

## Physical activity and perceived environment among adults from a city in Southern Brazilian

Atividade física e percepção do ambiente em adultos de uma cidade do Sul do Brasil

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**Abstract** *The article aimed to verify the association between physical activity (PA) and perceived environment among adults from a city in southern Brazil. This is a population-based cross-sectional study with 820 adults living in the city of Criciúma-SC. Perceived environment was assessed using the Neighborhood Environmental Walkability scale and PA in the leisure and transportation domains using the long version of the International PA Questionnaire. It was observed that the neighborhood with public spaces for the practice of physical exercises and dog walking was associated with higher prevalence of compliance with moderate-to-vigorous physical activity (MVPA) guidelines. The fact of having an invitation from friends and/or relatives for PA, sporting events and the habit of dog walking were associated with leisure-time walking. Access to places for the purchase of fresh fruits/vegetables, light/diet foods, to have sidewalks in most streets, to have pedestrian crossings and sporting events in the neighborhood were associated with higher prevalence of active transportation. Conversely, places for snacks or fast food in the neighborhood were associated with lower prevalence of active transportation. The perception of environmental variables was associated with MVPA, walking and active transportation.*

**Key words** *Epidemiology, Leisure activities, Environmental health*

**Resumo** *O objetivo foi verificar a associação entre a prática de atividade física (AF) e a percepção do ambiente em adultos de uma cidade do Sul do Brasil. Estudo transversal de base populacional com 820 adultos, residentes na cidade de Criciúma-SC. A percepção do ambiente foi avaliada pela escala Neighborhood Environmental Walkability, e a AF no domínio do lazer e transporte ativo pela versão longa do Questionário Internacional de AF. Observou-se que o bairro com lugar público para a prática de exercícios físicos e o fato de passear com o cachorro estiveram associados a maiores prevalências de atendimento às recomendações de AF moderada à vigorosa (AFMV). O fato de ter convite de amigos e/ou parentes para AF, a realização de eventos esportivos e o hábito de passear com o cachorro estiveram associados à caminhada no lazer. O acesso a locais para aquisição de frutas/legumes frescos, alimentos light/diet, ter calçadas na maioria das ruas, ter faixas de segurança e ter eventos esportivos no bairro estiveram associados a maiores prevalências de deslocamento ativo. De forma contrária, lugares para lanches ou fast-food no bairro se associaram a menor prevalência de deslocamento ativo. A percepção de variáveis do ambiente esteve associada à APMV, à prática de caminhada e ao transporte ativo.*

**Palavras-chave** *Epidemiologia, Atividades de lazer, Saúde ambiental*

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## Introduction

According to the World Health Organization (WHO), physical inactivity is one of the top ten global causes of mortality and disability worldwide, accounting for approximately two million deaths per year<sup>1</sup>. The literature shows robust evidence of health benefits related to the regular practice of physical activities (PA)<sup>2,3</sup>. In the Global Action Plan on PA broadcasted around the world, there are five policy actions that address the need to create supportive spaces and places that promote the rights of all people to have equitable access to safe places and spaces in cities and communities in which they can engage in regular PA<sup>4</sup>.

The neighborhoods in which people live represent an important environment and can establish limits for the engagement in healthy lifestyles<sup>5</sup>, being one of the contextual determinants of non-communicable Diseases (NCD)<sup>5</sup>. In addition to being natural, the environment must be built to meet the social and community demands adapted to the specific needs of the population for the provision of PA programs in community environments and creation or improved access to places for the practice of PA<sup>6</sup>.

Studies have reported that the attributes of a neighborhood environment, including residential density, population density, land use, connectivity of streets and sidewalks, are closely associated with various types of PA<sup>2,7</sup>. The perception of a neighborhood's environment plays a fundamental role in the relationship between PA and environmental factors; generally, people's perceptions and explanations about their surroundings affect their involvement in PA, and perception measures can be used to assess potentially important factors, such as aesthetics and the feeling of security, which cannot be objectively measured<sup>8</sup>.

As the practice of PA occurs in specific locations, investigating the characteristics of the environment that facilitate this behavior is important in view of the fact that environmental factors may present a relationship or determination of the physically active behavior<sup>8</sup>. In addition, the monitoring of PA and the relationship of this behavior with environmental characteristics is an object of debate by international public health organizations, and one of the recommendations is the constant investigation of the relationship between PA and environmental characteristics of cities<sup>9,10</sup>. Thus, the aim of the study was to verify the association between practice of PA and per-

ceived environment among adults from a city in southern Brazil.

## Methods

A population-based cross-sectional study was carried out with individuals aged 18 years or older living in the urban area of the city of Criciúma-SC, Brazil. The municipality had estimated population of 215,186 inhabitants in 2019, spread over a territorial extension of 234,865 km<sup>11</sup>. The human development index (HDI) of the municipality was 0.788 in 2010 and the percentage of the population with *per capita* monthly income of up to half the minimum wage was 26.2%. The schooling rate was 98.5% in 2010 and the infant mortality rate was 8.71 deaths per thousand live births in 2017<sup>11</sup>. The study was approved by the Research Ethics Committee of the "Extremo Sul Catarinense" University under protocol number 3.084.521 on 12/14/2018, and all individuals who agreed to participate signed the informed consent form.

The sampling process took place in two stages based on data from the 2010 Demographic Census: primary units, which are the census tracts, and secondary units, which are the households. Initially, all urban census sectors ( $n = 306$ ) with private properties in the municipality of Criciúma were placed in ascending order according to the code for each sector. Subsequently, a random selection of 25% ( $n = 77$ ) of census sectors was carried out. The number of households was determined by means of sampling proportional to the size of the sector, with 618 households systematically selected within census sectors being visited. All adults in the selected households were invited to participate in the research.

The reference population consisted of individuals of both sexes aged 18 years or older living in the urban area. It was estimated that this population was 215,186 inhabitants in 2019<sup>11</sup>. To calculate the sample size, 95% confidence interval was considered, unknown prevalence for the outcomes (50%), sampling error of five percentage points, design effect of 1.5 and increment of 15% for eventual losses and refusals, which resulted in 661 necessary interviews.

The study included all individuals aged 18 years or older living in the urban area of the city of Criciúma. Individuals with physical and/or mental disabilities to answer the questionnaire were not included in the study.

Data were collected from March to December 2019 through face-to-face interviews.

Because the present study used a set of information to examine issues different from those that were the primary objective of the macro-project from which the analyzed data came, the statistical power, which refers to the probability of rejecting a false null hypothesis (i.e., to determine that there is no difference when in fact it exists – values > 80% are considered adequate to avoid this error)<sup>12</sup>, it was calculated, and the results can be seen in full in Table 1.

Previously trained interviewers used a pre-coded questionnaire with closed questions

printed on paper. Data were tabulated in Epidata in the form of double entry to check for any discrepancies in the tabulation.

### Study variables

#### Dependent variable

PA was measured through the leisure and transportation section of the International Physical Activity Questionnaire (long version)<sup>13</sup>, which consists of questions about weekly frequency and daily duration of activities such as walking,

**Table 1.** Statistical power for analysis from Poisson regression for the relationship between environmental variables with moderate-to-vigorous physical activity, leisure-time walking and active transportation. Criciúma (SC), Brazil, 2019 (n = 820).

Environmental variables	MVPA (≥ 150 min/week)			Walking			Active transportation		
	n	%	power	n	%	power	n	%	power
<b>Favorable conditions</b>									
Public place for the practice of PA									
No	53	18.1	28.3	80	27.4	0.07	190	66.2	0.04
Yes	150	29.5		162	31.7		325	65.0	
Enjoys living in the neighborhood									
No	09	16.7	0.02	09	17.0	0.04	28	52.8	25.0
Yes	194	25.6		234	30.7		493	66.2	
Fresh fruits and vegetables near home									
No	48	28.1	0.05	50	29.2	0.03	97	57.4	43.5
Yes	157	24.4		195	30.3		426	67.6	
Light/diet foods for sale near home									
No	53	22.9	0.05	67	29.0	0.03	134	59.0	42.0
Yes	148	26.6		172	30.9		371	67.9	
Sidewalks on most streets near home									
No	44	23.0	0.05	46	24.2	11.0	112	59.9	25.0
Yes	161	25.8		199	31.7		411	66.9	
Green areas with trees near home									
No	71	24.4	0.03	93	31.8	0.05	177	61.7	0.22
Yes	134	25.7		152	29.1		344	67.3	
Flat streets near home									
No	129	25.2	0.04	152	29.7	0.03	330	65.6	0.03
Yes	76	25.0		93	30.5		193	65.0	
Pedestrian crossings near home									
No	111	22.1	0.19	134	26.7	27.1	299	61.1	0.67
Yes	93	29.8		111	35.5		222	71.6	
Well-lit streets near home at night									
No	21	23.1	0.02	22	24.2	0.05	55	62.5	0.05
Yes	184	25.4		223	30.7		468	65.6	
Safe to walk/cycle/performing exercises near home during the day									
No	17	16.2	0.06	24	22.6	0.07	62	60.2	12.0
Yes	188	26.4		221	31.1		461	66.0	

it continues

**Table 1.** Statistical power for analysis from Poisson regression for the relationship between environmental variables with moderate-to-vigorous physical activity, leisure-time walking and active transportation. Criciúma (SC), Brazil, 2019 (n = 820).

Environmental variables	MVPA (≥ 150 min/week)			Walking			Active transportation		
	n	%	power	n	%	power	n	%	power
Safe to walk/cycle/performing exercises near home at night									
No	119	25.4	0.03	141	30.0	0.03	302	65.8	0.04
Yes	86	24.8		104	29.0		221	64.6	
Invitation from friends to walk/cycle/exercise in the neighborhood									
No	130	23.3	0.12	152	27.2	0.25	355	64.8	0.05
Yes	75	29.3		92	35.9		168	66.9	
Invitation from parents to walk/cycle/exercise in the neighborhood									
No	130	23.5	0.09	151	27.3	0.23	351	64.9	0.04
Yes	75	28.5		94	35.6		172	66.1	
Sporting events in the neighborhood									
No	140	24.7	0.07	157	27.7	0.29	355	63.6	48.0
Yes	53	29.4		69	38.1		130	73.4	
Has dog									
No	87	24.2	0.03	106	29.4	0.03	235	67.1	10.0
Yes	118	25.8		139	30.5		288	63.9	
Dog walking in the neighborhood									
No	160	22.1	0.90	200	27.6	0.73	457	64.3	24.0
Yes	45	48.9		45	48.9		66	73.3	
<b>Unfavorable conditions</b>									
House has already been stolen or mugged									
No	57	29.7	0.11	57	29.7	0.03	121	66.1	0.03
Yes	148	23.9		188	30.3		401	65.4	
Places for snacks or fast food in the neighborhood									
No	148	25.1	0.04	178	30.1	0.26	394	68.0	0.53
Yes	57	25.5		67	39.9		129	58.6	
Garbage accumulation near home									
No	39	25.8	0.03	55	36.2	0.16	100	67.1	0.05
Yes	164	24.9		188	28.5		418	64.7	
Sewage open sky near home									
No	25	21.5	0.03	35	30.2	0.04	76	66.7	0.03
Yes	177	25.6		206	29.8		441	65.0	
Traffic impairs walking in the neighborhood									
No	80	26.8	0.05	89	29.9	0.03	195	66.5	0.05
Yes	125	24.1		156	30.1		328	64.6	
Smoke or pollution near home									
No	64	39.6	0.60	66	31.4	0.03	134	64.4	0.04
Yes	141	23.3		179	29.5		389	65.7	
Weather impairs walking or performing sports in the neighborhood									
No	90	27.0	0.05	113	34.0	0.17	220	67.5	11.0
Yes	115	23.9		132	27.3		303	63.9	

MVPA: moderate-to-vigorous physical activity; PA: physical activity.

Source: Authors.

moderate-intensity PA and vigorous-intensity PA. Only moderate-to-vigorous physical activity (MVPA) with duration of at least 10 minutes in a typical week was considered. Moderate activities were those that make breathing and heartbeat a little faster than normal, and vigorous activities were those that make breathing and heartbeat much faster than normal. The instrument has good reproducibility indicators and validity was assessed with accelerometer, showing good psychometric characteristics<sup>14</sup>.

For analyses, the following outcomes were estimated: 1) practice of MVPA during leisure time and transportation, based on the sum of weekly time spent walking at leisure and transportation, activities of moderate and vigorous intensity at leisure and time spent cycling during transportation. So, those who reached 150 minutes or more per week in these activities were considered to meet sufficient MVPA recommendations and those who did not were considered not to meet sufficient MVPA recommendations<sup>15</sup>; 2) practice of leisure-time walking, for at least ten minutes, so that those who reported walking, were considered as practitioners and those who did not, as non-practitioners; 3) active transportation (walking or cycling), so that those who reported practicing such activities, for at least ten minutes, were considered as practitioners and those who reported not practicing, as non-practitioners.

### Independent variables

Environmental variables were collected using a modified perceived environment scale validated for Brazilian adults<sup>16</sup>, adapted from the international questionnaire called Neighborhood Environmental Walkability Scale (NEWS)<sup>17</sup>. This tool was used in other studies developed in Brazil<sup>18,19</sup>, and includes characteristics of the neighborhood environment (built, natural and social): access to commerce and places of practice of PA, traffic safety, safety in relation to crimes, aesthetics and satisfaction of the neighborhood, quality of streets and sidewalks, lighting, pollution, weather, social support and presence of dogs.

These variables were individually analyzed as absence and presence, and were also analyzed together, as the total sum of each question (scores 0 and 1). Twenty-three questions from the perceived environment questionnaire were used (excluding four questions whose responses depended on the previous question)<sup>16</sup>. Subsequently, the score (which could vary from 0 to 23 points) was divided into environment tertiles (neighbor-

hoods) more or less favorable to the practice of PA according to the individuals' perception (1<sup>st</sup> tertile = from zero to 12, 2<sup>nd</sup> tertile = from 13 to 15, 3<sup>rd</sup> tertile  $\geq$  16 up to 23). By sum, the score of the unfavorable questions for the practice of physical activity was inverted.

### Control variables

The variables used to describe the sample and that were considered covariates were sex (female / male), age in full years and, later, classified into age groups (18-29; 20-39; 40-49; 50-59; 60-69; 70-79;  $\geq$  80), skin color (white, brown, black, yellow and indigenous), marital status (single, married or in a stable relationship, separated or divorced, widowed), schooling in successfully completed years and grouped into 0 to 4, 5 to 8, 9 to 11, 12 years or more, time of living in the neighborhood (collected in years and classified into one, 1 to 4, 5 or more) and economic level, according to the purchasing power, classified in descending order (A, B, C, D-E)<sup>20</sup>.

### Data analysis

Initially, information was described by means of percentages and respective 95% confidence intervals (95%CI). Poisson regression was used, with robust variance adjustment, and estimates of prevalence ratios (PR) and respective 95%CI were presented using the p-value for heterogeneity to test the association between compliance with MVPA recommendations, practice of leisure-time walking and active transportation, and the characteristics of the neighborhood environment. Separate analysis models were built for MVPA, leisure-time walking and active transportation.

In the crude analysis, variables MVPA, walking and active transportation were individually investigated with each environment variable. In the adjusted analysis, each association was controlled for sex, age, marital status, skin color, schooling, purchasing power and time of living in the neighborhood. Variables were entered in the adjusted model regardless of significance value of the crude model.

In addition, adjusted probabilities predicted by the adjusted model between MVPA, walking and active transportation and variable environmental score in tertiles were estimated and graphically presented. All analyses were performed using the Stata 13.0 statistical package (StataCorp LP, College Station, USA).

## Results

This study included 820 participants, of which about two thirds were women (63.8%), with higher prevalence of individuals aged 60-69 years (24.5%), married or in a stable relationship (60.4%) and white skin color (80.7%). In addition, one in three respondents of the survey had 9-11 years of schooling and was classified as member of economic level "C" (54.0%). In addition, eight out of 10 individuals (81.2%) reported living in the neighborhood for five or more years. In relation to the practice of PA, one in four individuals (25.1%) performed a period equal to or greater than 150 minutes/week of MVPA, three out of ten participants (30.0%) practiced leisure-time walking and two out of the three individuals (65.3%) performed active transportation (Table 2).

Regarding the variables of interest investigated in this study, 70 individuals did not respond to the question regarding "Sporting events in the neighborhood" (highest item refusal response rate – 91.5%). For the other variables, the response rate ranged from 96.3% to 99.9%.

As for affirmative responses referring to the characteristics of the environment in which research participants were inserted, the most expressive response frequencies indicated that 93.4% of them reported that they enjoyed living in the neighborhood, 88.9% and 87.1 %, respectively, reported that the streets near their houses were well lit at night and that were safe to walk/cycle/perform exercises in the daytime. With regard to unfavorable environment conditions, the most expressive response frequencies indicated that 72.3% of the sample reported the presence of places for snacks or fast food in the neighborhood where they live. Further information for each item in the environment can be seen in Figure 1.

Information regarding the percentage and the association between MVPA, walking and active transportation and environmental variables are described in Table 3. The results of analyses adjusted for sex, age, marital status, skin color, schooling, socioeconomic level and time living in the neighborhood indicated that neighborhood with public place for the practice of physical exercises (PR = 1.4; 95%CI: 1.1-1.8), and dog walking (PR = 1.9; 95%CI: 1.5-2.6), were environmental aspects associated with higher prevalence of performing a period equal to or greater than 150 minutes / week of MVPA.

Being invited by friends (PR = 1.3; 95%CI: 1.1 - 1.7) or relatives (PR = 1.3; 95% CI: 1.1 - 1.6)

to walk/cycle/perform physical exercises in the neighborhood, to participate in sporting events in the neighborhood (PR = 1.4; 95%CI: 1.1-1.7) and dog walking in the neighborhood (PR = 1.9; 95%CI: 1.4-2.4) were environmental aspects associated with higher prevalence of leisure-time walking. On the other hand, the accumulation of garbage near houses (PR = 0.7; 95%CI: 0.6-0.9) and the fact that the weather impairs the practice of PA in the neighborhood (PR = 0.8; 95%CI: 0.6-0.9) were environmental aspects associated with lower prevalence of walking (Table 3).

Access to places for the purchase of fresh fruits and vegetables (PR = 1.2; 95%CI: 1.1-1.3), access to places for the purchase of light/diet foods near home (PR = 1.2 ; 95%CI: 1.1-1.3), having sidewalks on most streets near home (PR = 1.5; 95%CI: 1.1-1.3), having pedestrian crossings near home (PR = 1.2; 95%CI: 1.1-1.3) and having sporting events in the neighborhood (PR = 1.2; 95%CI: 1.1-1.3) were characteristics associated with higher prevalence for the adoption of active transportation. Conversely, places for snacks or fast food in the neighborhood near home (PR = 0.8; 95%CI: 0.7-0.9) were associated with lower prevalence for the adoption of active transportation (Table 3).

Figure 2 shows the adjusted probabilities predicted for the relationship between MVPA, leisure walking and active transportation, according to tertiles of the environmental perception score, with higher values indicating more favorable environment for the practice of PA. In relation to MVPA, greater probability of performing 150 minutes or more per week was identified concomitantly with the increase in the environmental perception score (Tertile 1 = 22.7%; Tertile 2 = 24.5%; Tertile 3 = 30.0%, p value <0.05). With regard to the practice of leisure-time walking, higher environmental perception score was related to the increased likelihood of leisure-time walking (Tertile 1 = 28.3%; Tertile 2 = 28.7%; Tertile 3 = 36.2%, p value <0.05). In addition, higher probability of adopting active transportation was directly related to the increase in the environmental perception score (Tertile 1 = 61.7%; Tertile 2 = 64.0%; Tertile 3 = 72.2%, p value < 0.05).

## Discussion

In recent years, Latin America has undergone an accelerated urbanization process, with significant demographic, epidemiological and socio-

**Table 2.** Descriptive characteristics of the sample of adults from Criciúma (SC), Brazil, 2019 (n = 820).

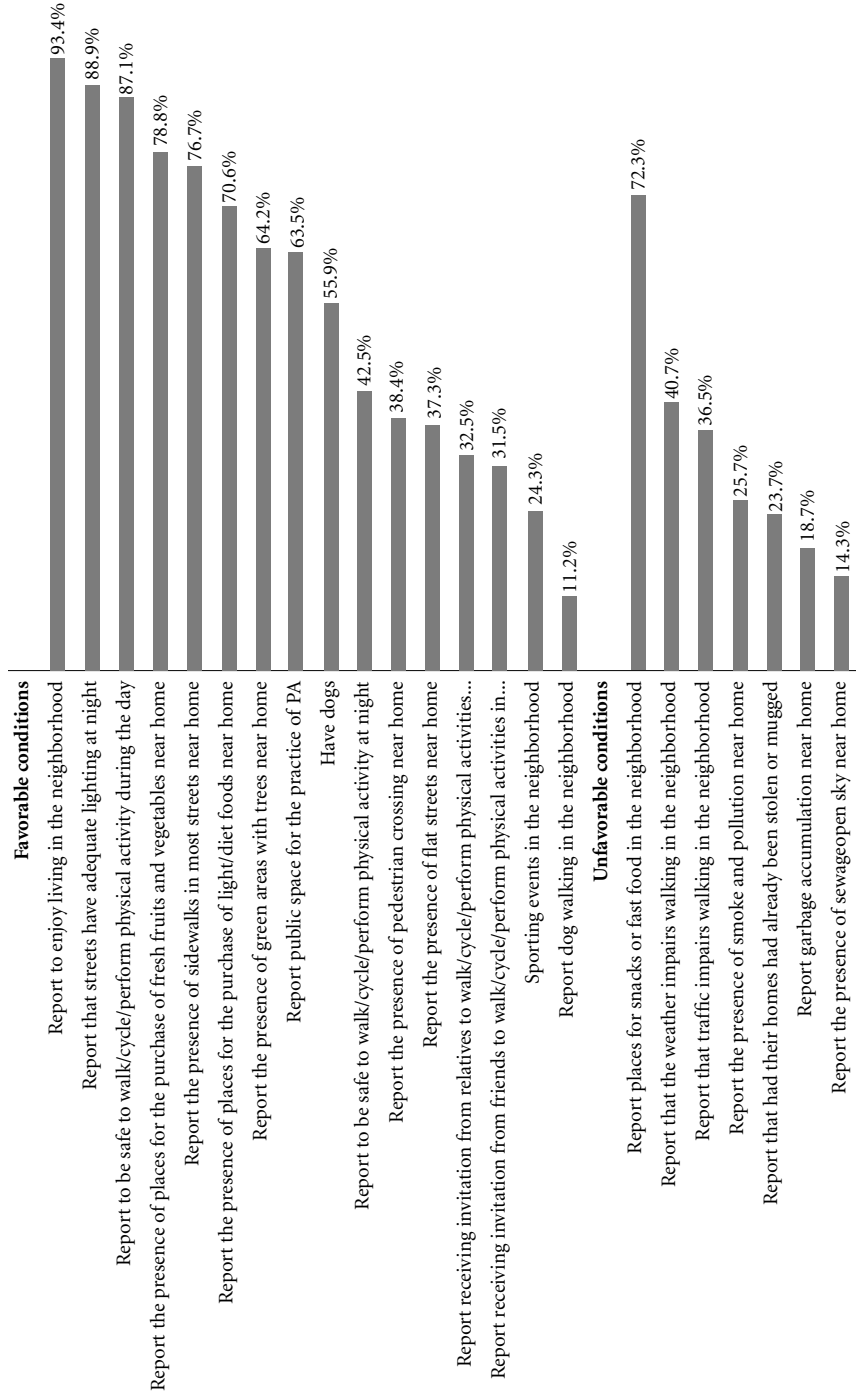
Variables	n	%	95%CI
<b>Sex</b>			
Male	297	36.2	(33.0; 39.6)
Female	523	63.8	(60.4; 67.0)
<b>Age</b>			
18-29 years	101	12.3	(10.2; 14.7)
20-39 years	93	11.3	(9.3; 13.7)
40-49 years	85	10.4	(8.4; 12.6)
50-59 years	172	21.0	(18.3; 23.9)
60-69 years	201	24.5	(21.7; 27.6)
70-79 years	129	15.7	(13.4; 18.4)
80 years or more	39	4.8	(3.5; 6.4)
<b>Marital status</b>			
Single (a)	147	17.9	(15.4; 20.7)
Married/in a stable relationship	495	60.4	(57.0; 63.7)
Separated/divorced	77	9.4	(7.6; 11.6)
Widower	101	12.3	(10.2; 14.7)
<b>Skin color</b>			
White	660	80.7	(77.8; 83.3)
Brown	91	11.1	(9.1; 13.5)
Black/yellow/indigenous	67	8.2	(6.5; 10.3)
<b>Schooling (years of study)</b>			
0-4	219	26.7	(23.8; 29.9)
5-8	220	26.9	(23.9; 30.1)
9-11	266	32.5	(29.3; 35.8)
12 or more	114	13.9	(11.7; 16.5)
<b>Economic level</b>			
A	22	2.8	(1.8; 4.2)
B	296	37.2	(33.9; 40.6)
C	430	54.0	(50.5; 57.5)
D-E	48	6.0	(4.6; 7.9)
<b>Time living in the neighborhood (years)</b>			
Less than 1	65	7.9	(6.3; 10.0)
1-4	89	10.9	(8.9; 13.2)
5 or more	666	81.2	(78.4; 83.7)
<b>MVPA</b>			
< 150 minutes/week	611	74.9	(71.8; 77.8)
≥ 150 minutes/week	205	25.1	(22.3; 28.2)
<b>Leisure-time walking</b>			
No	572	70.0	(66.8; 73.1)
Yes	245	30.0	(26.9; 33.2)
<b>Active transportation</b>			
No	278	34.7	(31.5; 38.1)
Yes	523	65.3	(61.9; 68.5)

MVPA: moderate to vigorous physical activity during leisure and transportation; CI: confidence interval.

Source: Authors.

economic changes. These changes resulted in improvements in the general health and education indicators, but also in a decrease in the regular

practice of PA<sup>21</sup>. This process was accompanied, in many places, by lack of urban planning, which results in the lack of social and physical environ-



**Figure 1.** Relative frequencies of neighborhood variables, considering affirmative responses to each item. Criciúma (SC), Brazil, 2019.

Source: Authors.



ment for the practice of PA. One of the main result of the present study is the fact that greater probabilities of practicing MVPA, leisure-time walking and active transportation were observed in people living in neighborhoods with environ-

ments (built, natural and social) more conducive to the practice of PA.

The present study indicated that the presence of public spaces for the practice of physical exercises was an environmental aspect associated

**Table 3.** Percentage of practice of physical activity and gross and adjusted association\* of physical activity with environmental variables. Poisson regression models with robust adjustment of variance. Criciúma (SC), Brazil, 2019.

Environmental variables	MVPA ( $\geq 150$ min/week)			Walking			Active transportation		
	%	Crude analysis	Adjusted analysis *	%	Crude analysis	Adjusted analysis *	%	Crude analysis	Adjusted analysis *
		PR (95%CI)	PR (95%CI)		PR (95%CI)	PR (95%CI)		PR (95%CI)	PR (95%CI)
<b>Favorable conditions<sup>†</sup></b>									
Public place for the practice of PA	29.5	1.6 (1.2; 2.2)	1.4 (1.1; 1.8)	31.7	1.2 (0.9; 1.5)	1.1 (0.9; 1.4)	65.0	1.0 (0.9; 1.1)	0.9 (0.8; 1.1)
Enjoys living in the neighborhood	25.6	1.5 (0.8; 2.8)	1.5 (0.8; 2.6)	30.7	1.8 (0.9; 3.3)	1.7 (0.9; 3.0)	66.1	1.2 (0.9; 1.6)	1.3 (0.9; 1.6)
Fresh fruits and vegetables near home	24.4	0.9 (0.7; 1.1)	0.8 (0.6; 1.1)	30.3	1.0 (0.7; 1.3)	1.0 (0.8; 1.3)	67.6	1.2 (1.1; 1.3)	1.2 (1.1; 1.3)
Light/diet foods for sale near home	26.6	1.1 (0.8; 1.5)	0.9 (0.8; 1.3)	30.9	1.1 (0.8; 1.3)	1.0 (0.8; 1.2)	67.9	1.1 (1.0; 1.3)	1.2 (1.1; 1.3)
Sidewalks on most streets near home	25.8	1.1 (0.8; 1.5)	1.0 (0.8; 1.4)	31.7	1.3 (1.0; 1.7)	1.2 (0.9; 1.6)	66.9	1.1 (0.9; 1.3)	1.2 (1.1; 1.3)
Green areas with trees near home	25.7	1.0 (0.8; 1.4)	1.0 (0.8; 1.3)	29.1	0.9 (0.7; 1.1)	0.9 (0.7; 1.1)	67.3	1.1 (0.9; 1.2)	1.1 (0.9; 1.2)
Flat streets near home	25.0	1.0 (0.8; 1.2)	1.0 (0.8; 1.3)	30.5	1.0 (0.8; 1.3)	1.0 (0.8; 1.2)	65.0	1.0 (0.8; 1.1)	0.9 (0.9; 1.1)
Pedestrian crossings near home	29.8	1.3 (1.1; 1.7)	1.2 (0.9; 1.5)	35.5	1.3 (1.1; 1.6)	1.2 (0.9; 1.5)	71.6	1.2 (1.1; 1.3)	1.2 (1.1; 1.3)
Well-lit streets near home at night	25.4	1.1 (0.7; 1.6)	1.1 (0.7; 1.6)	30.7	1.3 (0.8; 1.9)	1.2 (0.7; 1.6)	65.6	1.0 (0.8; 1.2)	1.1 (0.9; 1.3)
Safe to walk/cycle/performing exercises near home during the day	26.4	1.6 (1.1; 2.5)	1.4 (0.9; 2.2)	31.1	1.4 (0.9; 1.9)	1.3 (0.9; 1.9)	66.0	1.1 (0.9; 1.2)	1.1 (0.9; 1.3)
Safe to walk/cycle/performing exercises near home at night	24.8	1.0 (0.7; 1.2)	1.0 (0.8; 1.2)	30.0	1.0 (0.8; 1.2)	1.0 (0.8; 1.3)	64.6	1.0 (0.9; 1.1)	0.9 (0.8; 1.1)
Invitation from friends to walk/cycle/exercise in the neighborhood	29.3	1.2 (0.9; 1.6)	1.3 (0.9; 1.6)	35.9	1.3 (1.1; 1.6)	1.3 (1.1; 1.7)	66.9	1.0 (0.9; 1.1)	1.0 (0.9; 1.1)
Invitation from parents to walk/cycle/exercise in the neighborhood	28.5	1.2 (0.9; 1.5)	1.1 (0.9; 1.5)	35.6	1.3 (1.1; 1.6)	1.3 (1.1; 1.6)	66.1	1.0 (0.9; 1.1)	1.0 (0.9; 1.1)
Sporting events in the neighborhood	29.4	1.2 (0.9; 1.5)	1.2 (0.9; 1.6)	38.1	1.3 (1.1; 1.7)	1.4 (1.1; 1.7)	73.4	1.2 (1.0; 1.3)	1.2 (1.1; 1.3)
Has dog	25.8	1.1 (0.8; 1.4)	1.1 (0.8; 1.3)	30.5	1.0 (0.8; 1.3)	1.1 (0.8; 1.3)	63.9	0.9 (0.9; 1.0)	0.9 (0.8; 1.1)
Dog walking in the neighborhood	48.9	2.1 (1.6; 2.7)	1.9 (1.5; 2.6)	48.9	1.8 (1.4; 2.3)	1.9 (1.4; 2.4)	73.3	1.1 (0.9; 1.3)	1.1 (0.9; 1.3)

it continues

**Table 3.** Percentage of practice of physical activity and gross and adjusted association\* of physical activity with environmental variables. Poisson regression models with robust adjustment of variance. Criciúma (SC), Brazil, 2019.

Environmental variables	MVPA ( $\geq 150$ min/week)			Walking			Active transportation		
	%	Crude analysis	Adjusted analysis *	%	Crude analysis	Adjusted analysis *	%	Crude analysis	Adjusted analysis *
		PR (95%CI)	PR (95%CI)		PR (95%CI)	PR (95%CI)		PR (95%CI)	PR (95%CI)
<b>Unfavorable conditions ‡</b>									
House has already been stolen or mugged	23.9	0.8 (0.6; 1.1)	0.9 (0.7; 1.1)	30.3	1.0 (0.7; 1.3)	1.1 (0.9; 1.4)	65.4	1.0 (0.8; 1.1)	0.9 (0.8; 1.1)
Places for snacks or fast food in the neighborhood	25.4	1.0 (0.8; 1.3)	1.1 (0.8; 1.4)	29.9	0.9 (0.7; 1.3)	1.0 (0.8; 1.3)	58.6	0.9 (0.7; 0.9)	0.8 (0.7; 0.9)
Garbage accumulation near home	24.9	0.9 (0.7; 1.3)	1.0 (0.7; 1.3)	28.5	0.7 (0.5; 1.0)	0.7 (0.6; 0.9)	64.7	1.0 (0.8; 1.1)	0.9 (0.8; 1.1)
Sewage open sky near home	25.6	1.2 (0.8; 1.7)	1.1 (0.7; 1.6)	29.8	1.0 (0.7; 1.3)	0.9 (0.6; 1.3)	65.0	1.0 (0.8; 1.1)	0.9 (0.8; 1.1)
Traffic impairs walking in the neighborhood	24.1	0.9 (0.7; 1.1)	0.9 (0.7; 1.2)	30.0	1.0 (0.8; 1.3)	1.0 (0.8; 1.3)	65.6	0.9 (0.8; 1.1)	1.0 (0.9; 1.1)
Smoke or pollution near home	23.3	0.8 (0.6; 0.9)	0.8 (0.6; 1.0)	29.5	0.9 (0.7; 1.2)	0.9 (0.7; 1.2)	65.7	1.0 (0.9; 1.2)	1.0 (0.9; 1.2)
Weather impairs walking or performing sports in the neighborhood	23.9	0.9 (0.7; 1.1)	0.9 (0.7; 1.1)	27.3	0.8 (0.6; 0.9)	0.8 (0.6; 0.9)	63.9	0.9 (0.9; 1.0)	0.9 (0.8; 1.1)

MVPA: moderate/vigorous physical activity; PR: prevalence ratio; CI: confidence interval; min/wk: minutes per week; \*: analyses adjusted for sex, age, marital status, skin color, schooling, socioeconomic level and time living in the neighborhood.

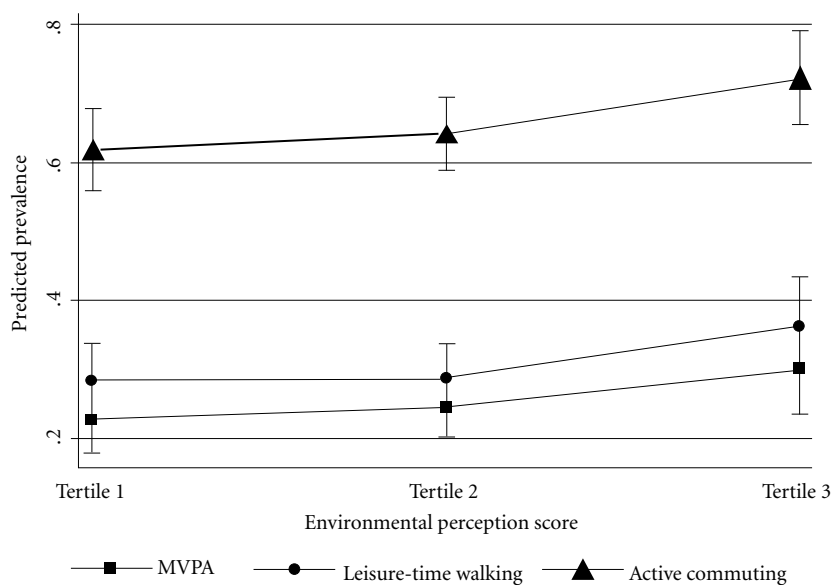
Source: Authors.

with the higher prevalence of performing a period equal to or greater than 150 minutes/ week of MVPA. Other studies have reported direct association between PA and presence of facilities and locations conducive to the practice of PA<sup>4,16,18</sup>. A study carried out by Sallis *et al*<sup>22</sup> in 11 countries (n = 11,541) including Brazil showed that the perception of greater access to commercial areas, bus stops, sidewalk streets, places to cycle and free public spaces is associated the greatest practice of MVPA. It is noteworthy that, although the existence of facilities conducive to the practice of PA does not determine an increase in the levels of PA, their presence in the neighborhood offers greater opportunity for this activity.

It was also found in the present study that dog walking was an environmental aspect associated with higher prevalence of meeting MVPA recommendations and the practice of leisure-time walking. Such results corroborate findings of previous studies<sup>23-25</sup>. Westgarth *et al*<sup>23</sup> developed a literature review of studies published from 1990 to 2012 and

found that higher levels of PA were more observed in individuals who walked their dogs in the neighborhood. In addition, researchers observed that if all dog owners (between 20-40% of the population) walked their animals for at least 30 minutes a day, they would easily reach PA recommendations. In this environmental aspect, the practice of walking stands out for being a pleasant activity commonly performed with animals<sup>25</sup> and can be performed in different public spaces<sup>7</sup>.

The presence of sidewalks on streets and the presence of pedestrian crossings near home were aspects associated with active transportation. Such results corroborate other studies<sup>26-28</sup>. In the study by Teixeira *et al.*<sup>26</sup> developed in the urban region of a city in southeastern Brazil, 36.8% of interviewees perceived the existence of pedestrian crossings near their homes and this environmental variable was significantly associated with the practice of PA. In this sense, a research carried out in Florianópolis-SC<sup>28</sup> found that when individuals had better perception of traffic safe-



**Figure 2.** Adjusted probability\* predicted for the relationship between general physical activity, walking and active transportation, according to tertiles of the environmental perception score. Criciúma (SC), Brazil, 2019. \*: analysis adjusted for sex, age, marital status, skin color, schooling, socioeconomic level and time living in the neighborhood;  $p < 0.05$  for all categories.

Source: Authors.

ty attributes, such as the presence of pedestrian crossings and sidewalks, they performed more transportation and leisure-time PA. Once individuals perceive that walking and/or cycling on public roads is safe, either due to the presence of signs on public roads or to a greater sense of security in the neighborhood, there is greater encouragement to practice outdoor PA, with consequent benefits for mental and physical health<sup>27</sup>.

Association between individuals who reported receiving an invitation from friends or relatives to walk/cycle/perform physical exercises in the neighborhood and leisure-time walking was observed. This can be explained by the fact that group activities provide motivation for their social environment, thus providing greater probability of meeting PA recommendations<sup>3</sup>.

The present study found that access to places for the purchase of fresh fruits and vegetables, light/diet foods near home and the presence of sporting events in the neighborhood were characteristics associated with greater probabilities for the adoption of active transportation. One of the great debates about improving urban mobility in cities is how to transform such spaces into more sustainable cities. One of the options highlighted in literature are compact cities, in which

in the same urban space, people have easy access to different services<sup>28</sup>. In addition, the proximity to places that present positive characteristics to health behaviors also facilitates the adoption of practice of PA<sup>29</sup>. In this sense, the promotion of sporting events and availability of services for the acquisition of healthy foods is suggested as one of the ways to stimulate active transportation.

Some aspects of the environment were perceived as barriers to the practice of leisure-time walking such as garbage accumulation near home and the weather. In addition, the fact of having a place in the neighborhood for the purchase of snacks or fast food was also associated with less active transportation. All these aspects have already been highlighted in literature as barriers to PA<sup>29-31</sup>. The food environment with fast food and the presence of convenience stores and grocery stores are related to increases in overweight, obesity, diabetes, hypertension and colorectal cancer, directly impacting the risk of developing cardiometabolic diseases, as these foods have a high nutritional deficiency. The consumption of these foods causes changes in lifestyle, especially in the reduction of physical activity. The search for practicality and convenience has led people to condition their diet to unhealthy solutions

with increased calorie intake. In general, neighborhoods where garbage accumulation is evident are aesthetically unpleasant and are more likely of having urban violence, which impair the practice of PA<sup>30</sup>. High and low temperatures and high rainfall rates are climatic factors that hinder involvement in PA<sup>31</sup>. In this sense, governmental strategies that offer air-conditioned and covered public spaces in cities can also be an alternative to stimulate involvement in PA<sup>31</sup>.

The present study has strengths, including the high number of perceived environment variables investigated in association with different contexts related to the activity, and the high response rate for the investigated variables, which gives greater reliability that the information analyzed represents fact the investigated sample. However, this study had some limitations such as the cross-sectional design, which does not allow the identification of cause and effect relationships between variables. Furthermore, reverse

causality cannot be ruled out. Another limitation of this research was not to research other domains of PA. Another limitation of the research was the use of the cut-point of 150 minutes/week for MVPA. PA guidelines suggest the cut-point of 150 minutes/week for MVPA when analyzing all PA domains. PA measure was self-reported, which may increase the chance of overestimating or underestimating this classification. The low statistical power available to test the associations of interest in this study is considered a limitation.

It could be concluded that the perceived characteristics of the built environment in neighborhoods are associated with MVPA, practice of walking and active transportation. Investments in facilities for the practice of PA in green areas, in the construction of planned neighborhoods with access to different services, with public signs and security can stimulate leisure-time walking, active transportation and, consequently, compliance with MVPA recommendations.

## Collaborations

LZ Monteiro collaborated in the article writing, and final approval. JM Farias, TR Lima and FO Meller collaborated in data analysis and interpretation, article writing, and final approval. AA Schafer collaborated on article writing and final review. DAS Silva collaborated in data interpretation, article writing, and final approval.

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