.12	0.87-1.46	0.67	0.47-0.96
≥ 60	1.14	0.93-1.38	1.40	0.99-1.98	0.18	0.06-0.50
Marital status						
Single	1.00	***	1.00	***	1.00	*
Married	0.91	0.80-1.04	0.79	0.62-1.00	0.77	0.54-1.10
Socioeconomic status						
Low	1.00	#	1.00	**	1.00	*
Medium	0.87	0.75-1.00	0.66	0.51-0.85	0.97	0.67-1.41
High	0.68	0.54-0.87	0.34	0.21-0.56	0.58	0.29-1.15
Nutritional status						
Normal	1.00	*	1.00	*	1.00	*
Excess weight	1.01	0.89-1.14	1.13	0.89-1.43	0.82	0.57-1.16
Self-rated health						
Negative	1.00	*	1.00	*	1.00	#
Positive	0.95	0.83-1.09	0.97	0.75-1.26	1.74	1.11-2.73
Self-rated quality of life						
Negative	1.00	*	1.00	*	1.00	***
Positive	1.07	0.92-1.24	1.03	0.78-1.35	1.40	0.91-2.16
Perceived crime in neighborhood						
No	1.00	*	1.00	*	1.00	#
Yes	1.05	0.92-1.20	1.02	0.80-1.29	0.68	0.47-0.97
Number of motor vehicles in household						
0	1.00	**	1.00	**	1.00	***
1	0.84	0.72-0.98	0.70	0.54-092	0.83	0.55-1.26
≥ 2	0.71	0.60-0.85	0.40	0.28-0.57	0.72	0.45-1.17
Use of public transportation (days/week)						
0	1.00	**	1.00	**	1.00	#
1-2	1.40	1.19-1.64	1.60	1-16-2.21	1.67	1.07-2.60
≥ 3	1.49	1.28-1.75	2.43	1.81-3.27	1.65	1.07-2.56

95%CI: 95% confidence interval; PR: prevalence ratio.

* $p \geq 0.20$;

** $p < 0.001$;

*** $p < 0.20$;

# $p < 0.05$.

shops and services, the high household vehicle ownership rate (76%) may favor the use of vehicles for these errands [28]. In fact, some 50% of the interviewees reported using their car or motorcycle as their main means of daily transportation (Table 1). Finally, although the medium "streetscape" score indicates street segments with better characteristics which may facilitate walking (pedestrian crossings and lights,

Table 3

Multilevel bivariate association between quality/presence of environmental variables and walking and bicycling for transportation in adults. Curitiba, Paraná State, Brazil, 2009 (N = 1,419).

	Walking I ≥ 10min/week		Walking II ≥ 150min/week		Bicycling ≥ 10min/week	
	PR	95%CI	PR	95%CI	PR	95%CI
Environmental variables						
Land use (reference: low)						
Medium	1.08	0.92-1.25	1.21	0.90-1.63	1.14	0.75-1.72
High	1.12	0.94-1.35	1.25	0.88-1.79	1.24	0.78-1.97
Public transportation (reference: 0 items)						
≥1 items	0.89	0.75-1.05	0.86	0.64-1.17	0.79	0.50-1.23
Streetscape (reference: low)						
Medium	1.08	0.90-1.29	0.62	0.41-0.92	0.53	0.29-0.97
High	1.08	0.91-1.28	0.93	0.67-1.30	0.79	0.51-1.22
Conditions and aesthetics (reference: low)						
Medium	1.00	0.85-1.18	0.87	0.63-1.20	1.10	0.72-1.68
High	1.06	0.89-1.26	1.25	0.89-1.77	0.94	0.60-1.46
Places for walking and bicycling						
Sidewalks (reference: low)						
Medium	1.02	0.87-1.19	1.30	0.97-1.74	0.89	0.59-1.34
High	0.99	0.84-1.18	1.01	0.72-1.41	0.76	0.48-1.19
Streets (reference: 0-2 items)						
≥ 3 items	0.99	0.84-1.17	1.08	0.80-1.46	1.05	0.68-1.61
Social environment (reference: low)						
Medium	1.02	0.88-1.19	0.91	0.68-1.21	0.84	0.55-1.27
High	1.06	0.89-1.26	1.11	0.81-1.51	1.09	0.70-1.69

95%CI: 95% confidence interval; PR: prevalence ratio.

speed bumps, etc.), besides the previously reported relationship between purchasing power and vehicle ownership and use, the presence of bus stops on most of the segments (85%) may also favor use of the latter means of transportation rather than walking and/or bicycling [23]. The proportion of participants that reported using car, motorcycle, or public transportation was actually quite high (83%) when compared to walking or bicycling (15%) (Table 1).

In addition, the inverse relationship observed between "streetscape" and bicycling may be explained by the fact that some target items (speed bumps, pedestrian lights and crossings, number of lanes on the street segment, among others) represent barriers, which ends up hindering walking and bicycling [36]. For example, Hino et al. [23] used geoprocessing data and found that presence of stoplights on street segments can reduce by 73% the odds of bicycling as transportation among adults in Curitiba. In addition, speed bumps, radars, and speed limit signs may be present mostly on street segments with heavy vehicle traffic [37]. This characteristic, among others, may increase the perceived fear of accidents by bicyclists, reported in the literature as an important barrier to cycling [38]. In fact, only 2% of the interviewees reported bicycling as their principal means of daily transportation (Table 1).

Most of the items in the systematic observation of the built and social environment were not associated with walking or bicycling for transportation. However, Hoehner et al. [25] used the same instrument to evaluate street segments in 1,053 adults living within a 400-meter radius in two American cities (Saint Louis, Missouri, and Savannah, Georgia) and found that the number of streets with bus stops, trees, and other pedestrian amenities, as well as the number of persons seen engaged in physical activity (positive social environment) showed a positive association with walking and bicycling for transportation [25]. Despite the difference in the direction and/or absence of most of the associations, it is important to note

Table 4

Adjusted multilevel association between quality/presence of environmental variables and walking and bicycling for transportation in adults. Curitiba, Paraná State, Brazil, 2009 (N= 1,419).

	Walking I ≥ 10min/week *		Walking II ≥ 150min/week **		Bicycling ≥ 10min/week ***	
	PR	95%CI	PR	95%CI	PR	95%CI
Environmental variables						
Land use (ref: low)						
Medium	1.07	0.91-1.24	1.18	0.87-1.59	1.08	0.72-1.64
High	1.11	0.92-1.33	1.19	0.83-1.70	1.12	0.71-1.78
		0.123 (0.036) #		0.385 (0.104) #		0.108 (0.031) #
Public transportation (ref: 0 items)						
≥ 1 items	0.89	0.75-1.06	0.88	0.65-1.20	0.75	0.48-1.17
		0.133 (0.038) #		0.410 (0.110) #		0.105 (0.030) #
Streetscape (ref: low)						
Medium	1.09	0.91-1.31	0.60	0.40-0.91	0.54	0.29-0.99
High	1.09	0.92-1.30	0.96	0.69-1.34	0.71	0.46-1.10
		0.127 (0.037) #		0.462 (0.123) #		5.06 (0.605) #
Conditions and aesthetics (ref: low)						
Medium	1.01	0.86-1.19	0.87	0.62-1.21	1.04	0.68-1.58
High	1.07	0.90-1.28	1.20	0.84-1.70	0.83	0.54-1.28
		0.127 (0.037) #		0.381 (0.103) #		0.000 (0.000) #
Places for walking and bicycling						
Sidewalks (ref: low)						
Medium	1.01	0.87-1.18	1.28	0.95-1.72	0.90	0.60-1.35
High	1.00	0.84-1.18	0.99	0.71-1.40	0.78	0.50-1.22
		0.140 (0.040) #		0.426 (0.114) #		0.000 (0.000) #
Streets (ref: 0-2 items)						
≥ 3 items	1.01	0.86-1.20	1.17	0.86-1.60	0.92	0.60-1.42
		0.139 (0.040) #		0.401 (0.108) #		0.080 (0.023) #
Social environment (ref: low)						
Medium	1.02	0.87-1.19	0.90	0.67-1.20	0.83	0.55-1.25
High	1.03	0.87-1.23	1.03	0.75-1.41	0.91	0.58-1.42
		0.133 (0.038) #		0.414 (0.111) #		0.084(0.024) #

95%CI: 95% confidence interval; PR: prevalence ratio.

* Adjusted for socioeconomic status, marital status, number of motor vehicles in household, and use of public transportation;

** Adjusted for age bracket, socioeconomic status, marital status, number of motor vehicles in household, and use of public transportation;

*** Adjusted for sex, age bracket, marital status, self-rated health and quality of life, crime in neighborhood, number of motor vehicles in household, and use of public transportation;

Values for constant and variance partifition coefficient (VPC).

that the current study's findings are similar to those in the literature [5,9,23,25]. Saelens et al. [5,9] highlight that cross-sectional studies tend to only show associations between variables from the built environment and transportation-related walking and/or bicycling. The lack of association may be attributed to the fact that this behavior may be influenced by other neighborhood predictors [5,9]. For example, studies show that adults living in neighborhoods with high walkability and access to services are more likely to walk when compared to adults living in neighborhoods with the opposite such characteristics [17,21,24].

Some limitations should be addressed for an adequate interpretation and extrapolation of the current study's results. IPAQ shows low sensitivity for measuring transportation-related physical activity, since it captures high rates of such activity, leading to an underestimation of shorter such periods (≥ 10 min/week), which may have led to the lack of the target associations [29]. However, in Curitiba some items in

the environment such as bus stops could be positively associated with less walking per week (≥ 10min/week), since the distance to bus stops is short (average of 175 meters) [23]. The sample does not represent the city's entire adult population, since it was limited to individuals living in the vicinity of eight parks with the potential for recreational physical activities [27]. Some studies have suggested that the presence of parks in the neighborhood is associated with greater appreciation of the surrounding areas, which would in turn lead to better characteristics in the built environment and little variability in the indicators between places [39]. The scores on the items from the environment were calculated from the measurement of the variables observed on the street segments of the participants' households, so it was not possible to calculate an "environmental quality " score within an area that the individual might be exposed to or cross when walking or pedaling, for example a circular buffer or street network buffer (including sausage buffer and detailed trimmed buffer, both with 25cm or 75cm radius on either side of street and; detailed biffer) measuring 300, 500, or 1,000 meters [40]. Finally, the cross-sectional design limits the causal interpretation between variables.

Conclusion

Streetscape was inversely associated with walking and bicycling as modes of transportation.

Future experimental studies should be conducted in lower-income countries like Brazil to test the effects of environmental changes on walking and bicycling for transportation in adults. In addition, triangulation of methods in the same study (evaluation of the perception of the built environment, geoprocessing data, systematic observation of the built environment, use of Global Positioning System equipment and focus group interviews) can also add to the understanding of the relationship between the built environment and transportation-related physical activity in adults.

Contributors

A. A. S. Lopes participated in the data collection, initial study conception, data analysis, literature review, and writing and critical revision of the article in all its stages. M. Kienteka, participated in the data collection, initial study conception, and first draft of the article. R. C. Fermino participated in the data collection, initial study conception, literature review, and writing and critical revision of the article in all its stages. R. S. Reis was responsible for the research project's conception and coordination and participated in the critical revision of the article.

Acknowledgments

The authors wish to thank the members of the Research Group on Physical Activity and Quality of Life of the Pontifical Catholic University of Paraná (GPAQ/PUCPR) for their collaboration in the data collection.

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Resumo

O objetivo deste estudo foi analisar a associação entre as características da microescala do ambiente construído e social com a caminhada e o uso da bicicleta no deslocamento em adultos de Curitiba, Paraná, Brasil. No ano de 2009 foi conduzido um estudo transversal com inquérito domiciliar em que participaram 1.419 adultos. A avaliação objetiva do ambiente foi realizada nos segmentos de rua dos moradores, com um instrumento de observação sistemática composto por seis dimensões: "uso do solo", "transporte público", "características das ruas", "condições e estética", "lugares para caminhar e andar de bicicleta" e "ambiente social". O escore de cada dimensão foi obtido pela soma dos itens positivos relacionados com a atividade física. Optou-se por dicotomizar os itens de "transporte público" (≥ 1 itens) e "lugares para caminhar e andar de bicicleta nas ruas" (≥ 3 itens), enquanto o escore dos demais foram classificados em tercis. A caminhada e o uso da bicicleta no deslocamento foram avaliados com o International Physical Activity Questionnaire*. Os dados foram analisados com a regressão de Poisson multinível. Os resultados demostraram que o escore intermediário de "características das ruas" foi inversamente associado com a caminhada ≥ 150min/sem (RP = 0,60; IC95%: 0,40-0,91; CPV = 12%) e uso da bicicleta (RP = 0,54; IC95%: 0,29-0,99; CPV = 60%). Conclui-se que apenas as "características das ruas" foram associadas à caminhada e o uso da bicicleta no deslocamento em adultos.*

Meio Ambiente Construído; Atividade Motora; Caminhada; Ciclismo

Resumen

Se El objetivo de este estudio ha sido analizar la asociación entre las características de la creación de una microescala social y ambiental con caminar y montar en bicicleta, como forma de transporte entre adultos en Curitiba, Estado de Paraná, Brasil. Se realizó un estudio transversal en 2009 con una encuesta a hogares que incluyó a 1.419 adultos. Se realizó una evaluación objetiva del entorno con segmentos de calle residenciales, usando un instrumento para la observación sistemática consistente en seis dimensiones: "uso de la tierra", "transporte público", "paisaje urbano", "condiciones y estética", "lugares para caminar y montar en bicicleta", y "entorno social". La puntuación para cada dimensión se obtuvo como la suma de ítems positivos relacionados con la actividad física. Los ítems para "transporte público" (≥ 1 ítem) y "lugares para pasear y montar en bicicleta en las calles" (≥ 3 ítems) fueron dicotomizados, mientras que las puntuaciones para los otros ítems fueron clasificadas en terciles. Andar y montar en bicicleta como transporte fueron evaluados con el International Physical Activity Questionnaire *(IPAQ). Los datos se analizaron usando la regresión multinivel de Poisson. Una puntuación media en "paisaje urbano" estaba inversamente asociada con caminar ≥ 150min/semana (PR = 0.60; 95%CI: 0.40-0.91; CPV = 12%) y montar en bicicleta (PR = 0.54; 95%CI: 0.29-0.99; CPV = 60%). En conclusión, solamente "paisaje urbano" estaba asociado con caminar y montar en bicicleta para el transporte en adultos.*

Medio Ambiente Controlado; Actividad Motora; Caminata; Ciclismo

Submitted on 29/Nov/2016
Final version resubmitted on 09/May/2017
Approved on 01/Jun/2017