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Article

Use of an elevated avenue for leisure-time physical activity by adults from São Paulo downtown, Brazil

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Abstract

Leisure-time physical activity (LTPA) is associated with access and use of public open spaces. The "President João Goulart Elevated Avenue" and current denominated "Minhocão" is a facility for leisure activities that are open for people during the night/weekends. The aim of this study was to examine if the prevalence of LTPA among individuals living in the surroundings of Minhocão is different according to proximity to, and use of, the facility. We conducted a cross-sectional study with cluster sampling with people aged ≥18 years who lived in households until 500m and between 501m to 1500m of Minhocão. The survey was conducted between December/2017 until March/2019 with an electronic questionnaire self-responded. We conducted bivariate analysis and Poisson regression to examine possible differences in LTPA according to the proximity of residences and use of Minhocão. The analysis used post-stratification weights. A total of 12,030 telephone numbers of people were drawn (≤500m = 6,942; and >500m to ≤1500m = 5,088). The final sample analyzed were of 235 residents who returned the questionnaires. There was a higher prevalence of individuals engaging in at least 150 minutes per week of LTPA among users than non-users (Prevalence Ratio=2.23, IC95%1.72-2.90). People who used the park had higher prevalence of all types of LTPA than non-users. The results can serve to inform government decision-making on the future of Minhocão.

Keywords: Public open spaces; Open streets; Built environment; Leisure-time physical activity; Epidemiology

1. Introduction

Previous studies have shown that engagement in leisure-time physical activity (LTPA) can attenuate a variety of chronic diseases, decrease mortality, improve quality of life and life satisfaction, and increase life expectancy [1–3]. However, the systematic review showed that several variables are associated with LTPA, including individual and contextual factors [4]. Because of this, according to Sallis et al. [5], the most promising interventions for making individuals more active should be based on an ecological model

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approach. This model includes the built environment and facilities for LTPA, which should be available near residences of people.

From a public health perspective to promote LTPA, the public open spaces such as parks, pocket parks or squares, and bike paths are promising venues for engagement in these activities [6,7]. Studies show that a variety of factors can influence the use of public open spaces [8–11]. The quantity and quality of these spaces, their proximity of residences, and accessibility are some factors that are associated with usage for LTPA [8–11]. In addition to the public open spaces, the literature has reported other environmental interventions to promote LTPA like the open streets, which are avenues or streets that are closed temporarily for cars and open for people on weekends [12–14]. These interventions have been referred to in the literature using different terminology according to their objectives, such as "Recreational Bike Paths", "Open Streets", "Play Streets", "Leisure Cycling Routes", and "Leisure Places" [15]. These can consist of public open spaces for recreation, to provide community activities (e.g., LTPA classes), and to promote sustainable, efficient means of transport (e.g., cycling) [16].

The study by Sarmiento et al. [16] provided a summary of the available information on the open streets as a public health policy in the Americas and the Caribbean drawing on different databases. The authors identified a total of 38 programs. The most interventions were conducted in Colombia, United States, Peru, and Mexico. In addition, the authors identified some cities where initiatives entailing the closure of streets for LTPA have been implemented, that included São Paulo, in Brazil. The problem is the lack of studies evaluating the effectiveness of these interventions to verify relationships with physical activity in adults living in low- and middle-income countries.

The "President João Goulart Elevated Avenue", currently denominated "Minhocão" or "big earthworm" in English because of its shape in its 3.4 km long, was listed in Sarmiento et al. study [16] like an open street. This elevated avenue was inaugurated in 1971 only to ease traffic congestion for motor-vehicle traffic car [17,18]. However, this facility started to cause many problems for local residents like excess noise, dirt and air pollution [17]. Because this, São Paulo City Hall authorities have closed this elevated avenue for the motor-vehicle traffic initially at nights and later also on weekends an effort to reduce these problems [18]. Since this initiative was taken, the local population has been using voluntarily the elevated avenue for different LTPA, such as walking, running, and biking at nighttime and weekends. In 2018, the municipal councilors of São Paulo City approved the law of "Minhocão Park" [19], where the project provided the discussion for gradual phasing out of use of the elevated avenue by motor vehicles. The project had been included in the New Master Plan of São Paulo city since 2014 [20]. However, the discussion also includes the possible demolition of the elevated avenue and in 2021 the law of "Minhocão Park" was annulated.

In this case, it is important to verify possible contributions of this facility for LTPA for people living near of this elevated avenue. The rationale behind this study is underpinned by scientific and policy evidence. Firstly, a study conducted by Florindo et al. [7] showed that adults who lived in São Paulo city, Brazil, between 2014 and 2015 and that had access to two or more public open spaces (such as parks, squares or bike paths) within a 500-meter radius from their homes had significantly more likelihood to engage in leisure-time walking compared to those without these spaces available in their neighborhood. The study conducted with adults from Curitiba, south in Brazil, showed that users of parks at least once a week had a higher prevalence of leisure-time walking than non-users [21]. However, there are few studies that evaluated the contributions of open streets

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like Minhocão for LTPA in low- and medium-income countries. Lastly, from a political standpoint, discussions on the future of the elevated avenue (demolition or creation of a park) gained impetus in 2021 with the review of the New Master Plan for São Paulo approved in 2014 [20]. Thus, the results of the present study can serve to foster this discussion. Therefore, the objective of the present study was to examine if the prevalence of LTPA among individuals living in the surrounding of Minhocão is different according to proximity of their residences and according to the usage of the facility.

2. Materials and Methods

2.1. Study site

São Paulo is the most populous city in Brazil and the eighth in the world, with an estimated population for 2021 of 12,396,372 million inhabitants living in 1,521,110 km^2 [22], a concentration of 11% of the Gross Domestic Product of Brazil, currently has 651.9 km of cycle paths and cycle lanes [23], 101.1 km of subway lines with 89 stations [24] and 106 parks.

The Minhocão is an elevated highway (Figure 1a) with 3.4 km, five meters above the ground, dual roadway, with four lanes in each direction separated by a central concrete barrier wall. The elevated avenue has nine points of access. Some of its sections are only five meters away of the facades of buildings on its sides [25]. The elevated highway is closed for motor-vehicle traffic and open for recreational activities, including physical activity from Monday to Thursday, from 8 pm to 7 am and, on weekends 8 pm on Friday until 6 am on Monday.

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Figure 1. Location of Minhocão in São Paulo city, Brazil (1a); and census tracts of residents randomly selected according to buffer zones with different radiuses from entrances to Minhocão (1b).

Figure 1a

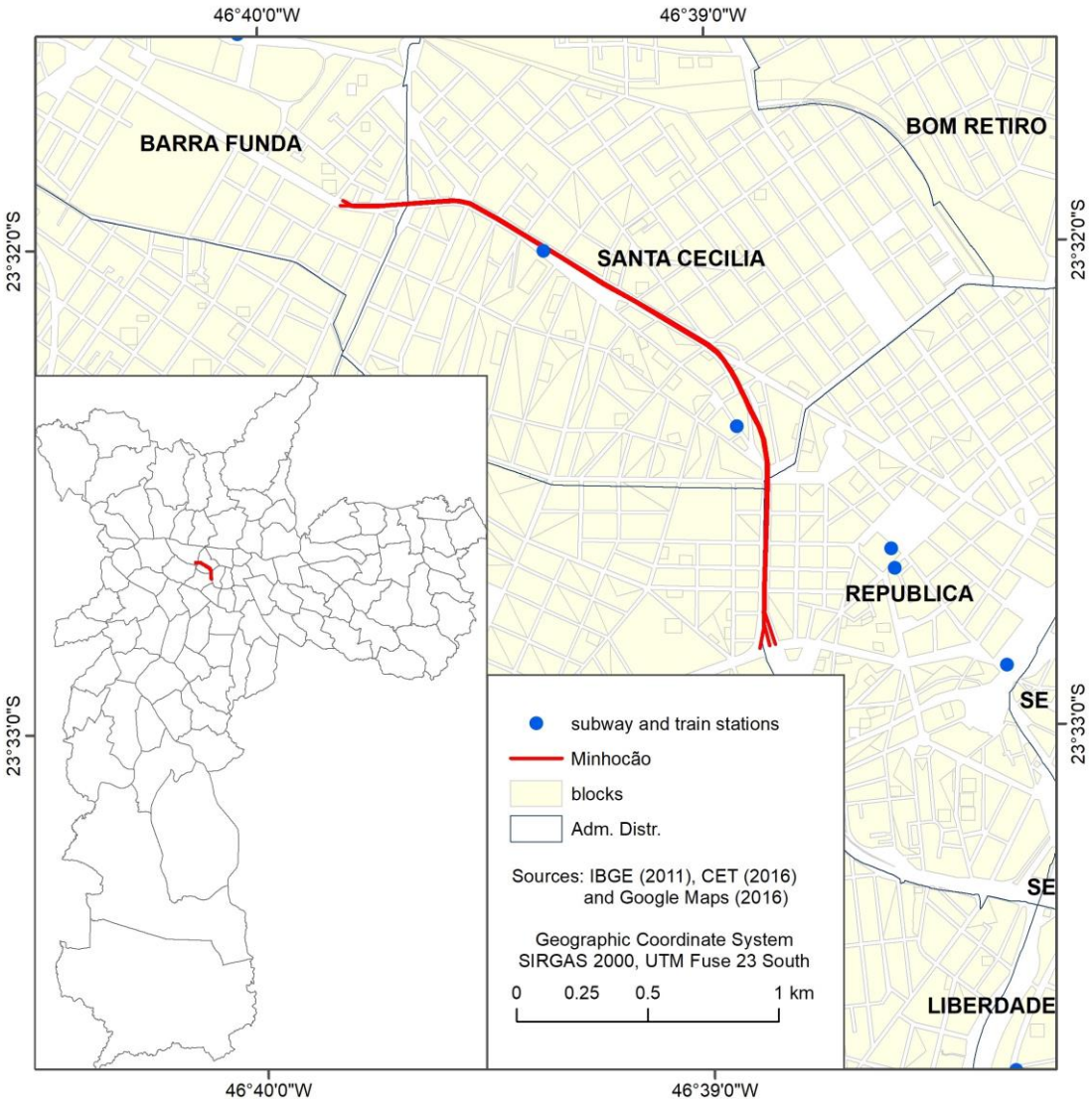

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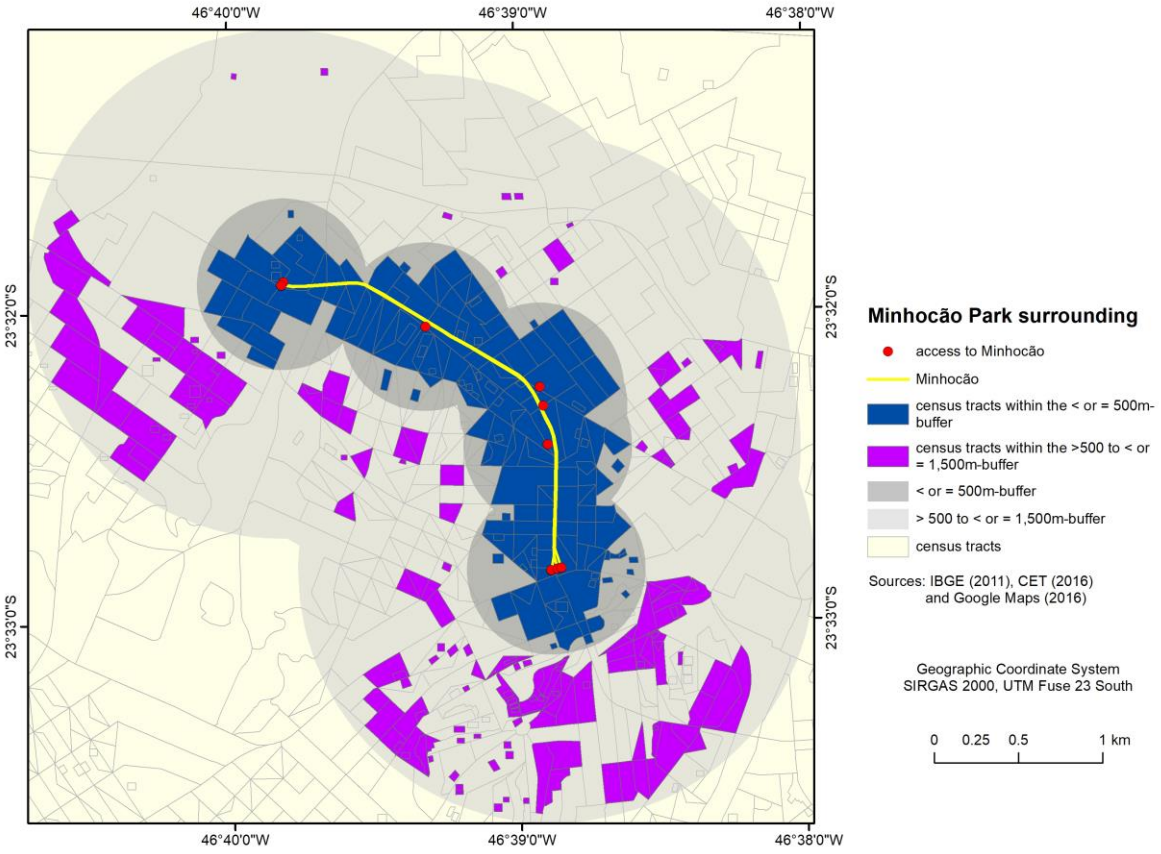
Figure 1b.



2.2. Study design and sample

We conducted a cross-sectional telephone and email survey. The target population comprised individuals aged ≥18 years who lived in households until within 1,500 meters of the main access of Minhocão (Figure 1b).

The sample size was calculated considering a confidence level of 95%, test power of 80%, the proportion of people exposed positives of 45% (people who lived until 500 meters of a facility for bicycle and walking and practiced ≥150 minutes per week of LTPA), and non-exposed positives of 34% (people who lived between 501 meters until 1500 meters of a facility for bicycle and walking, and practiced <150 minutes per week of LTPA). The results were obtained in a study conducted by Pazin et al. [26]. The needed sample size would be 616 adults in total (308 adults living until 500 meters of the main access, and 308 adults living between 501 meters to 1,500 meters of the main access).

Households located within 1,500 meters of the elevated highway access points were randomly selected. Using Arc Map version 10.3 (Redlands, CA, USA), we identified the census tracts lying fully within one of the two buffer zones of interest: ≤500 meters (Group 1), and >500 to ≤1,500 meters radius (Group 2) from a highway access (Figure 1b). Census tracts were based on the 2010 national census conducted by the Brazilian Institute of Geography and Statistics. Buffer sizes were based on the results from the study by Pazin et al. [26]. We identified 164 tracts in Group 1 and other 164 tracts in Group 2.

We conducted cluster sampling with a 2-stage selection process and probability proportional to the cluster size. The census tracts were the primary sampling units. Fifty-eight tracts were randomly selected in Group 1 and 37 tracts in Group 2. The second sampling

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units were the addresses (street name, number, and postal code of each randomized tract), with a total of 15 addresses randomly selected per tract. After random selection of addresses, we randomly selected home telephone numbers. The list of telephone numbers associated to a given address was retrieved from the websites of the telephone service operators. All available telephone numbers associated with the selected addresses were collected. For example, if an address corresponded to an apartment building, all available telephone numbers of all apartments were selected. A total of 12,030 telephone numbers of individuals living in the vicinity of Minhocão (≤500m = 6,942; and >500m to ≤1500m = 5,088) were randomly selected.

2.3. Telephone call to sampled participants

Undergraduate students from the Physical Activity Epidemiology Group at University of São Paulo were trained for a total of 15 hours on conducting telephone calls to the numbers of the randomly selected households. The students were given a password-protected spreadsheet containing all the randomly selected telephone numbers. In the event of three unsuccessful attempts to the same number at different times and on different days, no further calls were made to the number. In the event of successful calls, interviewers explained the objectives and importance of the survey and invited all adults (≥18 years of age) members of the household to take part in the study. All individuals who agreed to participate were asked to provide an e-mail where the electronic survey questionnaire could be sent to. Follow-up letters and email messages were sent to survey participants to stimulate response rate. A mean of 1.3 call was conducted per number, resulting in successful contact for 6,977 telephone numbers (58%). We posted follow-up letters to 1,306 households with at least one person who agreed on taking part in the survey.

2.4. Electronic survey questionnaire

The survey was conducted between December 2017 and March 2019. The questionnaire comprised of open and multiple-choice questions divided into six blocks: 1. Sociodemographic variables, self-rated health, and self-reported weight and height; 2. Leisure-time PA; 3. Use of Minhocão for leisure-time PA; 4. Personal and environmental barriers to use the Minhocão; 5. Social support; 6. Self-efficacy. For this paper, responses to blocks 1, 2 and 3 were analyzed.

Leisure-time PA was evaluated by the long version of the International Physical Activity Questionnaire (IPAQ), which was validated in a sample of Brazilian adults for its applicability in electronic form [27] and via e-mail [28], demonstrating good validity, reproducibility and concordance in both studies. This version of the IPAQ was standardized to collect information on engagement in leisure-time PA during the past seven days in minutes per day and number of days per week spent on walking, moderate and vigorous. Participants were probed about whether they used the Minhocão for leisure-time PA (yes or no).

The questionnaire was developed on the free platform Google Forms, allowing form sharing via any communication media using an URL to the questionnaire and real-time storage of responses on the cloud in the form of spreadsheets, with no need for manual data entry.

2.5. Data analyses

Means, confidence intervals, and absolute (n) and relative frequencies (%) were used to describe the data. The chi-square test was applied to explore associations between (a)

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usage of the Minhocão (yes or not) and (b) distance from the participants' households to the closest entrance to the elevated avenue (≤500m; and >500m to ≤1,500m) and leisure-time walking, moderate and vigorous physical activity. In cases where chi-square assumptions were not met (cells containing expected values ≥5), then Fisher´s exact test was employed.

For associations with p-value <0.05 in the bivariate analyses, we used Poisson regression models to determine the direction and magnitude of association between different types of LTPA and distance to and usage of the Minhocão. Multivariate models were adjusted for sex, age e education. Prevalence ratio (PR) were calculated with 95% confidence intervals. The construction of post-stratification weights was used to correct the bias due to the low response rate of the survey. The weights were calculated using the rake method, the variables age and sex of the population from the 2010 Census were used as a reference population in the construction of the weights. All statistical analyses were performed in the Stata software version SE 16.1 (StataCorp, College Station, TX, USA), using post-stratification weights to adjust the sample distribution for the population according to age and sex using the survey module (svy) [29].

2.6. Study ethics

The study was approved by the Research Ethics Committee of the University of São Paulo School of Public Health (protocol number 58449816.4.0000.5421).

3. Results

Of the results of 6,977 telephone numbers of people that were contacted with successful, we received the return of 421 emails of people with interest to answer the questionnaire. For finally, a total of 242 questionnaires were completed. Six questionnaires were subsequently excluded for containing non-randomized addresses, while another questionnaire was not included because the respondent was under 18 years of age. A total of 235 residents living near the Minhocão were included in the analysis. Respondents were predominantly male (53.6%), aged 18 to 29 years (28.9%), with educated to the higher level (56.2%), lived within 500 meters of park entrances (66.8%), and only 36.0% used the facility for PA in leisure-time. Most of the sample reported walking and moderate physical activity in leisure time (Table1).

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Table 1. Social and demographic characteristics, usage of the facility, and leisure-time physical activity of respondents that residing until 1,500 meters from the main access of Minhocão, São Paulo city, São Paulo State, Brazil, 2017-2019.

Variables	%*	(95%CI)
Sex		
Female	46.4	(39.4 – 53.6)
Male	53.6	(46.4 – 60.6)
Age group (years)		
18-29	28.9	(22.1 – 36.8)
30-39	21.5	(16.2 – 27.9)
40-49	16.3	(11.7 – 22.2)
50-59	14.2	(10.9 – 18.3)
≥60	19.1	(14.6 – 24.8)
Education		
Until complete high school	15.1	(10.4 – 21.4)
Incomplete or complete graduate	56.2	(49.0 – 63.2)
Incomplete or complete postgraduate	28.7	(22.8 – 35.4)
Distance of residence from main access Minhocão		
≤500 meters	66.8	(59.8 – 73.3)
>500 to ≤1500 meters	33.2	(26.8 – 40.2)
Use of Minhocão for LTPA		
No	64.0	(56.6 – 70.9)
Yes	36.0	(29.1 – 43.4)
Leisure-time walking		
No	42.1	(35.3 - 49.3)
Yes	57.9	(50.7 - 64.7)
Moderate physical activity in leisure time		
No	43.7	(36.8 - 50.9)
Yes	56.3	(49.1 - 63.2)
Vigorous physical activity in leisure time		
No	66.8	(59.4 - 73.5)
Yes	33.2	(26.6 - 40.6)
Total LTPA in the week**		
<150 minutes	45.3	(38.2 – 52.5)

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≥150 minutes	54.7	(47.5 – 61.7)	

Notes: *post-stratification weight by age and sex; **Leisure-time physical activity (LTPA) including walking, moderate or vigorous; Abbreviation: CI: confidence interval

The LTPA not was associated with the proximity to the nearest of the access of Minhocão, according to people's home address (Table 2).

Table 2. Association of leisure-time physical activity among residents living in the surroundings of Minhocão according to distance of the residence address in São Paulo city, São Paulo state, Brazil, 2017-2019.

LTPA in past week	≤500 meters		501 to ≤1500 meters		
	%*	(95%CI)	%*	(95%CI)	*p***
Walking					
No	40.3	(32.1 - 49.1)	45.8	(33.9 - 58.2)	0.470
Yes	59.7	(51.0 - 67.9)	54.2	(41.8 - 66.1)	
Moderate					
No	43.1	(34.7 - 51.9)	45.0	(33.2 - 57.4)	0.803
Yes	56.9	(48.1 - 65.3)	55.0	(42.6 - 66.8)	
Vigorous					
No	64.3	(55.1 - 72.5)	71.8	(58.8 - 81.9)	0.327
Yes	35.7	(27.5 - 44.9)	28.2	(18.1 - 41.2)	
Total LTPA* **					
<150 minutes per week	44.8	(36.3 - 53.6)	46.3	(34.4 - 58.7)	0.844
≥150 minutes per week	55.2	(46.4 - 63.7)	53.7	(41.3 - 65.6)	

Notes: *post-stratification weight by age and sex; **p-values for Pearson's chi-squared test; ****Leisure-time physical activity (LTPA) including walking, moderate or vigorous; Abbreviation: CI: confidence interval*

Minhocão usage was positively associated with walking, moderate, and vigorous LTPA (Table 3).

Table 3. Association between use of Minhocão and leisure-time PA among adults living until 1,500m from main access in São Paulo city, São Paulo state, Brazil, 2017-2019.

LTPA in past week	Use of Minhocão for leisure-time PA				
	No		Yes		
	%*	(95%CI)	%*	(95%CI)	*p***

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Walking					
No	60.5	(51.4 - 68.9)	13.1	(6.3 - 25.1)	**<0.0001**
Yes	39.5	(31.1 - 48.6)	86.9	(74.9 - 93.7)	
Moderate					
No	61.3	(52.2 - 69.7)	13.3	(6.8 - 24.4)	**<0.0001**
Yes	38.7	(30.3 - 47.8)	86.7	(75.6 - 93.2)	
Vigorous					
No	76.6	(67.6 - 83.8)	44.1	(31.9 - 57.0)	**<0.0001**
Yes	23.4	(16.2 - 32.4)	55.9	(43.0 - 68.1)	
Total LTPA					
<150 minutes per week	63.1	(53.9 - 71.4)	11.7	(5.8 - 21.9)	**<0.0001**
≥150 minutes per week	36.9	(28.6 - 46.1)	88.3	(78.1 - 94.2)	

Notes: *post-stratification weight by age and sex; **p-values for Pearson's chi-squared test; Boldface indicates significant associations; ***Leisure-time physical activity (LTPA) including walking, moderate or vigorous Abbreviation: CI: confidence interval

There was a higher prevalence of individuals engaging in leisure-time walking, moderate, vigorous and total LTPA among Minhocão users than non-users, independently of sex, age, and education (Table 4).

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Table 4. Prevalence ratios for leisure-time PA according to use of Minhocão among adults living in until 1,500m from main access, São Paulo city, São Paulo State, Brazil, 2017-2019.

Use of Minhocão for LTPA		Model 1 PR* (95%CI)	Model 2 PR* (95%CI)**
Walking			
	No	1	1
	Yes	**2.20 (1.72 – 2.82)**	**2.10 (1.63 – 2.71)**
Moderate			
	No	1	1
	Yes	**2.24 (1.75 – 2.87)**	**2.17 (1.69 – 2.80)**
Vigorous			
	No	1	1
	Yes	**2.39 (1.58 – 3.63)**	**2.08 (1.36 – 3.19)**
Total LTPA* **			
	<150 minutes per week	1	1
	≥150 minutes per week	**2.39 (1.86 – 3.09)**	**2.23 (1.72 – 2.90)**

Notes: *post-stratification weight by age and sex; **adjusted for sex, age, education; ***Leisure-time physical activity (LTPA) including walking, moderate or vigorous; Boldface indicates significant associations; Abbreviation: PR: Prevalence ratio; CI: confidence interval; PA (physical activity).

4. Discussion

This study examined the relationship between the proximity of residences of people and the usage of Minhocão with LTPA, which is an elevated avenue that is transformed into an open street for people during the nights and on the weekends. This paper found that Minhocão users engaged in more LTPA than non-users. People that used the facility had higher prevalence of all types of LTPA investigated and of people achieving the recommended levels of physical activity only in the leisure domain. However, the proximity of the nearest access of the elevated avenue according to people's home address was not associated with LTPA.

Studies have shown that facilities and open streets like Minhocão are important to promote LTPA [8,15,16,30–32], particularly in megalopolis like São Paulo, where environmental inequities are a big problem [20].

The results of this paper were like the cross-sectional study of 749 intentionally selected adults in four parks (n=303) and four squares (n=446) in Curitiba city, Southeast Brazil, which showed that users of parks at least once a week had a higher prevalence of leisure-time walking (Prevalence Ratio = 1.30; 95%CI 1.03-1.64) than non-users. [21].

However, this paper did not find a statistical association between the proximity of nearest access of Minhocão of people's residences (distances ≤500 meters) and LTPA,

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which was different from the results of another research [7]. The study conducted by Florindo et al. [7] with a sample of 3,145 adults of Sao Paulo city, Brazil, showed that individuals who had access to two or more public open spaces (such as parks, squares, or bike paths) within a 500-meter radius of their homes had a significantly greater likelihood of engaging in any level of leisure-time walking (OR = 1.65; 95%CI 1.09 – 2.55) compared with individuals without access to these spaces near their homes. A cross-sectional study carried out in Hong Kong, China, between 2007 and 2008 reported similar results, showing that the presence of parks within a 400-meter radius of residences of older adults was associated with engagement in leisure-time walking (OR = 1.03 95%CI = 1.02-1.05) [33]. Probably our analyses suffered with the small sample size, which might not be sufficient to answer this question. This type of sample selection conducted in two phases (telephone and email) was very difficult, and the response rate was low. Another possible issue is the characteristics of Minhocão, which is an open street and not a traditional park. The Minhocão is open for people during the night and the weekend days. Questions about safety also are important, because the region where the elevated avenue is has a high index of criminality in thefts and robberies [34].

The present study had two several limitations. The first was that the online surveys were only completed by respondents who had a landline, an email address and internet access via computer, smartphone or tablet. With advances in technology, many telephone users rely on mobile phones and no longer have a landline. However, according to the National Telecommunications Agency, São Paulo State had 89.3% coverage of households with landlines in 2019 [35] and, according to Bernal et al. [36], the use of domestic landlines is recommended for carrying out epidemiological surveys in areas whose coverage exceeds 70%. The use of post-stratification wieghts by age and sex according to the Population Census helped decrease this limitation.

Another aspect to note was the low response rate and the self-selection bias. The sample selection procedure conducted in two phases (by telephone and by email) was very difficult. Individuals may have declined to answer the questionnaire because they had limited accessibility to the internet or familiarity with computers, smartphones, emails, and the internet, particularly among low socioeconomic level families and older people. In addition, it is unclear whether the high refusal rates reflect resistance to implementing the park among local residents or whether most respondents were in favor of creating the park. This sample size might have affected the power of our analysis examining the relationship between the proximity of residences to the nearest park entrance and LTPA. But the use of post-stratification weights in the analysis decreases the self-selection bias.

Despite these limitations, *we believe that the first results that showed that the users of Minhocão are more physically active in the* LTPA *than non-*users *are important to support this* open street *to* physical activity *promotion in Downtown in* São Paulo *city*. The results are relevant to help the gap about evaluation studies of open streets for physical activity promotion in low- and middle-income countries. For example, in Colombia, a free community program called "Ciclovía Recreativa" makes available 121 km of temporarily pedestrianized streets to the public for LTPA on pre-defined days and hours [16]. A cross-sectional study found that 59.5% of program users attained recommended levels of physical activity only in the leisure domain [38].

For finally, actions and programs coordinate by City Hall authorities that exploit the built environment creating open streets for people during the weekends, as it is done for Minhocão, are important population-level interventions with the potential to reach a large

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number of people, contributing to the World Health Organization Global Action Plan for physical activity promotion [39]. These efforts are important to continue with good results in public health like an increase of 7.8% in LTPA populations levels among adults residing in São Paulo between 2006 and 2016 [40]. Such initiatives are especially relevant amid the COVID-19 pandemic, where recent Brazilian epidemiological studies have revealed a decline in LTPA among adults [41].

5. Conclusion

This study showed that the users of Minhocão are more physically active in their leisure time than non-users. However, the proximity between people's residences and the nearest access to the elevated avenue was not statically associated with LTPA. We believe that these results can inform new discussions about the elevated avenue and inform the government and population during decision-making about the future of this open street.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Conflicts of Interest: All authors declare no conflict of interest.

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