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Nutritional status and metabolic risk in adults: association with diet quality as assessed with ESQUADA

Estado nutricional e risco metabólico em adultos: associação com a qualidade da dieta medida pela ESQUADA

Danilla Michelle Costa e Silva[I], Thanise Sabrina Souza Santos[II], Wolney Lisboa Conde[II], Betzabeth Slater[II]

ABSTRACT: ***Objective*:** To analyze the association between diet quality assessed with the Diet Quality Scale (ESQUADA) and the nutritional status and metabolic risk in adults. ***Methods*:** The data included 1,147 adults aged 20 to 59, from the population-based study with complex sampling. Weight, height, tricipital (TSF) and subscapular (SSF) skinfolds, and waist (WC) and mid-arm (MAC) circumferences were measured. Body mass index (BMI) and mid-arm muscle circumference (MAMC) were calculated. Nutritional status and metabolic risk were classified considering BMI and WC values, respectively. Diet quality was assessed with ESQUADA. Data were collected at household using the Epicollect5 application. Diet quality (in scores) was analyzed as continuous data and later categorized. The confidence interval was used for comparison between groups, Fisher's exact test for an association study. Adjusted multiple linear regression models were also estimated. $P < 0.05$ was adopted for statistical significance. ***Results*:** Overweight prevailed in 60.33% of individuals, especially among women (60.73%). High or very high metabolic risk was more frequent among women with "very good or excellent" diet quality. Higher diet quality score was associated with a reduction in TSF (β = -0.07; 95%CI -0.13 – -0.01) and an increase in MAMC (β = 0.09; 95%CI 0.00 – 0,18) in men and the reduction in weight (β = -0.04; 95%CI -0.07 – -0.01), SSF (β = -0.07; 95%CI -0.13 – -0,00) and WC in women (β = -0.06; 95%CI -0.09 – -0.02). ***Conclusion*:** A better diet quality is positively associated with lean mass in men, and negatively with fat mass in men and women.

Keywords: Adult. Anthropometry. Overweight. Food consumption. Psychometrics.

[I]Universidade Federal do Piauí – Picos (PI), Brazil.

[II]Faculty of Public Health, Universidade de São Paulo – São Paulo (SP), Brazil.

Corresponding author: Danilla Michelle Costa e Silva. Rua Antonieta Rodrigues Araújo, 325, Canto da Várzea, CEP: 64600-171, Picos, PI, Brazil. E-mail: dmcsilva@ufpi.edu.br

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RESUMO: ***Objetivo:*** Analisar a associação entre qualidade da dieta medida pela Escala de Qualidade da Dieta (ESQUADA) e estado nutricional e risco metabólico em adultos. ***Métodos:*** Analisaram-se dados de 1.147 adultos (de 20 a 59 anos), participantes de inquérito populacional com amostragem complexa por conglomerado. Aferiram-se peso, altura, pregas cutâneas tricipital (PCT), subescapular (PSE) e circunferências da cintura (CC) e do braço (CB). Calcularam-se índice de massa corporal (IMC) e circunferência muscular do braço (CMB). O estado nutricional e o risco metabólico foram classificados considerando valores de IMC e CC, respectivamente. A qualidade da dieta foi avaliada com aplicação da ESQUADA. Os dados foram coletados em domicílio com o aplicativo Epicollect5. A qualidade da dieta foi medida em escores e analisada de forma contínua e em categorias. O intervalo de confiança foi utilizado para comparação entre grupos, e o teste exato de Fisher, para estudo de associação, além de modelo de regressão linear ajustado. Adotou-se $p < 0,05$ para significância estatística. ***Resultados:*** O excesso de peso prevaleceu em 60,33% dos indivíduos, especialmente entre mulheres (60,73%). O risco metabólico elevado ou muito elevado foi mais frequente entre mulheres com qualidade da dieta muito boa ou excelente. O maior escore de qualidade da dieta associou-se à redução da PCT ($\beta = -0,07$; intervalo de confiança de 95% — IC95% -0,13 – -0,01) e ao aumento da CMB ($\beta = 0,09$; IC95% 0 – 0,18) em homens e à redução do peso ($\beta = -0,04$; IC95% -0,07 – -0,01), da PSE ($\beta = -0,07$; IC95% -0,13 – -0,00) e da CC em mulheres ($\beta = -0,06$; IC95% -0,09 – -0,02). ***Conclusão:*** A melhor qualidade da dieta associa-se positivamente a medidas antropométricas que indicam massa magra em homens e negativamente à massa gorda em homens e mulheres.

Palavras-chave: Adulto. Antropometria. Sobrepeso. Consumo de alimentos. Psicometria.

INTRODUCTION

In Brazil, the nutritional and epidemiological transition process is antagonistic, coexisting deficiency, infectious and contagious diseases with chronic non-communicable diseases (NCDs).[1-3] In this changing scenario, there was a 72% increase in the prevalence of obesity between 2006 and 2019, with greater growth among younger adults of both sexes.[3,4]

For monitoring nutritional status and obesity, body mass index (BMI) has been widely used in population-based studies in Brazil[3,5,6] as it is easy to apply and has a low cost.[7,8] However, it has limitations regarding the differentiation between lean mass and body fat, as well as the segmentation of that fat. To minimize this limitation, using other anthropometric parameters is recommended, such as skinfolds and body circumferences.[8,9]

Among the four main modifiable risk factors for chronic diseases, including obesity, is unhealthy eating.[10] Cohort studies have shown that better diet quality, assessed by different indices, reduced the genetic predisposition to obesity,[11] protected against weight gain and central adiposity,[12] and was associated with lower BMI, lower waist and height ratio, and smaller waist circumference.[13] The results suggest that better eating patterns are related to markers of better nutritional status and metabolic health, which are important to prevent obesity.

On the other hand, low diet quality, with high intake of sodium, fat, cholesterol and low intake of fruits, cereals, and vegetables was associated with an increased risk of metabolic syndrome.[14] In addition, the patterns of food consumption of the Brazilian

population[15] at home[16] and outside home,[17] characterized by increased consumption of ultra-processed foods, have been linked to chronic diseases, especially obesity, and increased central adiposity.[18,19]

Assessing data on food consumption is an important tool to monitor some of the risk factors for NCDs in Brazil[3,20] and, given the change in the healthy eating paradigm,[21] new tools for measuring diet quality have been proposed.[22-25] The Diet Quality Scale (ESQUADA), developed by Santos et al.,[22,23] was based on the new food paradigm, which guided the Dietary Guidelines for the Brazilian Population of 2014, considering food (and not nutrients), the NOVA system of food classification, dietary practices, and sustainability.[21] Furthermore, ESQUADA was guided by the item response theory (IRT),[26] which enabled the selection of more discriminative items and the non-subjective definition of the final score.[23]

Considering the importance and complexity of an accurate assessment in epidemiological research, the present study uses a new tool[22,23] to assess diet quality, which comprehensively considers this latent trait and current dietary guidelines.[21] In this sense, to the best of our knowledge, no previous investigation has evaluated diet quality with ESQUADA. The study of the relation between diet quality measured by ESQUADA and other variables of interest to health may strengthen the tool's use, as well as make it possible to gather evidence of the measure's quality.

Therefore, the objective was to analyze the association between diet quality and anthropometric variables that indicate nutritional status and metabolic risk in a population-based study, by applying the ESQUADA.

METHODS

In order to carry out this cross-sectional population-based study, data from the population-based health survey in the municipalities of Teresina and Picos (Piauí State) (ISAD-PI), conducted in 2018 and 2019 by Universidade Federal Piauí, were used, in partnership with the Department of Nutrition, Faculty of Public Health, Universidade de São Paulo.

All individuals living in private households (household in which the relationship between their occupants is dictated by family ties, domestic dependence, or by coexistence rules) were included in ISAD-PI in the urban area of the municipalities of Teresina and Picos. The study sample was estimated based on the number of households and the population living in both cities in 2010.[27] The number of households calculated was 578 for Teresina and 620 for Picos. There was an increase of 10% in these numbers, considering the possible loss, obtaining the estimate of a final sample of 642 and 688 households in Teresina and Picos, respectively.

In ISAD-PI, the complex sampling process by conglomerate was carried out in two stages: primary sampling units (PSUs) and households. PSUs were ordered according to their code

and, in the first stage of sampling, a sample of 30 PSUs in Teresina and 24 in Picos was systematically selected, with probability proportional to size. The second stage involved the systematic sampling of households within each selected PSU, 22 in Teresina and 26 in Picos, also using a list with the order of households which were drawn. The selected households were identified, and all residents were eligible for the survey.

For the present study, adults of both sexes, aged 20 to 59 were elected, excluding pregnant women (n = 12) and those who did not respond to the items considered herein (n = 48) or did not participate in the anthropometric assessment (n = 41), resulting in the final sample of 1,147 participants. ISAD-PI was completed with 1,248 adults. Therefore, for research analysis, there was a loss of 8.09% (n = 101) of volunteers. Such loss did not compromise the representativeness of the interest group or estimates precision, which depends not only on the number of individuals, but on the homogeneity of the variable under study within the clusters and on the average number of participants in each PSU.

Trained interviewers conducted the interviews at home using a questionnaire structured in specific thematic blocks for the stratum of adults, previously tested in a pilot study. The questionnaire was inserted on the *website* of the mobile data collection platform Epicollect5 and was applied through a program compatible with the Android operating system on mobile phones and tablets.

Anthropometric data were measured on the right side of the participant's body by anthropometrists trained by the team of the Laboratory of Nutritional Assessment of Populations of the Department of Nutrition of Universidade de São Paulo. Each measurement was performed twice, and the mean was considered in the analyzes. Participants were weighed with the aid of a portable scale, with a maximum capacity of 150 kg, with an electronic scale, of 0.1 kg accuracy. Height was measured with a portable stadiometer, of 0.2 mm accuracy, 0.1 cm graduation, and total length of 200 cm.[28] Weight and height measurements were used to calculate BMI and the following cutoff points,[7] adopted for the classification of nutritional status:

- BMI < 18.5 kg/m^2: thinness;
- BMI ≥ 18.5 and < 25 kg/m^2: eutrophy;
- BMI ≥ 25 and < 30 kg/m^2: overweight;
- BMI ≥ 30 kg/m^2: obesity;

The tricipital (TSF) and subscapular (SSF) skinfolds were clamped following a standardized procedure[29] and were measured with a scientific adipometer, with precision and sensitivity of 0.1 mm, and reading range of 85 mm diagonally. In turn, the waist (WC) and mid-arm (MAC) circumferences were measured with a flexible and non-extensible tape measure, with an accuracy of 0.1 cm.[28,29] WC was used to describe the risk of metabolic complications, classified considering the WC measure and sex:[8] for men, WC ≥ 94 cm and <102 cm represents a high risk; and WC ≥ 102 cm, very high risk; and for women, WC ≥ 80 cm and <88 cm points to a high risk; and WC ≥ 88 cm, very high risk. The muscular circumference of the mid-arm (MAMC), which indicates lean body mass, was estimated based on the TSF and SSF values, using the formula proposed by Jelliffe.[30]

Diet quality was scored using ESQUADA,[22,23] which was built using IRT, following the gradual response model of Samejima[31] of cumulative nature, which assumes that the latent trait described at higher levels accumulate the characteristics of the latent trait described at lower levels.[23,32] ESQUADA is composed of 25 items, which include eating practices and food consumption according to their processing degree.[23] Of these items, 24 were used to calculate the final score of the study sample. The item "Do you usually replace your lunch or dinner meal with snacks?" was excluded for presenting divergences among the categories of responses registered on the Epicollect5 platform and those proposed in the final version of ESQUADA. This exclusion did not preclude the calculation of the score or the interpretation of the scale, since interpreting the scale and producing meaning to the calculated score is feasible with the application of IRT, even with the adoption of a different number of items.[26,33]

Scores were calculated using the mirt and mirtCAT packages in RStudio software for Windows (R-tools Technology Inc.), version 3.5, according to the gradual response model, considering parameters *a* and *d* of the items calibrated in the construction of the scale by Santos et al.[23] Then, the scores generated on the scale (0.1) (with mean of 0 and standard deviation of 1) underwent linear transformation for scale with mean = 250 and standard deviation = 50. That is, the scores generated on the scale (0.1) were multiplied by the constant alpha transformation ($\alpha = 59.09$) and added to the constant beta transformation ($\beta = 250.12$).

Once calculated, scores can be categorized into five levels of diet quality:

- very poor, for scores ≤ 150;
- poor, for scores> 150 and ≤ 200;
- good, for scores > 200 and ≤ 275;

Chart 1. Brief description of diet quality levels grouped for the present study.

Level	Scale (250.50)	Description
Poor or very poor	Less than or equal to 200	- Individuals consume ultra-processed foods and replace meals with snacks up to two days a week. They eat fruits and vegetables in less than one day a week.
Good	Greater than 200, and less than or equal to 275	Individuals replace meals with snacks in less than one day a week. They do not consume some ultra-processed foods, but consume sugar sweetened beverages in less than one day a week. They eat fruits and vegetables on one to four days a week; and oats, rye, quinoa, nuts, walnuts, and brown rice/ whole-grain pasta in less than one day a week. They have breakfast on at least one day a week.
Very good or excellent	Greater than 275	- Individuals do not substitute meals for snacks. They do not consume any ultra-processed food. They have breakfast on at least one day a week. They eat fruits and vegetables on one to four days a week; and oats, rye, quinoa, nuts, walnuts, and brown rice/whole-grain pasta on one or more days a week.

Source: adapted from Santos et al.[23]

- very good, for scores > 275 and ≤ 375;
- excellent, for scores > 375.[23]

For this study, scores were used continuously and categorized into three groups: poor or very poor, good and very good, or excellent (Chart 1). This grouping was chosen due to the small number of participants in the extreme levels of diet quality.

Descriptive and statistical analyzes were performed using Stata program, version 14.0 (Stata Corp, College Station, United States). Data were presented as mean, confidence interval,[34] and minimum and maximum values. The distribution of the mean of anthropometric parameters with their respective confidence intervals by level of diet quality was also pointed out. Non-overlapping of confidence intervals was considered to identify the differences among groups.[35] The association between the classification of nutritional status and metabolic risk with the levels of diet quality was tested with Fisher's exact test ($p < 0.05$).

Linear regression models were developed for each dependent variable. Anthropometric variables (weight, BMI, TSF, SSF, MAMC and WC) were considered continuous values as dependent variables. Diet quality, in continuous scores, was the independent variable. All variables were standardized to have a mean of 0 and standard deviation 1, in order to make the regression coefficients obtained from the explanatory variables comparable to each other. To adjust the models, the variables age, family income in minimum wages, leisure-time physical activity (dummy),[36,37] presence of chronic disease (dummy), and place of residence (Teresina City, Picos City) were applied. Additionally, BMI was selected as a fixed covariate in the models that took the other anthropometric variables into account as dependent variables.

The analyzes were separated by sex. $P < 0.05$ was adopted for statistical significance. There was no weighting of data, since the probability of sample selection was equiprobabilistic. The analyzes were made in the survey module of Stata, considering the complex sampling.

All participants signed the Free and Informed consent form. This study was approved by the Ethics Committee of the Faculty of Public Health of Universidade de São Paulo (Opinion No. 3.576.735, of September 16, 2019).

RESULTS

A total of 434 men (37.84%) and 713 women (62.16%) participated in the study, with a mean age of 37.47 (95%CI 36.39 – 38.55) and 38.98 years (95%CI 38.15 – 39.80), respectively.

The anthropometric characterization of adults according to sex is found in Table 1. Men had higher body weight, MAMC, and WC compared to women. Women showed higher values of TSF and SSF.

The distribution of the mean of anthropometric parameters with their respective confidence intervals according to the level of diet quality is shown in Table 2. The means of

anthropometric parameters were similar among the levels of diet quality considered in this study, for both sexes.

In the study population, overweight prevailed (60.33%; n = 692), which was more pronounced among women (60.73%; n = 433) than among men (59.68%; n = 259). As for metabolic risk, most participants were at risk, high for 29.21% (n = 335) and very high for 26.07% (n = 299) of adults. When analyzing by sex, metabolic risk was also more prevalent among women (64.09%) (Table 3).

In the analysis of association between nutritional status and metabolic risk of adults, and levels of diet quality, most participants had a good or very good, or excellent quality diet, with an association between having metabolic risk and presenting very good or excellent diet quality only among women (p = 0.014) (Table 3).

Results of the linear regression analysis indicated that a higher diet quality score is associated with reduced TSF and increased MAMC in men, whereas among women, better diet quality is related to weight reduction, SSF, and WC (Table 4).

DISCUSSION

The high prevalence of overweight verified here was similar to those found at national and international levels,[3,4,6,38,39] in addition to revealing an increasing trend over the years, especially for women.[3,4] In agreement with the data of the present study, abdominal obesity

Table 1. Anthropometric characterization of the adults participating in the study, according to sex. Piauí State, Brazil, 2019 *.

	Men			Women		
	Mean ± SD	Minimum–Maximum	95%CI	Mean ± SD	Minimum–Maximum	95%CI
Body weight (kg)	76.92 ± 16.55	44.60 – 150.00	**75.36 – 78.48**	65.29 ± 13.26	33.60 – 128.10	64.31 – 66.26
Tricipital skinfold (mm)	16.06 ± 8.64	3.00 – 57.50	15.24 – 16.87	25.88 ± 8.46	6.50 – 55.00	**25.26 – 26.50**
Subscapular skinfold (mm)	19.22 ± 8.24	5.00 – 59.50	18.45 – 20.00	22.69 ± 8.82	5.00 – 60.00	**22.04 – 23.34**
Mid-arm muscle circumference (cm)	26.95 ± 3.38	17.36 – 41.36	**26.63 – 27.27**	22.17 ± 3.00	11.91 – 36.36	21.95 – 22.39
Waist circumference (cm)	91.24 ± 12.74	64.50 – 136.50	**90.03 – 92.44**	84.51 ± 11.65	56.20 – 128.50	83.65 – 85.37
Body mass index (kg/m^2)	26.80 ± 5.17	16.07 – 54.76	26.31 – 27.29	26.88 ± 5.33	13.71 – 49.88	26.49 – 27.27

*In bold, the confidence interval values of the parameters for which there was a difference between sexes;
SD: standard deviation; 95%CI: 95% confidence interval.

Table 2. Anthropometric parameters (mean ± SD and 95%CI) of adults by sex and second level of diet quality measured with the Diet Quality Scale. Piauí State, Brazil, 2019.

Score/Level	Men (n = 434)					
	Poor or very poor		Good		Very good or excellent	
Minimum–Maximum	114.72 – 199.73		201.94 – 274.58		275.18 – 364.46	
n	18		273		143	
Weight (Kg)	73.6 ± 17.7	64.77 – 82.42	77.5 ± 17.1	75.50 – 79.58	76.2 ± 15.2	73.65 – 78.68
TSF (mm)	17.2 ± 8.0	13.24 – 21.20	16.5 ± 9.2	15.38 – 17.59	15.1 ± 7.4	13.88 – 16.31
SSF (mm)	18.4 ± 8.9	13.99 – 22.84	19.5 ± 8.6	18.47 – 20.52	18.8 ± 7.4	17.58 – 20.03
MAMC (cm)	26.3 ± 2.6	25.02 – 27.58	26.9 ± 3.4	26.45 – 27.27	27.2 ± 3.4	26.63 – 27.76
WC (cm)	87.4 ± 15.0	79.93 – 94.83	91.1 ± 13.3	89.56 – 92.73	91.9 ± 11.2	90.03 – 93.75
BMI (kg/m^2)	26.0 ± 5.2	23.37 – 28.54	26.7 ± 5.2	26.06 – 27.32	27.1 ± 5.0	26.29 – 27.94
Score/Level	Women (n = 713)					
	Poor or very poor		Good		Very good or excellent	
Minimum–Maximum	131.99 – 198.82		200.21 – 274.88		275.01 – 402.83	
N	26		327		360	
Weight (Kg)	66.1 ± 13.8	60.57 – 71.72	65.2 ± 13.2	63.72 – 66.61	65.3 ± 13.2	63.96 – 66.71
TSF (mm)	24.3 ± 8.7	20.75 – 27.78	26.0 ± 8.7	25.05 – 26.95	25.8 ± 8.2	25.05 – 26.74
SSF (mm)	21.1 ± 7.9	17.86 – 24.29	23.0 ± 9.1	22.03 – 24.01	22.5 ± 8.6	21.62 – 23.40
MAMC (cm)	22.0 ± 3.6	20.56 – 23.51	21.9 ± 2.9	21.62 – 22.27	22.4 ± 3.0	22.08 – 22.70
WC (cm)	82.1 ± 11.4	77.47 – 86.71	83.5 ± 11.7	82.25 – 84.80	85.6 ± 11.5	84.39 – 86.78
BMI (kg/m^2)	25.7 ± 5.0	23.72 – 27.75	26.4 ± 5.3	25.84 – 27.00	27.4 ± 5.3	26.83 – 27.94

SD: standard deviation; 95%CI: 95% confidence interval; Min–Max: minimum–maximum; n: number of participants; TSF: tricipital skinfold; SSF: subscapular skinfold; MAMC: mid-arm muscle circumference; WC: waist circumference; BMI: body mass index.

Table 3. Nutritional status and metabolic risk of adults by sex and level of diet quality measured by the Diet Quality Scale. Piauí State, Brazil, 2019.

	Total		Men (n = 434)						Total		Women (n = 713)					
			Poor or very poor		Good		Very good or excellent				Poor or very poor		Good		Very good or excellent	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Nutritional status	p = 0.152*								p = 0.095*							
Thinness	9	2.07	0	0	7	77.78	2	22.22	24	3.37	0	0	15	62.50	9	37.50
Eutrophy	166	38.25	10	6.02	111	66.87	45	27.11	256	35.90	14	5.47	126	49.22	116	45.31
Overweight	162	37.33	5	3.09	93	57.41	64	39.51	265	37.17	9	3.40	116	43.77	140	52.83
Obesity	97	22.35	3	3.09	62	63.92	32	32.99	168	23.56	3	1.79	70	41.67	95	56.55
Metabolic risk	p = 0.832*								p = 0.014*							
No risk	257	59.22	13	5.06	161	62.65	83	32.30	256	35.90	15	5.86	129	50.39	112	43.75
High	98	22.58	2	2.04	62	63.27	34	34.69	201	28.20	3	1.49	93	46.27	105	52.24
Very high	79	18.20	3	3.80	50	63.29	26	32.95	256	35.90	8	3.13	105	41.02	143	55.86

*Fisher's exact test.

Table 4. Association between the diet quality score measured with the Diet Quality Scale and anthropometric parameters. Piauí State, Brazil, 2019.

	Men (n = 434)						Women (n = 713)					
	Gross model			Adjusted model[b]			Gross model			Adjusted model[b]		
	β[a]	95%CI	p	β	95%CI	p	β[a]	95%CI	p	B	95%CI	p
Weight (Kg)	0.02	-0.07 – 0.12	0.638	0.02	-0.02 – 0.06	0.335	0.00	-0.07 – 0.07	0.987	-0.04*	-0.07 – -0.01	0.018
TSF (mm)	-0.05	-0.12 – 0.03	0.215	-0.07*	-0.13 – -0.01	0.032	0.02	-0.03 – 0.08	0.418	-0.03	-0.07 – 0.01	0.201
SSF (mm)	-0.01	-0.11 – 0.08	0.767	-0.05	-0.11 – 0.02	0.158	0.00	-0.07 – 0.08	0.907	-0.07*	-0.13 – -0.00	0.033
MAMC (cm)	0.06	-0.03 – 0.14	0.182	0.09*	0.00 – 0.18	0.041	0.05	-0.01 – 0.11	0.115	-0.01	-0.05 – 0.03	0.647
WC (cm)	0.12*	0.02 – 0.22	0.023	-0.02	-0.07 – 0.03	0.378	0.11*	0.03 – 0.18	0.008	-0.06**	-0.09 – -0.02	0.001
BMI (kg/m^2)	0.09*	0.01 – 0.17	0.028	0.01	-0.10 – 0.11	0.893	0.10*	0.03 – 0.18	0.009	0.01	-0.08 – 0.10	0.798

TSF: tricipital skinfold; SSF: subscapular skinfold; MAMC: mid-arm muscle circumference; WC: waist circumference; BMI: body mass index; [a]standardized regression coefficient obtained by standardizing all variables to have a mean of 0 and standard deviation of 1; [b]adjusted for age, income, leisure-time physical activity, presence of chronic disease, and place of residence for all variables, adding BMI for anthropometric variables; *p < 0.05; **p < 0.005.

was also more prevalent among women in a survey conducted in the inland part of Bahia State.[40] WC seems to be a better predictive marker for chronic diseases related to obesity, when compared to BMI.[41]

As it is a complex event, food is not easily assessed, and must be observed within a food system, in which there are bilateral relations between individuals and their realities. Food is influenced by social, economic, cultural, and environmental drivers, which influence food choices, contributing to adequate or unsuitable dietary patterns and associated health conditions.

In view of this complexity in assessing food, the authors have analyzed diet quality in different ways, however some limitations have been revealed regarding the tools used, such as: the non-standardization between food groups considered in final score's calculation, with classification of foods with different types of processing in the same food grou;[42,43] different methodologies used, making it difficult to compare studies;[44] inaccuracy in food consumption data considered in the analysis inherent to the food surveys used;[7] and the non-adoption of updated dietary guidelines.[5,43]

The generation of the diet quality score with the use of ESQUADA does not require the use of individual data on food and/or nutrient consumption. Therefore, it does not depend on the previous application of tools, such as food frequency questionnaire, 24-hour recall hours, or food log. ESQUADA is theoretically based on the Dietary Guidelines for the Brazilian Population[21] and proposes an expansion of the concept of diet quality beyond the consumption of nutrients and food, considering the investigation of food consumption according to the type of processing and dietary practices.[23] In Brazil, ultra-processed products, which are industrial formulations that simulate food or culinary food preparations,[21,45] have had an increasing participation in the diet of Brazilians over the last 40 years, at the same time that the consumption of fresh foods or minimally processed and culinary ingredients has been reduced.[15]

The availability of ultra-processed products among Brazilian families and their consumption were positively associated with the average BMI and the prevalence of overweight and obesity, increasing the chance of developing obesity in the classes with the highest energy consumption resulting from these products.[16,18] The popularization of such consumption is believed to have contributed to the current situation of overweight and obesity in the country,[3,4] leading to a change in the diet paradigm that culminated in the publication of the Dietary Guidelines for the Brazilian Population in 2014.[21]

In the present study, the associations found may reveal a reverse causality, common in cross-sectional studies. At very good or excellent diet quality levels, individuals frequently consume vegetables, greens, and fruits; whole grains, chestnuts, and nuts are eaten at least one day a week, in addition to not usually eating ultra-processed foods.[23] Research results suggest that women who are overweight and present high metabolic risk tend to adopt a healthier and more balanced diet as a measure to reduce the risks to health and body fat.

In a longitudinal study conducted by Franco et al.,[46] the low consumption of ultra-processed and added ingredients promoted a reduction in the anthropometric

parameters that indicated body fat in overweight women. A better diet quality among women has been associated with the presence of chronic diseases, weight control, and body dissatisfaction.[5,47]

Among young men, body image seems to stand out among the most common motivators for healthy eating and physical activity.[48] Leisure-time physical activity, used as an adjustment variable in the present study, showed a positive and significant association with MAMC and a negative and significant association with TSF.

In a systematic review,[42] eating patterns that included foods such as whole or skim milk, meats, breads, natural juices, vegetables, cereals, beans, fruits, and dairy products were directly associated with general and abdominal obesity (BMI) (WC), characterizing risk for NCDs. Azevedo et al.[42] attributed these results to reverse causality, although they highlight the difficulties in interpreting the data due to the different methodologies employed and the heterogeneous definition of dietary patterns, with the inclusion of foods such as fruits and diet soft drinks in the same pattern.

Although it is a common variable in studies that assess changes in anthropometric parameters associated with food, energy intake was not assessed in the present study, as this is not the objective of ESQUADA. Diet quality and healthy eating based on Brazilian dietary guidelines are associated with anthropometric parameters that indicate nutritional status, regardless of the energy consumed.[49-51]

In view of the results found, dealing with overweight is imperative in the population studied. Obesity is one of the pandemics that define the current situation of global syndemic[52] and, more recently, alongside other chronic diseases, it has been associated with complications and worse health outcomes in individuals infected with the new coronavirus.[53,54]

This new pandemic, called covid-19, was responsible for thousands of deaths worldwide in a few months. Such finding reinforces the need to adopt a healthy lifestyle, including good nutrition and physical activity to strengthen immunity and improve the body's response to infections.[54,55]

As limitations, due to the study's cross-sectional design, the findings are subject to reverse causality bias, reinforcing that research aimed to investigate the association between variables, and not to identify or establish causal relations. Another possible limiting factor is the low proportion of individuals at extreme levels of diet quality and the high prevalence of overweight, which may have made it difficult to find other associations between diet quality and other variables studied. Considering that these participants may have omitted their real eating patterns, for fear of disapproval or desire for approval towards the research team, must be considered.

As strengths, the study provides evidence of the validity of an innovative metric that comes to meet the difficulties and limitations pointed out in recent studies. ESQUADA allows the comparison among different groups and populations due to its construction, based on IRT. The study of associations between the generated score and anthropometric parameters indicates that this tool can contribute to monitor Brazilians' adherence to national dietary guidelines and to the prediction of health outcomes.

The high prevalence of overweight among the adults participating in the study is a warning sign for both the population and authorities. The best diet quality among women is related to weight reduction and central fat mass. In men, the best diet quality is linked to the increase in muscle mass and the reduction of peripheral fat. The present study points to evidence of the validity of ESQUADA in associations with anthropometric parameters that indicate nutritional status and metabolic risk. This tool is promising in assessing population's adherence to Brazilian dietary guidelines.

The findings of the present study reveal the need for strategies that aim to increase adult adherence to Brazilian dietary guidelines as preventive and health promotion measures. Intervention and prospective studies should investigate the predictive ability of ESQUADA and the association of diet quality with health outcomes.

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