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Consumer food environment and overweight

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ABSTRACT

Objectives: The aim of this study was to investigate the association between aspects of the consumer food environment in food stores selling fruit and vegetables (FVs) and the incidence of overweight among users of a Brazilian primary health care service.
Methods: This cross-sectional study assessed individual-level and food environment variables, within the context of a representative sample of a primary health care service in a Brazilian city (the Health Academy Program [HAP]) in 2013. Users of HAP units and multiple aspects of the consumer food environment (availability, diversity, variety, quality, advertising, and price) related to FVs and ultraprocessed foods (UPFs) were examined. Multilevel logistic models were used to examine the relationships among overweight and consumer environment characteristics. We analyzed 2810 participants and audited 336 food stores.
Results: More than 70% of stores had adequate diversity and variety of FVs; Regarding quality, only 24.5% of stores presented inadequate quality of fruits and 39.6% inadequate quality of vegetables. UPFs were present in 60.6% of FV stores. The results indicated a high prevalence of overweight (62.6%) in participants of the health promotion service and the multilevel models revealed an association with variety of vegetables in stores (0.99; 95% confidence interval, 0.97–0.99; $P < 0.05$).
Conclusions: Given the importance of food environment in food choice at the time of purchase, it is important to consider consumer food environment in determining consumption. The results suggest that increased exposure to healthy foods should be included as guidelines for weight management.

Introduction

Currently, 39% of adults ≥18 y of age are overweight and 13% are obese worldwide [1]. Individual lifestyles, such as diet and physical activity, play an important role in nutritional status. However, individual behaviors are determined by individual and environmental factors that will interact with each other [2].

Studies that investigate the association between body weight and neighborhood features are extensive. However, studies that already explore this link have focused on the availability of stores, although increasingly evidence shows how strategies of products offers are used to stimulate consumption. Aspects that influence the purchase of consumers include availability, marketing, promotions and practiciality of products. In a scenario where ultraprocessed food (UPF) dominates food systems [3], increased overweight and obesity rates occurred in parallel with the growth of UPF availability [4]. Thus, environmental studies are need to take into account the association between UPFs and the development of overweight and non-communicable diseases (NCD). There is also a need to explore aspects of consumer food environment related to UPF in context of supply to healthy food.

The promotion of healthy behaviors is priority; and the aspects of the food environment being key in this context. The stores

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selling good quality, healthy foods like fruits and vegetables (FVs), have contributed to healthy environments because this promote healthy food choices [5–7]. Results show community environments with greater access to stores that sell fresh foods such as FVs are associated with better food choice and lower risk for overweight [6,7]. But in other studies, distance and density of establishments were not associated with dietary intake or body mass index (BMI) of participants [5–7,9,10,]. Despite the evidence that the food system drives the growth of overweight, the complexity of the context makes it a challenge to identify the environmental factors with the greatest affect [11].

Some studies classify food stores as "healthy" and "unhealthy" [9]. Some stores classified as healthy may have high availability of unhealthy foods and advertising associated with them [5]. Therefore, it is important to considerer characteristics of the consumer environment that are not frequently evaluated, to describe what consumers find within the stores, such as food quality, price, and advertising [10–12].

Identification of the aspects of the consumer food environment that are associated with overweight in different countries can contribute to a better understanding of the current dynamics of the food system and its relationship with overweight. Thus, the objective of this study was to evaluate the association between aspects of the consumer food environment in food stores that sell FVs and overweight among users of a Brazilian primary health care system. We evaluated only stores selling FVs to explore the possible competition between healthy and unhealthy foods within those stores and to explore the importance of healthy food in determining overweight.

Methods

Study design, setting, and sample

This study was conducted in Belo Horizonte, the sixth largest city in Brazil and the eighth largest in Latin America, with an estimated population of >2 million [13]. The city is divided into nine administrative districts across which the health centers of the Health Academy Program (HAP) are distributed; all districts were included in study.

The public health system in Brazil has invested heavily in primary care. The system is divided into different health services, such as basic health units and HAP. The HAP service offers free physical exercise classes and focuses on contributing to healthy environments and increasing population autonomy to adopt healthy lifestyles [14]. The innovative HAP service represents an important initiative to promote health and prevent and control prevalence of NCDs in populations with high social vulnerability. It is a relevant service to the environment in which individuals are inserted, advocating intersectoral activities, comprehensive care, and public participation [15]. The participants of HAP are in vulnerable situations, with low socioeconomic conditions and a high prevalence of NCDs [16]. Considering the innovation and importance of this service for primary health care in Brazil, HAP was used as the research settings for this study.

From among 42 eligible HAP units, 18 were selected to participate in the study by stratified cluster sampling and were stratified according to the nine administrative regions of the city, with two units per region. These units were representative of the municipality, with 95% confidence and <1.4% error. More information about methods and sampling can be seen in a previous publication [17].

This cross-sectional study used two data sources: face-to-face individual interviews with HAP users to investigate individual-level measures and food store audits to investigate consumer food environment measures.

Consumer food environment

All stores and open-air food markets that sold FVs and were located within 1600 m (1 mile) of each HAP unit were audited by trained dietitians. The initial information (including address) of the stores and open-air food markets was provided by the city administration. In addition, the study included non-registered stores that were identified during the audit [18].

We investigated the consumer food environment regarding healthy and unhealthy food: fresh FVs (diversity, variety, quality, advertising, and price) and UPFs (availability, variety, advertising, and price). All retail food stores and open-air food markets were systematically assessed using a tool validated for the Brazilian setting [10] and adapted for the 10 most frequently purchased fruits (bananas, oranges, papaya, watermelon, apples, mangos, pineapples, tangerines, grapes and melons) and vegetables (pumpkins, chayote, tomatoes, carrots, lettuce, zucchini, cabbage, beetroot, kale, and okra) in the municipality [19]. Tubers and roots were not considered in the FVs assessments because they are rich in carbohydrates.

The UPFs evaluated included the five most consumed in Brazil [13], which are regular soda, fruit-flavored drinks and juice or nectars with added sugar, cream-filled chocolate cookies, and corn chip snacks.

The measures assessed from the consumer nutrition environment and their classifications are described in Table 1. The availability of FVs and UPFs was evaluated by the presence of at least one item. We determined the variety of FVs by the number of different types of item (e.g., iceberg lettuce, green-leaf lettuce, red-leaf lettuce) and of UPFs by different brands and flavors. The quality was evaluated depending on whether most of the food was withered, bruised, overripe, or old looking [10]. The price index (PI) of FVs and UPFs were analyzed through *z*-score scale, which allowed us to investigate comparable prices of the different items. The *z*-score had a mean of 0 and an SD of 1 and indicated how many SDs the variable was from the mean. It was obtained by subtracting the mean price (of each food item across all the food stores) from each observation and then dividing the difference by the SD.

Individual-level measures

The individuals included HAP participants ≥20 y of age. The exclusion criteria included pregnant women and individuals with cognitive difficulties that prevented participation.

The analysis in this study included only those users who lived within the audited food environment buffer zone and who had at least one food store within 500 m of their homes. This distance was used because it was considered to represent easy access and has been used in several studies on the food environment [20].

Data were obtained through face-to-face interviews. The questionnaire included questions about sex, age (y), marital status (married/with partner or separated/divorced/ never married), educational level (y), the period that each participant had attended the HAP unit (mo), and economic classification (classes A/B, C, D/E). The Brazilian Economic Classification Criteria considers the amount of material assets in the household and the educational attainment of the family head [21].

The outcome variable of this study, overweight, was obtained by BMI (weight [kg]/height [m]^2), which was calculated from the weight and height of each participant, which were measured by trained researchers. We used the proper BMI classification for adults [22] and > 60y participants [23]. Overweight was defined for adults as those with BMI ≥25 kg/m^2 and for elderly as BMI ≥27 kg/m^2. HAP users without weight and height data were excluded from the analyses (n = 188).

Statistical analyses

The characteristics of the participants were presented according to the presence of overweight. To verify association between overweight and individual-level measures, Student's *t* test for independent samples was used for numeric variables and χ^2 for categorical variables. Characteristics of the consumer environment were described by frequencies, mean, and confidence interval (CI).

Multilevel logistic models were used to examine the extent to which consumer food environment explained the overweight adjusted by individual measures. This analysis allows the consideration of the hierarchical structure of the data aggregation level, in addition to the insertion of individual and contextual variables. The individual outcome was overweight, with participants (level 1) nested within HAP centers areas (level 2). The construction of the model was in steps. First we constructed the null model, then the individual variables were inserted, and finally the consumer food environment variables were added. Different models were tested with the possible explanatory variables of the food environment. The final model included the variables that presented the greatest association with the outcome, adjusted for individual variables, and with greater explanatory power. For all models, we checked the quality of the fit and tested possible assumptions violation.

The intraclass correlation coefficient (ICC) was quantified to analyze the variability within and between territories, providing the proportion of total variability that is due to differences between territories.

All analyses were performed with the statistical software package Stata/SE version 14 (StataCorp., College Station, TX, USA) and the statistical significance was set at 5%.

This study has conducted according to the guidelines of the Declaration of Helsinki and all the procedures involving human subjects were by the Ethics Committee University and the City Hall. Written informed consent was obtained from all participants.

Results

We included 2810 participants in the analysis. Most of the participants were older women and had low levels of education (Table 2). The mean BMI was 27.8 kg/m^2 (SD = 4.9), and the

Table 1
Variables assessed within the consumer food environment

Variable	Measure	Evaluation
Fruit diversity	Number of FV among the 10 investigated items	Inadequate: <fourth quartile of fruits number Adequate: fourth quartile of fruits number
Vegetable diversity		Inadequate: <fourth quartile vegetables number Adequate: fourth quartile of vegetables number
UPF availability	Availability of any UPF	Not available: no products were found Available: ≥1 product was found
Variety of certain fruits	Number of different types of FV within each kind (e.g., apple – green apple, gala apple, fuji apple) among the 10 items investigated	Inadequate: <fourth quartile of the total number of available fruit varieties Adequate: fourth quartile of the total number of available fruit varieties
Variety of certain vegetables		Inadequate: <fourth quartile of the total number of available vegetable varieties Adequate: fourth quartile of the total number of available vegetable varieties
UPF variety	The number of different brands and flavors among the 5 items investigated	Little variety: below median Great variety: above median
Fruit quality	Subjective rating (bruised, old-looking, overripe, or spotted) of the 4 most consumed fruits and 4 most consumed vegetables in the city	Good: ≥75% of the investigated fruit were evaluated as good Bad: ≥25% of the investigated fruit were evaluated as bad
Vegetable quality		Good: ≥75% of the investigated vegetables were evaluated as good Bad: ≥25% of the investigated vegetables were evaluated as bad
FV advertising	Presence of printed materials containing messages or images, tasting counters, samples, demonstration or distribution, pennants, posters and banners, display or folder	Not available: no advertising was found Available: ≥1 advertising was found
UPF advertising		Not available: No advertising was found Available: ≥1 advertising was found
FV price index	Standard price of 2 fruit and 2 vegetables more available among the investigated	Mean of the standard index of the evaluated FVs
UPF price index	Standard price of the most consumed brand of soda (350 mL), juice or nectar (1 L), cream-filled chocolate cookie, and corn chip (30–66 g)	Mean of the standard index of the UPFs evaluated

FV, fruit and vegetables; UPF, ultraprocessed food.

majority was overweight (62.6%). Women, individuals aged between 30 and 59 y, married or with partner, within economy class C and lower education were significantly more likely to be overweight (Table 2).

We audited 336 food stores. More than 75% of them had adequate FV diversity and variety. However, the quality of fruits was better than the vegetables, which were inadequate in >33% of the stores. In FV stores, little advertising for this kind of food was observed (23.4%; Fig. 1): 24.1% were related to economy and 44% linked to the FV consumption to health (data not show).

UPFs were available in 60.6% of the audited stores that sell FVs and 51.6% offered a large variety of brands and flavors. The UPFs were available in the same section of FVs in 65.6% of the food stores (Fig. 1). One-third of the stores displayed advertising for UPFs. Advertising was related to economy (24.1%), free gifts (19.1%), and health claims (18.1%) (data not shown). The PI for FVs was −$0.04 ± $0.61 and for UPFs was −$0.13 ± $0.61, without difference between them (data not show).

Table 3 presents the multivariable multilevel logistic regression. In model 1, we observed that being 30 to 59 y of age was associated with being overweight, whereas having ≥9 y of education and not having a partner were inversely associated with overweight. After adjusting for individual-level variables, we observed the only variable of the consumer environment associated with overweight was the variety of vegetables, showing that a smaller variety of vegetables was associated with overweight (Table 3). The between-group variability and the ICC across models were progressively reduced, indicating that the covariates helped to explain overweight.

Discussion

The results confirm our hypothesis that the consumer food environment influences overweight, showing that the variety of vegetables has an effect on overweight. The food environment investigated was characterized by stores that sell FVs with a high availability of UPFs and low quality of vegetables than the fruits. The results suggested that poor variety of healthy foods, such as vegetables, might contribute to an increase in the prevalence of overweight.

FVs consumption is one of the 10 most important risk factors for the global burden of diseases and is associated with mortality and development of chronic diseases, including overweight [24,25]. Studies that aimed to explore the relationship between food environment and individual health outcomes initially hypothesized that better access to stores that sell FVs was associated with better health indicators [26]. Although there is some evidence relating consumer environmental variables to health, the conclusions vary according to the context [8,26]. In the United States, store access and prices were positively associated with obesity [12].

A review of studies conducted in the United States reported that a better availability of healthy foods was associated with a lower self-reported BMI [24]. In other studies, low availability of FVs was associated with worse food quality. Research in Europe showed no association between the availability of healthy foods and nutritional conditions [6]. In Brazil, the association of overweight and food environment was investigated in a study with school children, showing association between the community food environment level and overweight [5]. To our knowledge, this is the first study

Table 2
Individual-level variables by overweight status. Belo Horizonte, Minas Gerais, Brazil, 2013

Variables	Overweight						
	Total		No (n = 1050)		Yes (n = 1760)		
	n	values	n	values	n	values	
Sex (%)							0.018*
Female	2483	88.4	908	86.5	1575	89.5	
Male	327	11.6	142	13.5	185	10.5	
Age (y)							
20–29	48	1.7	20	1.9	28	1.6	<0.001*
30–59	1519	54.1	444	42.3	1075	61.1	
≥60	1243	44.2	586	55.8	657	37.3	
Occupation (%)							
Housewife	822	29.3	283	26.9	539	30.6	<0.001*
Retired	1038	36.9	460	43.8	578	32.9	
Unemployed	46	1,64	17	1.6	29	1.6	
Employed	903	32.15	290	27.2	613	34.8	
Marital status (%)							
Married/With partner	1736	61.8	602	57.3	1134	64.5	<0.001*
Separated/Divorced/Never married/Widow	1073	38.2	448	42.7	625	35.5	
Economic classification (%)†							0.072*
A/B	166	8.1	74	10.5	92	7.5	
C	894	46.4	315	44.5	572	47.4	
D/E	868	45	318	45	550	45	
Education (y)							
≤4	1033	36.8	382	36.4	651	37	0.018*
5–8	689	24.5	288	21.7	461	26.2	
9–11	841	29.9	338	32.2	503	28.6	
≥12	246	8.8	102	9.7	144	8.2	
Time in HAP (mo)‡	2755	20.7 ± 15.9	1028	21.3 ± 15.3	1727	20.4 ± 16.2	0.111§

HAP, Health Academy Program.
*χ^2 test.
†Brazilian Economic Classification Criteria.
‡Mean and SD.
§*t* test.

to explore the relationship between multiple aspects of the consumer food environment (obtained by audit) with overweight, within the public health service setting.

Despite the high diversity and variety of FVs, we observed a low quality of vegetables and a high presence of UPFs. A research in four U.S. cities showed low availability of healthy food items, particularly in single-aisle and small stores [27]. In this way, the food environment is discouraging the consumption of healthy foods. Previews of qualitative data from the same participants for this study showed the barriers to FVs consumption included limited access, low purchasing power, price, and lack of public initiatives [28]. Thus, some aspects related to the consumer food environment can be used as a stimulus for healthy habits such as promotions, advertisements, and arrangement of items in the store [26]. These strategies are more often used by UPFs. To illustrate, in our study we found a large amount of advertisements for UPFs and these ads were present in the FV section.

Although we did not find a relation between UPF access and obesity, we observed a large presence of UPFs in fresh food stores. There is an increasing trend toward places with more UPF variety and availability, which is associated with higher individual UPF consumption and, consequently, overweight [6].

When considering the simultaneous presence of healthy foods and UPFs that promote overweight, some authors emphasize the importance of FVs availability [29,30]. The present study examined this relationship in food stores. Because the only aspect of the environment associated with overweight was the variety of vegetables, the results reinforce the importance of the consumer food environment as it relates to healthy foods for the determination of overweight. The low variety of these foods in food stores can lead to restriction in the consumption of healthy foods. We also highlight that these facts become even more relevant when considering that areas studied were vulnerable, with an average income below the Brazilian population. Public policies can be used to improve access to healthy foods and prevent overweight [31]. These actions could encourage FVs intake, particularly among low-income consumers. However, the low effect observed and the specific evaluation of the context of the health service, suggest the need for further studies to confirm our hypothesis.

This study examined the food features that consumers encounter within the stores. These features often are neglected in research on food environment, limiting the evidence on their association with nutrition and health outcomes [7,9]. Therefore, in this study we aimed to reinforce the need to consider not only physical access to food stores that sell healthy foods to promote weight control, but also different aspects of the consumer food environment such as the availability, diversity, variety, and quality of FVs and UPFs.

The prevalence of overweight in HAP was 62.6%, higher than the prevalence (54%) found in Brazilian adults [32]. One possible explanation for these data is the characteristics of health service participants who were in general women, older, and had low education level [16]. Additionally, access to the service may be by referral from a health professional to control risk factors for NCD, such as being overweight.

Our study was subject to some limitations. The audited food stores were located within a defined radius around participants' homes; however, other food environments, such as food stores closer to their workplaces, may influence the participants. However, it is important to note that most of the participants (67.8%) did not work; thus, we believe the scenario explored (the food

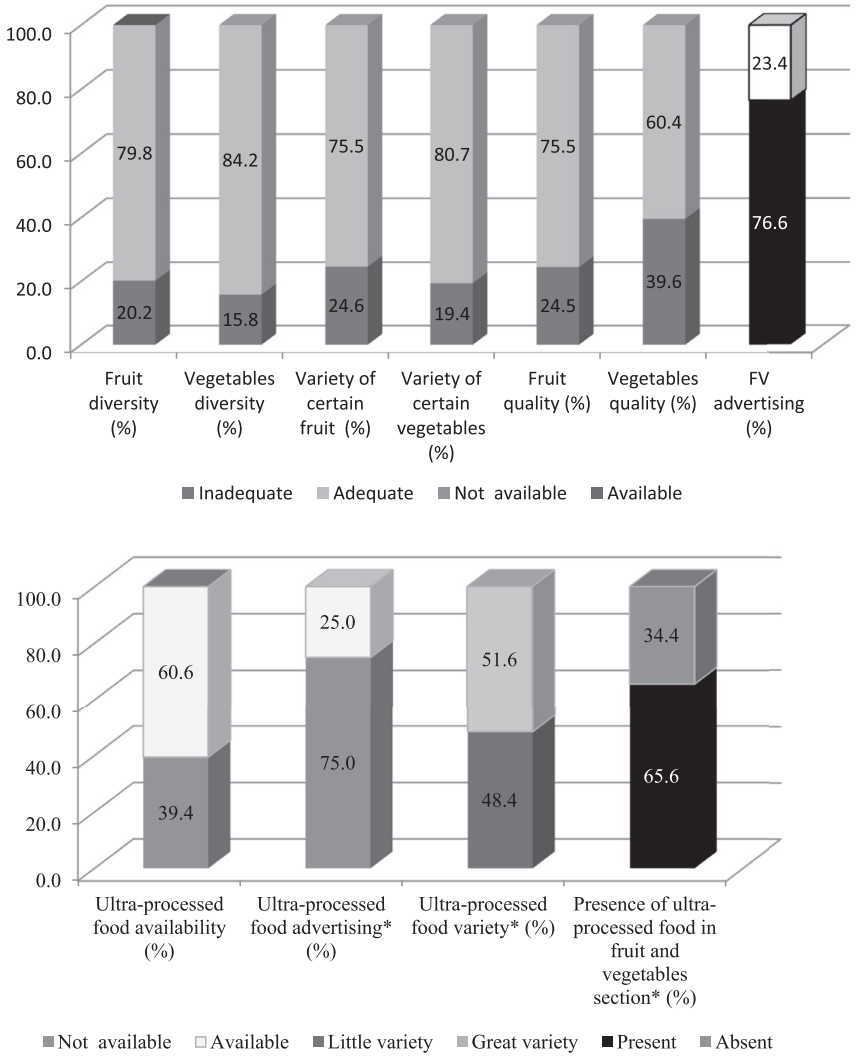

Fig. 1. Consumer environmental variables, Belo Horizonte, Minas Gerais, Brazil, 2013. FVs, fruits and vegetables; UPFs, ultraprocessed food. *Not evaluated in open-air food markets.

environment of the HAP territory) is of great importance because of the health promotion aspect and because users live close and routinely attend the service three times a week for a median of 2 y.

Other contextual factors that may affect overweight have not been evaluated, such as environment to promote physical exercise, like walking trails and parks. However, this study was performed on the context of a health service that offers free physical exercise. The HAP is an intervention model of urban health promotion that provides physical activity to the most vulnerable population, and effects even those who do not use the program [33].

We audited only food stores that sold FVs. In a scenario where people are highly exposed to unhealthy food environments [34], our aim was to evaluate the possible competition between healthy and unhealthy foods within the stores and to investigate the role of a healthy environment in determining overweight. It is also important to note that we investigated the most important food stores in Brazil, which account for the largest percentage of the total daily energy consumed according to a national survey of 55 970 households: supermarkets, small markets and green groceries [35]. However, the participants were also exposed to stores that did not sell healthy foods. In the interpretation of our results, it is important to consider that participants may have an increased exposure to unhealthy foods that further contribute to weight gain.

The composition of the sample may have limited our potential to generalization. Considering external validity, the findings may be extrapolated for primary care users and populations that live in situations of social vulnerability. Although cross-sectional studies do not permit causal inference, the results of the present study suggest that the poor variety of vegetables affected food choice, promoting weight gain. However, more studies, especially longitudinal ones, are needed to confirm this hypothesis.

Conclusions

This study had interesting contributions for literature and implications for health actions. It provided information about the relationship between aspects of the consumer food environment and overweight among individuals with low income and education levels residing in a middle-income country, which is scarce in the literature [6,7]. We audited the consumer food environment and investigated a large number of participants visiting public health services. Actions to promote adequate and healthy food intake should involve consideration of the area in which individuals live as well as their living conditions. Thus, health policies and programs for overweight control and health promotion, like HAP, should include intersectoral actions on the environment, contributing to

Table 3
Multilevel regression model of overweight: Belo Horizonte, Minas Gerais, Brazil, 2013

Variables	Null model		Model 1		Model 2	
	Coefficient	95% CI	Coefficient	95% CI	Coefficient	95% CI
Intercept	1.68	1.51–1.87	1.59	1.28–1.96	3.38	1.80–6.34
			OR	95% CI	OR	95% CI
Individual-level variables						
Sex (%)						
Female			1.00		1.0	
Male			0.83	0.64–1.06	0.84	0.65–1.07
Age, y (%)						
≥60			1.00		1.00	
30–59			2.31	1.94–2.76*	2.33	1.95–2.78*
20–29			1.52	0.83–2.78	1.49	0.82–2.73
Marital status (%)						
Married/With partner			1.00		1.0	
Separated/Divorced/Never married/Widow			0.80	0.68–0.95†	0.80	0.68–0.95†
Education, y(%)						
≤4			1.00		1.0	
5–8			0.96	0.78–1.19	0.98	0.78–1.21
9–11			0.60	0.48–0.74*	0.60	0.48–0.74*
≥12			0.69	0.51–0.94†	0.72	0.53–0.98†
Time in HAP (mo)			0.99	0.99–1.00	0.99	0.99–1.00
Consumer food environment (%)						
Vegetable diversity					1.01	0.99; 1.02
Vegetable variety					0.99	0.97–0.99†
Vegetable quality					1.00	0.99–1.00
Ultraprocessed food availability (%)					1.00	0.99–1.00
Between-group variability (τ00)	0.16	0.07–0.35	0.04	0.0–111.3	0.00	5.63–992.8
Within-group variability (σ2)	0.01	0.00–0.03	0.00	4.7–1.00	1.70	9.6–0.99

FV, fruits and vegetables; HAP, Health Academy Program.
Model 1: individual-level variables; Model 2: consumer environmental variables adjusted for individual variable.
*$P < 0.001$.
†$P < 0.05$.

the creation of health-promoting environments that favor the recommended practices of health care [34].

This study showed that low vegetable access was the major contributor to being overweight in the studied population, revealing that low supply of healthful food choices may increase the risk for overweight. These results suggest that interventions aimed at improving food environment as a strategy to prevent overweight must go beyond promoting availability to food stores that sell fresh food. They also need to act on aspects such as the quality and variety of the food they provide.

References

[1] World Health Organization. Obesity and overweight. Available at: http://www.who.int/mediacentre/factsheets/fs311/en/; 2018. Accessed 04 June 2019.
[2] Schwartz M, Just DR, Chriqui JF, Ammerman AS. Appetite self-regulation: environmental and policy influences on eating behaviors. Obesity 2017;25:S26–38.
[3] Monteiro CA, Cannon G, Levy R, Moubarac JC, Jaime P, Martins AP, et al. NOVA. The star shines bright. Food classification. Public Health World Nutr 2016;7:28–38.
[4] Pan American Health Organization. Ultra-processed food and drink products in Latin America: trends, impact on obesity, policy implication. Washington DC: Author; 2015.
[5] Corrêa EN, Rossi CE, das Neves J, Silva DAS, de Vasconcelos FdAG. Utilization and environmental availability of food outlets and overweight/obesity among schoolchildren in a city in the south of Brazil. J Public Health 2017;40:106–13.
[6] Gustafson A, Hankins S, Jilcott S. Measures of the consumer food store environment: a systematic review of the evidence 2000-2011. J Community Health 2012;4:897–911.
[7] Black C, Moon G, Baird J. Dietary inequalities: what is the evidence for the effect of the neighbourhood food environment? Health Place 2014;27:229–42.
[8] Ni Mhurchu C, Vandevijvere S, Waterlander W, Thornton LE, Kelly B, Cameron AJ, et al. Monitoring the availability of healthy and unhealthy foods and non-alcoholic beverages in community and consumer retail food environments globally. Obes Rev 2013;14(suppl 1):108–19.
[9] Duran AC, Almeida SL, Latorre MR, Jaime PC. The role of the local retail food environment in fruit, vegetable and sugar-sweetened beverage consumption in Brazil. Public Health Nutr 2015;19:1093–102.
[10] Duran AC, Lock K, Latorre MR, Jaime PC. Evaluating the use of in-store measures in retail food stores and restaurants in Brazil. Rev Saúde Pública 2015;49:1–10.
[11] Mackenbach JD, Rutter H, Compernolle S, Glonti K, Oppert JM, Charreire H, et al. Obesogenic environments: a systematic review of the association between the physical environment and adult weight status, the SPOTLIGHT project. BMC Public Health 2014;14:1–15.
[12] Ghosh-Dastidar B, Cohen D, Hunter G, Zenk SN, Huang C, Beckman R, et al. Distance to store, food prices, and obesity in urban food deserts. Am J Prev Med 2014;47:587–95.
[13] Brazilian Institute of Geography and Statistics. Census 2010. Available at: https://cidades.ibge.gov.br/brasil/mg/belo-horizonte/panorama; 2011. Accessed 06 June 2019.
[14] Ministry of Health. Portal No. 2.681, of November 7, 2013. It redefines the Health Academy Program under the United Health System (SUS). Available at: http://sintse.tse.jus.br/documentos/2013/Nov/8/portaria-no-2-681-de-7-de-novembro-de-2013; 2013. Accessed 04 June 2019.
[15] Ministry of Health. Gabinete do ministro. Redefine as regras e os critérios do referente aos incentivos financeiros de investimentos para construção de polos e de custeio e no âmbito do Programa Academia da Saúde e os critérios de similaridade entre Programas em Desenvolvimento no Distrito Federal ou no Município e o Programa Academia da Saúde. Portaria n. 2.684, de 08 de novembro de 2013. Available at: http://bvsms.saude.gov.br/bvs/saudelegis/gm/2013/prt2684_08_11_2013.html; 2013. Accessed 04 June 2019.
[16] Mendonça RD, Horta PM, Santos dos LC, Lopes AC. The dietary profile of socially vulnerable participants in health promotion programs in a brazilian metropolis. Rev Bras Epidemiol 2015;18:454–65.
[17] Menezes MC, Costa BVL, Ferreira NL, Pinheiro de Freitas P, Deus Mendonca R, Lopes MA, et al. Methodological course of a community controlled trial in health: a translational epidemiological research on nutrition. Demetra 2017;12:1203–22.
[18] Costa BVL, Freitas PP, Menezes MC, Guimarães LMF, Ferreira LF, Alves MSC, et al. Food environment: validation of measurement and characterization in the territory with the Academy of Public Health. Cad Saúde Pública 2018;34:e00168817.
[19] Instituto Brasileiro de Geografia e Estatística. Pesquisa de Orçamentos Familiares 2008-2009: Análise do consumo alimentar pessoal no Brasil. Rio de Janeiro: Author; 2011.
[20] Menezes M, Diez Roux A, Costa B, Lopes AC. Individual and food environmental factors: association with diet. Public Health Nutr 2018;21:2782–92.
[21] Associação Brasileira de Empresas de Pesquisa. Brazilian economic classification criteria. Available at: http://www.abep.org/criterio-brasil. Accessed 04 June 2019.

[22] World Health Organization. Obesity: preventing and managing the global epidemic. Report of a WHO Consultation, WHO Technical Report Series 894. Geneva, Switzerland: Author; 2000.
[23] Nutrition Screening Initiative. Nutrition interventions manual for professionals caring for older Americans. Washington DC: Author; 1992.
[24] Rist PM, Buring JE, Kase CS, Kurth T. Healthy lifestyle and functional outcomes from stroke in women. Am J Med 2016;129:715–24.
[25] Khera AV, Emdin CA, Drake I, Natarajan P, Bick AG, Cook NR, et al. Genetic risk, adherence to a healthy lifestyle, and coronary disease. N Engl J Med 2016;375:2349–58.
[26] Engler-Stringer R, Gerrard A, Muhajarine N. The community and consumer food environment and children's diet: a systematic review. BMC Public Health 2014;14:1–15.
[27] Laska M, Borradaile K, Tester J, Foster GD, Gittelsohn J. Healthy food availability in small urban food stores: a comparison of four US cities. Public Health Nutrition 2010;13:1031–5.
[28] Figueira TR, Lopes ACS, Modena CM. Barriers and factors promoting the consumption of fruits and vegetables among users of the Health Academy Program. Rev Nutr 2016;29:85–95.
[29] Neumark-Sztainer D, Wall M, Perry C, Story M. Correlates of fruit and vegetable intake among adolescents: findings from Project EAT. Prev Med 2003;37:198–208.
[30] Soares ALG, Franca GVA, Gonçalves H. Household food availability in Pelotas, Brazil: an approach to assess the obesogenic environment. Rev Nutr 2014;27 (suppl 2):193–203.
[31] Zenk SN, Schulz AJ, Hollis-Neely T, Campbell RT, Holmes N, Watkins G, et al. Fruit and vegetable intake in African Americans income and store characteristics. Am J Prev Med 2005;29:1–9.
[32] Ministry of Health. Secretaria de Vigilância em Saúde. Departamento de Vigilância de Doenças e Agravos não Transmissíveis e Promoção da Saúde, Vigitel Brasil 2017: Vigilância de fatores de risco e proteção para doenças crônicas por inquérito telefônico: Estimativas sobre frequência e distribuição sociodemográfica de fatores de risco e proteção para doenças crônicas nas capitais dos 26 estados brasileiros e no Distrito Federal em 2017. Brasília: Author; 2018.
[33] Fernandes AP, Andrade ACS, Costa DAS, Dias MAS, Malta DC, Caiaffa WT. Health Academies Program and the promotion of physical activity in the city: the experience of Belo Horizonte, Minas Gerais state, Brazil. Ciênc Saúde Coletiva 2017;22:3903–14.
[34] Roberto CA, Swinburn B, Hawkes C, Huang TTK, Costa S. Patchy progress on obesity prevention: Emerging examples, entrenched barriers, and new thinking. Lancet 2015;385:2400–9.
[35] Machado PP, Claro RM, Martins APB, Costa JC, Levy RB. Is food store type associated with the consumption of ultra-processed food and drink products in Brazil? Public Health Nutr 2018;21:201–9.