ORIGINAL ARTICLE

ASSOCIATION BETWEEN THE DIETARY CARBOHYDRATE QUALITY INDEX AND THE NUTRITIONAL STATUS OF PATIENTS WITH HYPERTENSION

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Highlights: (1) High prevalence of overweight among women and increased waist circumference. (2) More than half of the participants presented insufficient fiber intake. (3) The dietary Carbohydrate Quality Index (CQI) ranged from moderate to high, suggesting unhealthy dietary patterns. (4) High consumption of liquid carbohydrates is detrimental to health and contributes to the increase in noncommunicable chronic diseases (NCDs).

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ABSTRACT

Objective: To assess the dietary Carbohydrate Quality Index (CQI) of patients with systemic arterial hypertension (SAH) receiving care through the Brazilian Unified Health System and its association with their nutritional status. **Methods:** This study included a convenience sample of 488 patients receiving care at six Primary Health Care Units in Fortaleza, Ceará, Brazil. The CQI was determined, as proposed by its authors, by the sum of four dietary components: glycemic index, dietary fiber (g/day), the ratio of whole grains to total grains, and the ratio of solid carbohydrates to total carbohydrates. The association between CQI and nutritional status (body mass index - BMI and waist circumference - WC) was assessed using Spearman's correlation test, with $p < 0.05$ considered statistically significant. **Results:** The median CQI was 12 (9–15). No correlation was observed between CQI and WC ($p = 0.764$) or BMI ($p = 0.129$). However, when stratified by sex, a weak but significant inverse relationship was observed between CQI and BMI among women ($p = 0.042$), as well as between CQI and BMI among obese and non-obese women ($p = 0.047$). **Conclusion:** The evaluated group presented excess body weight and a diet with a low CQI, with no important association between these variables.

Keywords: Dietary Carbohydrates; Nutritional Status; Hypertension.

PRE-PROOF

INTRODUCTION

Systemic arterial hypertension (SAH) is a multifactorial clinical condition characterized by persistently elevated blood pressure levels ≥140/90 mmHg. It is a chronic and often asymptomatic condition and a major risk factor for several diseases, including stroke, renal failure, and coronary artery disease[1].

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Among the risk factors for this disease, studies indicate associations with age group, sex, low educational level, Black race/ethnicity, smoking, diabetes, high cholesterol, and obesity[2-3]. Regarding the latter, it is well established that hypertensive patients often present multiple comorbidities, while weight loss is associated with better blood pressure control[4-5].

In addition to the aforementioned risk factors, inadequate diet is also frequently reported, characterized by high intake of total fat, saturated fat, cholesterol, and sodium above recommended levels, along with low dietary fiber intake[6-7].

In this context, among the strategies for the non-pharmacological treatment of SAH, the adoption of healthy habits, including changes in diet and lifestyle, has been shown to help prevent disease progression and reduce the risk of chronic diseases. In recent years, increasing attention has been given to carbohydrates, as excessive consumption may contribute to weight gain, which may lead to obesity and, consequently, to the development of noncommunicable chronic diseases (NCDs), such as SAH[8-9].

To evaluate the healthfulness of a diet with respect to carbohydrate intake, Massimino et al.[10] developed the Carbohydrate Quality Index (CQI), a tool that assesses dietary quality based on the quantity and types of carbohydrates consumed. The index is calculated using the following components: the proportion of whole grains relative to total grains, dietary fiber intake, the ratio of solid to total carbohydrates, and the glycemic index.

The assessment of dietary carbohydrates is relevant because simple, refined carbohydrates with a high glycemic index exert deleterious metabolic effects and have been associated with an increased risk of different chronic diseases. Understanding the proportion of these lower-quality carbohydrates in the diet allows educational strategies to be more effectively directed toward the population. In this context, the CQI represents a valuable tool for such monitoring[10].

In light of the above, this study aimed to evaluate the Carbohydrate Quality Index (CQI) of the diet of patients with systemic arterial hypertension receiving care through the Brazilian Unified Health System (SUS) and to examine its association with their nutritional status. In this context, the study seeks to understand how the quality of consumed carbohydrates may influence the management of SAH and contribute to guiding strategies aimed at improving the dietary profile of these individuals.

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Thus, this study aims to evaluate the CQI of patients with SAH receiving care through the Brazilian Unified Health System and its association with their nutritional status. Although substantial evidence exists regarding the relationship between carbohydrate intake and diabetes mellitus[6-10-11-12-13-14], studies addressing the monitoring of carbohydrate consumption and its relationship with SAH remain limited in the literature. This underscores the relevance of the present study, considering that the macronutrient most frequently investigated in this context has been dietary fat. By focusing on the quality of carbohydrate consumption, this study proposes a new perspective on the dietary patterns of individuals diagnosed with systemic arterial hypertension.

METHOD

Study characteristics

This study is part of the research line "Management of Health Organizations, Technology, and Innovation" of the Professional Master's Program in Health Management at the State University of Ceará and is linked to the "PREVENDO Project – Health, aging, diet, and inflammation: development, validation, and standardization of instruments for health promotion and the prevention of noncommunicable chronic diseases," which involves the study participants. The PREVENDO Project is a cross-sectional study with a quantitative and analytical approach aimed at developing, validating, and standardizing instruments for health promotion and the prevention of noncommunicable chronic diseases among users of the Brazilian Unified Health System, considering the interrelationships among health, aging, diet, and inflammation.

Population and sample

The population consisted of patients with SAH being treated at six Primary Health Care Units (PHCUs). This study included a convenience sample of 488 patients. The selection of the PHCUs was justified by the concentration of the highest number of consultations for individuals with SAH, according to the Municipal Health Secretariat of Fortaleza, based on prior analyses of the municipality's epidemiological data.

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Patients of both sexes diagnosed with systemic arterial hypertension, aged 18 years or older, and able to read and write were included in the study. Participants were required to have no difficulty understanding the questions included in the data collection instrument and no physical limitations, such as wheelchair use, limb amputation, or being bedridden, which could prevent the measurement of current weight and height.

Individuals who had previously undergone coronary surgery or had a prior history of myocardial infarction were excluded from the sample. In the case of women, pregnant individuals were also excluded.

Study location and data collection

The study was conducted in the city of Fortaleza, CE, Brazil, at Primary Health Care Units. Data collection took place from February to July 2019. The process was performed by undergraduate Nutrition students from the State University of Ceará (UECE), all of whom had received prior training.

Interviews and the collection of sociodemographic data, including age, education level, family income, and marital status, were conducted in the waiting rooms of the Primary Health Care Units. To assess dietary intake, a semi-quantitative Food Frequency Questionnaire (FFQ) consisting of 114 food items, developed by the Longitudinal Study of Adult Health (ELSA-Brasil), known as the FFQ–ELSA-Brasil[15], was administered. This questionnaire is designed to evaluate participants' usual dietary intake over the previous 12 months and was administered by Nutrition students who had received prior training regarding both completion procedures and the questions to be asked.

Subsequently, anthropometric measurements were performed, including weight, height, and waist circumference. The protocol adopted for obtaining these measurements was that of the Centers for Disease Control and Prevention: The National Health and Nutrition Examination Survey (NHANES) Anthropometry Procedures Manual[16]. Anthropometric assessments were conducted by trained Nutrition students and recorded according to the procedures described in the aforementioned manual.

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Data analysis

Demographic and socioeconomic data were tabulated and presented as simple frequencies and percentages.

Nutritional status was classified based on body mass index (BMI), expressed in kg/m², and waist circumference (WC). BMI was categorized according to the criteria of the World Health Organization (WHO)[17] for adults (<60 years) and those of the Pan American Health Organization (PAHO)[18] for older adults (≥60 years). Thus, for adults, individuals were classified as follows: underweight (BMI < 18.50 kg/m²); normal weight (BMI 18.50–24.99 kg/m²); overweight or pre-obesity (BMI 25.00–29.99 kg/m²); and obesity (BMI ≥ 30.00 kg/m²), with the three obesity classes grouped together. For older adults, the categorization was: underweight (BMI ≤ 23.00 kg/m²); adequate weight or normal weight (BMI > 23 and < 28 kg/m²); pre-obesity (BMI ≥ 28 and < 30 kg/m²); and obesity (BMI ≥ 30 kg/m²). WC was classified as normal or elevated, defined respectively as <88 cm and ≥88 cm for women and <102 cm and ≥102 cm for men[16].

Regarding dietary intake, the FFQ data were recorded in household measures and subsequently converted into grams or milliliters and expressed as daily intake. These data were entered into the DietWin Plus® software, version 3090. The chemical composition of the diet was determined using the United States Department of Agriculture (USDA) food composition database available in the software. When data were missing, they were supplemented using the Food Composition Table for Foods Consumed in Brazil, developed by the Household Budget Survey (POF) 2008–2009[19].

The Carbohydrate Quality Index was determined according to Massimino et al.[10] by summing four components: glycemic index, dietary fiber intake (g/day), the ratio of whole grains to total grains, and the ratio of solid carbohydrates to total carbohydrates.

The authors established a scoring system based on quintiles, with values ranging from 1 point for the first quintile to 5 points for the fifth quintile (for the glycemic index, individuals in the fifth quintile receive 1 point and those in the first quintile receive 5 points). Subsequently, all values are summed to calculate the CQI, which is also divided into quintiles: Q1: 4–8; Q2: 9–10; Q3: 11–12; Q4: 13–14; Q5: 15–20. Thus, the CQI can range from 4 to 20, and the authors indicate that higher values correspond to better index scores[10].

Fiber intake was obtained directly from the software. Whole grain intake referred to the consumption of whole cereals and whole-grain products. Total grains were defined as the sum of whole grains (and their whole-grain derivatives) and refined grains (and their refined derivatives). Liquid carbohydrates referred to those present in sugar-sweetened beverages and fruit juices, whereas solid carbohydrates included all carbohydrates contained in solid foods. Total carbohydrates corresponded to the sum of liquid and solid carbohydrates.

Since Massimino et al.[10] did not specify the method used to determine the glycemic index (GI), it was determined in this study according to the protocol proposed by the Food and Agriculture Organization (FAO) within the World Health Organization (WHO)[17]:

- Identification of the total glycemic carbohydrate (in grams) of each food consumed per meal;
- Determination of the proportion of GI of each food in relation to the total glycemic carbohydrate of each meal;
- Identification of the GI of each food (considering glucose as the reference) in specific tables[17-20];
- Categorization of the GI according to the classification proposed by Atkinson et al.[20]: low GI (≤ 55), moderate GI (56–69), and high GI (≥ 70), with a low-GI diet considered appropriate[21].

The statistical analysis was initially performed by assessing the normality of the sample distribution using the Shapiro–Wilk test. The results indicated that the variables CQI, BMI, and WC did not follow a normal distribution; therefore, the data were presented as medians and interquartile ranges. The association between anthropometric variables and the CQI was assessed using Spearman's correlation test.

The Mann–Whitney test was used to compare variables between sexes and to compare the CQI between obese and non-obese individuals. The chi-square test was employed to compare anthropometric data between sexes, with BMI categories dichotomized into excess weight (overweight + obesity) and without excess weight. Demographic and socioeconomic variables were also dichotomized for comparison between sexes (older adult vs. non–older adult; married vs. not married; ≤ 3 minimum wages/month vs. > 3 minimum wages/month; ≤ 8 years of schooling vs. > 8 years of schooling). In all tests, $p < 0.05$ was adopted as the level

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of statistical significance. Statistical analyses were performed using Stata software, version 14.

Ethical aspects

The study was conducted in accordance with Resolution 466/2012 and approved by the Research Ethics Committee for Human Subjects of the State University of Ceará under CAAE number 18054613.0.0000.5534. All participants signed an informed consent form.

RESULTS

Table 1 presents the demographic and socioeconomic characteristics of the participants. Women represented a higher proportion of the sample (87.1%). The majority of participants were under 60 years of age (56.55%), not married (59.63%), had a monthly family income of up to three minimum wages (94.47%), and had up to eight years of schooling (61.68%). The proportion of unmarried individuals was higher among men (73.02%) than among women (60%).

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Table 1. Distribution of hypertensive patients evaluated according to demographic and socioeconomic variables. Fortaleza, 2022.

Variables	Women (n = 425)		Men (n = 63)		Total (n = 488)		p-value*
	N	%	N	%	N	%	
Age (years)							0.207
< 30	4	0.94	1	1.59	5	1.02	
30-39	26	6.12	5	7.94	31	6.35	
40-49	73	17.18	6	9.52	79	16.19	
50-59	142	33.41	19	30.16	161	32.99	
≥ 60	180	42.35	32	50.79	212	43.44	
Marital status							0.047
Married	170	40	17	26.98	197	40.37	
Not married	255	60	46	73.02	291	59.63	
Income**							0.138
< 1	134	31.53	22	34.92	156	31.97	
1 – 3	270	63.53	35	55.55	305	62.5	
3 – 5	18	4.24	5	7.94	23	4.71	
> 5	3	0.71	1	1.59	4	0.82	
Years of schooling							0.969
≤ 8	262	61.65	39	61.90	301	61.68	
9 – 11	75	17.65	8	12.70	83	17	
≥ 12	88	20.71	16	25.40	104	21.31	

Source: The authors
*Chi-square test, with p < 0.05 considered the level of statistical significance; dichotomized variables: older adult, non–older adult; married, not married; ≤ 3 minimum wages/month, > 3 minimum wages/month; ≤ 8 years of schooling, > 8 years of schooling. **Monthly household income, in minimum wages – BRL 1,200.00.

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The median BMI of the group was 29.76 kg/m² (26.12–33.48), with a median of 30.22 kg/m² (26.51–33.89) among women and 28.37 kg/m² (24.68–30.90) among men. Women presented higher BMI values than men (p = 0.009). The median WC of the group, regardless of sex, was 95.5 cm (87.8–103). Median values were not compared by sex because the cutoff points for normality differ between men and women.

The nutritional status of participants with systemic arterial hypertension, based on BMI and WC, is shown in Table 2. A high prevalence of excess weight (pre-obesity and obesity) was observed among patients, reaching 318 (74.82%) women and 39 (61.90%) men. Regarding WC, higher values were observed among women, with 313 (73.65%) presenting elevated WC, whereas the majority of men, 45 (71.43%), had adequate WC. Considering the categories of the anthropometric variables, women exhibited a higher prevalence of excess weight than men ($\chi^2 = 4.663$; $p = 0.031$), and a greater proportion also presented elevated WC ($\chi^2 = 51.086$; $p < 0.001$).

Table 2. Distribution of hypertensive patients evaluated according to anthropometric variables. Fortaleza – CE, 2022.

Variables	Women (n = 425)		Men (n = 63)		Total (n = 488)	
	N	%	N	%	N	%
Body Mass Index (BMI)						
Underweight	16	3.76%	1	1.59%	17	3.48%
Normal weight	91	21.41%	23	36.51%	114	23.36%
Pre-obesity	98	23.06%	21	33.33%	119	24.39%
Obesity	220	51.76%	18	28.57%	238	48.77%
Waist Circumference (WC)						
Adequate	112	26.35%	45	71.43%	157	32.17%
Elevated	313	73.65%	18	28.57%	331	67.83%

Source: The authors
*Chi-square test, with p < 0.05 considered the level of statistical significance.

The median CQI of the individuals was 12 (9–15). The median CQI among women was 12 (10–15), and among men it was 11 (9–13), with women presenting higher values than men ($p = 0.019$). Table 3 presents the mean intake of the CQI components according to score quintiles.

Table 3. Distribution of hypertensive patients according to mean (standard deviation) intake of the components of the dietary Carbohydrate Quality Index (CQI) and score quintiles*. Fortaleza – CE, 2022.

CQI components	Q1 81 (16,60%)	Q2 94 (19,26%)	Q3 107 (21,93%)	Q4 83 (17,01%)	Q5 123 (25,20%)
Dietary fiber (g/day)	17.98 ± 25.10	19.65 ± 12.53	21.34 ± 11.45	29.51 ± 16.44	41.51 ± 20.46
WG/TG** ratio	0.00 ± 0.01	0.03 ± 0.07	0.08 ± 0.16	0.16 ± 0.18	0.34 ± 0.27
SC/TC*** ratio	0.72 ± 0.14	0.79 ± 0.17	0.84 ± 0.16	0.85 ± 0.13	0.89 ± 0.09
Glycemic Index	73.05 ± 32.44	66.16 ± 5.85	65.41 ± 16.56	61.86 ± 7.60	56.00 ± 5.92

Source: The authors
* *According to Zazpe et al.[37], the CQI score ranges for each quintile are: Q1: 4–8; Q2: 9–10; Q3: 11–12; Q4: 13–14; Q5: 15–20. **WG/TG = whole grains/total grains. ***SC/TC = solid carbohydrates/total carbohydrates.

The CQI of the diet of patients with SAH was evaluated for its association with nutritional status. Table 4 presents the results. A weak inverse relationship was observed when considering the CQI of the diets of the evaluated women. In light of this finding, an additional comparison (Mann–Whitney test) was performed between obese and non-obese women, which also revealed an inverse association with the CQI (p = 0.047).

Table 4. Association* between the dietary Carbohydrate Quality Index (CQI) and anthropometric variables of hypertensive individuals. Fortaleza – CE, 2022.

	Carbohydrate Quality Index (CQI)					
Anthropometric variables	**Women**		**Men**		**Total**	
	r	p	r	P	r	p
Body mass index	-0.0988	0.042	0.0360	0.779	-0.0688	0.129
Waist circumference	0.0028	0.954	-0.1109	0.387	-0.0136	0.764

Source: The authors
*Spearman correlation test; p < 0.05 considered statistically significant.

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DISCUSSION

The profile of the evaluated individuals suggests a more vulnerable group due to factors such as income and educational level. Individuals with lower levels of education tend to seek less information about their health status and may also experience greater difficulty in understanding the information provided[22]. Moreover, women accounted for a large proportion of the respondents (425; 87.09%). According to the Position Statement on Ischemic Heart Disease, cardiovascular diseases are the leading cause of morbidity and mortality among women worldwide, accounting for the deaths of more than one-third of women in 2021[23].

Regarding the nutritional status of the patients, a high prevalence of excess weight was observed across the entire group, particularly obesity among women. Women also presented higher WC values. The literature has likewise reported a higher prevalence of excess weight and greater WC among hypertensive patients[5-24].

Since the CQI comprises four components, each component should be considered separately. In the case of fiber, a minimum intake of 25 g of dietary fiber per day is recommended for a healthy diet and as a protective factor against NCDs such as type 2 diabetes, hypertension, and obesity. As reported, only quintiles 4 and 5 presented mean values considered adequate in relation to fiber intake, which indicates that 282 patients (57.8%) presented insufficient intake of this nutrient[25-26].

It is important to emphasize that dietary fiber intake is a central factor associated with reductions in blood pressure. The mechanisms underlying this reduction include decreased weight gain, improvements in vascular health, reductions in total cholesterol and elevated low-density lipoprotein (LDL) levels, and decreased systemic inflammation[27].

Moreover, a low intake of whole grains is also associated with low fiber consumption, since whole-grain products are richer in fiber and therefore contribute to achieving adequate intake of this component[28]. The Brazilian Hypertension Guidelines[29] recommend a higher intake of whole-grain carbohydrates rather than refined carbohydrates. However, regarding the component representing the ratio of whole grains to total grains, all quintiles showed a low proportion of whole-grain consumption, indicating a high intake of refined carbohydrates.

Excessive consumption of refined carbohydrates is also associated with the development of obesity, which in turn is linked to hyperglycemia, hypertriglyceridemia, insulin resistance, and cardiovascular diseases, such as hypertension[29]. Moreover, it has been demonstrated that a high intake of refined carbohydrates increases the risk of developing type 2 diabetes mellitus, a condition interrelated with SAH, as it causes hyperinsulinemia, which may increase sympathetic nervous system activity and consequently elevate sodium retention[30].

The GI of foods is another important factor to consider. The index classifies the impact of foods based on their carbohydrate absorption and glycemic response. In this sense, diets with a high GI are associated with an increased risk of cardiometabolic diseases[31].

The mean GI observed in each CQI quintile was classified as moderate[16], except for quintile 1, which presented a high result. Therefore, based on the GI, the diet can be considered inadequate, since a healthy diet should have a low GI[21].

It is known that a low GI is associated with a reduced risk of type 2 diabetes mellitus[31]. The relationship between type 2 diabetes mellitus and SAH[29] has already been established, making GI an important factor in addressing these comorbidities. Moreover, combined indicators of carbohydrate quality have been associated with positive health outcomes, such as diets rich in fiber-containing carbohydrates.

Considering the ratio of solid carbohydrates to total carbohydrates, the mean values indicated a low ratio across all quintiles, indicating a high intake of liquid carbohydrates.

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Sugar-sweetened beverage consumption is associated with adverse health outcomes at the population level, contributing to an increased prevalence of conditions such as obesity, diabetes, and hypertension. The increased consumption of these beverages is mainly linked to poor dietary quality and is associated with a low intake of vegetables, greens, and fruits[32-33].

Having discussed the potential impact of each component of the CQI, it can be stated that, in the studied group, the low score observed is influenced by all its components. In this sense, improvements in dietary patterns are required, leading to an increase in the CQI, which would promote a diet with higher fiber intake and greater consumption of whole-grain products, lower intake of liquid carbohydrates, and a lower glycemic index[34].

Even though women presented higher excess weight and evidence of abdominal adiposity (estimated by elevated WC), the CQI of their diets was higher. This may reflect the study design; however, it is also possible that, due to their nutritional status, they had already begun implementing changes to improve the quality of their diets based on guidance received at the Primary Health Care Units. However, this aspect was not investigated in the present study.

Janbozorgi et al.[36] evaluated 850 adults in a cross-sectional study to examine the association between CQI and general obesity. The authors observed a higher CQI among individuals with excess weight. Furthermore, they identified an inverse relationship between CQI and general obesity among men. In a case–control study, Suara et al.[14] analyzed 124 individuals diagnosed with type 2 diabetes mellitus and found that overweight individuals had higher dietary CQI values. Nevertheless, these authors also reported an inverse association between CQI and WC.

On the other hand, an inverse relationship was observed between CQI and BMI among women in the sample, but not in the overall sample or among male participants. WC, in turn, was not associated with CQI. The homogeneity of diets, reflected in the low scores obtained, may have influenced these findings. Additionally, a possible influence of the cross-sectional study design cannot be ruled out. Limitations related to dietary intake assessment should be considered, such as the underreporting of foods perceived as unhealthy and the overreporting of foods considered healthy[14-34].

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Studies have reported an inverse relationship between CQI and SAH[13-35-37-38]. In the study by Suara et al.[14], CQI was inversely associated with the presence of SAH, indicating that the higher the CQI, the lower the prevalence of SAH in the study population.

Nikrad et al.[35] investigated the association between CQI and the prevalence of obesity and hypertension among 12,027 Korean adults aged 19 to 64 years. The authors found a negative association between CQI and the prevalence of SAH, as well as obesity.

A study by Jenkins et al.[38] also demonstrated that higher dietary carbohydrate quality is significantly inversely associated with the incidence of cardiovascular diseases. The authors emphasized that a "heart-healthy" diet should focus on improving the quality of dietary carbohydrates rather than limiting their quantity. In the study by Zazpe et al.[37], a significant inverse association was found between overall CQI and all-cause mortality; however, no association was observed when the CQI components were analyzed separately.

Few studies have evaluated the relationship between CQI and SAH, particularly when considering the role of anthropometric variables. The present study highlights directions for future research in this area, such as conducting comparative studies among patients with different chronic conditions in which diet represents an important risk factor. Additionally, future analyses could extend beyond the investigation of the relationship between CQI and nutritional status to examine associations with different socioeconomic profiles based on probabilistic and stratified samples.

Some limitations of the present study should be acknowledged, including the use of a convenience sample, which may have influenced the findings. This aspect was minimized by inviting all individuals present at the Primary Health Care Units to participate and by including a large number of participants. The FFQ is also a dietary assessment method that has limitations, as it depends on the participant's memory as well as the accuracy of the information provided[10]. This effect was minimized through the training of those responsible for data collection.

On the other hand, the study provides a novel contribution in Brazil by evaluating the dietary Carbohydrate Quality Index. Primary Health Care Units represent the main entry point to the Brazilian Unified Health System and are therefore important settings for the follow-up care of individuals with noncommunicable chronic diseases, including patients with SAH.

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CQI is not currently part of the routine assessment of dietary habits; however, the low values identified justify the inclusion of CQI assessment by expanding knowledge of the dietary patterns of this population and allowing better guidance for educational interventions.

This research provides practical and clinical implications by offering a holistic perspective on the diet of patients diagnosed with SAH. Based on the results presented, more targeted dietary interventions can be developed to guide the treatment of patients with SAH.

CONCLUSION

The hypertensive patients receiving primary health care evaluated in this study exhibited a high proportion of excess body weight, particularly among women, who also presented greater abdominal fat accumulation, as indicated by waist circumference. The patients also had a low CQI. Considering that the associations identified were weak, no association between CQI and anthropometric variables was observed in this group. However, actions aimed at improving both nutritional status and the quality of dietary carbohydrate intake are needed in this population.

Although the study provides important information on the relationship between CQI and the nutritional status of hypertensive patients, some gaps remain that justify further research. Longitudinal studies are required to investigate the causal relationship between carbohydrate quality and the progression of indicators such as BMI, WC, and blood pressure control, using representative samples stratified by sex, age, and socioeconomic profile to improve the generalizability of the findings.

More broadly, randomized controlled trials would be relevant to evaluate the impact of specific CQI components, such as dietary fiber, whole grains, glycemic index, and the quality of carbohydrate intake on blood pressure, metabolic markers, and body composition. Such studies would also allow comparisons among patients with different noncommunicable chronic diseases to determine whether the quality of carbohydrate intake influences these conditions in different ways.

Future studies should include larger and more representative samples and employ more precise dietary assessment methods to reduce reporting bias, thereby improving

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understanding of the impact of carbohydrate quality on the health of the hypertensive population.

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