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ACTIVE MOBILITY AS AN INSTRUMENT TO REDUCE INACTIVE OR INSUFFICIENTLY ACTIVE LIFESTYLE IN URBAN CENTERS: THE CASE OF BELO HORIZONTE

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RESUMEN

En la mayoría de las ciudades, un estilo de vida sedentario, representado en este trabajo por un estilo de vida inactivo o insuficientemente activo, significa una de las principales condiciones asociadas a las enfermedades crónicas no transmisibles. Las inversiones en modos de transporte no motorizados, como caminar, pueden ser una forma de ayudar a cambiar este comportamiento en la vida diaria de las personas. Este trabajo identifica factores ambientales urbanos que podrían estimular el transporte activo como una alternativa para reducir el estilo de vida inactivo o insuficientemente activo entre los usuarios de automóviles, analizando Belo Horizonte, Brasil. Los datos se obtuvieron de una encuesta basada en la web. Los resultados indican que los motivos de trabajo y estudio de los desplazamientos diarios influyen en la asociación entre género y nivel de actividad física. Además, la seguridad pública, el acoso, la forestación, el ancho de las aceras y la topografía son los principales factores ambientales urbanos que contribuyen al uso del automóvil. La creación de un entorno urbano al que se enfrentan las personas asociadas a campañas que valoran caminar para desplazarse y promover el entorno urbano de los peatones asociado a beneficios para la salud puede fomentar un cambio de comportamiento en los usuarios de automóviles.

Palabras clave movilidad urbana, movilidad activa, salud pública.

ABSTRACT

In most cities, a sedentary lifestyle, in this paper represented by an inactive or insufficiently active lifestyle, means one of the main conditions associated with chronic non-communicable diseases. Investments in non-motorised transport modes, such as walking, can be a way to help to change this behaviour in people's daily lives. This paper identifies urban environmental factors that could stimulate active transportation as an alternative to reduce the inactive or insufficiently active lifestyle among car users, analysing the Belo Horizonte, Brazil. The data was obtained from a web-based survey. The results indicate the work and study reasons for daily displacements have influence in the association among gender and physical activity level. Also, public safety, harassment, afforestation, sidewalks' width, and topography are the main urban environmental factors which contribute to the car use. The creation of an urban environment facing people associated to campaigns valuing walking to commute and promote pedestrians' urban environment associates with health benefits can encourage a change in behaviour for car users.

Keywords *urban mobility, active mobility, public health.*

1. INTRODUCTION

Urban mobility is related to people and cargo's displacements in urban areas (IPEA, 2012). The importance of urban mobility has been increasing due to the expansion of the urban population in most cities worldwide.

A consequence of urban growth was individual motorised transportation modes since the 20th century, especially in Brazil. The urban development contributed to urban mobility problems, such as traffic congestion and the dispute over the use of the streets' available space between the various modes of transport (Boareto, 2008). The car allowed cities to expand, provide more job opportunities for residents and the possibility of weekend recreation in the countryside; in contrast contributed to urban sprawl, traffic congestion, air pollution, and led to the dehumanisation of urban centres (Kleinert and Horton, 2016). Also, motorised transport's convenience reduced the physical dependence for longer or steeper paths, contributing to increasing the sedentary behaviour by favouring door-to-door displacements using motorised modes for less than 5 km distances (González-Gross et al., 2013).

On a world scale, increasing sedentary behaviour could be a consequence of the excessive use of private motorised transportation. However, physical inactivity is a global pandemic, responsible for more than 5 million deaths by year, being one of the main targets for reducing chronic non-communicable diseases (CNCD) by the United Nations (Sallis et al., 2016).

This paper identifies urban environmental factors that could stimulate active transportation as an alternative to reduce the inactive or insufficiently active lifestyle among car users, in an analysis for Belo Horizonte, Brazil. We have the following hypothesis: (i) gender influence the physical activity levels, (ii) reasons of displacement influence the physical activity levels, (iii) car users have an inactive or insufficiently active lifestyle; (iv) some urban environmental factors influence the physical activity levels.

This paper has five sections to present the results of our paper's goal: After this brief introduction, section 2 exposes the inactive or insufficiently active lifestyle and active transportation mode. Section 3 introduces the research method, and the results are presented in section 4. Section 5 concludes this paper.

2. AN INACTIVE OR INSUFFICIENTLY ACTIVE LIFESTYLE AND NON-MOTORISED TRANSPORTATION MODE

A person has an inactive or insufficiently active lifestyle when he/she does not practice any physical activity or performing less than 150 minutes of exercise per week at moderate intensity or less than 75 minutes per week of vigorous-intensity activity (WHO, 2017). Alternatively, 100 minutes of urban cycling per week or 170 minutes of weekly walking are necessary to reach an active physical lifestyle (WHO, 2017). According to the Brazilian Ministry of Health (2016), 49% of the Brazilian population are insufficiently active, and 15% has an inactive lifestyle. Hallal et al. (2012) state that more than 30% of adults are considered inactive globally. Inactive or insufficiently active lifestyle accounts for 21% of malignant tumour cases in the breast and colon, 27% of diabetes registries and 30% of heart disease complaints (WHO, 2018).

Physical activity is the most variable component of daily energy expenditure. It accounts for between 20% and 30% of daily energy expenditure for most adult sedentary individuals. This percentage can increase up to 40% on active individuals, considering the more significant daily caloric expenditure in people who exercise regularly (Negrão, 2010). The benefits of physical activity can be achieved by exercising at low, moderate or high intensity. However, physical activities to obtaining and maintaining health and improving physical conditioning require at least 30 minutes of moderate-intensity exercises, five days by week. The International Association for the Study of Obesity recommends 60 to 90 minutes per day of moderate physical activity or 35 minutes of vigorous physical exercise per day to prevent weight gain or induce weight loss in obese people.

Active urban mobility can be a great option to increase daily caloric expenditure and promote positive changes in the population's health indicators, such as lower incidences of chronic non-communicable diseases (CDNT), like obesity and cardiovascular diseases.

Using a linear dose-response function between physical activity and all-cause mortality, Andersen et al. (2000) found about 22% of risk reduction in those averaging 29 minutes of daily walking and a 28% reduction in mortality among those who spent 3 hours per week on active bicycle transport. Other studies have also evaluated the relation of active urban mobility in health-related aspects in a non-linear way, considering the basal levels of physical conditioning of the population studied (Rabl et al., 2012; Dhondt et al., 2013; Woodcock et al., 2013). The shift from a motorised transportation mode to an active one reduced all-cause mortality, cardiovascular disease, type 2 diabetes, weight gain, cancer, falls or mental health problems.

The active transportation mode is a way of non-motorised displacement using human propulsion for locomotion. Walking and cycling, the most common active means of transportation in Brazil, offers a promising way of reversing the inactivity levels of the population in a more tolerable way than other forms of physical activity, causing a positive impact on the health of the population (Reynolds et al., 2010). According to Reynolds et al. (2010), the benefits of active transportation to society are reducing air pollution, costs with health care, traffic noise and congestion, the incentive to urban design more connected and accessible, and the user's benefit through an economic cost-benefit analysis. The encouraging active urban transport associated with public transportation represents a promising strategy for urban traffic and environmental pollution and provides substantial health benefits (Hartog et al., 2010).

Due to the Brazilian population's predominantly inactive or insufficiently active behaviour, active transport can improve its health indicators to compensate and/or complement at least 2.5 hours (150 minutes) of moderate-intensity exercise per week. Also, active transportation is a good option for regular and repetitive physical activity for those who do not have enough time to exercise. The rugged relief in some Brazilian cities, such as Belo Horizonte, can be favour physical conditioning, with a more pronounced improvement in cardiovascular and metabolic health indicators, considering that the energy expenditure is higher in mountainous regions.

Therefore, it is essential to recognise the lack of active modes daily as urban planning and a public health problem. Sallis et al. (2016) state that the design of urban environments can contribute about

90 minutes by a week of physical activity, representing 60% of the 150 minutes by a week recommended in the physical activity guidelines. Still, considering the study carried out in 14 different countries identified the positive effects of the active transport modes daily, indicating that its incentive should be a public health priority, representing a socially and economically viable solution.

3. RESEARCH APPROACH

We designed a questionnaire to obtain data for this paper. Table 1 shows the structure of the questionnaire. Data were obtained from a web-based survey. We estimated the response time of the web-based survey in approximately 20 minutes. The questionnaire was shared by WhatsApp application, email and social networks. The target respondents live in Belo Horizonte, over 18 years old, and daily use the car. We performed the survey in March/2018.

The sample of respondents was based on Triola (2008). We considered 99% of the confidence level and 5% of the error margin. As population proportion is not known for this study's situation, Triola (2008) suggests assigning the value of 0.50 for each variable ($\hat{p}$ and $\hat{q}$). Thus, the minimum sample should be at least 664 responses to reach the 99% confidence coefficient with an estimated error of 5%. We obtained 900 valid answers.

The body mass index (BMI) was calculated based on weight and height for overweight and obesity diagnosis, being an indirect health status indicator. Table 2 shows the obesity classification, degree of obesity, and risk of disease from the BMI.

Firstly, we analysed the data using descriptive statistics to identify the respondent's socioeconomic and health profile.

We used three statistical methods to address our research hypothesis: Analysis of variance, Bonferroni test, and chi-squared test. The chi-squared test was used to identify relation among BMI, physical activity levels, gender, and reason of displacement, and urban environmental factors, gender, physical activity levels, and reason of displacements. The null hypothesis indicates the independence among the variables (p-value > 0.1), while the alternative hypothesis suggests a relationship among the variables (p-value < 0.1). This test verifies the following research assumptions (i) gender influence the physical activity levels, (ii) reasons of displacement influence the physical activity levels, and (iv) some urban environmental factors influence the physical activity levels.

Also, we used the analysis of variance (ANOVA) test for the hypothesis (iii), *car users have an inactive or insufficiently active lifestyle.* We considered the physical activity levels as the independent groups, testing whether there is a statistically significant difference in the BMI' average among the physical activity levels. The null hypothesis (H_0) of ANOVA is all means are equal. We rejected the H_0 if p-value < 0.05, indicating that the BMI' average is not similar among the physical activity levels. Further, we used the Bonferroni test to test a significant difference between the two levels of physical activity if the p-value of the ANOVA test has statistically significant. The use of the Bonferroni test avoids Type-I error (a false-positive result), considering a confidence level $\alpha = 0.1$. The results of these analyses are presented in the next section.

Table 1 Structure of the questionnaire

Group	Variable	Class of variables
Socioeconomic data	Gender	• Woman • Man
	Age	• 18-24 years • 25-34 years • 35-44 years • 45-54 years • 55-64 years • Over 65 years
	Weight (kg)	Inform your weight
	Height (cm)	Inform your hight
	Neighbourhood of residence	Identify the neighbourhood
	Reason for the main daily displacement	• Work • School • Shopping • Leisure • Others
Health information	Smoke regularly	• Yes • No
	Chronic disease	• Yes • No
	Good health	• Yes • No
	Physical activities level	• Inactive • Insufficiently active • Physically active
Factors of the urban environment that influence the walk	Street lighting	• No influence • Influence
	Changing rooms	
	Vehicles' speed	
	Traffic safety related to accidents	
	Vehicle's noise	
	Public safety related to burglaries	
	Harassment	
	Afforestation	
	Sidewalks' width	
	Sidewalks' condition	
	Topography related to slope	

Table 2 Body Mass Index and Disease Risk (WHO, 2016)

BMI (KG/M²)	Obesity classification	Degree of obesity	Risk of disease
<18,5	Low weight	0	Normal or high
18,5-24,9	Average	0	Normal
25-29,9	Overweight or pre-obese	0	Not very high
30-34,9	Obesity	I	High
34,9-39,9	Obesity	II	Very high
≥40,0	Severe obesity	III	Very high

4. RESULTS

The survey was answered by 900 residents of Belo Horizonte, distributed throughout several city neighbourhoods, as shown in Figure 1.

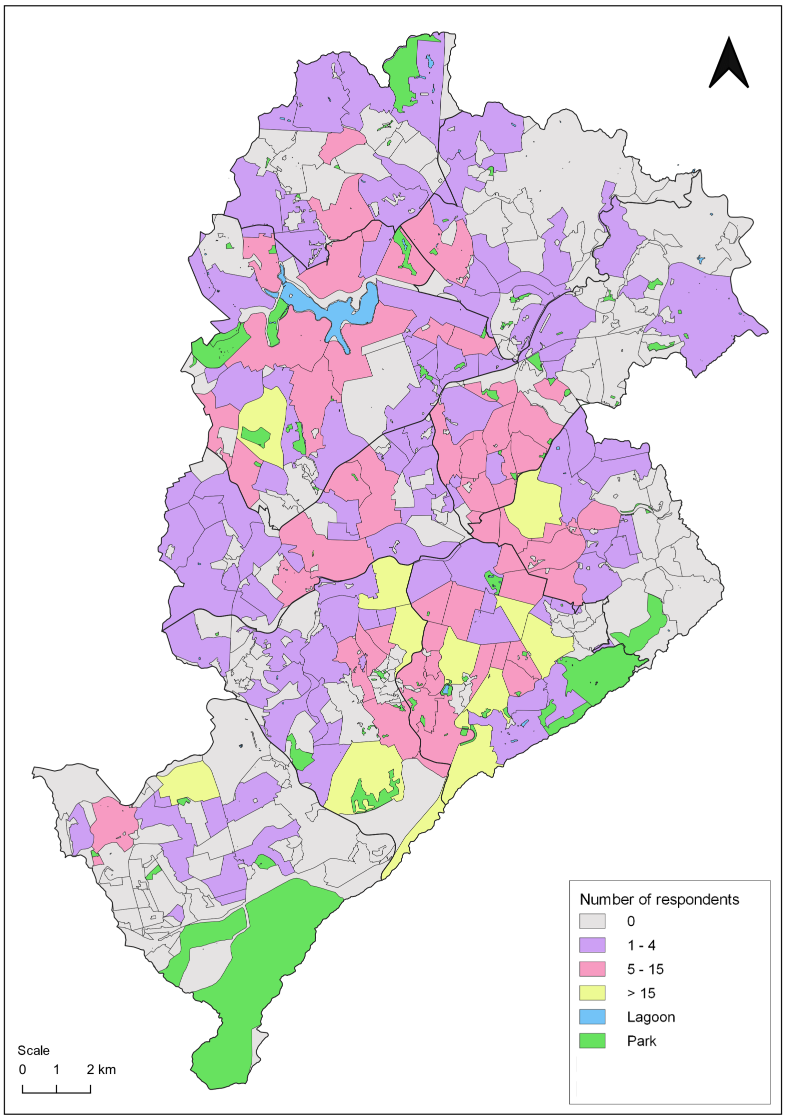

Figure 1 Division of responses by neighbourhood in the city of Belo Horizonte

Table 3 shows a summary of the respondents' profile by gender. The sample is composed mostly of women (61%). The respondents' average family income was considered high concerning Belo Horizonte's population, which was already expected, considering that the target population was exclusively people who use the private vehicle in the daily main displacement. Still, we observed that 78% of the respondents have their work as the main reason for the daily displacements.

Table 3 General profile of the participants

Variable	Female		Male		Total	
Age						
18 to 24	37	9,6%	21	8,5%	58	9,2%
25 to 34	96	25,0%	84	33,9%	180	28,5%
45 to 54	127	33,1%	69	27,8%	196	31,0%
55 to 64	106	27,6%	55	22,2%	161	25,5%
65 or more	18	4,7%	19	7,7%	37	5,9%
Income (Minimum Wage)[1]						
1 to 2	8	1,5%	7	2,0%	15	1,7%
2 to 4	206	37,4%	132	38,2%	338	37,7%
4 to 10	54	9,8%	37	10,7%	91	10,1%
10 to 20	189	34,3%	100	28,9%	289	32,2%
Over 20	94	17,1%	70	20,2%	164	18,3%
Reason for the main daily displacement						
Study	56	10,1%	22	6,3%	78	8,7%
Work	403	73,0%	299	85,9%	702	78,0%
Shopping	47	8,5%	9	2,6%	56	6,2%
Recreation	22	4,0%	11	3,2%	33	3,7%
Other	24	4,3%	7	2,0%	31	3,4%

[1] A minimum wage was BRL 954 ≈ US$ 175.69, on February 18, 2021.

Table 4 presents the health profile of the respondents, of which most of the respondents are no smoker, 25% have some chronic illness, 49% of them have overweight or obesity concerning the WHO criteria (BMI) (most of them are male), and 90% declared to have good health.

Table 5 shows the physical activities level according to the respondents, of which 45% are considered physically active (most of them are male), and 26% are considered inactive (most of them are female).

According to Brazil (2016), 36% of Belo Horizonte people were considered physically active. Considering the 3-year time difference between the official data and the sample, we could infer that the population's awareness of physical exercises' benefits may contribute to physical activities' regular practice. However, a larger sample is needed to prove this conclusion.

Table 4 Participants' Health Profile

Variable	Female		Male		Total	
Regular smoker						
Yes	44	8%	35	10%	79	9%
No	508	92%	313	90%	821	91%
Chronic disease						
Yes	143	26%	82	24%	225	25%
No	409	74%	266	76%	675	75%
Body Mass Index						
Underweight	14	3%	3	1%	17	2%
Regular weight	312	57%	128	37%	440	49%
Overweight	158	29%	144	41%	302	34%
Obesity I	42	8%	58	17%	100	11%
Obesity II	25	5%	13	4%	38	4%
Obesity III	1	0%	2	7%	3	0%
Good health						
Yes	501	91%	308	89%	809	90%
No	51	9%	40	11%	91	10%

Table 5 Physical activities level by gender

Level	Female		Male		Total	
Inactive	165	30%	71	20%	236	26%
Insufficiently active	158	29%	103	30%	261	29%
Physically active	229	41%	174	50%	403	44%

4.1 Relation among BMI, physical activity levels, gender, and reason of displacement

We used chi-squared test to identify relationship among BMI, physical activity levels, gender, and reason of displacement (Table 6). The gender did not influence the association among physical activity level e reason for displacement, physical activity level and BMI, and BMI versus reasons for displacement. However, the work and study reasons for daily displacements have influence in the association among gender and physical activity level. The conclusion of this analysis is other factors have more influence in the physical activity level and BMI, than to be car users.

Table 7 shows that the descriptive statistics of body mass index (BMI) among the physical activity levels are similar (see the minimum, maximum, average and standard deviation values). Comparing the BMI' average with the physical activity levels, the analysis of variance (ANOVA) results has a p-value < 0.05, rejecting the null hypothesis. Therefore, BMI is not equal among the inactive or insufficiently active and physically active levels declared by car users, despite the descriptive statistical similarity.

Table 6 Relationship among BMI, physical activity levels, gender, and reason of displacement

Association between variables	Chi-squared test (p-value)
Physical activity level versus Gender	10.855 (0.004)
Physical activity level versus Reason for displacement	16.381 (0.04)
Physical activity level versus Reason for displacement for men car users	8.147 (0.419)
Physical activity level versus Reason for displacement for women car users	7.251 (0.123)
Physical activity level versus BMI	1,302 (0.03)
Physical activity level versus BMI for men car users	572.1 (0.179)
Physical activity level versus BMI for women car users	368.14 (0.231)
Gender and inactive or insufficiently active lifestyle	4.388 (0.036)
Gender and Physical activity level for work and study reasons	10.606 (0.005)
BMI versus reason for displacement	2,480.3 (0.193)
BMI versus reason for displacement for men car users	1,029.3 (0.879)
BMI versus reason for displacement for women car users	1421.2 (0.313)

Table 7 Relation between BMI and physical activity levels

Levels	Minimum BMI	Average BMI	Maximum MBI	Standard Deviation of BMI
Inactive	17.32	26.88	41.52	5.36
Insufficiently active	16.02	25.88	39.39	4.53
Physically active	15.23	24.81	38.10	3.53
All respondents	15.23	25.67	41.52	4.45
ANOVA Test F test = 17.19 p-value = 4.71E-08 Degree of freedom = 2				

The Bonferroni test was performed to compare the statistical difference among the physical activity levels, considering the BMI's average. All comparisons resulted in a p-value < 0.05 (Table 8). Therefore, we concluded that car users did not differ in their physical activity levels, considering the average BMI.

Table 8 Confirmation of ANOVA test result

Pairwise comparison between physical activity level	Bonferroni Test p-value
Inactive versus Insufficiently active	0.003
Inactive versus Physically active	0.000
Insufficiently active versus Physically active	0.044

4.2 Relation of urban environmental factors, gender, physical activity levels, and reason of displacements

Figure 2 presents the factors that affect walking as a daily displacement by car users. The factors with influence on walking are *public safety (burglaries)* (70%) and *street lighting* (66%). In another way, *vehicle's noise* (83%), *harassment* (81%), and *changing rooms in the buildings* (79%) are factors with no influence on walking.

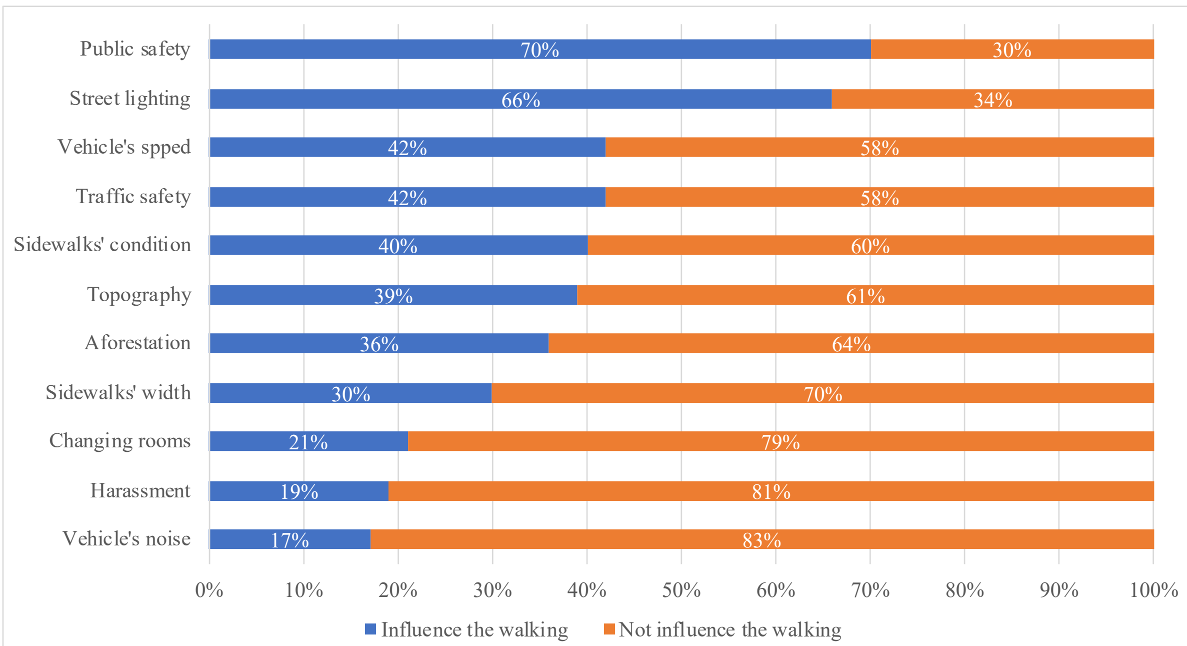

Figure 2 Percentage of urban environmental factors that influence the choice of walking

Figure 3 shows the influence of the urban environmental considering the physical activity levels. With rare exceptions, the factors are similar, regardless of the interviewees' level of physical activity.

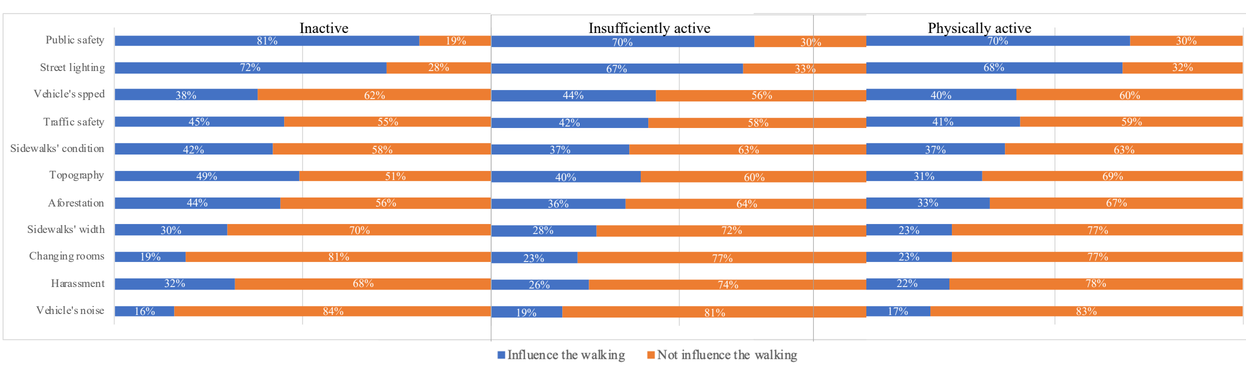

Figure 3 Percentage of urban environmental factors that influence the walking considering the physical activity levels

We performed a chi-squared test to evaluate the dependence between urban environmental factors and physical activity levels, presented in Table 8. Results highlighted in bold indicated the variables associated. Results indicate that the public safety, harassment, afforestation, sidewalks' width, and topography factors have a relationship with all physical activity levels, meaning that the car users did not walk daily displacements due to these urban environmental factors. Thus, walking as a transportation mode in daily displacements has some challenges to attract car users. Some factors (e.g., sidewalks' width and afforestation) require creating an urban environment facing people. Other (e.g., public safety and harassment) require supervision to create a safe urban environment. Finally, Belo Horizonte is a city with rugged topography. In some neighbourhoods, this factor does not make walking attractive, which proven the dependence between the use of the car and the physical activity lifestyle.

Table 8 Chi-squared test between urban environmental factors, gender, physical activity levels, and reason of displacements

Urban environmental factors	All levels (p-value)	Men physical activity levels (p-value)	Women physical activity levels (p-value)	Inactive or insufficient active (p-value)	Work or study displacements (p-value)
Street lighting	0.962 (0.618)	1.0678 (0.586)	0.662 (0.718)	0.407 (0.524)	0.218 (0.640)
Changing rooms	1.390 (0.500)	0.9892 (0.610)	0.513 (0.774)	0.707 (0.400)	2.056 (0.152)
Vehicle's speed	1.188 (0.552)	0.3499 (0.840)	1.982 (0.371)	0.900 (0.343)	2.928 (0.087)
Traffic safety	1.970 (0.373)	1.5607 (0.458)	0.309 (0.857)	1.043 (0.307)	0.000 (1)
Vehicle's noise	1.337 (0.513)	2.294 (0.318)	0.040 (0.980)	1.018 (0.313)	2.229 (0.136)
Public safety	9.862 (0.007)	5.211 (0.074)	1.602 (0.449)	5.927 (0.015)	0.810 (0.386)
Harassment	10.198 (0.006)	5.350 (0.069)	0.273 (0.872)	2.597 (0.107)	7.841 (0.005)
Afforestation	7.898 (0.019)	11.423 (0.003)	0.373 (0.830)	3.721 (0.054)	0.671 (0.413)
Sidewalks' width	6.120 (0.047)	2.038 (0.361)	4.349 (0.114)	0.519 (0.471)	0.598 (0.439)
Sidewalks' condition	1.594 (0.451)	0.235 (0.889)	2.166 (0.339)	0.814 (0.367)	0.802 (0.370)
Topography	22.752 (0.000)	10.716 (0.0047)	9.487 (0.009)	2.133 (0.144)	4.848 (0.028)

In another way, some factors as street lighting, sidewalks' condition, and traffic safety are not related to the physical activity lifestyle. This result indicates these factors did not influence the walking by car users. Thus, campaigns valuing walking to commute and promote pedestrians' urban environment can encourage a change in behaviour for car users.

The same association was found for men physical activity levels. In another way, only the topography is a dependent factor for women physical activity levels, indicating the women car users has willing to walking, independent of other urban environmental factors. The public safety and afforestation are factors with association with inactive or insufficient active car user lifestyle, indicating improvements in these factors contributing to behaviour changing. Finally, the displacements due to work or study is associated to traffic safety, harassment, and topography. Thus, a rugged topography will contribute to use the car displacement. However, a rugged topography is an urban environmental difficult to change. However, technology could be used to stimulate the walking in rugged topography conditions. In another way, the traffic safety and harassment are factors possible to change in order to stimulate the walking among car users.

5. CONCLUSION

The behaviour shift from motorized transportation modes to non-motorized modes is one of the possible ways to make more human cities, less dependent on motorised transportation. However, it is essential to understand the association of urban environment factors to this behaviour change.

In summary, results showed the gender did not influence the association among physical activity level, reasons for displacement, and BMI. However, the work and study reasons for daily displacements have influence in the association among gender and physical activity level. In relation to the urban environmental factors, public safety, harassment, afforestation, sidewalks' width, and topography are the main factors which contribute to the car use. Some factors (e.g., sidewalks' width and afforestation) require creation of an urban environment facing people while other (e.g., public safety and harassment) require supervision to create a safe urban environment. In special, the afforestation negatively influences people with inactive or insufficiently active lifestyle to migrate to active transport. The absence of a mild environment, with comfortable temperatures associated with the shadows from the trees, discourages the practice of walking, mainly in the inactive or insufficiently active levels and, to a lesser extent, among the people of the physically active group.

Likewise, we can infer that active urban mobility is one way to change people's sedentary behaviour since it is possible to comply with the recommendations of weekly time and intensity of physical exercises through active transportation. Promoting structural changes that encourage active urban mobility can be one way to improve health indicators and reduce the prevalence of chronic non-communicable diseases, such as diabetes, hypertension, stroke, some cancers and acute myocardial infarction. Also, campaigns valuing walking to commute and promote pedestrians' urban environment associates with health benefits can encourage a change in behaviour for car users.

For it, public policies to improve infrastructure and road safety should be encouraged to stimulate the migration from motorized to active transport, especially in the more resistant population to change their behaviour.

Finally, the urban environment can contribute to those people interested in exercising, playing sports, walking or cycling. The access to quality public spaces and inviting walking routes favour both active recreation and active transportation. Also, the frequent use of public spaces stimulates others to use them, making them more secure, while people feel less vulnerable to harassment.

We suggest for future works analyses the perception of urban environment factors on daily displacements by others transportation modes, and the contribution on these factors to reduce the inactive or insufficiently active levels.

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