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Factors associated with diet quality among Brazilian individuals with cardiovascular diseases

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Abstract

Background: An individual's dietary pattern contributes in different ways to the prevention and control of recurrent cardiovascular events. However, the quality of the diet is influenced by several factors. The present study aimed to evaluate the quality of the diet of individuals with cardiovascular diseases and determine whether there is an association between sociodemographic and lifestyle factors.

Methods: This is a cross-sectional study carried out with individuals with atherosclerosis (coronary artery disease, cerebrovascular disease or peripheral arterial disease) recruited from 35 reference centres for the treatment of cardiovascular disease in Brazil. Diet quality was assessed according to the Modified Alternative Healthy Eating Index (mAHEI) and stratified into tertiles. For comparing two groups, the Mann–Whitney or Pearson's chi-squared tests were used. However, for comparing three or more groups, analysis of variance or Kruskal–Wallis was used. For the confounding analysis, a multinomial regression model was used. $p < 0.05$ was considered statistically significant.

Results: In total, 2360 individuals were evaluated: 58.5% male and 64.2% elderly. The median (interquartile range [IQR]) of the mAHEI was 24.0

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(20.0–30.0), ranging from 0.4 to 56.0 points. When comparing the odds ratios (ORs) for the low (first tertile) and medium (second tertile) diet quality groups with the high-quality group (third tertile), it was observed that there was an association between diet quality with a family income of 1.885 (95% confidence intervals [CI] = 1.302–2.729) and 1.566 (95% CI = 1.097–2.235), as well as physical activity of 1.391 (95% CI = 1.107–1.749) and 1.346 (95% CI = 1.086–1.667), respectively. In addition, associations were observed between diet quality and region of residence.

Conclusions: A low-quality diet was associated with family income, sedentarism and geographical area. These data are extremely relevant to assist in coping with cardiovascular disease because they enable an assessment of the distribution of these factors in different regions of the country.

KEYWORDS

atherosclerosis, cardiovascular diseases, diet patterns, diet quality, modified alternative healthy eating index

Key points

A better diet quality was observed for individuals who practiced physical activity, with a medium or high family income, as well as for individuals residing in the Northeast region of Brazil. By contrast, poor diet quality was observed in individuals residing in the South Region. When analysing the level of education, the increase in the consumption of vegetables, whole grains and fruits was associated with education, being higher for those with 13 years or more of study ($p = 0.047$; $p = 0.012$) and 9–12 years of study ($p = 0.008$), respectively, compared to those who studied up to 8 years. These findings are relevant to understanding the factors that may be associated with diet quality in different regions of the country.

INTRODUCTION

Cardiovascular diseases (CVD) are the leading cause of death at the global level for the last 20 years. Data from the World Health Organization (WHO) show that CVDs represent 32% of all global deaths.[1] In Brazil, although CVD mortality rates have decreased in recent years, the total number of CVD deaths has increased, probably as a result of population growth and increased life expectancy.[2]

Secondary cardiovascular prevention is defined as preventive care carried out on a continuous and early basis, with a focus on risk stratification, access to reference health services and the adoption of interventions aimed at halting the progression of the disease.[3]

It is known that the individual's dietary pattern contributes in different ways to the prevention and control of recurrent cardiovascular events[4,5] and this is why changes in lifestyle and the adoption of healthy eating habits are important strategies for individuals in secondary prevention.[3,6,7] Studies have shown that the quality of the diet is influenced by socio-economic aspects[8] and lifestyle[9] because high-quality diets are associated with higher purchasing power[10] and a lower prevalence of sedentary lifestyle.[11] The data are extremely relevant for the Brazilian population because Brazil is a continental country of extreme diversity in terms of eating habits, lifestyle, social and economic aspects.[2]

Some indices for assessing the global quality of the diet have been proposed to qualitatively estimate the eating habits in populations or groups of individuals.[4] These can be classified into indices based on the adherence to dietary recommendations, in food or dietary standards associated with the risk of chronic diseases and based on statistical data.[12] Among them, we have the Alternative Healthy Eating Index (AHEI), which measures adherence to dietary guidelines and was highly predictive of CVD risk.[13] Its modified version, called Modified Alternative Healthy Eating Index (mAHEI), has been described in a prospective cohort study in 40 countries with high cardiovascular risk individuals.[5]

Thus, considering the importance of adopting healthy eating habits for cardiovascular prevention and that the recognition of the diet quality of individuals with CVD makes it possible to monitor the main dietary factors and carry out early interventions, the present study aimed to evaluate the quality of the diet of individuals with CVD and determine whether there is an association between sociodemographic and lifestyle factors.

METHODS

Study approach and design

This is a cross-sectional study based on baseline data from an open-label, randomised, multicentre trial performed in 35 sites in Brazil, entitled: 'Effect of the Brazilian Cardioprotective Food Program on the Reduction of Events and risk factors in the secondary prevention of cardiovascular disease: a randomised clinical trial (BALANCE)',[14] developed by the Research Institute (RI) of the Hospital do Coração (RI-HCor) in partnership with the Programa de Apoio ao Desenvolvimento Institucional of the Brazilian Public Health System (PROADI-SUS), Brazilian Ministry of Health.

Research centre and participants

A cross-sectional study was carried out with the participants of the BALANCE study recruited from 35 reference centers for the treatment of CVD, located in different regions of Brazil, considering cultural diversity, economic aspects, access and use of health services.[2] Subjects were aged 45 years and over, of both sexes, with evidence of manifest atherosclerosis (coronary artery disease, cerebrovascular disease or peripheral artery disease) confirmed by a physician at most 10 years prior to enrolment in the study.

Individuals without a 24-h food recall; those with a psychiatric/neurocognitive condition that prevented data collection; with a life expectancy of fewer than 6 months, pregnancy or lactation; liver failure with a history of encephalopathy or anasarca; kidney failure with an indication for dialysis; congestive heart failure; organ transplantation; gastroplasty; wheelchair users and participants with oral feeding difficulties were not included. A detailed description of the study design, sample size and recruiting centres was previously published.[14,15]

Socio-economic and clinical assessment

A structured form was used to collect sociodemographic information regarding the Brazilian region of residence, gender, age, lifestyle (smoking and physical activity level) and socio-economic data. The level of physical activity was classified according to the activities performed by the individual in sedentary and active (light activity, moderate activity and intense activity).[16]

The socio-economic classification was performed through an adaptation in the definition by Associação Brasileira de Empresas de Pesquisa (Brazilian Economic Classification Criteria),[17] in which low family income was equivalent to an average family income of R$1700.00 per month or U$319,0; middle family income means average family income of R$7000.00 per month or U $1313.3; higher family income means an average family income of R$ 20,888.00 per month or US$ 3919.0. Schooling was classified as no study or less than a complete year of study: from 1 to 8, from 9 to 12, and 13 or more years of study.

Regarding clinical variables, data were collected from medical records on an established diagnosis of CVD (coronary artery disease, cerebrovascular disease or peripheral arterial disease), and the presence of comorbidities (diabetes mellitus, arterial hypertension and dyslipidaemia).

Anthropometric assessment

Anthropometric measures were performed according to standardised techniques.[18–20] Body mass index (BMI) and waist circumference (WC) were used as anthropometric indicators. Body weight (kg) and height (m) were measured for later calculation of BMI.

Assessment of the nutritional quality of the diet

Regarding the analysis of food intake, the 24-h food recall of the initial visit was used. The recalls were obtained using the multiple-pass methodology, which is a method proposed by the United States Department of Agriculture (USDA),[21] with the use of a photo album of measurements and portions of food, aiming to increase the reliability of the information collected. For the analysis of the nutritional composition of the R24H obtained, the Nutriquanti® (São Paulo, Brazil)) program was used, which prioritises the Brazilian nutritional composition tables.

Diet quality was assessed according to the mAHEI. The mAHEI is based on seven items: consumption of vegetables; fruits; nuts (oilseeds and legumes) and soy protein; the ratio between fish intake and consumption of red meat and eggs; whole grains; fried foods; and alcohol intake. Each component has criteria to reach a minimum score (0 points), for the absence of consumption, except for the alcohol and fried foods component, and a maximum score (10 points) when reaching the recommended portion. However, the intermediate values, between 0 and 10, were calculated in proportion to the consumption. All component scores were added together, giving rise to the mAHEI, with a score ranging from 0 to 70 points, in which higher scores mean better diet quality.[5]

Training of researchers and data collection

Measurements of variables that could suffer deviations in the results caused by inter- and intra-observer variations,

such as anthropometric measurements and food consumption, were performed by previously trained nutritionists using standardised procedures.

Statistical analysis

Data were entered into an online data management system developed by RI-HCor. The information was analysed periodically in search of conflicting data, aiming to correct inconsistencies. For data analysis, the SPSS, version 17 (IBM Corp., Armonk, NY, USA) was used.

The mAHEI score was stratified into tertiles, considering the total mAHEI score. Diet quality was considered as: first tertile – low quality, score up to 20.0; second tertile – average quality, score between 21.0 and 27.0; and third tertile – high quality, score equals to or greater than 28.0.

Considering that the Brazilian territory is marked by deep regional inequalities, for comparison, the grouping of recruitment centres was carried out, according to their location, with the Brazilian regions being used as a reference.

Categorical variables were expressed by absolute and relative frequency and continuous variables by mean and standard deviation (SD) or median (Md) and interquartile range (IQR). To compare two groups, the Mann–Whitney or Pearson's chi-squared tests were used. In the comparison among three or more groups, analysis of variance or Kruskal–Wallis were performed. $p < 0.05$ was considered statistically significant.

For the confounding analysis, a multinomial regression model was used, with the quality of food as dependent variable (mAHEI) and, as independent variables, those that presented $p < 0.05$ in the bivariate analysis, comprising family income, region of residence, smoking and physical activity. For analysis, reference categories (the best option) were created for each variable, namely: family income – 'high income'; 'region of residence' – Northeast; smoking – 'no smoking' and physical activity – 'active'. In turn, for the dependent variable, the third tertile – 'high quality of the diet' was used as the reference category. The results are presented as the odds ratio (OR) and respective 95% confidence interval (CI).

RESULTS

Out of the 2534 individuals recruited for the study, 174 patients were excluded because they did not have the 24-h food recall at the initial visit. The final sample consisted of 2360 individuals, with a mean (SD) age of 63.2 (9.0) years, 58.5% male and 64.2% elderly. Regarding the region of the country, individuals from the Southeast region (34.1%) predominated, followed by the South (27.2%) and Northeast (25.5%) regions (Table 1). Regarding comorbidities, 90.2% of individuals had a diagnosis of arterial hypertension, 77.8% were dyslipidaemia, 44.2% had diabetes mellitus and 38.4% were obese.

The median (IQR) of the mAHEI was 24.0 (20.0–30.0), ranging from 0.4 to 56.0 points. Low scores were observed for the components whole grains (1.0 [1.0–1.0] points), a ratio of fish/red meat and eggs (0.0 [0.0–0.0] points), vegetables (1.7 [1.7–3.9] points) and fruits (2.9 [0.5–5.7] points), and higher scores for the nuts and soy protein groups (10 [0.0–10.0] points) and fries (10.0 [10.0–10.0] points).

Differences in sociodemographic variables were observed according to lifestyle. Diet quality in individuals who practiced physical activity, with middle or high family income and individuals residing in the Northeast Region, had higher diet quality. By contrast, poor diet quality was more frequently observed in individuals with low average family income, residents of the South Region and those with active smoking, as described in Table 1. The results of the multinomial regression analysis are provided in the Appendix (Table A1). When comparing the low (first tertile) and medium (second tertile) diet quality groups with the high-quality group (third tertile), it was observed that the associations between diet quality and family income, region of residence and physical activity remained; however, the association with smoking disappeared after adjustment.

When analysing the mAHEI qualitatively, Tables 2–4 present the scores of the index components, according to the region of residence, average family income and level of education, respectively. In Table 2, it is observed that the Southeast Region of Brazil, compared to the other regions, presented a higher frequency of individuals who reached the minimum mAHEI score in the fruit component ($p = 0.039$), the ratio of fish/meat and eggs ($p < 0.001$), and whole grains ($p = 0.006$). By contrast, the Northeast Region had a higher frequency of individuals who reached the maximum mAHEI score in these components.

When analysing the components of the mAHEI and the average family income, an increase in the consumption of vegetables was observed as the family income increased; however, no significant difference was observed between the other components of the mAHEI (Table 3). When analysing the level of education, it was observed that the increase in consumption of vegetables, whole grains and fruits was associated with education, being higher for those with 13 or more years of schooling ($p = 0.047$; $p = 0.012$) and 9–12 years of study ($p = 0.008$), respectively, compared to those who studied up to 8 years.

Figure 1 shows the distribution of data according to the mAHEI, according to the Region, with a higher mAHEI score being observed in the Northeast Region (25.2 [20.0–31.5]), followed by the Midwest Region (24.6 [20.4–30.0]), Southeast (24.1 [20.0–29.2]), North (24.0 [16.9–30.0]) and South (23.2 [18.4–29.1]), $p < 0.001$.

TABLE 1 Comparison between Modified Alternative Healthy Eating Index (mAHEI) tertiles, sociodemographic, lifestyle and anthropometric characteristics of individuals with cardiovascular disease, Brazil, 2013–2017.

Characteristics	Total ($n = 2.360$)	mAHEI tertiles			p value
		Tertile 1 (up to 20.0)	Tertile 2 (from 21.0 to 27.0)	Tertile 3 (28.0 and over)	
Age, mean (SD)	63.2 (9.0)	62.8 (9.0)	63.6 (9.0)	63.0 (8.9)	0.145[a]
Gender, *n*, (%)					0.138[b]
Male	1380 (58.5)	392 (28.4)	507 (36.7)	481 (34.9)	
Women	980 (41.5)	301 (30.7)	363 (37.0)	316 (32.2)	
Family income, *n* (%)					0.01[b]
Low	303 (14.0)	107 (35.3)	119 (39.3)	77 (25.4)	
Middle	1234 (57.0)	354 (28.7)	440 (35.7)	440 (35.7)	
High	627 (29.0)	173 (27.6)	232 (37.0)	222 (35.4)	
Years of study, *n* (%)					0.051[b]
None or less than 1	611 (28.2)	189 (30.9)	237 (38.8)	185 (30.3)	
1–8	985 (45.4)	287 (29.1)	357 (36.2)	341 (34.6)	
9–12	403 (18.6)	104 (25.8)	145 (36.0)	154 (38.2)	
13 or more	169 (7.8)	54 (32.0)	53 (31.4)	62 (36.7)	
Region of residence, *n* (%)					0.017[b]
Southeast	804 (34.1)	217 (27.0)	327 (40.7)	260 (32.3)	
South	643 (27.2)	221 (34.4)	222 (34.5)	200 (31.1)	
Northeast	601 (25.5)	164 (27.3)	204 (33.9)	233 (38.8)	
Midwest	169 (7.2)	43 (25.4)	67 (39.6)	59 (34.9)	
North	143 (6.1)	48 (33.6)	50 (35.0)	45 (31.5)	
Smoking, *n* (%)	182 (7.7)	74 (40.7)	59 (32.4)	49 (26.9)	0.001[b]
Physical activity, *n* (%)					0.001[b]
Sedentarism	1544 (66.1)	476 (30.8)	584 (37.8)	484 (31.3)	
Active	792 (33.9)	210 (26.5)	275 (34.7)	307 (38.8)	
Body mass index (kg/m²), median (IQR)	28.4 (25.6–31.9)	28.7 (25.9–32.1)	28.5 (25.6–32.0)	28.2 (25.5–31.4)	0.076[c]
Waist circumference (cm), median (IQR)	99.3 (92.0–107.0)	100.0 (92.0–108.0)	100.0 (91.5–107.3)	99.0 (92.0–105.5)	0.241[c]

Abbreviation: IQR, interquartile range.

[a]Comparison of means using analysis of variance.

[b]Ch-squared test.

[c]Kruskal–Wallis test.

In addition, differences were observed among the different regions, concerning the mAHEI score, as described in Figure 1.

DISCUSSION

The results obtained in the present study demonstrate a low quality of diet in individuals with low average family income and those residents of the Southern Region of Brazil, especially regarding the consumption of whole grains, the ratio of fish/red meat and eggs, vegetables, and fruits. By contrast, better diet quality was observed in individuals who practiced physical activity, who had middle or high family income and in residents of the Northeast Region.

Several inadequacies in food intake were evidenced, indicating that the evaluated individuals did not have adequate eating habits, as recommended for secondary cardiovascular prevention, corroborating other studies.[22]

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TABLE 2 Modified Alternative Healthy Eating Index (mAHEI) component scores according to Region of residence of individuals with cardiovascular disease, Brazil, 2013–2017.

Component	Total, *n* = 2.360		Southeast Region, *n* = 804 (34.1%)		South Region, *n* = 643 (27.2%)		Northeast Region, *n* = 601 (25.5%)		Midwest Region, *n* = 143 (7.2%)		North Region, *n* = 169 (6.1%)		*p* value[a]
	Minimum score, *n* (%)	Maximum score, *n* (%)	Minimum score, *n* (%)	Maximum score, *n* (%)	Minimum score, *n* (%)	Maximum score, *n* (%)	Minimum score, *n* (%)	Maximum score, *n* (%)	Minimum score, *n* (%)	Maximum score, *n* (%)	Minimum score, *n* (%)	Maximum score, *n* (%)	
Vegetable	749 (31.7)	146 (6.2)	229 (30.6)	48 (32.9)	157 (21.0)	39 (26.7)	256 (34.2)	35 (24.0)	36 (4.8)	15 (10.3)	71 (9.5)	9 (6.2)	0.126
Fruits	588 (24.9)	219 (9.3)	216 (36.7)	54 (24.7)	178 (30.3)	58 (26.5)	100 (17.0)	73 (33.3)	62 (10.5)	16 (7.3)	32 (5.4)	18 (8.2)	0.039
Nuts and soy protein	755 (32.0)	1526 (64.7)	203 (26.9)	572 (37.5)	233 (30.9)	389 (25.5)	222 (29.4)	359 (23.5)	37 (4.9)	126 (8.3)	60 (7.9)	80 (5.2)	0.857
Fish/red meat and eggs	2157 (91.4)	133 (5.6)	749 (34.7)	37 (27.8)	621 (28.8)	11 (8.3)	508 (23.6)	67 (50.4)	159 (7.4)	6 (4.5)	120 (5.6)	12 (9.0)	<0.001
Whole grains	1925 (81.6)	260 (11.0)	685 (35.6)	65 (25.0)	537 (27.9)	61 (23.5)	448 (23.3)	101 (38.8)	141 (7.3)	15 (5.8)	114 (5.9)	18 (6.9)	0.006
Fried food	22 (0.9)	2181 (92.4)	9 (40.9)	732 (33.6)	5 (22.7)	601 (27.6)	5 (22.7)	566 (26.0)	–	158 (7.2)	3 (13.6)	124 (5.7)	–
Alcohol	2303 (97.6)	15 (0.6)	781 (33.9)	6 (40.0)	616 (26.7)	7 (46.7)	598 (26.0)	–	166 (7.2)	1 (6.7)	142 (6.2)	1 (6.7)	–

Note: Minimum score: 0 points; maximum score: 10 points.

[a]Chi-squared test.

TABLE 3 Modified Alternative Healthy Eating Index (mAHEI) component scores according to the social class of individuals with cardiovascular disease, Brazil, 2013–2017.

Component	Average family income									*p* value[a]
	Low			Middle			High			
	Minimum score, *n* (%)	Intermediate score, *n* (%)	Maximum score, *n* (%)	Minimum score, *n* (%)	Intermediate score, *n* (%)	Maximum score, *n* (%)	Minimum score, *n* (%)	Intermediate score, *n* (%)	Maximum score, *n* (%)	
Vegetable	138 (45.5)	149 (49.2)	16 (5.3)	386 (31.3)	774 (62.7)	74 (6.0)	159 (25.4)	428 (68.3)	40 (6.4)	<0.001
Fruits	81 (26.7)	195 (64.4)	27 (8.9)	305 (24.7)	810 (65.6)	119 (9.6)	141 (22.5)	429 (68.4)	57 (9.1)	0.267
Nuts and soy protein	109 (36.0)	6 (2.0)	188 (62.0)	364 (29.5)	40 (3.2)	830 (67.3)	219 (34.9)	28 (4.5)	380 (60.6)	0.389
Fish/red meat and eggs	272 (89.8)	12 (4.0)	19 (6.3)	1124 (91.1)	40 (3.2)	70 (5.7)	578 (92.2)	15 (2.4)	34 (5.4)	0.149
Whole grains	255 (84.2)	14 (4.6)	34 (11.2)	1014 (82.2)	91 (7.4)	129 (10.5)	494 (78.8)	58 (9.3)	75 (12.0)	0.119
Fried food	1 (0.3)	19 (6.3)	283 (93.4)	10 (0.8)	74 (6.0)	1150 (93.2)	7 (1.1)	48 (7.7)	572 (91.2)	–
Alcohol	302 (99.7)	1 (0.3)	0	1215 (98.5)	13 (1.1)	6 (0.5)	593 (94.6)	26 (4.1)	8 (1.3)	–

Note: Minimum score: 0 points; intermediate score: 1–9 points; maximum score: 10 points.

[a]Chi-squared. Low family income was equivalent to an average family income of R$ 1700.00 per month or US$ 319,0; middle family income means an average family income of R$7.000,00 per month or U$1.313,3; higher family income means an average family income of R$ 20.888,00 per month or US$ 3.919,0.

TABLE 4 Modified Alternative Healthy Eating Index (mAHEI) component scores according to the level of education of individuals with cardiovascular disease, Brazil, 2013–2017.

Component	Level of education None or primary education Minimum score, *n* (%)	Intermediate score, *n* (%)	Maximum score, *n* (%)	Secondary education Minimum score, *n* (%)	Intermediate score, *n* (%)	Maximum score, *n* (%)	Higher education Minimum score, *n* (%)	Intermediate score, *n* (%)	Maximum score, *n* (%)	*p* value[a]
Vegetable	523 (32.8)	988 (61.9)	85 (5.3)	119 (29.5)	251 (62.3)	33 (8.2)	40 (23.7)	115 (68.0)	14 (8.3)	0.047
Fruits	411 (25.8)	1049 (65.7)	136 (8.5)	82 (20.3)	271 (67.2)	50 (12.4)	35 (20.7)	117 (69.2)	17 (10.1)	0.008
Nuts and soy protein	480 (30.1)	50 (3.1)	1066 (66.8)	141 (35.0)	18 (4.5)	244 (60.5)	71 (42.0)	6 (3.6)	92 (54.4)	<0.001
Fish/red meat and eggs	1469 (92.0)	47 (2.9)	80 (5.0)	357 (88.6)	14 (3.5)	32 (7.9)	153 (90.5)	6 (3.6)	10 (5.9)	0.159
Whole grains	1327 (83.1)	102 (6.4)	167 (10.5)	310 (76.9)	44 (10.9)	49 (12.2)	129 (76.3)	18 (10.7)	22 (13.0)	0.012
Fried food	12 (0.8)	100 (6.3)	1484 (93.0)	5 (1.2)	27 (6.7)	371 (92.1)	1 (0.6)	15 (8.9)	153 (90.5)	–
Alcohol	1564 (98.0)	21 (1.3)	11 (0.7)	389 (96.5)	11 (2.7)	3 (0.7)	161 (95.3)	8 (4.7)	0	–

Note: None or primary education: none or up to 8 years of study; secondary education: 9–12 years of study; higher education: 13 and over. Minimum score: 0 points; intermediate score: 1–9 points; maximum score: 10 points.
[a]Chi-squared test.

The diet quality assessment by the mAHEI showed a median of 24.0 (20.0–30.0) points, so that 50% of the studied sample failed to reach at least half of the index level (35 points). Similar findings were found in another study conducted with individuals with CVD.[23] The data are alarming because they demonstrate the need for urgent intervention, considering that the adoption of healthy eating habits is among the priority strategies in the secondary prevention of CVD.[24,25]

Food is classically considered one of the main determinants of cardiovascular health[26] because lifestyle changes and the adoption of healthy eating habits are important strategies in preventing recurrent events.[24,27]

Cardiovascular risk is related to the quality of the diet, possibly because diets of low nutritional quality are rich in refined carbohydrates, ultra-processed foods, added sugars, sodium, saturated and trans fatty acids,[28] as well as having a low content of whole grains, fruits, vegetables, legumes, fish and oilseeds.[29]

Despite the importance of diet in cardiovascular prevention, it was found that the components whole grains, ratio of fish/red meat and eggs, vegetables, and fruits are the groups with the lowest consumption or often not consumed by the individuals studied. A hypothesis for this pattern of food consumption observed would be family income because 71% of individuals had middle to low family income and cultural habits,[30] considering that differences were observed in the quality of the diet among the Brazilian regions.

When examining the results of surveys carried out at the national level, it is noted that socio-economic position influences the discrimination of the food consumption of Brazilians.[31,32] In the present study, a positive association was observed between diet quality and middle-family income. Therefore, when there are limited economic resources, these are possibly associated with low-quality diets.[8,33,34]

A longitudinal study with an average follow-up of 5 years in secondary cardiovascular prevention showed a 22% risk reduction in outcomes (cardiovascular mortality, acute myocardial infarct, stroke, or congestive heart failure) for subjects with high adherence to a healthy diet, compared to subjects with low adherence, defined as mAHEI ≥ 28.7 points and mAHEI < 16 points, respectively.[5]

Brazil is considered a country with continental dimensions, and it is widely known that Brazilian regions differ in geographical, cultural and access to health service aspects. When evaluating the five Brazilian macro-regions, it is observed that the Northeast and Southeast Regions of Brazil had the highest number of individuals who reached the maximum score of the mAHEI components. The Northeast Region had the highest ratio of fish/red meat and eggs. This can be attributed to the economic, geographical, cultural and unique eating habits of the region. By contrast to expectations, there is also a higher consumption of whole

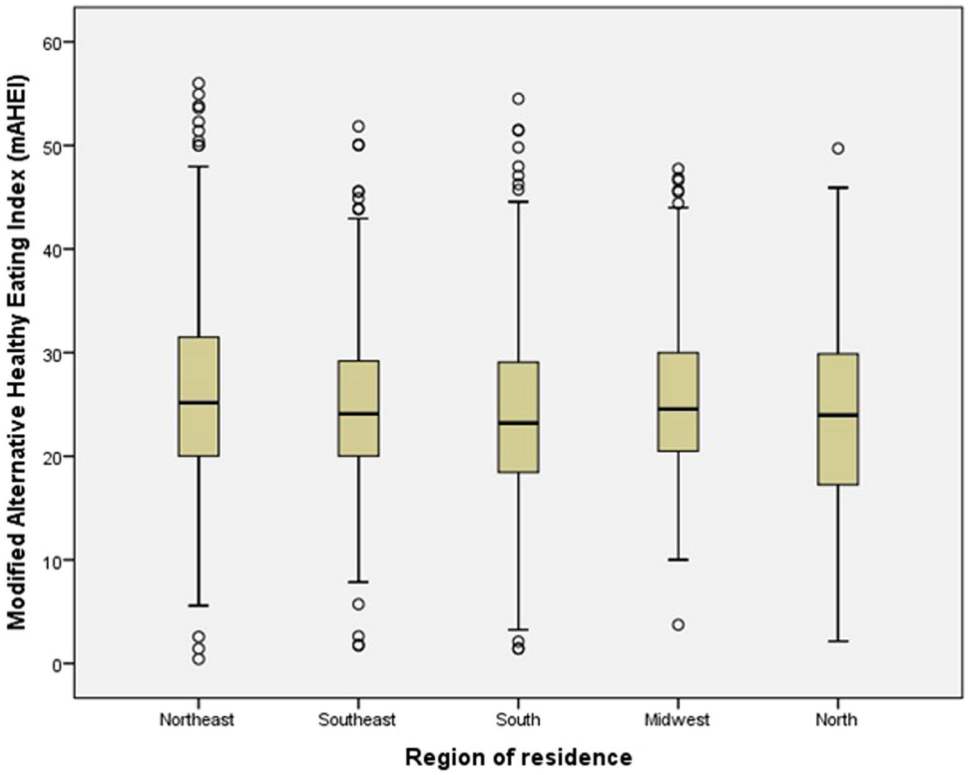

FIGURE 1 Boxplot of modified Alternative Healthy Eating Index (mAHEI) values, according to the Region of residence of individuals undergoing secondary cardiovascular prevention, Brazil, 2013–2017. $p < 0.001$, comparing all Brazilian regions; $p = 0.006$, comparing the Northeast and Southeast Regions; $p < 0.001$, comparing the Northeast and South Regions; $p = 0.030$, comparing the Northeast and North Regions; $p = 0.510$, comparing the Northeast and Midwest Regions; $p = 0.026$, comparing the Southeast and South Regions; $p = 0.295$, comparing the Southeast and Midwest Regions; $p = 0.448$, comparing the Southeast and North Regions; $p = 0.017$, comparing the South and Midwest Regions; $p = 0.709$, comparing the South and North Regions. To compare all regions, the Kruskal-Wallis test was used, and the Mann-Whitney test was used for two regions.

grains and fruits in the Northeast region, information not found in the last survey by the Brazilian Institute of Geography and Statistics (IBGE) on family budgets.[31]

As expected, when analysing schooling as proxies or an indirect measure of income, a higher consumption of fruits, vegetables and whole grains was observed in individuals with higher schooling levels. However, a higher consumption of nuts (oilseeds and legumes) and soy protein was observed in social strata with lower education levels. This can be explained by considering legumes (including beans) in this component. Another particularity is that beans are one of the basic ingredients and lower cost of the Brazilian diet.[31,35] Data from the 2017 to 2018 Brazilian Household Budget Survey (POF) showed that lower social class individuals consume several items considered part of a healthy diet, such as rice and beans, in greater quantities compared to individuals from higher class income.[31]

The adoption of inappropriate eating habits has shown to have an important influence on reducing the consumption of a typically Brazilian preparation, rice and beans.[31,35,36] Beans are an important source of nutrients and the result of their combination with rice is a meal with adequate nutritional value.[35] Over the years, a reduction in the purchase of traditional Brazilian foods such as beans has been observed in the social classes with higher purchasing power, and, on the other hand, an increase in the consumption of ultra-processed foods has been observed. Meanwhile, the lower classes have a higher consumption of these grains.[31] In addition, soy is often used as an alternative to meat consumption as a result of the lower acquisition cost.[37]

Studies have been dedicated to evaluating the role of diet quality and physical activity in reducing the progression of chronic diseases.[38] One of the secondary cardiovascular prevention strategies is to encourage lifestyle changes and the adoption of healthy eating habits.[3,25] In two large prospective cohort studies, it was observed that individuals with the highest intake of whole grains were physically active individuals.[39] In the present study, it was observed that individuals who practiced physical activity had a better quality of diet compared to sedentary individuals. This finding can be explained by active individuals being more willing to follow healthy eating habits.[40]

There are some methodological limitations to be considered in the present study. The main limitation is the use of only one food recall for each participant.

Despite this consideration, we believe that, because of the large sample size, this limitation could have been minimised. In addition, because the sample is composed mainly of individuals from lower social classes, these individuals are likely to have low variability in food intake, which can minimise variation in food choices.

Another limitation is the lack of standardisation of a specific index to assess diet quality, in addition to the use of different scoring systems for each index, which may be based on the median of the studied sample, intakes based on quintiles or on specific cut-off points for some diet quality indices.[41] As a result, mAHEI was used in the present study because, in a previous study, it was shown to be highly predictive of CVD risk.[5] However, it is worth noting that additional studies are needed to better understand the relationship between the mAHEI in individuals with CVD and its relationship with socio-economic factors.

CONCLUSIONS

The results of the present study demonstrate that the low quality of the diet in the individuals evaluated in secondary cardiovascular prevention was associated with monthly family income and geographical area of residence. By contrast, better diet quality was observed in practitioners of regular physical activity, in individuals with better economic status, and for residents of the Northeast Region. These data are extremely relevant to assist in coping with CVD because they make it possible to assess the distribution of these factors in different regions of the country. Therefore, it is essential to recognise these factors to define strategies and organise priority health actions according to the needs of each region.

AUTHOR CONTRIBUTIONS

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CONFLICTS OF INTEREST STATEMENT

The authors declare that there are no conflicts of interest.

DATA AVAILABILITY STATEMENT

Data sharing not applicable to this article because no data sets were generated or analysed during the current study.

TRANSPARENCY DECLARATION

The lead author affirms that this manuscript is an honest, accurate and transparent account of the study being reported. The lead author affirms that no important aspects of the study have been omitted and that any discrepancies from the study as planned have been explained. The clinical trial was registered at https://clinicaltrials.gov/ and the unique identifier is NCT01620398.

ETHICAL STATEMENT

The research was approved by the Ethics Committee for Research with Human Beings of the Hospital do Coração (Opinion No. 58318), as well as by the ethics committees of each collaborating research centre. All participants provided their informed consent.

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PEER REVIEW

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APPENDIX

TABLE A1 Comparison between Modified Alternative Healthy Eating Index (mAHEI) tertiles, sociodemographic, lifestyle and anthropometric characteristics of individuals with cardiovascular disease, in a multinomial regression analysis

Characteristics	mAHEI tertile	
	Tertile 1—low × Tertile 3—high quality, odds (95% CI) (*p* value)	Tertile 2—average × Tertile 3—high quality, odds (95% CI) (*p* value)
Family income, *n* (%)		
Low	1.885 (1.302–2.729) (0.001)	1.566 (1.097–2.235) (0.013)
Middle	0.998 (0.779–1.280) (0.989)	0.941 (0.747–1.186) (0.608)
High[a]	0	0
Region of residence, *n* (%)		
North	1.881 (1.156–3.059) (0.011)	1.292 (0.792–2.107) (0.306)
Southeast	1.397 (1.041–1.873) (0.026)	1.598 (1.220–2.092) (0.001)
South	1.778 (1.313–2.407) (<0.001)	1.386 (1.037–1.853) (0.028)
Midwest	1.147 (0.716–1.838) (0.568)	1.368 (0.894–2.093) (0.149)
Northeast[a]	0	0
Smoking, *n* (%)		
Yes	1.490 (0.986–2.250) (0.058)	1.123 (0.741–1.702) (0.583)
No[a]	0	0
Physical activity, *n* (%)		
Sedentarism	1.391 (1.107–1.749) (0.005)	1.346 (1.086–1.667) (0.007)
Active[a]	0	0

Abbreviation: CI, confidence interval.

[a]Reference category. A multinomial regression model with the outcome variable "diet quality" and the independent variables: family income, region of residence, smoking, and physical activity.

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