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Spatial distribution of sedentary behavior and unhealthy eating habits in Belo Horizonte, Brazil: the role of the neighborhood environment

Distribuição espacial do comportamento sedentário e do hábito alimentar não saudável em Belo Horizonte, Brasil: o papel do ambiente da vizinhança

Crizian Saar Gomes (https://orcid.org/0000-0001-6586-4561) [1]
Larissa Loures Mendes (https://orcid.org/0000-0003-0776-6845) [2]
Maria Alice Vieira (https://orcid.org/0000-0002-4837-0911) [1]
Marcelo Azevedo Costa (https://orcid.org/0000-0002-2330-5056) [3]
Gustavo Velasquez Melendez (https://orcid.org/0000-0001-8349-5042) [1]

Abstract *The study aimed to analyze the spatial distribution of sedentary behavior and unhealthy eating habits, and to assess its relationship with the neighborhood environment. Cross-sectional study with data of Surveillance System of Risk and Protective Factors for Chronic Diseases, carried out in Belo Horizonte, Minas Gerais. Watching television for four hours or more per day was identified as sedentary behavior. Unhealthy eating habits were defined based on regular consumption of sodas, excess fat meat, and red meat, and irregular consumption of fruits and vegetables. Georeferenced data of places for physical activity, food establishments, population and residential density, homicide rate, mean total income, and social vulnerability index were entered into the Vigitel database. The coverage area by basic health units was used as the geographical unit of neighborhood. SaTScan was used to analyze the spatial distribution. Spatial analysis identified a significant cluster of high prevalence of sedentary behavior and unhealthy eating habits, after adjusting for sociodemographic characteristics. The comparison of environmental characteristics inside and outside clusters showed significant differences in the physical and social environment. Physical and social environment might be related to clusters of high prevalence of sedentary behavior and unhealthy eating habits.*

Key words *Sedentary behavior, Feeding behavior, Spatial analysis, Environment and public health*

Resumo *O objetivo foi analisar a distribuição espacial do comportamento sedentário e do hábito alimentar não saudável e verificar a relação com o ambiente da vizinhança. Estudo transversal com dados do Sistema de Vigilância de fatores de risco e proteção para doenças crônicas, realizado em Belo Horizonte, Minas Gerais. Considerou-se comportamento sedentário o hábito de assistir televisão quatro ou mais horas por dia. O hábito alimentar não saudável foi avaliado pelo consumo regular de carne com excesso de gordura, refrigerante e carne vermelha e irregular de frutas e hortaliças. Informações georreferenciadas dos locais para a prática de atividade física, estabelecimentos com venda de alimentos, densidade populacional e residencial, taxa de homicídio, renda e índice de vulnerabilidade social foram inseridas na base do Vigitel. A área de abrangência da unidade básica de saúde foi usada como unidade geográfica da vizinhança. A análise espacial identificou cluster significativo de alta prevalência de comportamento sedentário e hábito alimentar não saudável, mesmo após ajuste. Os ambientes físico e social podem estar relacionados a cluster de alta prevalência de comportamento sedentário e hábito alimentar não saudável.*

Palavras-chave *Comportamento sedentário, Hábito alimentar, Análise espacial, Ambiente e saúde pública*

[1] Departamento de Enfermagem Materno Infantil e Saúde Pública, Escola de Enfermagem, Universidade Federal de Minas Gerais. Av. Alfredo Balena 190 Santa Efigênia, 30130-100 Belo Horizonte MG Brasil. criziansaar@gmail.com
[2] Departamento de Nutrição, Escola de Enfermagem, Universidade Federal de Minas Gerais. Belo Horizonte MG Brasil.
[3] Departamento de Engenharia de Produção, Escola de Engenharia, Universidade Federal de Minas Gerais. Belo Horizonte MG Brasil.

Introduction

Sedentary behavior (SB) and unhealthy eating habits stand out as important risk factors for chronic noncommunicable diseases (NCDs). Therefore, they are directly related to the increase in morbidity and mortality in Brazil and worldwide[1-5].

Several factors may cause individuals to engage in SB and having unhealthy eating habits. Ecological determination models recognize these behaviors as multifactorial and do not hold individuals solely responsible, thus highlighting the importance of the neighborhood environment in health outcomes. The context of individuals are inserted, such as their place of residence, neighborhood and workplace, is an important determinant of health, since it has characteristics which may facilitate or prevent the adoption of healthy habits[6-9]. It is noteworthy that television viewing time is widely used as an indicator of SB.

Although a recent topic in health research, some studies report geographical differences in the prevalence of diseases/behavior, even on a local scale. Additionally, individuals who live close to each other have similar environmental characteristics, which could explain these geographical differences[10-13].

Therefore, spatial analysis techniques have emerged as an innovative way to investigate the role of environment as a contextual risk factor for disease development, to investigate spatial patterns of diseases, to identify areas of high risk and to better understand geographical patterns to guide and foster further studies for designing public health research and interventions. Recent studies evaluated physical activity, tobacco smoking, and obesity[14-17] as risk/protective behaviors for disease. Collectively, these results provide evidence that the place of residence plays a key role in disease and lifestyle.

However, studies on this subject are scarce and are restricted to specific populations, or high-income countries. Therefore, the scope for generalizing these findings is unclear, especially among countries undergoing an intense social, economic, epidemiological, and nutritional transition, such as Brazil. In addition, most studies report limitations in the use of environmental variables and spatial data using relatively large spatial units, such as states and countries. Furthermore, studies on eating habits primarily assess the consumption of nutrients or isolated foods, such as fruit and vegetable consumption. However, multidimensional dietary assessment is important and necessary, since combining foods, nutrients, and other food constituents is beneficial for disease prevention. Moreover, few studies adjust for potential confounders and assess the differences in environmental characteristics inside and outside spatial clusters.

Thus, this study aimed to *analyze the spatial distribution of sedentary behavior and unhealthy eating habits, and to assess its relationship with the neighborhood environment*.

Method

Participants

This cross-sectional study included the Surveillance System of Risk and Protective Factors for Chronic Diseases by Telephone Survey (Vigitel) data collected from 2008 to 2010 in the city of Belo Horizonte, Minas Gerais.

Since 2006, the Vigitel system has used telephonic interviews to estimate the prevalence of risk and protective factors for NCDs among adults living in the capitals of 26 Brazilian states and of the Federal District. The system collects data on demographic and socioeconomic characteristics of individuals, including age, sex, marital status, race/color, education level, number of household members, number of adults, and number of telephone landlines; characteristics of eating patterns and physical activity; self-reported weight and height; tobacco smoking and alcohol consumption; and self-reported health status and prior medical diagnosis of hypertension, diabetes, and dyslipidemia. Detailed information regarding the Vigitel system has been reported previously[18].

Sedentary behavior

The time, in hours, spent watching television (TV) per day, was used as an indicator proxy of sedentary behavior and it was based on the answers to the following question: "On average, how many hours a day do you spend watching television?". Watching television for four hours or more per day was identified as SB[19]. The cut-off point was adopted based on the results of a specific meta-analysis for the domain TV time and mortality from all causes which revealed a significant increase in mortality from 4 hours daily time TV[19].

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Unhealthy eating habits

Unhealthy eating habits were assessed based on a diet score, derived by principal component analysis (PCA). The following variables were used to construct the score:

Consumption of excess fat meat: Consumption of meat with apparent fat or chicken with skin. Consumption of excess fat meat was considered the positive answer to the question: *When you eat red meat with fat, do you usually eat the fat?* or *When you eat chicken with skin, do you usually eat the skin?*;

Regular consumption of soda: Consumption of soda on five or more days a week. For the composition of this indicator, the answers *Five to six days a week* and *Every day (including Saturday and Sunday)* were considered for the question: *How many days of the week do you usually drink soda? or artificial juice?*, regardless of quantity and type.

Regular consumption of red meat consumption: Consumption of red meat five or more days a week. For the composition of this indicator, the answers *Five to six days a week* and *Every day (including Saturday and Sunday)* were considered for the question: *On how many days of the week do you usually eat? red meat (beef, pork, kid)?*

Irregular consumption of fruits and vegetables: Consumption of fruits and vegetables in less than five days per week, estimated from the questions: *How many days of the week do you usually eat fruits?*, *How many days of the week do you usually drink natural fruit juice?* and *How many days of the week do you usually eat at least one type of vegetable or legume (lettuce, tomato, cabbage, carrot, chayote, eggplant, zucchini - not worth potatoes, manioc or yams)?*

The diet score derived by PCA reported an eigenvalue of 1.43, accounting for 36% of the variance in the four variables, and the factorial load ranged from 0.47 to 0.53. The mean diet score was 0.13 (standard error of the mean (SEM) = 0.018), ranging from -1.67 to 2.57, with high scores characterized as unhealthy consumption. Scores in the fourth quartile (≥ 0.61) indicated as a category of unhealthy eating habits[20].

Neighborhood environment

For the purposes of this study, the geographical unit representing neighborhood unit was the coverage area by basic health units (CABHU). Belo Horizonte has 148 BHUs. The geographical position of a participant's home was determined using the ZIP code.

Neighborhood environment characteristics were geocoded based on the full address of the sites, available from various commercial and government sources and merged in the database of the Vigitel system. The following environmental features were selected in this study:

1) Population density: population of the coverage area/area (km^2) of the coverage area (km^2), provided by the Brazilian Institute of Geography and Statistics - IBGE;

2) Residential density: Number of households of the coverage area/ area (km^2) of the coverage area, provided by the IBGE;

3) Density of establishments predominantly selling healthy food: number of butcher shops, fish shops, produce markets, dairy stores, and hortifruti in the coverage area/ area (km^2) of the coverage area, provided by the National Classification of Economic Activities - CNAE. These establishments were considered healthy since they predominantly sell in nature or minimally processed foods, including fruits and vegetables.

4) Density of establishments predominantly selling unhealthy food: number of establishments selling sweets, candies, chocolates and the like, snack bars, bars, street vendors, department stores, and minimarkets in the coverage area/ area (km^2) of the coverage area , provided by the CNAE. These establishments were categorized as unhealthy because they predominantly sell ultra-processed foods like hamburgers, hot dogs, pasta, pizza and candies.

5) Density of establishments selling mixed foods: number of hypermarkets, supermarkets, restaurants, and bakeries in the coverage area/ area (km^2) of the coverage area, provided by the CNAE. These establishments were categorized as mixed because they sell both healthy and unhealthy foods.

6) Density of places for physical activity: number of public parks, squares and running tracks, city gyms, sports and dance schools, and fitness centers and social sports clubs in the coverage area/ area (km^2) of the coverage area, provided by the Municipal Health Secretariat/Information and Informatics Company of the City of Belo Horizonte- SMS/PRODABEL;

7) Density of private places for physical activity: number of sports and dance schools, and fitness centers and social sports clubs in the coverage area/ area (km^2) of the coverage area, provided by the SMS/PRODABEL;

8) Density of public places for physical activity: number of public parks, squares, running tracks, and city gyms in the coverage area/ area

(km^2) of the coverage area, provided by the SMS/PRODABEL;

9) Homicide rate: number of homicide cases in the coverage area/ coverage area population x 10000), provided by the Military Police of Minas Gerais;

10) Mean Family Income: total income of people aged 10 years or older of the coverage area, provided by the IBGE; and

11) Health Vulnerability Index: health vulnerability index of the coverage area—HVI, provided by the SMS/PRODABEL.

Covariates

The variables sex, age, education, and marital status were used as adjustment variables.

Statistical analysis

To describe the data, relative frequency and 95% confidence interval were used for qualitative variables, and measures of central tendency and dispersion were used for quantitative variables. Descriptive statistical tests were performed using Stata version 14.0.

The spatial scanning technique, also known as the spatial scan statistic, was used to detect clusters of high prevalence of outcomes, that is, unhealthy eating habits and SB[21-23]. The spatial scan statistic detects the location of clusters, when present, and assesses their statistical significance. The spatial scan statistic can adjust the uneven geographical density of a population background, and the analysis depends on the total number of observed cases. The spatial scan statistic imposes a circular window on the map and allows the center of the circle to move gradually throughout the study area. This technique tests whether nearby areas are more similar to the study variable than expected in a random pattern. The null hypothesis states that the spatial distribution of the study event is random.

Furthermore, spatial scan analysis, proposed by Kulldorff, was performed, adjusting for covariates. According to Kulldorff (2015)[23], the adjustment for covariates can be performed using a regression model for estimating the expected number of cases for each area. The expected number of cases is used to re-estimate the reference population in each area. Therefore, the covariates are not included in the spatial scanning model but instead in the adjusted population.

The Mann-Whitney U test was used to compare environmental variables according to the presence of a cluster, since the variables were not symmetrically distributed.

The spatial analysis was performed using SaTScan version 9.2, with a 0.05 level of significance.

Ethical aspects

This study was approved by the Ethics Committee of the Ministry of Health of Brazil and the Research Ethics Committee of the Federal University of Minas Gerais (*Universidade Federal de Minas Gerais*—UFMG; opinion number 25447414.1.0000.5149).

Results

Participant characteristics

The sample constituted 5,783 individuals, with a mean age of 42.1 years (±16.3). Most participants were women (53.9%), aged from 25 to 34 years (24.6%), with 0 to 8 years of education (40.5%), without a live-in partner (53.9%), and with mulatto/brown skin color (54.1%). SB and unhealthy eating habits were reported by 11.0% and 26.6% of participants, respectively. The characteristics of the study participants, according to the presence of SB and unhealthy eating habits, are outlined in Table 1.

Spatial cluster of sedentary behavior

A significant cluster of high prevalence of SB was identified, using spatial analysis, in Belo Horizonte (Figure 1a). The cluster has a radius of 2.107 m and encompasses 145 participants, of whom 34 (23.4%) exhibit SB. The probability of finding a participant with SB in the cluster is 2.11 times (RR = 2.11; p = 0.016) that of CABHU's outside the cluster.

The location of the cluster remained unchanged after adjusting for sex, age, education, and marital status (Figure 1b). However, the size of the cluster reduced to a radius of 1.350 m. The probability of finding a participant with SB in the cluster is 2.51 times (RR = 2.51; p = 0.046) that of CABHU's outside the cluster.

The environment of the coverage areas included in the cluster of high prevalence of SB differs from that of the areas outside the cluster (Table 2). The densities of public places for physical activity and of private places for physical activity were lower, while the homicide rate, income, and HVI were higher in the areas within the cluster.

Table 1. Characteristics of the participants according to the presence of sedentary behavior and unhealthy eating habits. Belo Horizonte, Minas Gerais, 2008-2010.

Characteristics	Sedentary behavior			p value*	Unhealthy eating habits		p value*
	Total	No	Yes		No	Yes	
	% (95%CI)	% (95%CI)	% (95%CI)		% (95%CI)	% (95%CI)	
Sex							
Male	46.1 (44.5–47.6)	90.0 (88.5–91.4)	10.0 (8.6–11.5)	0.046[a]	64.5 (62.1–66.8)	35.5 (33.2–37.9)	< 0.001[a]
Female	53.9 (52.4–55.4)	88.0 (86.7–89.2)	12.0 (10.7–13.3)		81.0 (79.4–82.5)	19.0 (17.5–20.6)	
Age (years)							
18–24	14.6 (13.5–15.7)	87.5 (84.3–90.1)	12.5 (9.9–15.7)	0.008 [a]	61.0 (57.0–65.0)	39.9 (35.0–43.1)	< 0.001[a]
25–34	24.6 (23.2–26.1)	89.9 (87.5–91.8)	10.1 (8.2–12.4)		66.9 (63.4–70.2)	33.1 (29.8–36.6)	
35–44	20.0 (18.8–21.2)	91.6 (89.5–93.3)	8.4 (6.7–10.5)		71.3 (68.2–74.2)	28.7 (25.8–31.8)	
45–54	17.4 (16.3–18.6)	88.9 (86.4–91.0)	11.1 (9.0–13.6)		77.7 (74.5–80.5)	22.3 (19.5–25.5)	
55–64	11.9 (11.0–12.8)	88.3 (85.6–90.5)	11.7 (9.5–14.4)		83.9 (80.6–86.7)	17.1 (13.3–19.4)	
> 65	11.5 (10.7–12.4)	85.1 (82.4–87.4)	14.9 (12.6–17.6)		89.2 (86.4–91.4)	10.9 (8.6–13.6)	
Education (years)							
0 to 8	40.5 (39.0–42.1)	86.4 (84.5–88.1)	13.6 (11.8–15.5)	< 0.001[a]	72.6 (70.1–75.0)	27.4 (25.0–29.8)	< 0.001[a]
9 to 11	35.2 (33.8–36.6)	88.2 (86.6–89.7)	11.8 (10.3–13.4)		69.5 (67.1–71.7)	30.5 (28.3–32.9)	
12 or more	24.3 (23.1–25.5)	94.3 (93.0–95.3)	5.7 (4.6–7.0)		80.2 (77.8–82.4)	19.8 (17.5–22.1)	
Marital Status							
With live-in partner	46.1 (52.3–55.4)	87.8 (86.3–89.2)	12.2 (10.8–13.7)	< 0.001[a]	70.2 (68.1–72.3)	29.8 (27.7–31.9)	< 0.001 [a]
Without live-in partner	53.9 (52.3–55.4)	91.0 (89.7–92.2)	9.0 (7.8–10.3)		77.5 (75.6–79.4)	22.5 (20.6–24.4)	
Color/Race							
White	37.6 (36.2–39.1)	89.7 (88.2-91.0)	10.3 (8.9–11.8)	0.460	77.9 (75.8–79.8)	22.1 (20.2–24.2)	< 0.001[a]
Black	7.9 (7.0–8.8)	87.9 (84.0–90.9)	12.1 (9.0–15.9)		70.7 (65.3–75.6)	29.3 (24.4–34.7)	
Mulatto/Brown	54.1 (52.5–55.6)	88.5 (87.1–89.8)	11.5 (10.1–12.9)		70.5 (68.4–72.5)	29.5 (27.5–31.6)	
Others	0.4 (0.2–0.6)	95.3 (72.9-99.3)	4.7 (0.6–27.0)		84.2 (63.5–94.2)	15.8 (5.8–36.5)	

Note: 95% CI–95% Confidence Interval; * p value Chi-squared test; [a]: significant differences considering a 5% significance level.

Source: Research data.

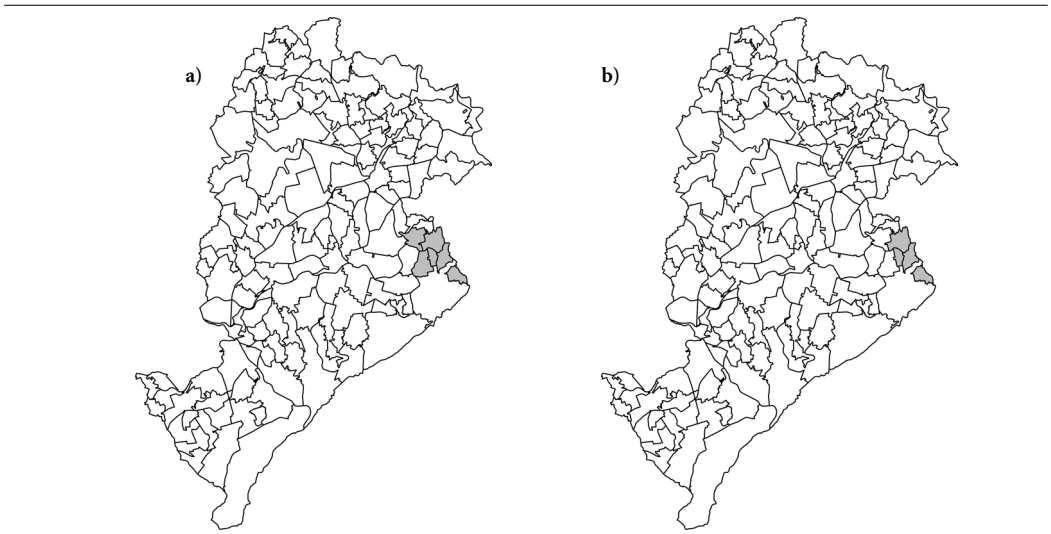

Figure 1. Spatial cluster of high prevalence of sedentary behavior (a) and high prevalence of sedentary behavior adjusted for sex, age, education, and marital status (b). Belo Horizonte, Minas Gerais, 2008-2010.

Note: Grey represents the cluster of high prevalence of sedentary behavior.

Source: Research data.

Spatial cluster of unhealthy eating habits

Spatial analysis revealed a significant cluster of unhealthy eating habits in Belo Horizonte (Figure 2a), which includes 715 individuals, of whom 30.3% exhibit unhealthy eating habits. In comparison with CABHUBHU's outside the cluster, the probability of finding a participant with unhealthy eating habits in the cluster was 36% higher (RR = 1.36; p = 0.0021).

After adjusting for sex, age, education, and marital status, the location of the cluster changed slightly; some of the CABHU were no longer part of the cluster, whereas others were included (Figure 2b). This cluster has a radius of 5,074 m, and includes 560 individuals, of whom 199 (35.5%) exhibit unhealthy eating habits. The probability of finding an individual with unhealthy eating habits in the cluster was 32% higher (RR = 1.32; p = 0.0144) than that in CABHU outside the cluster.

Table 2. Environmental characteristics inside and outside the cluster of high prevalence of sedentary behavior. Belo Horizonte, Minas Gerais, 2008-2010.

Characteristics	Cluster	Outside the cluster	p value*
	Median (IQ)	Median (IQ)	
Density of places for physical activity (number/km²)	0.69 (0.00–1.68)	2.75 (1.00–4.33)	0.044
Density of public places for physical activity (number/km²)	0.69 (0.00–1.68)	0.44 (0.00–0.92)	0.678
Density of private places for physical activity (number/km²)	0 (0.00–0.00)	1.93 (0.00–3.65)	0.004
Population density (inhabitants/km²)	11980 (7964–19475)	9385 (7129–11582)	0.227
Homicide rate (per 10,000 inhabitants)	8.51 (7.53–15.19)	5.91 (3.89–8.49)	0.05
Mean family income of the CABHU	445 (229–744)	959 (611–2034)	0.035
Health vulnerability index (HVI)	0.36 (0.30–0.40)	0.25 (0.20–0.30)	0.02
Residential density (households/km²)	3352 (2258–5408)	2992 (2223–3698)	0.47

IQ - Interquartile range; * Mann-Whitney U test.

Source: Research data.

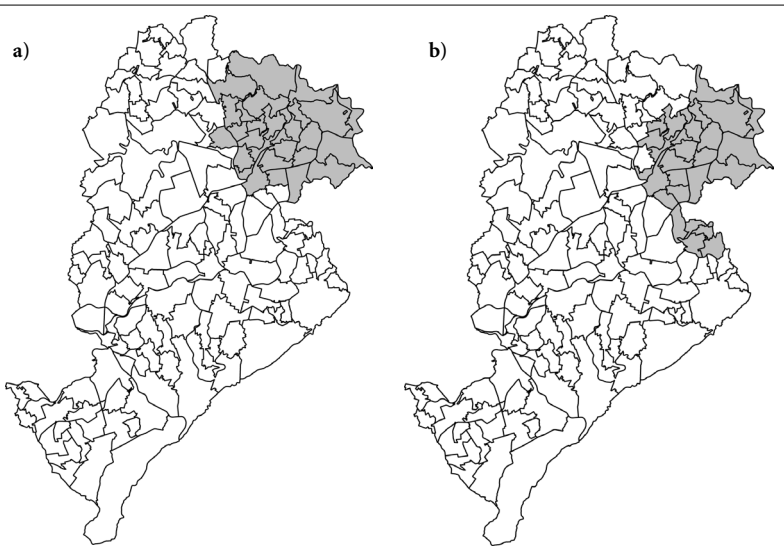

Figure 2. Spatial cluster of high prevalence of unhealthy eating habits (a) and high prevalence of unhealthy eating habits adjusted for sex, age, education, and marital status (b). Belo Horizonte, Minas Gerais, 2008-2010.

Note: Grey represents the cluster of high prevalence of unhealthy eating habits.

Source: Research data.

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In comparison with areas outside the cluster, the cluster showed lower family income and density of establishments selling mixed foods (Table 3).

Discussion

This study carried-out spatial analysis technique to identify clusters of SB and unhealthy eating habits in an urban area of a Brazilian city. Cluster areas showed significant differences in environment characteristics as compared with non-cluster areas, adjusted by potential confounders. The cluster location confirmed that the environment is potential obesogenic, and, thus, may lead to unhealthy behaviors.

The identification of disease / behavior clusters has been an important tool for health researchers, since this may assist in the identification of health inequalities and in the development of health intervention strategies for the neediest areas.

The cluster of high proportion of unhealthy eating habits in this study was located in a less developed area of the city and it was observed lower family income and lower density of establishments selling mixed foods, even after adjustment for individual variables. This relationship may be explained by the impact of income on the number of food establishments available, in addition to product quality and price[24-26]. A relationship between neighborhood with better socioeconomic conditions and greater availability of food establishments, and the consequent the better food consumption was shown in various studies[16,26-28].

In the cluster of high prevalence of SB, CABHU presented a lower density of places for physical activity, and socioeconomic deprivation, represented by a high homicide rate and high HVI score. Studies on environmental determinants of SB report that neighborhood socioeconomic status is the most investigated environmental factor, indicating that individuals living in neighborhoods with greater socioeconomic deprivation show longer sitting times and screen times, including television time[29-32]. Furthermore, higher density of and proximity to recreational facilities are associated with less SB[32-35]. A possible speculation for these results that could be a higher density of places for physical activity and the proximity to recreational facilities increase access to these areas and reduce the time of SB. In addition, seeing people being active is also associated with lower SB[36]. However, it is important to mention that most studies focus on density and proximity to public places, such as green areas[32.]

Criminality rates may increase social disorganization and disorder in a neighborhood, resulting in fear and insecurity in performing outdoor activities, with individuals favoring to spend more time at home, thus encouraging SB[30, 32-36]. Research evaluating the association between the

Table 3. Environmental characteristics outside and inside the cluster of high prevalence of unhealthy eating habits. Belo Horizonte, Minas Gerais, 2008-2010.

Characteristics	Cluster	Outside the cluster	p value*
	Median (IQ)	Median (IQ)	
Density of establishments predominantly selling healthy foods (number/km²)	6.8 (2.0–13.2)	7.3 (4.2–10.2)	0.899
Density of establishments predominantly selling unhealthy foods (number/km²)	20.6 (12.0–34.0)	24.3 (15.9–36.4)	0.305
Density of establishments selling mixed foods (number/km²)	4.8 (2.8–11.0)	10.6 (5.6–15.2)	0.005
Density of food establishments (number/Km²)	38.8 (19.3–50.0)	42.5 (28.8–63.4)	0.178
Homicide rate (per 10.000 inhabitants)	5.5 (3.1–8.6)	6.0 (4.1–8.5)	0.298
Mean family income	639 (369.7–915.3)	1107 (666.8–2666.9)	0.0000
Health vulnerability index (HVI)	0.26 (0.24–0.30)	0.25 (0.20–0.30)	0.106
Population density (inhabitants/km²)	9038 (7109–11292)	9495 (7148–11848)	0.628

IQ – Interquartile range; * Mann-Whitney U test.

Source: Research data.

neighborhood environment and SB is still scarce, and the results are contradictory and depend on the behavioral variable evaluated [28, 36-39].

The sedentary behavior is not synonymous of physical inactivity or the opposite of PA. PA and SB can coexist, that is, the individual can be sufficiently active, according to the recommendations of the PA guides, but spend most of the time in SC[3].

Finally, it is highlighted the influence of TV time on lifestyle habits especially eating habits, that are related with increased energy intake, which can be due to higher consumption of ultra-processed foods while watching TV, as well as higher exposure to ultra-processed advertises[40-42].

These results may facilitate a better understanding of the role of the neighborhood environment in health outcomes and disease prevention in urban areas. The use of surveillance systems in combination with spatial analysis techniques is underlined by their power to identify high-risk areas and to focus on interventions. However, some specific limitations should be reported, including the use of self-reported measures of the study outcomes, which is inherent to the methodological proposal of surveillance systems using telephone survey. Nevertheless, Vigitel questionnaire validation studies indicate satisfactory results for the measures assessed by telephone surveys compared to face-to-face interviews, and showed good reproducibility and validity[43-45].

Another limitation refers to the use of CABHU as neighborhood units. CABHU are used as neighborhood boundaries, but this may be inconsistent with the individuals' notions/perceptions of "neighborhood." The use of contextual data gathered from commercial and governmental sources, which may be subject to inaccuracies and which refer to a slightly different period (2009-2012) from that of individual data (2008–2010), is also a limitation. However, no major changes in neighborhood environments presumably occurred in this period. The results are consistent with most national and international literature demonstrate the consistency of findings. An additional limitation concerns the exclusion of households without telephone landlines. However, the coverage of landlines in Belo Horizonte is higher than the average of the country, which reduces the possible selection bias[46].

In conclusion, strong evidence of clusters of high prevalence of SB and unhealthy eating habits were observed in the city of Belo Horizonte, which may be associated to physical and social environment deprivation. Reducing inequalities is important for reducing SB and improving eating habits, thereby reducing the risk of chronic diseases. Our results may facilitate the design and implementation of more effective and geographically oriented public policies aimed at reducing obesogenic behavior and gaining a better understanding of geographical patterns in relation to the environment. Studies investigating the geographical distribution of diseases/behaviors may aid in understanding the epidemiological factors of population health status, to identify health inequalities, to understand risk and protective factors, and to develop strategies for health interventions in the most needed areas.

Collaborations

CS Gomes was responsible for conception, analysis and interpretation of data, writing the article, relevant critical review of intellectual content, final approval of the version to be published. LL Mendes was responsible for interpretation of data, relevant critical review of intellectual content, final approval of the version to be published. MA Vieira was responsible for interpretation of data, relevant critical review of intellectual content, final approval of the version to be published. MA Costa was responsible for analysis and interpretation of data, relevant critical review of intellectual content, final approval of the version to be published. GV Melendez was responsible for conception, analysis and interpretation of data, writing the article, relevant critical review of intellectual content, final approval of the version to be published.

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