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Effects of a new walking and cycling route on leisure-time physical activity of Brazilian adults: A longitudinal quasi-experiment

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ABSTRACT

The primary aim of this study was to evaluate the effects of a new walking and cycling route on leisure-time physical activity (PA) (walking and moderate-to-vigorous PA) of adults. Furthermore, we also investigated the use, intention to use and barriers to use the new route for leisure-time PA. A longitudinal quasi-experiment was carried out. Three exposure groups were defined, based on the distance from home to the new route: 0–500 m, 501–1000 m and 1001–1500 m. Telephone-based interviews were carried out in 2009 and 2012. Those living around the new walking and cycling route increased their leisure-time walking by 15 min/week on average. Those residing up to 500 m from the route increased leisure-time walking by 30 min/week and walking plus moderate-to-vigorous PA by 50 min/week. The proportion of people who started walking or practicing moderate-to-vigorous PA during leisure time and who reported intention to use the new route was higher among those living closer to it. Perceived distance was the most prevalent barrier to use the new route.

1. Introduction

Changes in the built environment have the potential to increase opportunities and remove barriers to upturn population physical activity (PA) levels, and may have an important role in achieving sustainable behavior change and public health impact (Hoehner et al., 2005; Beale et al., 2012; Cerin et al., 2014; Franco et al., 2015). However, understanding the effects of those changes on PA levels is still challenging.

Most evidence on the relationship between built environment and PA comes from observational studies (McCormack and Shiell, 2011; Mayne et al., 2015; Van Holle et al., 2012), which allow the assessment of correlations between environmental features and outcomes, but have limitations to investigate the long-term consequences of changes in built infrastructure on people's behavior. Natural experiments and longitudinal quasi-experiments can help to overcome some of those limitations, improving causal inference (Craig et al., 2012).

Natural experiments can be defined as “natural circumstances in which subsets of the population have different levels of exposure to a supposed causal factor in a situation resembling an actual experiment. […] The presence of persons in a particular group is typically non-random; yet for a natural experiment, it suffices that their presence is independent of (unrelated to) potential confounders” (Porta, 2008). However, in a real policy setting it is difficult to guarantee the latter condition, because the intervention, such as a new or refurbished facility, can be delivered where people advocate strongly for it or where there is a clear unmeet demand. These are still very interesting opportunities to

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obtain evidence, although it is more adequate to denominate these studies as longitudinal quasi-experiments instead of natural experiments.

Mayne et al. (2015) pointed out that most studies considered as natural experiments and longitudinal quasi-experiments on PA actually used less robust designs, such as case-only or repeated cross-sectional with comparison group studies. This can undermine the confidence of the results. For example, results from repeated cross-sectional studies may be positively biased by residential self-selection, and effect size estimates from case-only studies can be uncertain because they lack a counterfactual reference (Mayne et al., 2015). found just three studies that used a within-person longitudinal design with comparison group, which allows better causal inference, among the 17 studies on PA included in their review. Two of those studies were carried out in adults. One found positive (West and Shores, 2011) and the other null (MacDonald et al., 2010) influence of the built environment on PA.

Some natural experiments and longitudinal quasi-experiments suggested a positive influence of constructing or changing built environment features – such as walking and cycling routes, places for physically active recreation and increasing streets connectivity – on leisure-time and transport-related PA (Giles-Corti et al., 2013; Gustat et al., 2012; Parker et al., 2013; Goodman et al., 2014). Besides, people living nearer walking and cycling routes may experience higher increases in PA level in the long-term (Goodman et al., 2014; Goodman et al., 2013). However, results are not consistent and some studies did not find evidence of significant increase in population PA practice (West and Shores, 2011; Goodman et al., 2013; Evenson et al., 2005) or a stronger effect of living closer to the new infrastructure, at least in the short-term (around one year time) (West and Shores 2011; Goodman et al., 2014; West and Shores 2015). These inconsistencies reflect the large heterogeneity among studies. For example, Mayne et al. (2015) identified that most studies with positive effects had follow-up periods larger than six months. Null or mixed results were found in studies with small samples. In general, assessment was made via a combination of self-report and systematic observation methods. Most studies reported the amount of people engaging in PA in a new or refurbished facility, but only about half reported PA levels, and these studies had the most heterogeneous result. The type of intervention also varies, ranging from improving a greenspace area to building a new cycling lane.

Finally, barriers and reasons that prevent people from using the new PA infrastructures are still a poorly explored topic on previous studies. Cross-sectional epidemiological studies conducted in Brazil suggest that intrapersonal barriers, such as lack of time, feeling too tired and disliking exercising (Reichert et al., 2007; Silva et al., 2016), as well as aspects of the perceived environment, like distance to PA facilities and safety (Florindo et al., 2009; Florindo et al., 2011), may be important elements during the individual decision-making process towards using new PA infrastructures and, ultimately, to the reach and success of the intervention.

Therefore, our primary aim was to evaluate the effects of a new walking and cycling route in Florianópolis, Brazil, on leisure-time PA (walking and moderate-to-vigorous PA) of adults residing nearby the route, using within-person longitudinal design with comparison group. Secondly, we investigated the use and intention of using the route for leisure-time PA, as well as the main reasons for not using it.

2. Method

2.1. Overview

In July 2010, a new walking and cycling route (2.3 km long) was inaugurated in the continental coast of Florianópolis, SC, Brazil, in order to improve the infrastructure for transportation and leisure-time PA in that region. To test the impact of this new route on PA, a longitudinal quasi-experiment was carried out. Three exposure groups were defined, based on the distance from people's residence to the new route, and a sample of adults living in those regions were evaluated 12–16 months before and 20–29 months after the new route was available to the public.

2.2. Intervention and context

The project was entirely planned and executed by the public sector of Florianópolis, primarily to reduce and organize the traffic on a specific region of the continental coast, which is a predominantly middle-income and mixed-use (commercial and residential) area with heavy traffic. The project included a new avenue, parking lots, and an on-road walking and cycling route, all along the seashore. Fig. S1 (supplementary material) shows the area where the new facilities were built, called Beira-Mara Continental (2.3 km long). A new project exists to add 8.3 km to the Beira-Mar Continental and to connect it with the main road of the city (BR 101), but this is still being planned.

Despite the main goal being to facilitate commuting, the walking and cycling route is mostly used for leisure-related activities at the moment. One reason is the current lack of connection of the route with other walking trails and cycling lanes of the city, hindering its use for commuting. Secondly, the community of that region was in need of an adequate, safe and free place to practice leisure-time PA. Until then, the options were mostly the neighborhoods' streets and sidewalks (that were dangerous because of the heavy traffic), few plazas and schools, and paid clubs and gyms. The new walking and cycling route brought a pleasant and safe place to practice leisure-time PA, alongside the shore.

2.3. Sampling and data collection processes

Six neighborhoods (Jardim Atlântico, Estreito, Capoeiras, Canto, Coloninha and Balneário) were within 1500 m from the new route, the area defined for this study, encompassing around 55.7 thousand residents in 2009. Brazilian Institute of Geography and Statistics (2010) The required sample size was calculated using the following parameters: 75% of adults not practicing at least 150 min/week of leisure-time PA, confidence interval of 95% and 3.3 percentage points of sampling error. The required sample size (656) was increased by 10% to account for losses and refusals, and then by 15% to allow controlling for confounding factors in multivariable analysis. Therefore, the required sample size was 820.

Systematic sampling was used to select households, based on the list of landlines of all streets within the study area at baseline ($n=7630$). Telephones from companies, those that were out of service or with no response after 10 calls made in different days and hours were non-eligible. The first adult (aged ≥ 18 years) of each selected household who answered the telephone call was invited to participate in the study. Participants were excluded if they met any of the following criteria: non-permanent resident in the house, planning to move from the neighborhood in a one-year period, current pregnancy, and being unable to practice PA due to health issues.

Telephone-based interviews were carried out by one trained interviewer between March and July in 2009 (baseline), and between March and December in 2012 (follow-up). Each participant

chose the best day and hour to answer the interview, which lasted around 10 min.

2.4. Outcomes

Leisure-time PA was assessed by the leisure section of the long-version International Physical Activity Questionnaire. Craig et al. (2003) min of walking, moderate and vigorous PA in leisure time during the week before the interview were estimated separately by multiplying daily duration by weekly frequency. Weekly volumes (min/week) of walking, moderate-to-vigorous PA, and walking plus moderate-to-vigorous PA in leisure time were analyzed.

Pre- and post-intervention answers of those who did not practice leisure-time PA at baseline were compared to assess the amount of people who started walking or practicing moderate-to-vigorous PA in leisure time after the new walking and cycling route was built.

During the follow-up assessment we asked whether they were using the new walking and cycling route for leisure-time PA ("Do you usually use the Beira-Mar Continental for walking, cycling or for doing another physical activity during your leisure time?"). Those who were not using the new route were asked about their intentions to use it in the future ("Do you intend to use the Beira-Mar Continental to walking, cycling or doing another physical activity during your leisure time in the next six months?"). In both questions, answer options were "yes" or "no".

Among those who reported not using the new route for leisure-time PA, we asked about the main barrier that prevented them from using it. The answers were categorized as: distance, unsafety, lack of time, dislike exercising, health problems, prefer other places to practice, dislike the infrastructure, difficult access, lack of company and feeling too tired.

2.5. Exposure

The region within 1500 m from the new route was divided in three areas: 0–500 m, 501–1000 m and 1001–1500 m (Fig. 1), each one representing a different exposure level to the new walking and cycling route. Terrain delimitation was made by the Institute of Urban Planning of Florianópolis, using the MicroStation software (Bentley Systems Inc.).

By the time the study was being planned, there was no consensus or clear pattern on the literature about what distances to use as exposure levels, so the decision was made based on: (a) studies that indicated that living less than a 10-min walk from a physical activity facilities was associated with higher leisure-time physical activity practice (Powell et al., 2003; Humpel et al., 2002); (b) the researchers' interest in investigate the hypothesis of a dose-response-like effect; and (c) logistic and resources delimitations.

2.6. Co-variables

Demographic and health-related data from the baseline assessment were used to describe and compare groups and, when necessary, as covariates in multivariate analysis. Sex (male; female), age (18–34; 35–54; 55–85 years), educational level (middle school; high school; college or higher), marital status (single; married or cohabiting; widowed; divorced), skin color (white; black; brown), nutritional status (eutrophic; overweight; obese – defined by body mass index (World Health Organization Expert Committee, 1995), using self-reported height and weight) and self-reported health status (positive; negative) were collected by questionnaire.

2.7. Statistical analysis

Data were described using absolute and relative frequencies, mean and 95% confidence intervals (95% CI). We tested demographic and health-related heterogeneity among distance groups at baseline using Chi-square and Fisher's exact tests. We analyzed the final sample, including people assessed at baseline and follow-up, and all people initially enrolled into the study.

We also examined the baseline leisure-time PA, demographic and health-related characteristics of individuals who did not complete the follow-up survey by their distance group, using Chi-square, Fisher's exact and Kruskall–Wallis tests. In addition, we compared the individuals who did not complete the follow-up survey with the final sample, within each distance group, using Chi-square, Fisher's exact and Mann–Whitney *U* tests.

We used generalized estimating equations to evaluate the effect of the new walking and cycling route on leisure-time PA. We set the models with Gamma probability distribution (one min/week was added to avoid null values) to account for the distribution of the outcomes, identity link function, unstructured working correlation matrix to allow each variance and covariance be uniquely estimated, and the Huber–White sandwich estimator

Fig. 1. Map of the experiment region.

to account for possible heteroskedasticity when calculating standard errors. Ziegler and Vens (2014) Bonferroni method was used for *post hoc* multiple comparisons. For each outcome, we estimated the effects of being a member of a specific distance group, of the period of evaluation (baseline and follow-up), and the interaction of both to assess differences in time trends between distance groups (our main interest). We included baseline sex, age and educational level as covariates. Covariates were chosen among the demographic and health-related ones that were associated ($p \leq 0.20$) in bivariate analyses with the PA variables (outcomes) and the distance group (exposure) at baseline, either considering the final sample or all people initially enrolled into the study.

We carried out the models with both the final sample and all people initially enrolled into the study (sensitivity analysis). For the sensitivity analysis, we used the last observation carried forward strategy to impute missing data of leisure-time PA at follow-up.

We performed Chi-square and Fisher's exact tests for trend to investigate the association between distance to the new route and (a) starting walking or practicing moderate-to-vigorous PA in leisure time, and (b) use, intention to use and barriers to use the new route for leisure-time PA.

Analyses were executed in the IBM® SPSS® Statistics software, version 22. We adopted a significance level of 5%.

2.8. Ethical issues

In the first telephone call, the interviewer explained the study, its aims, duration and protocols. If the person agreed to participate (recorded, oral consent), the interview was scheduled. The study was approved by the Federal University of Santa Catarina Research Ethics Committee, number 327/08.

3. Results

Seven hundred forty-five people were assessed at baseline, corresponding to a response rate of 91%, and to 10% of the eligible people living in the neighborhoods. Five hundred nineteen people (70% of the baseline) were reassessed at follow-up. Table 1 and S1 (Supplementary material) present baseline demographic and health-related characteristics by distance group. Distribution of age and educational level were different among distance groups.

The proportion of individuals who did not complete the follow-up survey was similar among distance groups, varying from 28% to 33%. Baseline leisure-time PA, demographic and health-related characteristics among those who did not complete the follow-up survey were similar among distance groups (Tables S2 and S3, Supplementary material). Individuals who did not complete the follow-up survey were younger ($p < 0.001$) and had lower educational level ($p = 0.05$) than the final sample, but there was no evidence of difference on leisure-time PA (p-value ranging from 0.24 to 0.85).

Fig. 2 presents the adjusted mean min/week of walking, moderate-to-vigorous PA and walking plus moderate-to-vigorous PA in leisure time for each distance group, at baseline and follow-up, for the final sample. In all cases, there was no evidence of difference among groups at baseline (p-value ranging from 0.18 to 1.00).

Leisure-time walking increased by 32 min/week (95% IC: 15–51) among residents living up to 500 m from the new walking and cycling route, while remained stable in the other two distance groups (Fig. 2a). In addition, there was a general increase of 14 min/week (95% IC: 3–24) and a higher weekly volume of walking at follow-up among residents up to 500 m from the new route compared to those living 501–1000 m away ($\delta = 31$ min/week, 95% IC: 11–51).

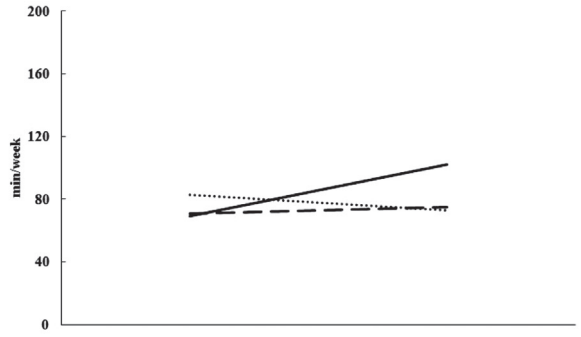
No change in moderate-to-vigorous leisure-time PA was

Table 1
Baseline demographic and health characteristics of the final sample. Florianópolis, SC, Brazil, 2009.

Characteristics	Total ($n=519$)		Distance to new route (meters)						
			0–500 ($n=192$)		501–1000 ($n=137$)		1001–1500 ($n=190$)		
	n	%	*n*	%	*n*	%	*n*	%	*p*
Sex									
Male	217	42	87	45	63	46	67	35	0.07
Female	302	58	105	55	74	54	123	65	
Age (years)									
18–34	99	19	31	16	28	20	40	21	0.31
35–54	205	40	79	41	46	34	80	42	
55–85	215	41	82	43	63	46	70	37	
Educational level									
Middle school	88	17	21	11	20	15	47	25	0.009
High school	176	34	68	36	49	35	59	31	
College or higher	254	49	102	53	68	50	84	44	
Marital status									
Single	112	21	43	22	27	20	42	22	0.36
Married or cohabiting	312	60	106	55	91	66	115	60	
Widowed	50	10	25	14	10	7	15	8	
Divorced	45	9	18	9	9	7	18	10	
Skin color									
White	397	77	154	80	105	77	138	73	0.48
Black	22	4	6	3	7	5	9	5	
Brown	100	19	32	17	25	18	43	22	
Nutritional status									
Eutrophic	263	52	97	52	72	53	94	50	0.90
Overweight	180	35	65	35	49	36	66	35	
Obese	67	13	24	13	15	11	28	15	
Self-reported health status									
Positive	401	77	154	80	101	74	146	77	0.38
Negative	118	23	38	20	36	26	44	23	

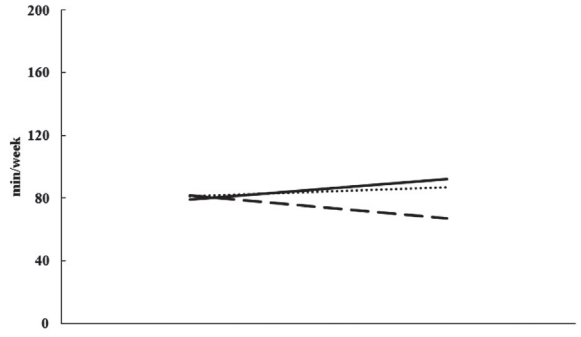
p-Values from Chi-square test.

a



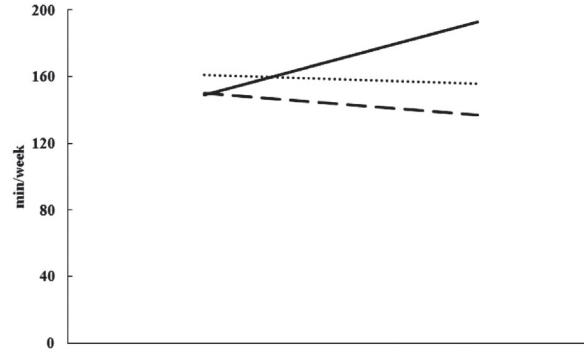
Distance (m)		Baseline		Follow-up			
		$\bar{x}$	95% CI	$\bar{x}$	95% CI	p	
0 – 500	——	57	48 – 67	89	72 – 106	*Group*	0.14
501 – 100	.....	65	48 – 82	58	49 – 67	*Time*	0.01
1001 – 1500	– –	63	47 – 80	79	57 – 103	*Group x Time*	0.004

b



Distance (m)		Baseline		Follow-up			
		$\bar{x}$	95% CI	$\bar{x}$	95% CI	p	
0 – 500	——	65	49 – 81	82	64 – 101	*Group*	0.91
501 – 100	.....	80	53 – 108	77	55 – 98	*Time*	0.88
1001 – 1500	– –	82	60 – 104	65	47 – 83	*Group x Time*	0.07

c



Distance (m)		Baseline		Follow-up			
		$\bar{x}$	95% CI	$\bar{x}$	95% CI	p	
0 – 500	——	107	90 – 124	158	130 – 187	*Group*	0.80
501 – 100	.....	149	105 – 193	128	99 – 156	*Time*	0.27
1001 – 1500	– –	140	107 – 173	146	114 – 117	*Group x Time*	0.02

Fig. 2. Estimated adjusted mean min/week of walking (a), moderate-to-vigorous PA (b), and walking + moderate-to-vigorous PA (c) in leisure time during the previous week, according to distance to the walking and cycling route. Analysis adjusted by sex, age and educational level. Florianópolis, SC, Brazil, 2009–2012. 95% CI = 95% confidence interval.

observed (Fig. 2b).

Walking plus moderate-to-vigorous PA in leisure time increased by 51 min/week (95% IC: 21–81) among people residing up to 500 m from the new route, but no significant changes were observed in the other distance groups (Fig. 2c).

Sensitivity analysis using all people initially enrolled into the study showed similar results (Fig. S2, Supplementary material).

The proportion of people who started walking or practicing moderate-to-vigorous PA in leisure time after the implementation of the new walking and cycling route was negatively associated with the distance to it (Fig. 3, *p*-values ranging from 0.02 to 0.03). Sensitivity analysis showed similar patterns (Fig. S3, Supplementary material).

Forty-six percent of those who answered the follow-up

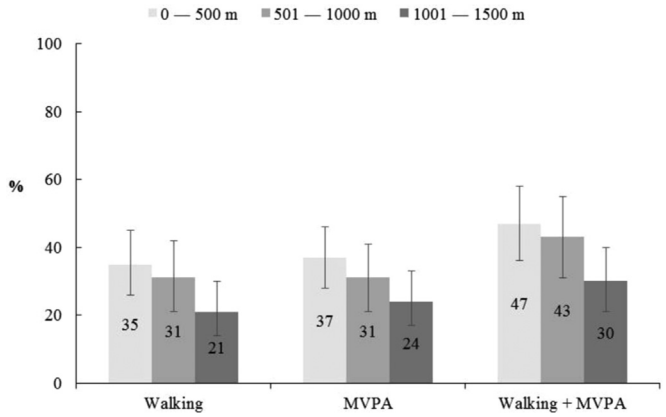


Fig. 3. Percentage of people who reported starting walking, practicing moderate-to-vigorous physical activity (MVPA), and walking + MVPA in leisure time after the new walking and cycling route, according to distance to it. Florianópolis, SC, Brazil, 2009–2012.

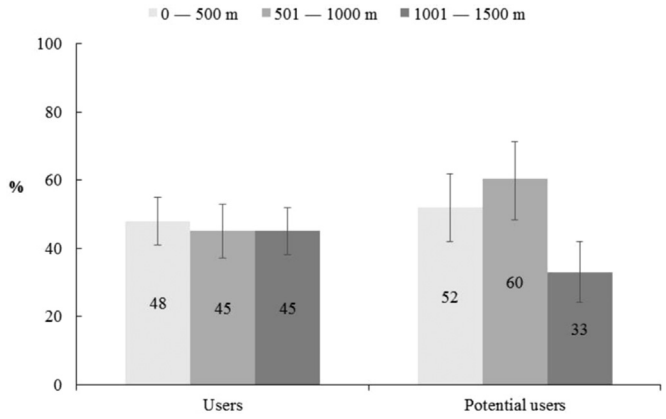


Fig. 4. Percentage of people who reported using or intending to use (among those who did not use) the new walking and cycling route for leisure-time physical activity, according to distance to it. Florianópolis, SC, Brazil, 2012.

assessment reported using the new route for leisure-time PA. There was no evidence of trend across distance groups ($p=0.50$). Among those who did not use it ($n=280$, 54%), more residents in the 0–500 m and 501–1000 m regions reported intention to use it compared to the 1001–1500 m region ($p=0.006$, Fig. 4).

One hundred eighty people (64% of the 280 non-users) reported the main barrier for using the new route for leisure-time PA. The most frequently reported barriers were distance (49%, 95% IC: 42–58), unsafety (14%, 95% IC: 9–19) and lack of time (10%, 95% IC: 6–14) (Fig. 5).

Perceived barriers did not vary significantly across distance groups (p-values ranging from 0.08 to 0.57). However, reports of distance as a barrier seem to increase with the distance to the route: 0–500 m: 42%; 501–1000 m: 48%; 1001–1500 m: 57% ($p=0.08$).

4. Discussion

Our study found that, after 2.5 years, adults living around a new walking and cycling route in Florianópolis increased their leisure-time walking by approximately 15 min/week, especially those residing up to 500 m from the route (around 30 min/week). In this group, walking plus moderate-to-vigorous PA in leisure time increased by 50 min/week on average. In addition, after implementing the new walking and cycling route, the percentage of people who started walking or practicing moderate-to-vigorous PA

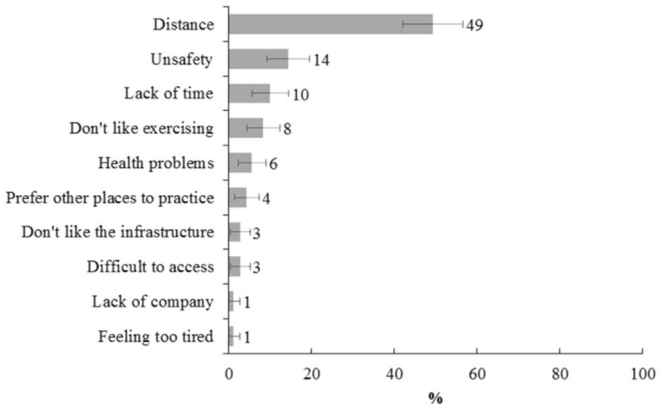


Fig. 5. Reported barriers for not using the new walking and cycling route for leisure-time physical activity. Florianópolis, SC, Brazil, 2012.

in leisure time was negatively associated with the distance to the route. Moreover, the number of people reporting intention to use the new infrastructure for leisure-time PA is higher among those living up to 1000 m from it, compared with those in the 1001–1500 m region. This result is consistent with the most prevalent barrier to use the new route: distance, reported by almost 50% of the sample.

Weekly volume of leisure-time PA increased among people living nearer the new route, but remained stable in the other groups over the 2-year study period. Surprisingly, information about the effect of objective distance on leisure-time PA is scarce on natural experiments and longitudinal quasi-experiments, especially among those using a within-person longitudinal design with comparison group. Goodman et al. (2014) observed the same pattern, where those living closer (< 1 km) to a new walking and cycling infrastructure increased their total PA, although they reported smaller effects (12.5 min/week average increase on total PA per km nearer). Interestingly, living nearer the route did not predict increases in total PA at 1-year follow-up, just after two years. On the other hand (West and Shores, 2011, 2015), did not find an association between living closer to a new greenway and increases on leisure-time PA after one year, comparing those living half mile, one mile and two to three miles from the new setting.

Our study seems to indicate that although implementing new appropriate places for walking and cycling can potentially increase community-level leisure-time PA, the effects may be importantly limited by spatial distribution. However, this result may not cover other relevant changes on PA behavior. For example, it is important to note that the percentage of people using the new route for leisure-time PA was similar among the three groups (around 45%), indicating a higher reach and benefit of the new route in the community, beyond the changes in leisure-time PA level, increasing the access to a new and free infrastructure to a greater number of people. This is an important outcome even considering that the volume of use may not be equally distributed across the different distances, being higher closer to the route.

Community-based interventions that implement new walking and cycling routes can be an important strategy to increase PA access *and* level. Before the new route, leisure-time walking was possible just on the neighborhoods' sidewalks, crossing busy streets and avenues, and bicycles should compete for space with cars, buses and motorcycles. The new route brought to the community an attractive place to practice PA, near the shore and with appropriate infrastructure for walking and cycling safely at day and night. Those benefits are strongly aligned with a broad perspective of PA promotion and reached people in the three groups equally, and might be part of the reason for the stronger effects observed in this study than in past ones.

Moreover, other environmental aspects might play an important role in the perception of access. The two most frequently reported barriers for using the new route for leisure-time PA were distance (49%) and unsafety (14%). This means that changes in the environment around the route and inside the neighborhoods may also be needed to increase its reach and impact, such as better streets network, safer and more connected sidewalks, more bike lanes, better lighting and increased safety.

On the other hand, distance cannot be disregarded. Among those who did not use the new route, less people living farther than 1000 m reported intention to use it, and distance was the most prevalent reported barrier (almost 50%). Accessibility and proximity to peoples' residencies are two well-known aspects related to use of open spaces for leisure-time PA and important elements for the success and reach of those structures within the communities (Gustat et al., 2012; Goodman et al., 2014; Fitzhugh et al., 2010; Zoellner et al., 2012). Our study suggests that distance as a perceived barrier to use the route for leisure-time PA may decrease with the actual distance, although the results were not statistically significant. However, perceived distance was a barrier even among those living closer to the route (42%). Perceived distance may have stronger effects among those living farther (*e.g.*, ≥ 3 km) (Goodman et al., 2013) or closer (≤ 200 m) (Krizek and Johnson, 2006) to PA facilities, but in general it seems that people living closer to PA facilities have higher probability of practicing PA and of perceiving distance as a barrier.

This study addressed some critical aspects pointed out by Mayne et al. (2015) about the quality of natural experiments and longitudinal quasi-experiments on PA. It used a more robust study design (*i.e.*, within-person longitudinal with comparison group), which allows better causal inference. Random sampling within each group was possible and all groups were comparable at baseline, before the construction of the new route. Nevertheless, PA was self-reported, which is less reliable than movement sensors, but questionnaires were still the best way to collect data by PA domain at that period. Attrition rate was around 30%, but similar in all groups and PA was not different between individuals who did and did not complete the follow-up survey. There was no control group unexposed to the new route, although we had three distance groups representing different exposure levels. Users of the route may also perceive barriers to more frequent use, but only non-users were asked about barriers. Finally, it is possible that the route was constructed in an area where residents were most likely to use it, which might overstate the effects.

In conclusion, the new cycling and walking route facilitated the access to an adequate place for leisure-time PA even among people living farther from it, especially because no other public available places for waking and cycling existed previously in that region. Nevertheless, as the volume of use is higher among people living closer to the route and perceived distance – the most important barrier – seems to increase with the actual distance, just constructing the route does not seem enough to increase leisure-time PA volume in the community level. To achieve this goal, changes in the built and social environment around the route may be needed, especially in order to reduce the perceived distance and improve safety (second most cited barrier). It seems that initiatives to build or improve walking and cycling routes cannot be restricted to the route itself and need to include a broader understanding of what drives people's behavior in that community. Future initiatives and experiments could test this hypothesis evaluating the reach and impact of changes on the environment around new infrastructures. Moreover, a more comprehensive evaluation, including economic and social impact assessments, is still needed in order to better understand the effects of new walking and cycling routes on communities.

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Appendix A. Supplementary material

Supplementary data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.healthplace.2016.02.005.

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