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# Neighbourhood environments and obesity among adults: A multilevel analysis of an urban Brazilian context

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ABSTRACT

*Objective*. This study identified environmental variables associated with obesity in the adult population of a city in Brazil.

*Methods*. It was conducted using the Surveillance System for Risk and Protective Factors for Chronic Diseases by Telephone Survey from 2008 to 2010. The body mass index (BMI) was calculated from the participants' self-reported weight and height. Obesity was defined as a BMI ≥ 30 kg/m2. The food establishments, georeferenced areas conducive to physical activity, total income of the neighbourhood, homicide rate and population density were used to characterise the environment. In addition, individual variables were considered. A multilevel logistic regression was performed.

*Results*. A total of 5273 individuals were evaluated. The odds of obesity was found to be significantly decreased with increases in the number of establishments that sell healthy food, number of restaurants, number of places for physical activity and total income — in different models. In addition, these associations remained significant after adjustment for age, gender, education and consumption of meat with visible fat.

*Conclusions*. This study contributes to a better understanding of the complex interaction between environmental and individual determinants of obesity and may aid in the development of effective interventions, such as the expansion of obesity control programmes.



## Introduction

Obesity is a global problem of epidemic proportions and has significant health consequences, especially in the development and progression of many chronic diseases (Choudhary et al., 2007; Low et al., 2009).

In middle-income countries, surveillance systems have found temporal trends of increasing obesity. Estimates of obesity prevalence reached 14.9, 15.8 and 17.1% for each year from 2010 to 2012, respectively (Brazil, 2010; Gigante et al., 2011).

Traditional measures to reduce obesity focus on changing individual behaviours. However, recent studies show that neighbourhood environment plays an important role in determining chronic diseases in several countries because it may discourage or encourage healthy lifestyles (Janssen et al., 2006; Popkin et al., 2005).

Conceptual shifts in understanding the aetiology of obesity from an ecological perspective have been proposed (Egger and Swinburn, 1997). In addition, studies show that characteristics related to the built (e.g., sports facilities, green areas, and the accessibility and availability of places to purchase healthy foods) and social environments may influence obesity rates, even on a local scale (Chaix et al., 2013).

The context of the urbanisation process in developing countries has been complex, with limitations in management and planning. There is a need for an environmental framework, in addition to biological and behavioural factors, to elucidate obesity-related variables (Kirk et al., 2010; Penney et al., 2013).

The objective of this paper is to estimate the association of environmental and individual factors with obesity in adults in a Brazilian urban context.

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## Methods

A cross-sectional study was conducted including 5273 adults, aged 18 to 93 years old, who were participants in the Surveillance System for Risk and Protective Factors for Chronic Diseases by Telephone Survey (VIGITEL) from 2008 to 2010 in the city of Belo Horizonte, Minas Gerais. This system interviews individuals aged 18 years old or older every year, in each of the capitals of the 26 Brazilian states and the Federal District. The databases were requested from the Ministry of Health.

The VIGITEL system collects data from individual standardized questionnaires that assess individual variables and protective and risk factors for non-communicable diseases, including sociodemographic characteristics, eating patterns, physical activity, weight, height, and the frequency of cigarette smoking and alcoholic beverage consumption (Brazil, 2010).

Pregnant women (n = 43) and women who did not know whether they were pregnant at the time of the interview (n = 4) were excluded from the analyses. Individuals without body mass index (BMI) data (n = 506) and georeferenced information (n = 208) were also excluded from this study.

For this study, the dependent variable of obesity was defined as a BMI ≥ 30 kg/m$^2$ (World Health Organization/WHO, 2011). The reported weight and height were used to calculate the BMI.

The individual level variables were gender; age in years; education (≤8, 9 to 11, or ≥12 years of study); marital status (single, married, widowed, or divorced; regular consumption (five or more days a week) of fruits and vegetables; consumption of meat with visible fat; and alcohol, smokers, and inactive behaviours in all domains.

Each participant's residence geographic coordinates (latitude and longitude) were based on their zip code.

The coverage areas (CAs) of the Basic Health Units (BHUs), which are administrative and health units of the public system for the health services in Brazil, were used as neighbourhood units. The city of Belo Horizonte is divided into 148 CAs that belong to nine health districts.

To evaluate the characteristics of the built and social environments within the CAs, we created a database of geocoded information obtained from various commercial and government sources and based on the address of the location.

The environmental variables included the number of restaurants and establishments where healthy foods are available for purchase, public and private places for physical activity, population density, homicide rate, and total income of the CA.

The STATA statistical package (svy function) was used for the statistical analyses. For all analyses, different aspects of the complex sampling design were considered, and the analyses considered the weights of the different probabilities of selection (Brazil, 2010; Carle, 2009).

Because the data structure included individual (level 1) and neighbourhood (level 2) variables, a fixed-effects multilevel logistic regression with random intercept was applied. Estimates of the odds ratio (OR) and 95% confidence interval (95% CI) were used. For all analyses, a 5% significance level was defined.

The median odds ratio (MOR) quantifies the variation in the outcome between clusters while considering the individual variables. The 80% interval odds ratio (IOR) is a measure to quantify the fixed effect of environmental variables (Merlo et al., 2005, 2006). Additionally, a reduction in variance for level 2 was achieved by introducing individual and environmental variables into the models. The Akaike information criterion (AIC) was used to compare the models.

Oral consent was obtained during the telephone interview, and the objectives of this study were approved by the Ethics Committee of the Ministry of Health and Ethics and Research Committee of the Universidade Federal de Minas Gerais — UFMG (no. 25447414.1.0000.5149).

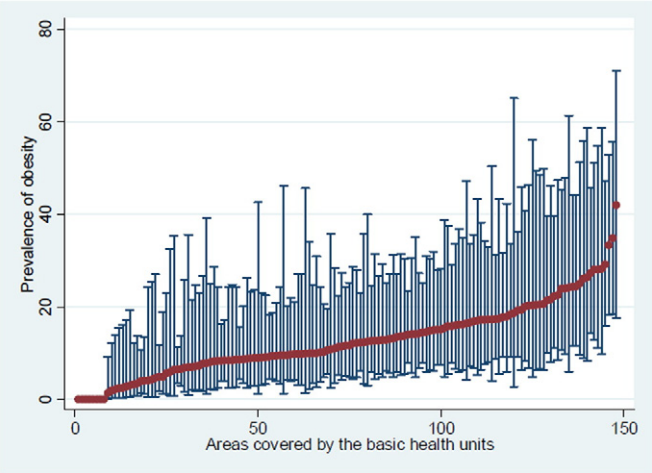


**Fig. 1.** Prevalence of obesity (%) among neighbourhoods. There was variation in obesity prevalence from 0 to 41.94% among coverage areas (likelihood ratio (LR) test, p = 0.002), defining the hierarchical structure of the data.

## Results

This study included 5273 individuals, living in 148 CAs, with an average age of 43.67 years (SD = 16.65). A total of 43.51% of participants were male, and 40.24% had 9 to 11 years of education.

The prevalence of obesity was 12.13% (95% CI: 11.20 to 13.12). Fig. 1 shows a variation in obesity prevalence from 0 to 41.94% among coverage areas (Fig. 1).

In the bivariate analysis, age, education, marital status, eating meat with visible fat, physical activity, number of restaurants, number of establishments selling health food, number of public and private places for physical activity practice, and total income of the neighbourhood were associated with obesity (Tables 1 and 2).

Four multivariate models (Table 3) were constructed. According to Models 1 to 4, for every increase in the number of establishments selling healthy food (OR = 0.88, 95% CI: 0.80 to 0.96), number of restaurants (OR = 0.97, 95% CI: 0.96 to 0.99), number of places for physical activity (OR = 0.89, 95% CI: 0.84 to 0.95), and total income (OR = 0.96, 95% CI: 0.94 to 0.98), the odds of obesity significantly decreases, after adjusting the models for age, gender, education and consumption of meat with visible fat. When compared to the null model, there was a 14.54% reduction in the level 2 variance for individual level variables. In all models, there was a significant reduction in the variance when introducing environmental variables (Table 3).

The MOR was greater than 1 for all models, indicating differences in obesity among areas. In addition, the IOR had a value of 1 in all models, showing that other context variables are necessary to explain the heterogeneity of the neighbourhoods (Table 3).

We observed a reduction in the AIC after the inclusion of individual-level and context variables in all models of Table 3.

## Discussion

This study was conducted with a probabilistic sample of adults within a Brazilian city. In this analysis, increases in the number of establishments that sold healthy foods, the number of public and private places for physical activity, and the total income were characteristics significantly associated with lower odds of obesity. These associations remained significant after adjustment for level 1 variables: age, gender, education, and consumption of meat with visible fat.

This study confirms previous results indicating that the environmental determinants partly explain the variation in health outcomes, i.e., they are a result of a hierarchical structure (Robert and Reither, 2004).