Public open spaces and physical activity: disparities of resources in Florianópolis

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ABSTRACT

OBJECTIVE: To analyze the association between sociodemographic characteristics of census tracts and the presence/quality of public open spaces and physical activity facilities.

METHODS: A cross-sectional study was conducted in 643 census tracts in Florianópolis, Brazil, the presence and quality of public open spaces and physical activity facilities were objectively analyzed and the data by census tracts using Geographic Information Systems was treated. Outcomes were analyzed considering the census tracts as having: ≥ 1 public open spaces; ≥ 1 public open spaces with high quality; ≥ 2 physical activity facilities and high-quality physical activity facilities. Sociodemographic characteristics were the independent variables. Logistic regression analysis was performed.

RESULTS: Census tracts with a medium-income (OR = 1.8; 95%CI 1.1–3.0) and high-income (OR = 2.4; 95%CI 1.4–4.0), in those with medium (OR = 1.7; 95%CI 1.0–2.7) and high residential density (OR = 2.0; 95%CI 1,2–3.3), and with higher proportions of older adults (OR = 3.3; 95%CI 1.9–5.7) had a higher proportion of public open spaces. Census tracts with higher proportions of children/adolescents (OR = 0.3; 95%CI 0.2–0.6) and non-white residents (OR= 0.6; 95%CI 0.3–0.9) were less likely to contain public open spaces. The tracts with medium (OR = 4.0; 95%CI 1.4–11.3) and high-income (OR = 3.6; 95%CI 1.2–10.2) were more likely to contain public open spaces with ≥ 2 structures for physical activity, compared with those with low-income. We observed the inverse in sectors with a high proportion of non-white residents (OR = 0.3; 95%CI 0.1–0.9).

CONCLUSIONS: Census tracts with higher proportions of children or adolescents, non-white individuals and those in the low-income strata had lower odds of containing public open spaces and physical activity facilities.

DESCRIPTORS: Motor Activity. Sports and Recreational Facilities. Socioeconomic Factors. Social Environment. Lifestyle. Public Health.

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INTRODUCTION

Recently, interest in the relation between public open spaces and increased time engaged in physical activities[1–3] has grown. Data from middle and low-income countries support these findings and show that the presence of public open spaces is positively related with time spent in physical activity during leisure time and transportation[4,5]. Esthetic aspects such as cleanliness and amenities in these places can encourage the engagement in physical activity[6]. The presence and quality of public open spaces assessment is important to identify the factors related to the use of spaces in different cultural and social contexts[2,7].

Although recognizing the importance of public open spaces and facilities for the promotion of physical activity, the results of studies conducted in high-income countries have shown important sociodemographic disparities in these places[3,6]. Within this context, low socioeconomic status areas had fewer public open spaces and physical activity facilities in good conditions of use[6,8]. In addition, areas with a high residential density include an unbalanced land occupation and the consequent absence of public investments in spaces of leisure[6]. Likewise, the number of these spaces is reduced in areas with a greater proportion of non-white residents and, when present, they have poor quality[6,9,10]. The presence of public open spaces may also be limited in areas with higher concentrations of older adults, children, and adolescents[11].

In Latin American countries such as Brazil, little is known about the presence of public open spaces and physical activity facilities and their relation with local characteristics. Studies using objective environmental measures such as systematic observation, combined with geographical information systems, have facilitated the understanding of these sociodemographic disparities in urban environments[6,9]. However, evidence on this topic in Latin American countries is limited and no objective environment measures and information about the quality of public open spaces have been used[12–14]. Hence, improving the distribution of public spaces in cities increases access to active-friendly environments with potential positive impacts on physical activity levels of the population[2,4,6]. Furthermore, to analyze the distribution and quality of public open spaces and facilities for physical activity, according to sociodemographic characteristics in census tracts, may contribute to the promotion of healthy environments and leisure opportunities of the population[15,16]. Therefore, this study analyzed the association between sociodemographic characteristics of census tracts and the presence and quality of public open spaces and physical activity facilities in a city in southern Brazil.

METHODS

A cross-sectional study was conducted in 2015 in the capital of Santa Catarina, Florianópolis, a coastal city in Southern Brazil. This city has a population of 418,623 residents, a population density of 623,68 inhabitants/km^2, and a human development index (0.847) above the national average (0.727)[17,18]. Florianópolis is composed of 646 census tracts (93.2% are urban census tracts). For the study, three census tracts were excluded as they were islands and had no residents living on at the time of the data collection. Thus, 643 tracts were considered the primary unit of analysis.

A total of 201 public open spaces were identified in the 2012 database of the Municipal Health Secretariat of Florianópolis. In addition, the community health agents of the municipality's Basic Health Units were consulted and identified 173 places not registered in the lists. A total of 374 public open spaces were computed, but ecological trails, private spaces and bikelane were excluded. Thus, 214 public open spaces were evaluated. Overall, the most frequently observed spaces were squares/woods (n = 214; 59.8%), free areas (22.0%) and, to a lesser extent, parks/groves (4.2%). A previous study[19] provides detailed characteristics of the public open spaces analyzed.

In this study, public open spaces refer to green areas such as squares, woods, parks, woods, and flower beds, as well as community institutions and leisure areas for free of charge use by the population. These spaces were geocoded in Google Earth after an on-site visit by a team of evaluators trained in the application of the instrument.

The dependent variables, presence and quality of physical activity facilities were evaluated by systematic observation of the environment using the Physical Activity Resource Assessment (PARA) instrument[20], used in the Brazilian context[21]. The instrument assesses the presence of physical activity facilities such as courts, sport fields, outdoor gyms and playgrounds, amenities (picnic tables, bathrooms, benches, lighting, drinking fountains, locker rooms, and dumpsters), and incivilities (broken glass, presence of animals, loose dogs, evidence of alcohol use, graffiti, scattered garbage, signs of vandalism, and high grass). Seven trained evaluators assessed the spaces. Inter-rater reliability was 0.85%. The average time for the evaluations of each space was 10 minutes and 76 seconds (standard deviation = 8.6 minutes).

The evaluators assessed the quality of physical activity facilities and amenities on a scale ranging from 0 (absent) to 3 (good quality) (0 = none; 1 = poor; 2 = medium, and 3 = good) and rated incivilities on an inverted scale from 0 (good quality) to 3 (poor quality) (0 = none; 1 = some; 2 = medium, and 3 = excessive incivilities). Thus, the quality of public open spaces is reported as the sum of the average quality scores of physical activity facilities and amenities and subtracting the average score of incivilities[6]. The final score ranged from -3 to 6, with positive values indicating higher quality.

To analyze the dependent variables by census tract, the Geographic Information Systems, ArcGIS 10.3 ESRI® software package was used to estimate the number of public open spaces and physical activity facilities by census tract. Finally, the presence of public open spaces by census tract was divided into two categories (no public open space versus ≥ 1 public open space). The average quality of space by census tract was categorized according into tertiles: low quality (≤ 2.0), medium quality (2.01 to 3.0), and high quality (≥ 3.01). The presence of physical activity facilities in these spaces was categorized into three levels: no facility, one facility, or ≥ 2 facilities. The quality of the facilities was categorized according to tertiles into low quality (≤ 2.0), medium quality (2.01 to 3.0), and high quality (≥ 3.01).

Secondary data of the Brazilian Institute of Geography and Statistics[17] indicated the independent variables. The mean monthly nominal income of the household heads was considered to the census tracts. The residential density was determined using the ArcGIS 10.3 ESRI® software package and the ratio between the number of residents and the area in square meters of the census tracts was estimated. The proportions of non-white and black or brown residents (n = 20,777 and n = 40,784, respectively), and age groups of children and adolescents (≤ 19 years; n = 51,190) and older adults (≥ 60 years; n = 48,183) were estimated as the ratio between the number of individuals with these characteristics in the census tract and the total number of residents. For all variables, the data were ranked and stratified into tertiles. The average income of the census tract was classified as low (≤ 1,818.00), medium (1,819.00–3,217.00), and high (≥ 3,218.00). The residential density was also classified as low (≤ 0.0008), medium (0.0009–0.0026), and high (≥ 0.0027). The proportions of children/adolescents (≤ 21.3%; 21.4–27.8% and ≥ 27.9%, respectively), older adults (≤ 8.6%; 8.7–14.4% and ≥ 14.5%, respectively), and non-white residents (≤ 7.0%; 7.1–13.7% and ≥ 13.8%, respectively) were classified into tertiles as low, medium and high by census tract. These procedures have been used in other studies[12,15,16].

For descriptive analysis, the absolute and relative frequency, median and interquartile ranges of the variables were estimated. Chi-square analysis was performed to analyze the percentage of categories and significance of the association between sociodemographic variables and outcomes (see Complementary Table 4). The association between the outcome (presence and quality of public open spaces and physical activity facilities) and exposure (sociodemographic characteristics of the census tract) was tested with logistic regressions (crude and adjusted). For association analysis, four dichotomous

(yes versus no) independent outcomes were evaluated considering the census tract area: presence of ≥ 1 public open space; presence of ≥ 1 high-quality public open space; presence of > 2 physical activity facilities; presence of high-quality physical activity facilities. The bivariate association was tested for each outcome, followed by simultaneous adjustment for confounding variables (area and population density of the census tract). The crude and adjusted models were rotated independently, and all the variables of the crude analysis were included. The Stata 12.0 software package was used and a 5% level of significance was adopted. Values are expressed as odds ratios (OR). The independent variable was stratified into tertiles: census tracts income (low-income tertile as reference) and residential density (high residential density tertile as reference). For the proportion of children/adolescents, older adults and non-white residents in the census tracts, the lower proportion was always used as the reference.

The procedures were approved by the Ethics Committee on Research involving Humans of the Federal University of Santa Catarina (Approval 47789015.8.0000.0121) and the Health Research Coordination of the Florianópolis City Council.

RESULTS

We analyzed a total of 643 urban census tracts of a city in southern Brazil. Public open spaces were present in 22.1% (n = 142) of these areas and absent in 77.9% (n = 501). Public open spaces with at least two physical activity facilities were in 49.3% (n = 70) of the census tracts 33.1% (n = 47) had only one facility and 17.6% (n = 25) had no facility. Regarding quality, 43.0% (n = 61) of the census tracts had at least one high-quality public open space. Table 1 shows other characteristics of the census tracts.

The high and middle income census tracts were more likely to have ≥ 1 public open space compared with those of low-income tracts (OR = 2.4; 95%CI 1.4–4.0; OR= 1.8; 95%CI 1.1–3.0, respectively). We observed the same in census tracts with low and medium residential density (OR = 2.0; 95%CI 1.2–3.3; OR = 1.7; 95%CI 1.0–2.7, respectively) and a medium and high proportion of older residents (OR = 2.2; 95%CI 1.3–3.6; OR = 3.3; 95%CI 1.9–5.7, respectively) compared with those with a high density and low proportion of older residents, respectively. On the other hand, the census tracts with a high proportion of children and adolescents (OR = 0.3; 95%CI 0.2–0.6) and non-white residents (OR = 0.6; 95%CI 0.3–0.9) had lower odds of having ≥ 1 public open space compared with those of low proportion of children and adolescents and white residents. The sociodemographic characteristics of the census tracts had no association with the quality of public open spaces (Table 2).

The medium and high income census tracts had greater odds of having > 2 physical activity facilities (OR = 4.0; 95%CI 1.4–11.3; OR=3.6; 95%CI 1.2–10.2, respectively) when compared with low-income tracts. In addition, tracts with a higher proportion of non-white residents had 70% lower odds of containing > 2 physical activity facilities (OR = 0.3; 95%CI 0.1–0.9). The sociodemographic characteristics of the census tracts had no association with the high quality of physical activity facilities (Table 3).

DISCUSSION

This is the first Latin American study that analyzed the relation between the sociodemographic characteristics of census tracts and the presence/quality of public open spaces and physical activity facilities to date. The results indicate a greater likelihood of spaces in areas with higher income, lower residential density, and a higher proportion of older adults. On the other hand, the presence of public open spaces was less common in census tracts with a higher proportion of children and adolescents and non-white residents. In addition, public open spaces with physical activity facilities were more frequent in higher income census tracts and less frequent in those with a higher proportion of non-white

Table 1. Description of the census tracts of Florianópolis according to study variables. Brazil, 2015.

Variables	n	%	Median (IR)
Income (n = 643)[a]			2,447 (1,562–3,854)
Low (≤ 1,818)	211	33.4	
Medium (1,819–3,217)	211	33.4	
High (≥ 3,218)	210	32.7	
Residential density[b]			0.014889(0.0006–0.004)
Low (≤ 0.0008)	210	33.3	
Medium (0.0009–0.0026)	210	33.3	
High (≥ 0.0027)	211	33.4	
Proportion of children and adolescents (≤ 19 years)[a]			24.3% (19.4%–29.6%)
Low (≤ 21.3%)	211	33.3	
Medium (21.4 to 27.8%)	213	33.7	
High (≥ 27.9%)	209	33.0	
Proportion of older adults (≥ 60 years)[a]			10.9% (7.6%–16.2%)
Low (≤ 8.6%)	213	33.7	
Medium (8.7 to 14.4%)	208	32.9	
High (≥ 14.5%)	212	33.5	
Proportion of non-white residents[a]			9.4% (5.8%–16.1%)
Low (≤ 7.0%)	211	33.4	
Medium (7.1 to 13.7%)	210	33.2	
High (≥ 13.8%)	211	33.4	
Presence of POS (n = 643)[a]			
No POS	501	77.9	
≥ 1 POS	142	22.1	
Quality of POS[a]			3.0 (1.8–4.0)
Low (≤ 2.0)	51	35.9	
Middle (2.01–3.0)	30	21.1	
High (≥ 3.01)	61	43.0	
Presence of PA facilities[a]			1.0 (1.0–4.0)
No facilities	25	17.6	
One facility	47	33.1	
≥ 2 facilities	70	49.3	
Quality of PA facilities[a]			3.0 (2.0–6.0)
Low (≤ 2.0)	31	26.7	
Medium (2.1–3.0)	33	28.4	
High (≥ 3.01)	52	44.8	

IR: interquartile range; POS: public open spaces; PA: physical activity
[a] According to the census tracts.
[b] According to the number of residents in the census tracts per square meter.

residents. Furthermore, the findings suggest inequalities in the distribution of public open spaces and consequent opportunities for physical activity facilities, especially for groups that are at higher risk of physical inactivity[6,11]. Regarding this, it is necessary to substantially increase the presence of these physical resources in areas where lower-income, non-white and younger people live.

Overall, only 22.1% of the census tracts had at least one public open space and just over 45.0% had more than two physical activity facilities in the spaces. These percentages are lower than those reported in six regions of the United States, where 46.0% of the tracts had at least one public open space and some facility was found in 52.0% of these spaces[11]. Public spaces for leisure can increase walking in adults by 0.7%[14]. In addition, the presence of these spaces does not only promote active behavior but also potential socialization and

Table 2. Crude and adjusted odds ratio (OR) for sociodemographic variables of the census tracts and the presence and quality of public open spaces in Florianópolis. Brazil, 2015.

Variables	≥ 1 public open space					Public open spaces with high quality				
	%	Crude		Adjusted[a]		%	Crude		Adjusted[a]	
		OR	95%IC	OR	95%IC		OR	95%IC	OR	95%IC
Income										
Low (≤ 1,818)	17.5	1.0		1.0		32.4	1.0		1.0	
Medium (1,819–3,217)	23.2	1.4	0.9–2.3	**1.8**	**1.1–3.0**	44.9	1.7	0.7–4.1	1.7	0.7–4.2
High (≥ 3,218)	26.2	**1.7**	**1.0–2.7**	**2.4**	**1.4–4.0**	49.1	2.0	0.8–4.9	1.8	0.7–4.5
Residencial density (m²)										
High (≥ 0.0027)	16.2	1.0		1.0		35.3	1.0		1.0	
Medium (0.0009–0.0026)	25.2	**1.7**	**1.1–2.8**	**1.7**	**1.0–2.7**	35.8	1.0	0.4–2.5	1.1	0.4–2.6
Low (≤ 0.0008)	25.1	**1.7**	**1.1–2.8**	**2.0**	**1.2–3.3**	56.6	2.4	0.9–5.8	2.3	0.9–5.8
Proportion of children and adolescents[b]										
Low (≤ 21.3%)	24.2	1.0		1.0		47.1	1.0		1.0	
Medium (21.4 to 27.8%)	25.4	1.1	0.7–1.7	0.9	0.6–1.4	48.2	1.0	0.5–2.2	1.2	0.5–2.7
High (≥ 27.9%)	17.2	0.7	0.4–1.1	**0.3**	**0.2–0.6**	30.6	0.5	0.2–1.2	0.7	0.2–1.9
Proportion of older adults[b]										
Low (≤ 8.6%)	14.6	1.0		1.0		32.3	1.0		1.0	
Medium (8.7 to 14.4%)	23.6	**1.8**	**1.1–3.0**	**2.2**	**1.3–3.6**	55.1	**2.6**	**1.0–6.6**	2.3	0.9–6.1
High (≥ 14.5%)	28.8	**2.4**	**1.5–3.8**	**3.3**	**1.9–5.7**	39.3	1.4	0.5–3.4	1.1	0.4–2.8
Proportion of non-white residents[c]										
Low (≤ 7.0%)	23.2	1.0		1.0		40.8	1.0		1.0	
Medium (7.1 to 13.7%)	23.3	1.0	0.6–1.6	0.9	0.5–1.4	55.1	1.8	0.8–4.0	2.0	0.9–4.6
High (≥ 13.8%)	20.4	0.8	0.5–1.3	**0.6**	**0.3–0.9**	32.6	0.7	0.3–1.6	1.0	0.4–2.5

[a] Adjustment variables: area in square meters of the census tracts and number of residents in the census tracts.
[b] Proportion of age range in the census tracts.
[c] Proportion of self-reported black or brown residents in the census tracts.
In bold: significant values < 0.05.

contemplation[4], increasing the number of people who attend these places[22]. However, this study showed the absence of public open spaces in about 80.0% of the census tracts. In terms of public policy, the investments in urban areas can increase leisure and physical activity opportunities and to be focus of national[23] and international actions[3].

The presence of public open spaces and physical activity facilities was higher in higher-income census tracts, in agreement with the literature[8,11]. People living in areas with lower *per capita* income have fewer open spaces in their neighborhoods[9,10]. On the other hand, one study showed that the presence of these spaces near the residences of the lower-income population improves health perception and quality of life[24]. Implementing plans to improve these public facilities for this group could increase opportunities for active behavior at the community level[4]. A study involving a representative sample of Brazilian low-income family workers showed that they often use spaces such as streets and parks for sports, demonstrating the importance of these spaces to promote physical activity in these income strata[25].

An increased presence of public open spaces was associated with a lower residential density of the census tracts. Similar results have been reported in high-income countries, indicating that higher residential density is associated with fewer leisure opportunities[14] and low quality of amenities in these spaces[10]. The accelerated growth of large urban centers likely influence the modes of land occupation and is therefore detrimental to the lifestyle of the population, especially vulnerable groups[14]. To a large extent, areas with lower residential density provide better access to services, urban mobility, leisure, as well as public and private investments in the quality of public open spaces, which are factors that may explain our findings[26]. Improving the unequal distribution of these spaces in areas with high residential density

Table 3. Crude and adjusted odds ratio (OR) for sociodemographic variables of the census tracts and the presence and quality of physical activity facilities in the public open spaces in Florianópolis. Brazil, 2015.

Variables	> 2 PA facilities					PA facilities with high quality				
	%	Crude		Adjusted[a]		%	Crude		Adjusted[a]	
		OR	95%IC	OR	95%IC		OR	95%IC	OR	95%IC
Income										
Low (≤ 1,818)	21.6	1.0		1.0		39.3	1.0		1.0	
Medium (1,819–3,217)	44.9	**3.0**	**1.1–7.7**	**4.0**	**1.4–11.3**	54.5	1.9	0.7–4.9	2.4	0.9–6.8
High (≥ 3,218)	40.0	2.4	0.9–6.3	**3.6**	**1.2–10.2**	38.6	1.0	0.4–2.6	1.4	0.5–4.0
Residencial density (m²)										
High (≥ 0.0027)	26.5	1.0		1.0		41,7	1.0		1.0	
Medium (0.0009–0.0026)	35.8	1.6	0.6–4.0	1.5	0.6–3.9	43,2	1.1	0.4–2.9	1.0	0.4–2.7
Low (≤ 0.0008)	45.3	2.3	0.9–5.9	2.0	0.7–5.3	48,9	1.3	0.5–3.6	1.2	0.4–3.4
Proportion of children and adolescents[b]										
Low (≤ 21.3%)	41.2	1.0		1.0		45.0	1.0		1.0	
Medium (21.4 to 27.8%)	37.0	0.8	0.4–1.8	0.7	0.3–1.5	42.2	0.9	0.4–2.1	0.7	0.3–1.7
High (≥ 27.9%)	30.6	0.6	0.3–1.5	0.3	0.1–1.0	48.4	1.1	0.4–2.9	0.6	0.2–1.9
Proportion of older adults[b]										
Low (≤ 8.6%)	35.5	1.0		1.0		46.4	1.0		1.0	
Medium (8.7 to 14.4%)	36.7	1.1	0.4–2.7	1.2	0.4–3.1	47.7	1.1	0.4–2.7	1.2	0.4–3.1
High (≥ 14.5%)	37.7	1.1	0.4–2.7	1.5	0.6–4.1	40.9	0.8	0.3–2.1	1.1	0.4–3.0
Proportion of non-white residents[c]										
Low (≤ 7.0%)	38.8	1.0		1.0		47.4	1.0		1.0	
Medium (7.1 to 13.7%)	44.9	1.3	0.6–2.9	1.2	0.5–2.7	45.2	0.9	0.4–2.2	0.9	0.3–2.2
High (≥ 13.8%)	25.6	0.5	0.2–1.3	**0.3**	**0.1–0.9**	41.7	0.8	0.3–2.0	0.4	0.1–1.3

PA: physical activity
[a] Adjustment variables: area in square meters of the census tracts and number of residents in the census tracts.
[b] Proportion of age range in the census tracts.
[c] Proportion of self-reported black or brown residents in the census tracts.
In bold: significant values < 0.05.

may raise the population's interest in active behavior[27], both for leisure[7] and for transport activities[5], and consequently contribute to improve public the health, the environment and even the property valuation in these areas[4].

We observed the largest number of public open spaces in census tracts with a higher proportion of older adults. In addition, a higher proportion of older adults lived in high-income areas. These data can be explained in part by the fact that Florianópolis is a city potentially chosen for retirement. Thus, self-selection of places with greater leisure options, including physical activity resources, occurs[28]. Similar studies have shown that older adults choose to live in areas near public spaces as an environmental health promotion facilitator[11]. Data from a representative sample of older residents (n = 1,705) in Florianópolis reveal that the presence of parks and/or recreation facilities increases by 60% the chance of achieving ≥ 150 minutes/week of leisure-time physical activity[28]. This result is positive since the presence of public open spaces can contribute to increase and maintain of physical activity in this population[2]. Although a high quality of spaces and facilities was not associated with the presence of older adults in the census tracts, a study has shown that the conditions of cleanliness, safety and amenities may encourage the participation of older people in outdoor physical activities[27].

On the other hand, few public open spaces were observed in census tracts with a predominance of children and adolescents. These data are a matter of concern as the proximity of these places to their home would allow greater participation in physical activity and is an important factor for socialization with their peers[1]. A representative survey of adolescents in Brazil (n = 74,589) showed that 53.6% of residents in

Florianópolis performed < 300 minutes/week of leisure physical activity (versus 58.0% in Belo Horizonte)[29]. However, this scenario could be modified by improving the accessibility and attractiveness of public open spaces for leisure to increase the participation of adolescents[1].

The results show that areas with a higher proportion of non-white residents have fewer public open spaces and physical activity facilities. Similar results have been reported in studies conducted in high-income countries[6,9,10]. The economic composition of a region and ethnic differences are possibly associated with the characteristics of the neighborhoods. Lower quality leisure infrastructure is found in areas with a higher proportion of black and low-income residents[11]. In this study, non-white residents accounted for 13.7% of the population in the city and most of them lived in lower-income areas. Within this context, the presence of physical activity facilities in low-income areas can minimize inequalities[9]. The implementation of public policies in Latin America designed to improve the distribution of these facilities may promote higher levels of physical activity in less active groups, such as those with low education level[30]. These data contribute to the urban planning of cities, which should include improvements in the distribution of public open spaces and physical activities facilities.

The quality of public open spaces and physical activity facilities was not associated with the sociodemographic characteristics of the census tracts. A previous study classified a greater proportion of public open spaces (n = 214) as high quality (51.9%) and more than half of the all physical activity facilities in these spaces (n = 377) had good quality (53.6%)[19]. Studies have shown an association between the use of public open spaces and better quality for physical activities[2,6], as well as a large number of spaces with high-quality spaces in higher income regions[8,10]. Possibly, the larger number and distribution of public open spaces identified in these studies has contributed to this association.

This study has some limitations. The sociodemographic data of the census tracts are from the 2010 census and should be analyzed with caution. However, these estimates are widely used for research purposes[21,28]. Natural areas were not included in the public open space, which may be important for the promotion of active behavior[21], especially in Florianópolis, since it is an island. The quality measure of these spaces was obtained at only one time point, a fact that may reduce the temporal consistency of the measure since the areas are subject to climate influences that can affect their quality. Furthermore, the reduced number of census tracts containing public open spaces limited inference of the data due to the estimates of effect observed in the analyses. The strengths of this study include the use of objective environment measures such as systematic observation of the spaces and geographic information systems for the analysis of spatial distribution by triangulation of the variables investigated. In addition, the data contribute to the limited publications on this subject in Latin America, encouraging the discussion of future actions and strategies to create physical activity-friendly cities.

CONCLUSIONS

The results led us to conclude that the presence of public open spaces and spaces with more than two physical activity facilities is higher in areas with higher income and low residential density. The census tracts with the highest proportion of older adults were associated with greater odds of having more than one public open spaces. Furthermore, the chance of having at least one space is reduced in places with a higher proportion of children and adolescents and non-white residents. Likewise, census tracts with a high proportion of children and adolescents were less likely to have more than two physical activity facilities. The sociodemographic variables tested were not associated with the quality of public open spaces and physical activity facilities.

Complementary Table (4). Descriptive data of the chi-square analysis between the outcome and exposure variables.

Variable	Public open spaces (POS)						Physical activity (PA) facilities					
	Presence of POS			Quality of POS			Presence of PA facilities			Quality of PA facilities		
	No	≥ 1 POS		Low-Middle	High		≤ 2 facilities	> 2 facilities		Low-Middle	High	
	n (%)	n (%)	p*	n (%)	n (%)	p*	n (%)	n (%)	p*	n (%)	n (%)	p*
Income			0.033			0.126			0.108			0.779
Low (≤ 1,818)	174 (82.5)	37 (17.5)		25 (67.6)	12 (32.4)		29 (78.4)	8 (21.6)		17 (60.7)	11 (39.3)	
Medium (1,819–3,217)	162 (76.8)	49 (23.2)		27 (33.8)	22 (44.9)		27 (55.1)	22 (44.9)		20 (45.5)	24 (54.5)	
High (≥ 3,218)	155 (73.8)	55 (26.2)		28 (35.0)	27 (49.1)		33 (60.0)	22 (40.0)		27 (61.4)	17 (38.6)	
Residencial density (m²)			**0.016**			0.066			0.081			0.564
High (≥ 0.0027)	176 (83.8)	34 (16.2)		22 (64.7)	12 (35.3)		25 (73.5)	9 (26.5)		14 (58.3)	10 (41.7)	
Medium (0.0009–0.0026)	157 (74.8)	53 (25.2)		34 (64.2)	19 (35.8)		34 (64.2)	19 (35.8)		25 (56.8)	19 (43.2)	
Low (≤ 0.0008)	158 (74.9)	53 (25.1)		23 (43.4)	30 (56.6)		29 (54.7)	24 (45.3)		24 (51.1)	23 (48.9)	
Proportion of children and adolescents (≤ 19 years)			0.088			0.157			0.318			0.805
Low (≤ 21.3%)	160 (75.8)	51 (24.2)		27 (52.9)	24 (47.1)		30 (58.8)	21 (41.2)		22 (55.0)	18 (45.0)	
Medium (21.4 to 27.8%)	159 (74.6)	54 (25.4)		28 (51.9)	26 (48.2)		34 (63.0)	20 (37.0)		26 (57.8)	19 (42.2)	
High (≥ 27.9%)	173 (82.8)	36 (17.2)		25 (69.4)	11 (30.6)		25 (69.4)	11 (30.6)		16 (51.6)	15 (48.4)	
Proportion of older adults (≥ 60 years)			**< 0.001**			0.824			0.834			0.603
Low (≤ 8.6%)	182 (85.4)	31 (14.6)		21 (67.6)	10 (32.3)		20 (64.5)	11 (35.5)		15 (53.6)	13 (46.4)	
Medium (8.7 to 14.4%)	159 (76.4)	49 (23.6)		22 (44.9)	27 (55.1)		31 (63.3)	18 (36.7)		23 (52.3)	21 (47.7)	
High (≥ 14.5%)	151 (71.2)	61 (28.8)		37 (60.7)	24 (39.3)		38 (62.3)	23 (37.7)		26 (59.1)	18 (40.9)	
Proportion of non-white residents			0.483			0.475			0.212			0.624
Low (≤ 7.0%)	162 (76.8)	49 (23.2)		29 (59.2)	20 (40.8)		30 (61.2)	19 (38.8)		20 (52.6)	18 (47.4)	
Medium (7.1 to 13.7%)	161 (76.7)	49 (23.3)		22 (44.9)	27 (55.1)		27 (55.1)	22 (44.9)		23 (54.8)	19 (45.2)	
High (≥ 13.8%)	168 (79.6)	43 (20.4)		29 (67.4)	14 (32.6)		32 (74.4)	11 (25.6)		21 (58.3)	15 (41.7)	

*p: chi-square test p-value linear association in bold significant values < 0.05.

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