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Association between the community food environment and dietary patterns in residents of areas of different socio-economic levels of a southern capital city in Brazil

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Abstract

This study aimed to verify the association between the community food environment and dietary patterns in a population of different socio-economic levels. This cross-sectional study was conducted with a sample of 400 adults and elderly aged between 20 and 70 years residing in the central area of Porto Alegre, Rio Grande do Sul. Four dietary patterns were explored: healthy, traditional Brazilian, refined carbohydrates and sugars, and fast food. The community food environment included the identification of all food stores by areas where individuals lived and auditing based on the Nutrition Environment Measures Survey in Stores (NEMS-S) score. Poisson regression was used to estimate the prevalence ratios (PR) and their respective 95 % CI. After the adjustment for individual sociodemographic characteristics, residents of the area with the best community food environment (highest NEMS-S score) had 12 % and 18 % lower probabilities of high consumption (upper tertile) of the traditional (PR = 0·88; 95 % CI (0·78, 0·98)) and refined carbohydrate and sugar (PR = 0·82; 95 % CI (0·73, 0·92)) dietary patterns, respectively, compared with those living in the area with the worst community food environment (lowest NEMS-S score). Healthy and fast-food dietary patterns showed no association with the community food environment. In conclusion, the community food environment is a factor associated with the consumption of certain dietary patterns, independent of individual sociodemographic characteristics. Thus, aspects of the community food environment become important in food and nutrition actions and policies aimed at health promotion.

Keywords: **Community food environment: Food consumption: Dietary patterns: Cross-sectional study: Brazil**

Intense economic and social changes associated with urbanisation that has occurred in the last decades have caused important transformations in the health conditions of the population, since several diseases are associated with the environment where a person lives and its surroundings[1,2]. The community food environment is located in the space where the individual is inserted and where consumers are involved in purchasing their food and make healthy or unhealthy food choices, depending on what is offered to them[3–6]. Thus, it can be defined and characterised by the physical, economic, political and sociocultural environments in which one lives, studies, and/or works, and these four types of environments are substantially interconnected, influencing food choice processes[7–10]. Moreover, it can be divided into macro- and micro-environment, where the former includes the density and location of food stores and proximity of stores to homes, schools and workplaces[9,11], whereas the latter includes availability, variety, quality, price, location and distribution within stores, and food promotion/advertising[9,12].

The community food environment has been an important social characteristic in determining the food consumption of individuals and can influence the food consumption of a given population through the availability, access, price, and quality of food and individual factors, such as culture, preference, acceptability and knowledge of the individual with food[7,13,14]. Studies conducted in high- and middle- to low-income countries, such as Brazil, have pointed out that a favourable community food

Abbreviations: NEMS-S, Nutrition Environment Measures Survey in Stores; PR, prevalence ratios; FFQ, Food Frequency Questionnaire.

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environment, characterised by greater availability of and access to healthy food outlets, may favour healthy eating habits and lower the prevalence of obesity[15–19]. However, studies associating the community food environment with certain types of dietary patterns remain insufficient in the literature, although dietary patterns represent a general picture of food and nutrient intake, characterised based on the usual eating habit of a given population group[20]. In addition, dietary pattern demonstrates real situations of food availability, allowing the understanding of the social constructions in which the individual is inserted[21].

Evidence indicates that the socio-economic status of the neighbourhood may also influence the health of individuals, including factors such as access to health food stores or restaurants due to price and availability[19,22–24]. Socially disadvantaged neighbourhoods tend to have lower availability of healthy foods compared with more advantaged neighbourhoods[25–28], and the distribution of healthy food outlets, as well as fruit and vegetable consumption, is higher in higher-income areas than in lower-income areas[18].

Therefore, based on the aforementioned and considering the existence of few studies on the community food environment in the Brazilian context, this study aimed to verify the association between the community food environment and dietary patterns in a population of adult and elderly residents of areas of different socio-economic levels of a city in southern Brazil.

Methods

Design

This was a cross-sectional, population-based study with a sample of adults aged between 20 and 70 years residing in the coverage area of a primary healthcare service located in the central area of the City of Porto Alegre, Rio Grande do Sul (RS). The present investigation included two stages: first, a data collection sample of the population residing in the territory was performed, and an identification and audit of all food establishments in the territory were performed subsequently. This study was conducted according to the guidelines laid down in the Declaration of Helsinki, and all procedures involving human participants were approved by the Ethics and Research Committee of the Federal University of Rio Grande do Sul (number: 46934015.3.0000.5347). Written informed consent was obtained from all participants.

Study population

The central area of the City of Porto Alegre has approximately 260 000 residents[29] who are served by three primary healthcare services. These services register approximately 12 000 households. Part of these families lives in four geographically well-defined areas of lower socio-economic status (average per capita income, R$ 1700·00), whereas the remaining families live in higher-income areas (average/capita income, R$ 4000·00)[30].

Sample size

The sample size (n 400) was calculated for the main objective of the broader study (social and environmental determinants of food and nutrition: an ecosocial approach)[31]. For the present study, this sample size had the power to identify dietary patterns according to the criteria proposed by Hair *et al.*[32] (five individuals per food item included in the principal component analysis and had 80 % statistical power to detect effect sizes of approximately 0·12 in the prevalence ratios (PR) for the association between food environment levels (exposure) and high consumption of dietary patterns (outcomes).

Sampling process

The inclusion criterion was individuals aged between 20 and 70 years of both sexes. The exclusion criteria were individuals with any physical or mental limitations that impeded data collection and pregnant women. To guarantee different socio-economic and environmental strata in this study, a proportional sample was obtained from residents in different lower- and higher-income areas. In the lower-income areas (areas 1 and 3), with only 250 families, all eligible participants were invited to participate in this study (census sampling); the 201 participants who agreed to participate were included (refusal rate, 16 %). In the higher-income areas (areas 2 and 4), the same number of individuals was included to maintain sample proportionality. A random sampling procedure was used to select the primary sampling unit (households) in these areas (refusal rate, 22 %). Only one individual per household was included. When more than one person in the household met the inclusion criteria, one was randomly selected for interview, alternating the sex of the participants for each household included (i.e. whenever a woman was included, an attempt was made to include a man in the next household, and vice versa).

Regarding the food environment assessment, it included all food retails present in the four areas (lower and higher socio-economic statuses).

Data collection

Individual data were collected through face-to-face interviews conducted between October 2018 and June 2019. A standardised, pre-coded and pre-tested questionnaire was used, contemplating sociodemographic and food consumption data. First, with the help of community health agents, the areas were mapped, and the residences were identified utilising maps and addresses. Thereafter, the research team went to the territory, identifying the individuals who met the inclusion criteria and inviting them to participate in this study. The interviews were conducted immediately or scheduled and took place either at the individuals' residences, preferably, or at the health service, when requested by the participants.

Data on the community food environment were collected between December 2019 and February 2020 by identifying and auditing all food retail establishments in the areas. Each establishment was identified, and this process was performed in pairs, where one researcher identified the trade and recorded the geographical coordinates, whereas the other was responsible for registering the establishment (type of establishment, address and trade name). After the identification and registration, the establishments were visited and evaluated using a standardised form, including information about food availability, price

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and quality. Prior to the identification and audit, the team was trained in the use and application of the form.

Assessment of food consumption (dietary patterns)

Food consumption was determined using a qualitative Food Frequency Questionnaire (FFQ) comprising eighty-five food items. The FFQ was validated for the Porto Alegre population[33]. Respondents reported on all food items consumed in the past year, recorded in the number of days per week, month or year. The food frequency data were transformed into an annual consumption rate[33], and there were no missing FFQ data. The dietary patterns derived from the FFQ were identified using a posteriori method with principal component analysis[34]. First, the food items were divided into forty-eight groups based on the statistical correlations between the dietary items ($P \leq 0{\cdot}05$) and nutritional and cultural similarities (items with a frequency of consumption below 5 % were excluded). Subsequently, the applicability of the method was verified using the Kaiser–Mayer–Olkin test (result obtained = 0·731) and Bartlett's test of sphericity (result obtained = $P < 0{\cdot}001$). Varimax rotation was applied. The number of factors to extract was determined using a scree plot graph and the Kaiser criterion (eigenvalues ≥ 1). The food items with absolute factor loadings of ≥ 0·30 were considered to significantly contribute to a given factor. The denomination of each dietary pattern considered the foods with higher factor loading and cultural aspects of food.

Four dietary patterns were derived: healthy (composed of fruits, vegetables and wholegrains), traditional (composed of foods consumed daily by Brazilians, such as rice, beans, pasta, potatoes and red meat), carbohydrates and refined sugars (composed of sugar, cookies, cakes, soft drinks, chocolate and bread), and fast food (composed predominantly of ultra-processed foods). The healthy dietary pattern presented the highest percentage of variance explanation (10·84 %), followed by the traditional (7·35 %), carbohydrate and refined sugar (4·86 %), and fast-food (4·29 %) dietary patterns. The four dietary patterns identified in the analysis and their respective components, factor loadings, and levels of explained variance are shown in Supplementary Table 1. A consumption score was generated for each dietary pattern, using the 'predict' command. Subsequently, they were stratified into tertiles and categorised into high (tertile 3) and low (tertiles 1 and 2) consumption, since the higher the score, the greater the consumption adherence to the dietary pattern. More details about the procedures and analyses performed to obtain the dietary patterns in this population study are available in a previous publication[35].

Assessment of the community food environment (contextual exposure)

The main exposure was evaluated by the assessment of aspects of the community food environment (food micro-environment), including the number and type of commercial establishments (categorised as butcher shop, candy retail/wholesaler, grocery stores, bakeries, farmers' markets/greengrocers/fruit markets, market/supermarkets and convenience stores). Moreover, the quality of the establishments was assessed by auditing and applying an instrument based on the Nutrition Environment Measures Survey in Stores (NEMS-S)[36]. This instrument was validated and adapted to assess the community food environment in Brazilian urban areas[37], considering an evaluation of the micro-environment, which contemplates the application of a scoring system used to classify food establishments according to the availability and price of 108 food items, in addition to the evaluation of the quality of fruits and vegetables marketed by the establishment. The instrument underwent adaptations in some items, considering the characteristics of the local food reality and based on previously published articles[38,39], and these adaptations were made by foods from the same food group. This system divides foods into three groups: (1) unprocessed or minimally processed foods; (2) refined ingredients for use in culinary preparations and the food industry; and (3) ultra-processed products. The foods in groups 1, 2 and 3 were considered 'healthier,' 'intermediate' and 'less healthy,' respectively. The score of each establishment was calculated by adding the points given to foods from groups 1 to 3 that are available in the food store. Groups 1 and 2 obtained positive points, concentrating the highest score in group 1 for being natural or minimally processed products. Group 3 foods received negative points, composing a total continuous score (between the limits of –30 and 100 points) for each establishment, and as the higher this value, the healthier the establishment was classified[36,37]. Subsequently, the general average was calculated for all establishments investigated and the four different income areas (housing areas). Thus, housing areas were classified ordinally according to the mean NEMS-S score, and it was considered the main contextual exposure, ranging from lowest mean NEMS-S score (area 1) to highest mean NEMS-S score (area 2).

Explanatory variables (covariates)

Demographic and socio-economic characteristics were used to characterise the sample and control for potential confounding factors in the multivariate analysis. The demographic characteristics used included sex (women and men), age in completed years (categorised into age groups), skin colour/race (self-reported according to the categories proposed by the Brazilian Institute of Geography and Statistic[29]: White/Black/Brown/Yellow/Indigenous) and marital status (with partner (married/in union), without partner (single/separated/divorced/widowed)). The following socio-economic characteristics were considered: education in completed years of study (< 8, 8–10, 11 and > 11), monthly family income referred to in minimum wage ranges, considering the Brazilian minimum wage value of R$ 998·00 in 2019 (< 1, 1–2, 3–5, > 5), and receipt of government benefits (not receiving, *Bolsa Família* (family allowance programme in Brazil), retirement or others).

Statistical analyses

Data entry was performed using the EpiData program, with double entry and subsequent comparison. Descriptive statistics were used to characterise the study sample and compare the characteristics between areas of residence/housing areas (1–4). Categorical variables are described using measures of absolute (*n*) and relative (%) frequency, whereas continuous variables are described using measures of central tendency

(mean and median) and dispersion (standard deviation, interquartile range, and minimum and maximum values). Pearson's χ^2 test was used to assess the heterogeneity of sociodemographic and dietary patterns according to housing areas. Fisher's exact test was used to assess the heterogeneity of the types of commerce by housing areas (this test is appropriate when dealing with small counts). The Kruskal–Wallis H test was used to compare the differences in the NEMS-S scores by different housing areas due to the non-parametric distribution of scores.

Unadjusted and adjusted PR were estimated for the association between food environment and high consumption of dietary patterns by Poisson regression with robust variance[40], including their respective 95 % CI obtained by the Wald test for linear trend. The contextual community food environments (exposure variable) included the four housing areas classified ordinally according to the mean NEMS-S score and considering area 1 (with lowest NEMS-S score) as the reference category in the analyses. The dietary patterns were analysed as dichotomous (binary) variables, considering their high consumption (tertile 3) as the outcomes. In addition, a multivariate analysis was performed, adjusting for all individual sociodemographic covariates associated with the high consumption of dietary patterns (outcomes) or food environment levels (exposure), with $P < 0{\cdot}20$ in an unadjusted analysis. All covariates were handled in the multivariate analysis as categorical variables, including the dummy categories of sociodemographic characteristics: sex, age, skin colour/race, marital status, education in completed years of study and family income.

All analyses were performed using Stata software (StataCorp.) version 12.0, with $P < 0{\cdot}05$ considered statistically significant.

Results

In this study, 201 and 199 participants from lower (areas 1 and 3) and higher income (areas 2 and 4), respectively, were included. Thus, 400 participants (mean age, 47·2 (SD = 13·9) years) were included in the final analysis.

Table 1 describes the sociodemographic and food consumption characteristics (dietary patterns) of the total sample and by area of residence. Most of the samples comprised women (75 %), white participants (62·3 %) and participants who lived without a partner (62·8 %). Regarding education in completed years of study, 39·9 % of the participants had 11 years of education, whereas 48·4 % of the participants reported family income of 3–5 minimum wages. The characteristics of area 1 (of lower socio-economic status) showed a predominance of individuals of brown and black, with less education in completed years of study and lower income and who were more often beneficiaries of government social programmes. Concerning the dietary patterns investigated, significant differences were observed according to the area of residence. Housing area 1 (of lower socio-economic status) showed differences from the other areas, characterised by residents with lower consumption of healthy and fast-food dietary patterns and higher consumption of the traditional Brazilian and refined carbohydrate and sugar dietary patterns (Table 1).

Table 2 presents the description of the types of food retail and measures of the assessment score of the supply of healthy and unhealthy foods obtained through the NEMS-S instrument for all the establishments identified and by housing area. A total of fifty-one establishments were identified. The most frequent types of food retail were grocery store (33·3 %, n 17), bakery (23·5 %, n 12), market/supermarket (19·6 %, n 10) and convenience stores (11·8 %, n 6). A significant difference was observed in the distribution of types of commerce among the housing areas; area 1 (of lower socio-economic status) presented a greater difference concerning the other areas, including a presence of convenience stores (40 %) and absence of markets and fruit stores, whereas area 4 (of higher socio-economic status) presented a higher number of market/supermarket (35·3 %) and bakeries (29·4 %) (Table 2).

Regarding the NEMS-S scale score for offering healthy and unhealthy foods in the establishments, a mean score of 17·6 points (SD = 23·9) was found among all the establishments identified in the territory. A lower mean score was observed in area 1 (of lower socio-economic status and with a higher number of convenience stores and absence of market/supermarket), whereas the highest mean score was verified in area 2 (of higher socio-economic status and with a higher number of grocery stores and absence of convenience stores) (Table 2). Data regarding the food items of the scoring system used to rank food establishments according to food availability, price and quality are available in Supplementary Tables 2, 3 and 4.

Table 3 presents the results of the unadjusted and adjusted PR for the association between the community food environment (housing areas classified according to the mean NEMS-S score) and high consumption (tertile 3) of dietary patterns. In the unadjusted analysis, a direct linear association was found between a better community food environment and a higher prevalence of high consumption of healthy and fast-food dietary patterns. In contrast, an inverse linear association was observed between a better community food environment and a lower prevalence of high consumption of traditional and refined carbohydrate and sugar dietary patterns.

After the adjustment for individual demographic characteristics, residents of the area with better community food environment (highest NEMS-S score) had a 12 % lower probability of high consumption (tertile 3) of the traditional dietary pattern (PR = 0·88; 95 % CI (0·78, 0·98)) and an 18 % lower probability of high consumption (tertile 3) of the refined carbohydrate and sugar dietary pattern (PR = 0·82; 95 % CI (0·73, 0·92)) compared with those living in the area with the worst community food environment (lowest NEMS-S score). Healthy and fast-food dietary patterns showed no significant association with the community food environment after adjustment (Table 3).

Discussion

The present study explored the association between the community food micro-environment and dietary patterns in a sample of adult and elderly residents of areas of different socio-economic levels located in the central region of the City of Porto Alegre, RS. Individuals residing in areas with a better community food

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Table 1. Sociodemographic characteristics and dietary patterns of the total sample and by housing area of residents in the coverage territory of a primary healthcare service, City of Porto Alegre, Rio Grande do Sul, Brazil (2018–2019)
(Numbers and percentages, *n* 400)

			Housing areas								
			Lower socio-economic				Higher socio-economic				
			Area 1 (*n* 108)		Area 3 (*n* 137)		Area 2 (*n* 51)		Area 4 (*n* 104)		
	Total *n* 400	%	*n*	%	*n*	%	*n*	%	*n*	%	*P**
Sex											0·743
Men	100	25·0	24	22·2	33	24·1	15	29·4	28	26·9	
Women	300	75·0	84	77·8	104	75·9	36	70·6	76	73·1	
Age group (years)											<0·001
19–36	105	26·3	31	28·7	46	33·6	16	31·4	12	11·5	
37–49	97	24·3	32	29·6	46	33·6	12	23·5	15	14·4	
50–59	110	27·5	25	23·2	38	27·7	6	11·8	38	36·5	
≥60	88	22·0	20	18·5	41	29·9	17	33·3	39	37·5	
Skin colour/race											0·001
White	249	62·3	51	47·2	82	59·9	41	80·4	75	72·1	
Black	78	19·5	30	27·8	28	20·4	6	11·8	14	13·5	
Brown/Yellow	73	18·3	27	25·0	27	19·7	4	7·8	15	14·4	
Marital status											0·131
With partner	149	37·3	40	37·0	58	42·3	12	23·5	39	37·5	
Without partner	251	62·8	68	63·0	79	57·7	39	76·5	65	62·5	
Education (years of study), *n* 395											<0·001
<8	73	18·5	39	37·5	25	18·4	3	5·9	6	5·8	
8–10	73	18·5	23	22·1	32	23·5	3	5·9	15	14·4	
11	146	39·9	30	28·9	51	37·5	23	45·1	42	40·4	
>11	103	26·1	12	11·5	28	20·6	22	43·1	41	39·4	
Family income (MW)											<0·001
<1	22	5·5	11	10·2	9	6·6	1	2·0	1	1·0	
1–2	112	28·1	44	40·7	44	32·4	9	17·7	15	14·4	
3–5	193	48·4	45	41·7	62	45·6	26	51·0	60	57·7	
>5	72	18·0	8	7·4	21	15·4	15	29·4	28	26·9	
DP 1 – healthy											0·069
Tertile 1 + 2 (low consumption)	266	66·5	76	70·4	96	70·1	26	51·0	68	65·4	
Tertile 3 (high consumption)	134	33·5	32	26·6	41	29·9	25	49·0	36	34·6	
DP 2 – traditional (Brazilian)											<0·001
Tertile 1 + 2 (low consumption)	266	66·5	57	52·8	79	57·7	44	86·3	86	82·7	
Tertile 3 (high consumption)	134	33·5	51	47·2	58	42·3	7	13·7	18	17·3	
DP 3 – refined carbohydrates and sugars											<0·001
Tertile 1 + 2 (low consumption)	267	66·8	54	50·0	85	62·0	43	84·3	85	81·7	
Tertile 3 (high consumption)	133	33·2	54	50·0	52	38·0	8	15·7	19	18·3	
DP 4 – fast food											0·002
Tertile 1 + 2 (low consumption)	266	66·5	87	80·6	81	59·1	35	68·6	63	60·6	
Tertile 3 (high consumption)	134	33·5	21	19·4	56	40·9	16	31·4	41	39·4	

MW, minimum wages; DP, dietary pattern; others = pension, cash transfer programme (*Bolsa Família*) or others.
* *P*-value for Pearson's χ^2 test for the heterogeneity of proportions (difference between categorical groups).

environment (higher NEMS-S score) had a lower probability of high consumption of the traditional Brazilian and refined carbohydrate and sugar dietary patterns compared with those residing in areas with the worst community food environment. Healthy and fast-food dietary patterns had no association with the community food environment.

A potential explanation for the association between the community food environment and food choice and consumption would be related to the availability and accessibility of food in the environment, since lack of food availability significantly affects food choice considering that food must be available before it can be purchased[14]. Individual choice can also be an important aspect of this association. People can experience multiple influences related to individual factors (cognitive, behavioural, biological and demographic) and the social and built environment and macro-environment, and these factors interact with each other directly and indirectly and can affect eating behaviour[41].

The income was also an important aspect, considering that in the present study, the area of better community food environment also had a better socio-economic status, which corroborates the findings in the literature that the number and distribution of establishments that sell healthy foods tend to be greater in higher-income areas, promoting greater access to these foods, than in lower-income areas[18,42,43]. Thus, living near supermarkets and specialty stores, such as fruit stands, tends to increase the consumption of fruits, vegetables and low-calorie snacks[44,45]. In contrast, previous studies have indicated that compared with residents of less economically vulnerable neighbourhoods, residents of more economically vulnerable neighbourhoods tend to have less access to food shopping places, such as markets, fairs and grocery stores, and thus have lower

Table 2. Distribution of food retail and measures of central tendency and dispersion for the score of evaluation of the supply of healthy and unhealthy foods, obtained using the Nutrition Environment Measures Survery in Stores (NEMS-S), commercialised in the establishments identified in the areas, total and by housing area, of coverage of a primary healthcare service, City of Porto Alegre, Rio Grande do Sul, Brazil (2020)
(*n* 51)

			Housing areas								
			Lower socio-economic				Higher socio-economic				
	Total *n* 51		Area 1 (*n* 10)		Area 3 (*n* 11)		Area 2 (*n* 13)		Area 4 (*n* 17)		
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*P*
Types of commerce*											0·035
Butcher shop	1	1·9	0		0		0		1	5·9	
Retail/wholesale candy	2	3·9	0		0		1	7·7	1	5·9	
Grocery store	17	33·3	5	50·0	3	27·3	7	53·9	2	11·8	
Bakery	12	23·5	1	10·0	3	27·3	3	23·1	5	29·4	
Sacolão/quitandas/fruit tree	3	5·9	0		1	9·1	0		2	11·8	
Market/supermarket	10	19·6	0		2	18·2	2	15·4	6	35·3	
Convenience stores	6	11·8	4	40·0	2	18·2	0		0		
NEMS-S score**											
Group 1 – healthy											0·703
Mean	30·8		20·8		31·8		36·5		31·6		
SD	24·8		20·7		26·6		24·4		26·6		
Median	30		12·5		30		48		31		
IQR	6, 52		7, 37		5, 50		6, 52		8, 60		
Min–max	0, 75		1, 60		0, 73		2, 75		0, 73		
Group 2 – intermediate											0·549
Mean	7·8		7·6		6·6		9·5		7·5		
SD	5·6		3·1		5·7		5·5		6·6		
Median	8		7·5		7		10		7		
IQR	3, 11		6, 10		0, 11		5, 15		1, 13		
Min–max	0, 19		3, 13		0, 15		0, 17		0, 19		
Group 3 – Unhealthy											0·934
Mean	−21·0		−21·8		−20·5		−22·8		−19·5		
SD	9·2		6·1		11·3		7·6		10·7		
Median	−24		−23		−20		−24		−22		
IQR	−28, −16		−26, −20		−28, −16		−28, −16		−28, −10		
Min–max	−34, 0		−30, −10		−34, 0		−34, −8		−32, 0		
Total NEMS-s (groups 1 + 2 + 3)											0·424
Mean	17·6		6·6		17·9		23·2		19·6		
SD	23·9		19·6		25·7		23·6		25·4		
Median	21		1–5		22		31		20		
IQR	−7, 39		−8, 21		−12, 39		−1, 38		−1, 43		
Min–Max	−17, 62		−16, 43		−16, 54		−17, 58		−15, 62		

IQR, interquartile range; Min–Max, minimum and maximum values.
* *P*-value for Fisher's exact test for the heterogeneity of proportions (difference between areas).
** NEMS-S score: *P*-value for the Kruskal–Wallis *H* test for score comparison between areas.
High quality: fruit/vegetable that scored positively in the five quality evaluation items (integrity, maturation, colour, odour and cleanliness).

availability and variety of healthy foods, which when available are of low quality and have higher prices. This causes the population living in this area to prioritise the essential food items, such as bean consumption and reducing the purchase of fresh fruits and vegetables[46–49].

In this study, the area with the best community food environment was characterised by the higher socio-economic status, higher number of grocery stores and absence of convenience stores, whereas the area with the worse community food environment was characterised by lower socio-economic status, higher number of convenience stores, and absence of market/supermarket and fruit stores. In this regard, previous studies conducted in high-income countries have indicated that low-income communities tend to have more convenience stores compared with middle- to high-income communities, including greater availability and sale of predominantly processed, high-energy foods and few fresh products[50–52]. However, a study that aimed to describe the community food environment of a medium-sized municipality in southern Brazil according to the sociodemographic characteristics of the surroundings found that higher-income areas had a greater number of convenience stores than lower-income areas[13]. A possible explanation for this difference between the findings may stem from the fact that the present study explored a central area of a capital city, possibly with characteristics more similar to areas in developed countries. Nevertheless, regarding the types of commerce, this study verified a higher number of grocery stores in the area of better community food environment (higher NEMS-S score), indicating a high presence of healthy foods in this type of commerce. This finding is still contradictory in the literature, as although some studies have pointed to higher availability of healthy foods in grocery stores, others have indicated a lower availability of these foods in grocery stores[50,53–56].

Table 3. Unadjusted and adjusted prevalence ratios (PR) for the association between the community food environment and high consumption (tertile 3) of dietary patterns (DP) among residents in the coverage territory of a primary healthcare service, City of Porto Alegre, Rio Grande do Sul, Brazil (2018–2019) (Numbers and percentages; prevalence ratio and 95 % confidence intervals, *n* 400)

			Unadjusted			Multivariate (adjusted)**		
	n	%	PR	95 % CI	*P**	PR	95 % CI	*P**
DP 1 – healthy								
Food environment (NEMS-S)					0·025			0·253
Area 1 (lowest score)	32	29·6	1·00			1·00		
Area 3	41	29·9	1·00	0·92, 1·10		0·99	0·91, 1·08	
Area 4	36	34·6	1·04	0·94, 1·14		0·98	0·88, 1·09	
Area 2 (highest score)	25	49·0	1·15	1·03, 1·29		1·10	0·98, 1·25	
DP 2 – traditional (Brazilian)								
Food environment (NEMS-S)					<0·001			0·018
Area 1 (lowest score)	51	47·2	1·00			1·00		
Area 3	58	42·3	0·97	0·89, 1·05		1·01	0·93, 1·09	
Area 4	18	17·3	0·80	0·73, 0·87		0·92	0·83, 1·02	
Area 2 (highest score)	7	13·7	0·77	0·70, 0·86		0·88	0·78, 0·98	
DP 3 – refined carbohydrates and sugars								
Food environment (NEMS-S)					<0·001			<0·001
Area 1 (lowest score)	54	50·0	1·00			1·00		
Area 3	52	37·9	0·92	0·84, 1·00		0·93	0·86, 1·02	
Area 4	19	18·3	0·79	0·72, 0·86		0·85	0·77, 0·94	
Area 2 (highest score)	8	15·7	0·77	0·69, 0·86		0·82	0·73, 0·92	
DP 4 – fast food								
Food environment (NEMS-S)					0·030			0·622
Area 1 (lowest score)	21	19·4	1·00			1·00		
Area 3	56	40·1	1·18	1·08, 1·28		1·15	1·05, 1·25	
Area 4	41	39·4	1·17	1·06, 1·28		1·12	1·01, 1·24	
Area 2 (highest score)	16	31·4	1·10	0·98, 1·23		1·01	0·90, 1·14	

NEMS-S, Nutrition Environment Measures Survey in Stores.

* *P*-value for the Wald test for linear trend obtained through Poisson regression with robust variance. The contextual community food environments (exposure variable) include the four housing areas classified ordinally according to the mean NEMS-S score and considering area 1 (with lowest NEMS-S score) as the reference category in the analyses. The dietary patterns were analysed as dichotomous (binary) variables, considering their high consumption (tertile 3) as the outcomes.

** Multivariate model adjusted for all individual sociodemographic covariates associated with the high consumption of dietary patterns (outcomes) or with the food environments levels (exposure), with $P < 0{\cdot}20$ in an unadjusted analysis. All covariates were handled in the multivariate analysis as categorical variables, including the dummy categories of socio-demographic characteristics: sex, age, skin colour/race, marital status, education in completed years of study and family income.

The area with the worst community food environment (lowest NEMS-S score) identified in this study can be classified as a food desert, considering that this term is defined as areas especially in low-income communities that do not provide access to foods that make up a healthy diet due to the low availability of establishments that sell these products, such as supermarkets, or by the difficult accessibility to these establishments[57,58]. Furthermore, the US Department of Agriculture defines a food desert as a place with low access to healthy foods and low income[6].

Finally, our results can provide key recommendations for health and food public policies. Understanding the role of environmental factors on food intake becomes increasingly necessary to understand the complex association between food behaviours and socio-economic aspects. Our findings highlighted the role of neighbourhood socio-economic characteristics on the community food environment and, consequently, individual food consumption. Thus, an agenda of the proposition of specific food and nutrition strategies, actions, and policies for health promotion and disease prevention in the population should necessarily consider driving changes in the community food environment, mainly in disadvantaged socio-economic neighbourhoods.

This is considered one of the first studies to explore the community food environment as an important factor associated with the consumption of specific dietary patterns in the Brazilian context. Thus, the strengths of this study are the inclusion of a sample of adults and elderly residents of a health territory located in the central area of a capital city in southern Brazil and the use of previously tested and validated instruments for the assessment and characterisation of the community food environment and for obtaining and defining dietary patterns. It is also noteworthy that multivariate analyses were performed for the association between the community food environment and dietary patterns, including control for important confounding factors, which reinforces the methodological rigour of the present study. However, some limitations should be highlighted and mentioned. One limitation of the present study concerns its design, considering that cross-sectional studies are limited as to the establishment of temporality between exposure and outcome, but this limitation may be attenuated since these residents have lived in the territory for a long time. In addition, the evaluation of dietary patterns has limitations regarding the subjectivity of the decisions made by the researchers and the use of a retrospective method, not ruling out a possible presence of recall error. Another possible limitation refers to the fact that this study was conducted with a sample that was not representative of the general population, including an overrepresentation of women. Thus, our findings must be taken with caution, and further investigations are necessary to elucidate the understanding of this association in other population groups.

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Conclusions

The present study revealed an important association between the community food environment and consumption of specific dietary patterns, independent of individual sociodemographic characteristics. Residents of an area with a better community food environment were less likely to have a high consumption of the traditional and refined carbohydrate and sugar dietary patterns compared with residents of an area with the worst community food environment. Furthermore, the presence of grocery stores was an important type of commerce for a better community food environment, whereas the presence of convenience stores and the absence of a market/supermarket tended to worsen the community food environment. Thus, aspects of the community food environment become important in food and nutrition actions and policies aimed at promoting health.

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I. J. D. A., A. G., V. B., C. M. L. C., I. S. and R. C. conceived the objective and processed data of this study; I. J. D. A., R. C. and A. G. analysed data and drafted the manuscript; I. J. D. A., A. G., R. C., V. B. and I. S. interpreted the findings and reviewed manuscript for important intellectual content. All authors read and approved the final manuscript.

The authors declare that they have no conflict of interest.

Supplementary material

For supplementary material/s referred to in this article, please visit https://doi.org/10.1017/S0007114522001969

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