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Association between the perceived environment and overweight in adults and elderly: a cross-sectional study

Fernanda Penido Matozinhos[1], Crizian Saar Gomes[1], Larissa Loures Mendes[2], Milene Cristine Pessoa[2], Cristina Maria Proença Padez[3], Geórgia das Graças Pena[4] and Gustavo Velasquez-Melendez[1*]

Abstract

Background: Overweight is a global issue of epidemic proportions, and its negative influence on individual health is clear. However, the relation between environment and overweight is not thoroughly clear, especially concerning to the perceived environment and the physical and social aspects. Therefore, this study aimed to analyze potential associations between the perceived environment and overweight in adults and elderly in a medium-sized city.

Methods: A cross-sectional population-based study was conducted with 808 adult and elderly individuals. Overweight was defined as body mass index ≥25 kg/m^2 based on the World Health Organization criteria. The Neighborhood Environment Walkability Scale was used evaluating the perceived environment. Poisson regression was performed evaluating the relationships between the perceived environment and overweight.

Results: The frequency of overweight was 50.4 %. Adjusted models showed association between overweight and the variable of surrounding neighborhood as follows: "1- to 3-story apartments or condos" (most category; PR = 0.30; CI 0.12–0.76) and "4- to 6-story apartments or condos" (all categories) (PR ranged 0.40 to 0.46; $p < 0.05$), and also, "land-use mix-diversity" was associated with overweight in this population (PR 0.81; CI 0.66–0.99).

Conclusions: In addition to individual characteristics, the environmental aspects are relevant to the occurrence of overweight in this population. Population-based studies using primary data on overweight remain scarce in Brazil. Finally, this study contributes to improve the understanding of the complex relationship between perceived environment and overweight, and we believe that our findings provide further justification for the development of future interventions and health promotion strategies.

Keywords: Perception, Environment and public health, Obesity, Overweight

Background

Overweight is a global problem of epidemic proportions in many countries around the world [1, 2], including Brazil. Studies in Brazil found out that on average, 50 % of the population are overweight or obese [3, 4].

Characteristics of the neighborhood, in addition to individual characteristics, may be associated with overweight [5, 6]. Studies in developed countries have shown that various characteristics of the perceived environment are associated with the prevalence of overweight and obesity [6, 7]. For example, perceptions about the quality of neighborhood environment, high residential density, greater accessibility, and smaller perceived distance to health and recreational facilities are associated with a lower prevalence of overweight [8]. Furthermore, unfavorable perceptions of the neighborhood, such as esthetics and poor road connectivity, besides the perception of security and crime rates are associated with higher prevalence of overweight individuals in populations [9]. These factors may discourage or restrict the practice of physical activities [8, 9]. In addition, the characteristics of the environment affect behaviors related to physical activity and eating. For instance, physical activity facilities and

* Correspondence: jguveme@gmail.com
[1]Department of Maternal and Child Nursing and Public Health, School of Nursing, Universidade Federal de Minas Gerais—UFMG, Av. Alfredo Balena, 190 - Bairro Santa Efigênia, 30130-100 Belo Horizonte, MG, Brazil
Full list of author information is available at the end of the article

food stores are associated with these behaviors, and this evidence could explain mechanisms of the relationship between perceived environment and obesity [10].

The Neighborhood Environment Walkability Scale (NEWS) stands out as one of the most commonly used instruments investigating the perceived environment in international and national research communities [11, 12]. This questionnaire aims to evaluate aspects of the environment that are favorable for recreational walking and other forms of recreation. Many studies have demonstrated the reproducibility and validity of this instrument [11–13].

In Brazil, some studies have used NEWS to examine the outcome of individual physical activity [14, 15]. These studies demonstrated that the perception of esthetically pleasant neighborhoods with greater "walkability" (characterized by high residential density, mixed land use, and street connectivity), easy access to destinations, and presence of sidewalks, bike lanes, and public and private places for leisure and the increased perception of safety in the neighborhood increase physical activity [14, 15]. These study results have been consistent with those of the international literature [16, 17].

The negative influence of obesity on individual health is evident. However, the causal relationship between the environment and overweight in Brazil is unclear, especially in medium-sized cities [18] such as Montes Claros.

There are not so many population-based studies using primary data on overweight in Brazil. Little is understood about the ways on which the perceived environment is related to the prevalence of overweight [9, 19, 20]. Additional studies that address individual perceptions of the physical and social aspects of each city are necessary. Therefore, the objective of this study was to determine characteristics of the perceived environment associated with overweight in individuals with 18 years or older from the city of Montes Claros, Minas Gerais.

Methods

A cross-sectional study was conducted using a representative sample of individuals who were 18 years or older from the city of Montes Claros, Minas Gerais (n=808). Montes Claros is a medium-sized city in the north of Minas Gerais State and belongs to Upper and Middle São Francisco watershed. In 2010, its estimated population was 361,971 inhabitants [21].

The sample size was calculated based on a 48 % expected prevalence of overweight [3], 95 % confidence interval, and a design effect (deff) of 2 [22]. Thus, the minimum sample size was 750 individuals.

The sample was performed in two stages. In the first stage, the census tract database [21] was used to draw the primary sampling units. In the second stage, households were randomly selected using the address list. All individuals in the households were invited to participate in the study. The data were collected from January 2012 to March 2013. The final sample constituted 46 census tracts and 342 households. A total of 808 individuals participated in the study.

Face-to-face interviews were conducted by trained researchers. The questionnaire included questions related to demographic and lifestyle characteristics, such as sex, age, education, skin color, marital status, and household income. Education and skin color were categorized according to the Brazilian Institute of Geography and Statistics (IBGE) [21]. Household income was set according to the number of minimum wages, whose categories were the folowing: <1, 1 to 4, 4 to 8, and >8. At the end of the interview, anthropometric measurements were performed. The anthropometric measurements were conducted according to the World Health Organization guidelines [23].

Weight and height were measured using a digital scale (Digital Magna® 150 Kg Model, G Tech Ltda®, São Paulo, SP) with an error of 0.1 kg and an individual Alturaexata® stadiometer (Minas Gerais (MG)), respectively.

Body mass index (BMI) was calculated as [weight (kg)/height^2 (m)] and classified according to the cutoff points proposed by the World Health Organization [23]. Overweight was defined as BMI ≥25 kg/m^2 and obesity as BMI ≥30 kg/m^2.

A validated Portuguese version of NEWS (the Brazilian version) was used evaluating the perceived environment [12]. The NEWS-A questionnaire captures measures of respondents' perceptions about their neighborhood environment using a 4-point scale (from "strongly disagree" to "strongly agree"), with the exception of the surrounding neighborhood (none, few, some, most, all); proximity to stores, facilities, and other things in their neighborhood (in minutes); and satisfaction with the neighborhood (completely satisfied, satisfied, indifferent, unsatisfied, or completely unsatisfied).

For the statistical analysis, the answers were divided into the following two categories: agreement ("strongly agree" and "partially agree") and disagreement ("strongly disagree" and "partially disagree"). The surrounding neighborhood categories remained unchanged. The "proximity to stores, facilities, and other things in your neighborhood" was categorized as "less than a 10-min walk" or "10 or more minutes of walking." The "satisfaction with the neighborhood" was reported as "satisfied, indifferent, or unsatisfied."

Furthermore, the following subscales were created from the NEWS data: residential density (6 items); mixed land-use diversity (22 items); perceptions of access to services (7 items); street connectivity (4 items); ease of walking or bicycling (5 items); neighborhood esthetics (5 items);

traffic safety (7 items); crime safety (6 items); and satisfaction with neighborhood (17 items). Details of the subscale calculations can be found in another publication [24].

The Statistical Software for Professional (Stata) statistical package (svy function) was used for the statistical analyses. Normal weight and overweight respondents were compared using chi-square statistics in bivariate analyses. Poisson regression models were constructed to quantify the relationships between perceived environment and overweight. Crude prevalence ratios (PRs) were calculated, as were PRs adjusted for age, sex, and years of school. Ninety-five percent confidence interval (95 % CI) was used to guide interpretation of Poisson models.

Due to the extent of the scale, the tables were organized into groups according to the NEWS.

This study was approved by the Research Ethics Committee at the Federal University of Minas Gerais (Comitê de Ética em Pesquisa da Universidade Federal de Minas Gerais), according to the Resolution no. 466/2012 of the National Health Council (Conselho Nacional de Saúde), following position no. 213.555. The procedure was explained to all participants prior to the study and the participants were asked to sign a voluntary informed consent.

Results

The sample was composed of 808 adults with 18 years old or more, and 52.7 % of them were female. The average age of these participants was 39.62 years (standard deviation (SD) = 16.32), and the predominant age group was between 18 and 30 years old (38.3 %), had complete high school or incomplete higher education (44.8 %), self-reported their skin color as brown (70.2 %), and had household incomes ranged from 1 to 4 (85.9 %) minimum wages. The frequency of overweight was 50.4 %, and 19.35 % were obese. Overweight was more frequent in married individuals ranging from 46 to 60 years old and ($p < 0.001$) (Table 1).

Tables 2, 3, 4, and 5 show the unadjusted and adjusted prevalence ratios of overweight according to perceived

Table 1 Percentages of overweight individuals based on sociodemographic variables. Montes Claros, Brazil, 2013

Variables	Total % (95 % CI)	Normal weight (49.60 %) % (95 % CI)	Overweight (50.40 %) % (95 % CI)	*p* value
Sex				
Male[a]	47.27 (43.95–50.62)	50.92 (44.63–57.17)	49.08 (42.83–55.37)	0.505
Female	52.73 (49.38–56.05)	48.38 (43.65–53.14)	51.62 (46.86–56.35)	
Age (years)				
18 to 30[a]	38.28 (34.40–42.31)	68.36 (60.20–75.53)	31.64 (24.47–39.80)	<0.001
31 to 45	29.41 (25.20–34.01)	41.89 (35.31–48.76)	58.11 (51.24–64.69)	
46 to 60	20.53 (17.56–23.85)	31.22 (24.85–38.40)	68.78 (61.60–75.15)	
>60	11.79 (9.41–14.66)	40.02 (32.90–47.58)	59.98 (52.42–67.10)	
Education				
None or incomplete primary school[a]	15.20 (12.24–18.72)	44.13 (36.38–52.18)	55.87 (47.82–63.62)	0.246
Complete primary school or incomplete high school	33.48 (29.44–37.77)	46.15 (38.94–53.53)	53.85 (46.47–61.06)	
Complete high school or incomplete higher education	44.82 (40.67–49.05)	53.52 (46.68–60.24)	46.48 (39.76–53.32)	
Complete higher education and graduate education	6.50 (4.64–9.03)	54.51 (38.74–69.43)	45.49 (30.57–61.26)	
Skin color				
Brown[a]	70.20 (66.40–73.99)	49.03 (44.50–53.58)	50.97 (46.42–55.50)	0.421
White	17.67 (14.33–21.01)	54.53 (44.21–64.47)	45.47 (35.53–55.79)	
Black, indigenous, and yellow	12.13 (9.00–15.25)	46.72 (38.35–55.28)	53.28 (44.72–61.65)	
Marital status				
Married[a]	54.59 (50.27–58.91)	40.95 (36.19–45.88)	59.05 (54.12–63.81)	<0.001
Separated, single, and widowed	45.40 (41.08–49.73)	59.88 (54.08–65.43)	40.12 (34.57–45.92)	
Household income (minimum wage equivalents)				
<1[a]	3.37 (1.94–5.80)	42.99 (25.26–62.73)	57.01 (37.27–74.74)	0.757
1 to 4	85.89 (80.15–90.17)	49.40 (45.05–53.76)	50.60 (46.24–54.95)	
4 to 8	8.83 (5.42–14.08)	54.53 (45.05–63.70)	45.47 (36.30–54.95)	
>8	1.91 (0.74–4.87)	49.43 (21.56–77.66)	50.57 (22.34–78.44)	

[a]Reference category

Table 2 Prevalence ratios of overweight for "Surroundings of your house". Montes Claros, Brazil, 2013

Variables	Overweight	
	Unadjusted PR (95 % CI)	Adjusted PR[a] (95 % CI)
Surrounding neighborhood (reference=all)		
Single-family residences in your surrounding neighborhood		
None	0.97 (0.48–1.98)	1.06 (0.55–2.02)
Few	0.92 (0.48–1.77)	1.05 (0.59–1.89)
Some	1.14 (0.59–2.22)	1.29 (0.71–2.35)
Most	1.00 (0.52–1.89)	1.10 (0.62–1.93)
1- to 3-story apartments or condos in your surrounding neighborhood		
None	*0.50 (0.44–0.55)*	0.70 (0.39–1.25)
Few	*0.51 (0.45–0.58)*	0.70 (0.38–1.26)
Some	*0.53 (0.40–0.69)*	0.69 (0.39–1.22)
Most	*0.21 (0.09–0.53)*	*0.30 (0.12–0.76)*
4- to 6-story apartments or condos in your surrounding neighborhood		
None	*0.49 (0.45–0.54)*	*0.40 (0.33–0.49)*
Few	*0.52 (0.44–0.61)*	*0.39 (0.30–0.52)*
Some	*0.67 (0.48–0.94)*	*0.46 (0.29–0.71)*
Most	–	–
7- to 12-story apartments or condos in your surrounding neighborhood		
None	–	–
Few	1.05 (0.62–1.76)	0.94 (0.53–1.67)
Some	*2.00 (1.84–2.16)*	*1.52 (1.18–1.96)*
Most	0.40 (0.05–3.07)	0.56 (0.08–3.75)
Apartments or condos with more than 13 stories in your surrounding neighborhood		
None	–	–
Few	*1.70 (1.37–2.11)*	1.40 (0.95–2.06)
Some	*2.01 (1.85–2.18)*	*1.92 (1.21–3.03)*
Most	0.55 (0.06–4.45)	0.79 (0.11–5.30)
Subscale—residential density	1.00 (0.99–1.00)	1.00 (0.99–1.00)

Italic values show $p < 0.05$ (Poisson regression)
[a]Age, sex, and education

environment variables in Montes Claros. In the unadjusted analysis, the environmental perception variables inversely associated with overweight were as follows: "1- to 3-story apartments or condos in your surrounding neighborhood"; "4- to 6-story apartments or condos in your surrounding neighborhood" (Table 2); "there is a grass/dirt strip that separates the streets from the sidewalks" (Table 4); and "the number of people whom you know (Table 5)".

After adjusting the models for age, sex, and education, the relations remained between overweight and the following variables: "1- to 3-story apartments or condos in your surrounding neighborhood ('most' category)," "4- to 6-story apartments or condos in your surrounding neighborhood" (all categories) (Table 2), and "land-use mix-diversity" (Table 3).

The variable "How common are townhouses or 1- to 3-story family homes in your surrounding neighborhood?" is not shown because there was not a sufficient number of individuals in this category.

No associations between the questions related to traffic or crime safety and overweight were found (Table 4).

No associations between the questions related to the level of neighborhood satisfaction and overweight were found after adjustment (Table 5).

Discussion

The present study was one of the first studies evaluating the perceived environment and overweight in adults in a Brazilian city. It was found that the perception of mixed land use and one of the surrounding neighborhood categories were associated with overweight.

The mixed land use (proximity to commerce and locations to exercise) has a relationship with overweight. Previous studies have suggested that a shorter walking

Table 3 "Stores, facilities, and other things in your neighborhood" and "Access to services." Montes Claros, Brazil, 2013

Variable	Overweight	
	Unadjusted PR (95 % CI)	Adjusted PR[a] (95 % CI)
Stores, facilities, and other things in your neighborhood (reference ≤10 min)		
Convenience/small grocery store	1.02 (0.79–1.31)	1.05 (0.82–1.33)
Supermarket	1.03 (0.87–1.22)	1.04 (0.88–1.23)
Hardware store	1.00 (0.85–1.17)	0.98 (0.84–1.15)
Fruit/vegetable store	1.09 (0.81–1.48)	1.15 (0.86–1.53)
Laundry/dry cleaner	0.97 (0.74–1.27)	0.99 (0.77–1.29)
Clothing stores	0.89 (0.74–1.07)	0.91 (0.75–1.10)
Post office	1.08 (0.82–1.42)	1.07 (0.81–1.41)
Library	0.89 (0.71–1.12)	0.91 (0.73–1.15)
Elementary school	1.03 (0.88–1.22)	1.02 (0.86–1.20)
Other school	1.00 (0.86–1.17)	1.04 (0.89–1.21)
Bookstore	1.01 (0.78–1.30)	1.09 (0.85–1.42)
Cafe	1.02 (0.87–1.20)	1.02 (0.88–1.19)
Bank/credit union	1.04 (0.78–1.39)	1.10 (0.82–1.45)
Restaurant	1.11 (0.92–1.33)	1.14 (0.95–1.37)
Video store	1.01 (0.85–1.21)	1.04 (0.87–1.23)
Pharmacy/drug store	1.00 (0.86–1.16)	1.02 (0.88–1.19)
Salon/barber	0.99 (0.80–1.23)	1.05 (0.85–1.29)
Your school or work	1.01 (0.83–1.23)	1.03 (0.85–1.26)
Bus stop	1.14 (0.96–1.37)	1.21 (1.03–1.43)
Park	0.94 (0.72–1.23)	0.97 (0.75–1.23)
Recreation/community center	0.94 (0.80–1.09)	0.97 (0.83–1.14)
Gym	1.00 (0.86–1.17)	1.00 (0.85–1.18)
Subscale—land-use mix	0.85 (0.70–1.02)	*0.81 (0.66–0.99)*
Access to services (reference = no/disagree)		
I can do most of my shopping at local stores.	1.00 (0.83–1.21)	0.98 (0.82–1.17)
Stores are within easy walking distance of my home.	0.97 (0.78–1.19)	0.93 (0.75–1.14)
Parking is difficult in local shopping areas.	1.14 (0.97–1.33)	1.07 (0.92–1.25)
Many places to go within easy walking distance of my home.	0.93 (0.60–1.44)	0.93 (0.61–1.40)
It is easy to walk to a bus stop (train, subway) from my home.	0.80 (0.53–1.20)	0.71 (0.45–1.13)
The streets are hilly, making my neighborhood difficult to walk in.	0.96 (0.82–1.12)	0.98 (0.85–1.14)
Many canyons/hillsides limit the number of routes for getting from place to place.	0.95 (0.77–1.18)	0.99 (0.81–1.21)
Subscale—perception of access to services	1.02 (0.84–1.26)	0.98 (0.80–1.20)

[a]Age, sex, and education
Italic values show $p < 0.05$ (Poisson regression)

time between residences and places to workout, social groups, and health stores is associated with the maintenance of healthy lifestyle habits, such as greater exercise and healthy eating. Consequently, such a walking time is associated with a normal body weight [25, 26]. A study in a small Brazilian city showed that an increased distance between primary schools, parks and squares, and outdoor locations with opportunities to exercise resulted in an increased chance of being overweight [25]. Many studies have used the connectivity of streets, mixed land use, and residential or population density evaluating the "walkability" of a neighborhood [27, 28].

Saelens and Handy [29] reviewed articles on the built environment that examined walking outcome from 2002 to 2006 in Australia, Portugal, Belgium, and the Netherlands. These authors found that neighborhoods with mixed land uses (residential, commercial, and other services) and a higher residential density were more conducive to walking. In addition to these characteristics, the neighborhood esthetic quality and the presence and

Table 4 "Streets," "places," "neighborhood surroundings," "traffic safety," and "safety from crime." Montes Claros, Brazil, 2013

Variables	Overweight	
	Unadjusted PR[a] (95 % CI)	Adjusted PR[a] (95 % CI)
Streets in my neighborhood (reference = no/disagree)		
The streets do not have many, or any, cul-de-sacs (dead-end streets).	1.02 (0.84–1.24)	0.99 (0.81–1.20)
There are walkways that connect cul-de-sacs to streets, trails, or other cul-de-sacs.	0.95 (0.79–1.13)	0.96 (0.81–1.14)
The distance between intersections is usually short (100 yards or less).	1.00 (0.78–1.28)	1.00 (0.76–1.31)
There are many alternative routes for getting from place to place (I do not have to go the same way every time).	1.11 (0.80–1.54)	1.06 (0.77–1.45)
Subscale—street connectivity	1.00 (0.84–1.19)	0.99 (0.83–1.18)
Places for walking or cycling (reference = no/disagree)		
There are sidewalks on most of the streets.	1.07 (0.81–1.43)	1.00 (0.76–1.31)
The sidewalks are well maintained (paved, even, and not many cracks).	1.14 (0.94–1.38)	1.10 (0.92–1.32)
There are bicycle or pedestrian trails in or near my neighborhood that are easy to access.	0.92 (0.66–1.27)	0.84 (0.62–1.13)
Sidewalks are separated from the road/traffic by parked cars.	0.94 (0.81–1.09)	0.89 (0.77–1.02)
There is a grass/dirt strip that separates the streets from the sidewalks.	*0.85 (0.72–0.99)*	0.86 (0.74–1.01)
Subscale—ease of walking and cycling	1.03 (0.87–1.20)	0.97 (0.83–1.13)
Neighborhood surroundings (reference = no/disagree)		
There are trees along the streets.	1.04 (0.85–1.27)	1.00 (0.81–1.22)
Trees give shade for the sidewalks.	1.03 (0.82–1.31)	0.98 (0.78–1.22)
There are many interesting things to look at while walking.	1.14 (0.99–1.31)	1.11 (0.97–1.27)
My neighborhood is generally free from litter.	0.93 (0.78–1.10)	0.89 (0.75–1.06)
There are attractive buildings/homes.	1.02 (0.85–1.22)	1.00 (0.83–1.21)
Subscale—neighborhood esthetic	1.13 (0.97–1.30)	1.06 (0.92–1.22)
Traffic safety (reference = no/disagree)		
So much traffic along the street I live on that it makes it difficult or unpleasant to walk.	0.97 (0.83–1.14)	0.96 (0.82–1.12)
So much traffic along nearby streets that it makes it difficult or unpleasant to walk.	1.07 (0.92–1.24)	1.03 (0.89–1.19)
The speed of traffic on the street I live on is usually slow (30 mph or less).		
Most drivers exceed the posted speed limits while driving.	1.00 (0.81–1.25)	1.06 (0.86–1.29)
Crosswalks and pedestrian signals to help walkers cross busy streets.	0.91 (0.74–1.13)	0.90 (0.73–1.11)
The crosswalks help walkers feel safe crossing busy streets.	0.97 (0.81–1.17)	0.93 (0.76–1.14)
When walking, there are many exhaust fumes (such as from cars, buses).	1.03 (0.88–1.21)	1.07 (0.91–1.25)
Subscale—traffic safety	0.94 (0.79–1.10)	0.93 (0.79–1.09)
Safety from crime (reference = no/disagree)		
Streets are well lit at night.	1.05 (0.79–1.42)	1.00 (0.77–1.31)
Walkers and bikers on the streets can be easily seen by people in their homes.	0.90 (0.70–1.15)	0.88 (0.69–1.12)
I see and speak to other people when I am walking.	1.21 (0.81–1.79)	1.19 (0.83–1.71)
There is a high crime rate.	1.03 (0.86–1.23)	1.05 (0.89–1.25)
The crime rate makes it unsafe to go on walks during the day.	0.97 (0.81–1.16)	0.96 (0.81–1.13)
The crime rate makes it unsafe to go on walks at night.	0.97 (0.81–1.16)	0.94 (0.79–1.11)
Subscale—crime safety	0.98 (0.82–1.18)	0.97 (0.82–1.15)

Italic values show $p < 0.05$ (Poisson regression) a Age, sex, and education

maintenance of sidewalks and connected streets were related to walking habits.

One item of residential density (4- to 6-story apartments or condominiums) was associated with overweight in this study. In the NEWS, various types of residences in a neighborhood were taken into consideration in order to create a residential density subscale [24]. In a medium-sized city, the presence of residences such as 4- to 6-story apartments or condominiums can be an indicator for higher residential density. In other

Table 5 Prevalence ratios of overweight and confidence intervals for "neighborhood satisfaction." Montes Claros, Brazil, 2013

Variables	Overweight	
	Unadjusted PR (95 % CI)	Adjusted PR[a] (95 % CI)
Level of neighborhood satisfaction (reference = satisfied)		
The highway access from your home		
Unsatisfied	0.93 (0.75–1.14)	1.01 (0.82–1.26)
Indifferent	1.04 (0.85–1.26)	1.01 (0.83–1.22)
Access to public transportation		
Unsatisfied	0.95 (0.73–1.24)	1.01 (0.79–1.29)
Indifferent	1.12 (0.89–1.40)	1.11 (0.90–1.38)
Your commuting time to work/school		
Unsatisfied	1.11 (0.81–1.51)	1.24 (0.91–1.70)
Indifferent	1.26 (0.99–1.61)	1.28 (1.00–1.65)
The access to shopping		
Unsatisfied	0.99 (0.73–1.34)	1.08 (0.81–1.43)
Indifferent	1.11 (0.97–1.27)	1.13 (0.98–1.32)
How many friends you have		
Unsatisfied	0.96 (0.70–1.31)	0.97 (0.71–1.32)
Indifferent	0.93 (0.68–1.27)	0.98 (0.73–1.31)
The number of people you know		
Unsatisfied	*0.61 (0.39–0.96)*	0.65 (0.42–1.00)
Indifferent	0.81 (0.57–1.15)	0.83 (0.60–1.15)
How easy and pleasant it is to walk		
Unsatisfied	0.76 (0.55–1.06)	0.81 (0.58–1.14)
Indifferent	0.99 (0.82–1.20)	0.99 (0.82–1.20)
How easy and pleasant it is to bicycle		
Unsatisfied	0.83 (0.58–1.20)	0.78 (0.56–1.09)
Indifferent	0.88 (0.66–1.17)	0.78 (0.59–1.02)
The quality of schools		
Unsatisfied	1.17 (0.98–1.40)	1.23 (1.04–1.47)
Indifferent	1.00 (0.76–1.30)	1.04 (0.78–1.40)
Access to entertainment (restaurants, movies, clubs, etc.)		
Unsatisfied	1.08 (0.78–1.49)	1.17 (0.85–1.59)
Indifferent	0.97 (0.68–1.39)	1.04 (0.74–1.45)
The safety from threat of crime		
Unsatisfied	1.13 (0.92–1.38)	1.17 (0.96–1.42)
Indifferent	1.22 (0.98–1.51)	1.20 (0.96–1.50)
The amount and speed of traffic		
Unsatisfied	0.91 (0.75–1.10)	0.95 (0.80–1.13)
Indifferent	0.97 (0.79–1.19)	1.04 (0.86–1.26)
The noise from traffic		
Unsatisfied	0.95 (0.79–1.16)	0.96 (0.80–1.16)
Indifferent	0.89 (0.74–1.07)	0.90 (0.75–1.08)
The number and quality of food stores		
Unsatisfied	1.06 (0.88–1.28)	1.09 (0.90–1.31)
Indifferent	0.94 (0.79–1.11)	0.95 (0.80–1.14)
The number and quality of restaurants		
Unsatisfied	0.99 (0.84–1.17)	1.06 (0.89–1.26)
Indifferent	1.05 (0.83–1.31)	1.09 (0.88–1.36)
Your neighborhood as a good place to raise children		
Unsatisfied	0.97 (0.77–1.23)	1.06 (0.83–1.36)
Indifferent	0.89 (0.63–1.25)	0.93 (0.67–1.28)
Your neighborhood as a good place to live		
Unsatisfied	0.94 (0.73–1.21)	1.06 (0.81–1.37)
Indifferent	0.91 (0.66–1.26)	0.98 (0.71–1.34)
Subscale—neighborhood satisfaction	1.00 (0.88–1.13)	0.96 (0.85–1.09)

Italic values show $p < 0.05$ (Poisson regression)
[a]Age, sex, and education

studied areas with a higher residential density, greater street connectivity and mixed land uses were associated with a reduced risk of overweight and obesity [30, 31].

Some aspects of the present study, such as the urban representativeness of a medium-sized city and the use of primary data, should be highlighted. Furthermore, there is a gap in our understanding of the environmental variables that explains the association between the perceived environment and overweight. To the extent of our knowledge, only one study of the perceived environment and overweight in Brazil used the NEWS version that was adopted in the current study [25].

Additionally, the high response rate and direct measurement of height and weight (as opposed to the use of self-reported measures to estimate BMI) contributed to the internal validity of this study.

Finally, the limitations of the present study must be considered. One limitation is the cross-sectional design, which prevents the establishment of causal relationships. Furthermore, authors do not have access to information of the city about variables, like density, street connectivity, crime, and traffic statistics, and objective data regarding the environment were not collected. Therefore, the variables represent the current individual perceptions of the availability and quality of environmental resources and security. Environmental perceptions depend on individuals' current knowledge of the neighborhood and their opinion of proximity. This knowledge can influence the results. However, these questions have been sufficiently addressed in previous studies of this nature.

The complex relationship between perceived environment and health events is a great challenge for the academic researchers and municipal and national managers. In this sense, the construction of environmental

indicators related and committed with health are necessary to enable obtaining better distribution of spaces. These spaces should be projected considering from better access to health or to recreational spaces for physical activity, until improvements in sanitation especially in most densely populated.

Further researches involving the microenvironment (household level) or work and school environments could be relevant in improving the knowledge on the health and environment relationship in other levels and in health events (other chronic diseases, for example). This way, different approaches could emerge to new public health policies.

Despite the potential limitations, the current research shows that individuals create different realities based on the way they interact with, observe, and interpret the characteristics of their environment according to socioeconomic and cultural factors [32]. Consequently, the perceived environment can provide relevant information about the interactions between people and their environment and, therefore, elucidate individual choices that affect health outcomes [18].

Conclusions

The results of this study provide arguments for discussing the relationship between the environment and health outcomes, such as overweight and obesity. The present investigation can also serve as a basis for developing public health and urban planning strategies and policies in medium-sized cities, such as Montes Claros, that can stimulate the adoption of healthy lifestyles by the population.

Abbreviations

95 % CI: Ninety-five percent confidence interval; ABEP: Associação Brasileira de Empresas de Pesquisa (Brazilian Association of Research Companies); BMI: Body mass index; deff: Design effect; IBGE: Instituto Brasileiro de Geografia e Estatística (Brazilian Institute of Geography and Statistics); MG: Minas Gerais; NEWS: Neighborhood Environment Walkability Scale; PRs: Prevalence ratios; SD: Standard deviation; Stata: Statistical Software for Professional

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Authors' contributions

FPM participated in the research plan, statistical analysis, data interpretation, writing of the article, literature review, and final approval of the manuscript. CSG participated in the statistical analysis, data interpretation, writing of the article, literature review, and final approval of the manuscript. LLM and MCP participated in the writing of the article, literature review, and final approval of the manuscript. CMPP participated in the literature review and final approval of the manuscript. GGP participated in the organization and surveillance of data collection, compilation of prior database, and revision and final approval of the manuscript. GVM was responsible for the conception of the project, statistical analysis, data interpretation, literature review, and final revision of the manuscript. All authors read and approved the final manuscript.

Competing interests

The authors declare that they have no competing interests.

Ethics approval and consent to participate

This study was approved by the Research Ethics Committee at the Federal University of Minas Gerais (Comitê de Ética em Pesquisa da Universidade Federal de Minas Gerais), according to the Resolution no. 466/2012 of the National Health Council (Conselho Nacional de Saúde), following position no. 213.555. The procedure was explained to all participants prior to the study and the participants were asked to sign a voluntary informed consent.

Author details

[1]Department of Maternal and Child Nursing and Public Health, School of Nursing, Universidade Federal de Minas Gerais—UFMG, Av. Alfredo Balena, 190 - Bairro Santa Efigênia, 30130-100 Belo Horizonte, MG, Brazil. [2]Department of Nutrition, School of Nursing, Universidade Federal de Minas Gerais—UFMG, Av. Alfredo Balena, 190 - Bairro Santa Efigênia, 30130-100 Belo Horizonte, MG, Brazil. [3]University of Coimbra, Coimbra, 374 Portugal. Rua Larga, Edifício Faculdade de Medicina (R/Ch. Esq.), 3004-504 375 Coimbra, Portugal. [4]School of Medicine, Universidade Federal de Uberlândia—UFU, Av. Pará, 1720, Umuarama, 38400-902 Uberlândia, MG, Brazil.

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