ORIGINAL ARTICLE

ESQUADA and its Correlation with Diet Markers in Health Survey:
Validity Evidences

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Highlights:
1. The levels of the ESQUADA agreed with eating markers used in surveys.
2. Fruits and sugary drinks had 62.5% of agreement with the levels of the ESQUADA.
3. The ESQUADA evaluates diet quality in a broader spectrum in comparison with markers.

ABSTRACT

The study aimed to evaluate the correlation between ESQUADA and healthy and unhealthy eating markers. This is a psychometric study carried out with adults participating in the Population-Based Health Survey in the municipalities of Teresina and Picos. ESQUADA was used to evaluate diet quality, measured in scores and classified into five quality levels ranging from "very poor" to "excellent". Eating habits were investigated with markers of healthy and unhealthy eating. The consumption frequencies obtained from the markers and the description of the dietary quality levels were ordered into categories, making them comparable. Kendall rank correlation coefficient was used in the study of correlation between frequencies, adopting a significance of 5%. The better the quality of the diet, according to ESQUADA, the healthier the individuals' diet, according to the markers. Agreements were observed ranging from 53% (cooked vegetables) to 62.5% (fruits and sugary drinks). The agreement analysis adds evidence of ESQUADA validity and endorses its use in health surveys, allowing the assessment of diet quality in line with the dietary guidelines for the Brazilian population.

Keywords: health surveys; diet surveys; surveys and questionnaires; validation study.

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INTRODUCTION

Diet is one of the five main risk factors for associated deaths in the world, being responsible for 2 to 8% of disability-adjusted life years in Brazil[1]. Between 2006 and 2019, there was a significant improvement in the regular consumption of fruits and vegetables, markers of healthy eating among Brazilians. However, between 2015 and 2019, a decrease in the consumption of these foods was observed[2,3]. Between 2002 and 2009, an increase in the consumption of ultra-processed foods, markers of unhealthy eating, was found, which was responsible for approximately 29% of the growth in the prevalence of obesity among Brazilians[4].

In this context, the importance of monitoring dietary patterns and practices in the Brazilian population is emphasized since, based on the evidence produced, it is possible to define and evaluate goals and actions for health promotion and prevention of diseases and injuries[5]. Examples of monitoring tools in Brazil are the Food and Nutritional Surveillance System[6] and health surveys, such as the National Health Survey (PNS, Plano Nacional de Saúde, as in Portuguese)[7] and the Surveillance of Risk and Protective Factors for Chronic Diseases by Telephone Survey (Vigitel, Vigilância de Fatores de Risco e Proteção para Doenças Crônicas por Inquérito Telefônico, as in Portuguese)[8], with caution being necessary when comparing results due to methodological differences in the process of assessing food consumption.

Widely used eating markers were part of the research protocols of the PNS, Vigitel, and the National School Health Survey[9]. The use of markers is highlighted in health surveys[9] and is aligned with routine food and nutritional surveillance in health services[6]. As markers of healthy patterns, the recommended consumption of fruits and vegetables and regular consumption of beans are considered. In turn, unhealthy markers include regular intake of soft drinks, whole milk, excessive fat meat, and salt consumption.

Thus, the application of eating markers has been a significant strategy for monitoring the consumption of healthy and unhealthy foods across the country[10], even so, it does not consider in its assessment the coexistence of the consumption of healthy and unhealthy foods. Again, the food guide for the Brazilian population[11] considers the NOVA Classification of foods, bringing a new food paradigm that bases the food quality on different aspects that include not only the food consumption itself. In this context, recently, the diet quality scale (ESQUADA)[12] was developed in line with the dietary guide for the Brazilian population[11], and it is significant to evaluate its validity evidence, such as concerning convergence with consumption markers.

Considering the pentagonal model of instrument validation[13], previous studies have gathered evidence regarding the content, response process, internal structure, association with external measures, and consequences of using ESQUADA[12,14,15]. Knowledge of new evidence of ESQUADA's validity contributes to referencing the quality of the measure and can enhance its use in health surveys and monitoring dietary practices. With the expansion of the employment of ESQUADA in national surveys, it will be possible to provide data that better elucidate the sociodemographic, economic, and other factors that contribute to low diet quality and, thus, enable more assertive policies and actions.

Starting from the ordinary measurement object - food, and the reasonable time to gather evidence of validation of ESQUADA from the Population-Based Health Survey in the municipalities of Teresina and Picos (PI) (ISAD-PI), this study aimed to evaluate the correlation between the levels of dietary quality proposed by ESQUADA and the markers of healthy and unhealthy eating used in health surveys.

METHODS

Characterization of the study and origin of data

This is a psychometric study to strengthen the set of ESQUADA validity evidence available. To this end, data from ISAD-PI, carried out in 2018 and 2019 by the Federal University of Piauí, in partnership with the Department of Nutrition of the Faculty of Public Health of the University of São Paulo, was used. ISAD-PI aimed to analyze the health determinants and conditions of the population living in the urban areas of Teresina and Picos in Piauí. For the study, all individuals living in private homes were eligible, except those with any disabilities – or disabilities that made it impossible to carry out the research[16].

For the ISAD-PI sample calculation, the size of the population of Teresina (767,557 inhabitants) and Picos (58,321 inhabitants) was considered, as well as the number of private households in the two cities (Teresina with 210,093 households and Picos with 16,944), in 2010. The calculated sample was 578 households for Teresina and 620 for Picos. There was a 10% increase in these numbers (considering possible losses), resulting in a final sample estimate of 642 and 688 households in Teresina and Picos, respectively[16].

ISAD-PI adopted a complex cluster sampling plan in two stages. In the first stage, Primary Sampling Units (UPAs) were ordered according to their code, based on census data from the Brazilian Institute of Geography and Statistics (IBGE, Instituto Brasileiro de Geografia e Estatística, as in Portuguese)[17] for 2010. A sample of 30 UPAs was selected in Teresina and 24 in Picos, with probability proportional to size. The second stage involved the systematic sampling of households within each selected UPA, 22 in Teresina and 26 in Picos, also using a list with the order in which the households were drawn.

After identifying the selected households, trained researchers collected the data using standardized techniques and structured questionnaires, using the Epicollect 5® application (Imperial College London, 2018)[18]. The questionnaires were previously tested in a pilot study.

1,248 adults aged from 20 to 59 years old partook in ISAD-PI. For this study, 1,189 adults who answered the questions of interest, and who were not pregnant, were evaluated. Adults answered, among others, questions covering sociodemographic, economic data, lifestyle, and eating habits.

Instruments

ESQUADA was used to evaluate diet quality. It consisted of 25 items encompassing eating practices and food consumption according to their degree of processing[12]. Of these items, 24 were used to calculate the final score of the study sample. The item "Do you usually replace meals for snacks at lunch or dinner?" was excluded due to discrepancies between the response categories registered on the Epicollect5 platform and those proposed in the final version of ESQUADA. This exclusion did not interfere on the calculation of the score or the interpretation of the scale unfeasible since ESQUADA was constructed using the Item Response Theory therefore, even with the adoption of a different number of items, it is possible to interpret the scale and produce meaning to the calculated score[19,20].

Diet quality was initially measured in scores calculated using the mirt and mirtCAT packages in the RStudio software for Windows (R-tools Technology Inc.), version 3.5, according to the graded response model, considering parameters a and d of the items calibrated in the construction of the scale by Santos and collaborators[12]. Then, the scores generated on the scale (0.1) (with mean equal to 0 and a standard deviation equal to 1) were multiplied by the alpha transformation constant (α = 50.00) and added to the beta transformation constant (β = 250.00) so that they undergo linear transformation to a scale with mean = 250 and standard deviation = 50.

Once the scores on the scale (250,50) were calculated, the individuals were categorized according to the five levels of dietary quality proposed in ESQUADA: very poor (scores ≤ 150); poor (scores > 150 and ≤ 200); good (scores > 200 and ≤ 275); very good (scores > 275 and ≤ 375); excellent (scores > 375)[12].

The eating habits of adults were investigated using markers of healthy and unhealthy eating, using questions about weekly and daily frequency of consumption, as investigated by the PNS (2013)[7]. Among the healthy eating markers, regular consumption of beans (five or more days a week); the recommended consumption of fruits and vegetables (five or more times a day on five or more days of the week); and regular consumption of fish (at least one day a week) were adopted. As markers of unhealthy eating, regular consumption of sweets (five or more days a week; regular replacement of meals with snacks (five or more days a week); high salt intake (proportion of people reporting high salt intake); and regular consumption of sugary soft drinks or artificial sugary juices - without being diet/light/zero (five or more days a week) were adopted.

Data analysis

The study sample was characterized according to the following sociodemographic and economic variables: sex (male and female); age group (20-34, 35-49, 50-59 years old); skin color (white, black, yellow, brown, indigenous or other); marital status (married, consensual marriage, single, divorced, widowed, did not respond); family income (minimum wages); instruction (years in school); place of residence (Teresina and Picos).

The analyses were carried out with Stata Software, version 14.0 (Stata Corp, College Station, United States), using survey procedures to incorporate the complexity of the sample. The association between the consumption of healthy and unhealthy eating markers with the levels of diet quality measured by ESQUADA was tested using Fisher's exact test ($p < 0.05$). To measure the correlation between the consumption frequencies obtained through questions relating to PNS food markers and the frequencies described in the diet quality levels measured by ESQUADA, the Kendall rank correlation coefficient was used, making - adjustment for ties in the classification (Kendall's Tau-b), adopting a significance of 5%. To this end, initially, the consumption frequencies obtained through questions relating to the markers and those described in the dietary quality levels were ordered into categories, making the positions comparable for the following markers:

- raw or cooked fruits and vegetables (order 1 – less than one day a week or not consumed; order 2 – one to four days a week; order 3 – five days or more a week);
- sugary drinks and cakes (order 1 – at least one day a week; order 2 – less than one day a week or not at all);
- replacing meals with snacks (order 1 – at least one day a week; order 2 – less than one day a week or not replaced).

ISAD-PI was approved by the Research Ethics Committee of the Federal University of Piauí (Opinion No. 2,552,426, dated March 20, 2018). After being informed about the objectives and procedures of the research, all the participants signed a Free and Informed Consent Form[16].

RESULTS

Table 1 describes some sociodemographic and economic characteristics of the study participants. Most were female, , and residents in Teresina; they were between 35 and 49 years old, spent nine to twelve years in school, and received from one to two minimum wages.

Most individuals had "good" (59.0%) and "very good" (38.3%) diet quality. Among those with "very good" diet quality, the highest proportion of individuals with weekly fish consumption; not regularly consuption of sweets and sugary drinks; not regularly replacement of meals with snacks; and perception of high salt intake, with statistical significance, was observed. In other words, the better the quality of the diet, observed by ESQUADA, the healthier the individuals' diet according to the PNS markers (Tables 2 and 3).

Table 1 – Sociodemographic and economics characteristics among adults, Population-Based Health Survey in the municipalities of Teresina and Picos (PI) (ISAD-PI), Brazil, 2018-2019. (n=1189)

	n	%
Gender		
Female	740	62.2
Male	449	37.8
Age range (years)		
20 to 34	464	39.0
35 to 49	494	41.6
50 to 59	231	19.4
Skin color		
White	205	17.2
Black	174	14.6
Yellow	69	5.8
Brown	714	60.1
Indigenous or other	27	2.3
Marital situation		
Married	466	39.2
Consensual marriage	244	20.5
Single	379	31.9
Divorced	77	6.5
Widowed	22	1.8
Did not answer	1	0.1
Family income (minimum wages)		
less than 1	142	11.9
1 to 2	607	51.1
3 to 4	280	23.6
5 to 9	120	10.1
10 to 20	17	1.4
more than 20	5	0.4
not informed	18	1.5

Instruction (years in school)		
0 to 4	123	10.3
5 to 8	163	13.7
9 t o 12	574	48.3
13 or more	329	27.7
Place of Residence		
Teresina	642	54.0
Picos	547	46.0

Table 2 – Diet quality according to healthy eating markers, Population-Based Health Survey in the municipalities of Teresina and Picos (PI) (ISAD-PI), Brazil, 2018-2019. (n=1189)

Diet quality	Total		Beans				Fruits and Vegetables				Fish*			
			No		Yes		No		Yes		No		Yes	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Very poor	1	0.1	0	0.0	1	100.0	0	0.0	1	100.0	0	0.0	1	100.0
Poor	30	2.5	13	43.3	17	56.7	3	10.0	27	90.0	19	63.3	11	36.7
Good	701	59.0	249	35.5	452	64.5	156	22.25	545	77.75	275	39.2	426	60.8
Very Good	456	38.3	140	30.7	316	69.3	104	22.8	352	77.2	167	36.6	289	63.4
Excellent	1	0.1	0	0.0	1	100.0	0	0.0	1	100.0	0	0.0	1	100.0

*Fisher's Exact p<0.05.

Table 3 – Diet quality according to markers of unhealthy eating, Population-Based Health Survey in the municipalities of Teresina and Picos (PI) (ISAD-PI), Brazil, 2018-2019. (n=1189)

Diet quality	Total		Sweets*				Replacing meals for snacks*				Salt*				Sugary drinks*			
			No		Yes		No		Yes		No		Yes		No		Yes	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Very poor	1	0.1	1	100.0	0	0.0	1	100.0	0	0.0	0	0.0	1	100.0	0	0.0	1	100.0
Poor	30	2.5	18	60.0	12	40.0	23	76.7	7	23.3	22	73.3	8	26.7	13	43.3	17	56.7
Good	701	59.0	568	81.0	133	19.0	664	94.7	37	5.3	578	82.5	123	17.5	598	85.3	103	14.7
Very Good	456	38.3	418	91.7	38	8.3	439	96.3	17	3.7	418	91.7	38	8.3	445	97.6	11	2.4
Excellent	1	0.1	1	100.0	0	0.0	1	100.0	0	0.0	1	100.0	0	0.0	1	100.0	0	0.0

*Fisher's Exact p<0.001.

Table 4 describes the results of the correlation analysis between ESQUADA and the PNS markers. Fruits and vegetables (markers of healthy eating) and sugary drinks (markers of unhealthy eating) were positively correlated with the levels of diet quality proposed by ESQUADA, with statistical significance. Agreements were observed ranging from 53% (cooked vegetables) to 62.5% (fruits and sugary drinks).

Table 4 – Correlation between the frequencies of consumption described in the levels of diet quality and the markers of healthy and unhealthy eating from the National Health Survey. Population-Based Health Survey in the municipalities of Teresina and Picos (PI) (ISAD-PI), Brazil, 2018-2019. (n=1189)

Markers	Kendall tau b	p	Agreement (%)
Fruits	0.25	<0.001	62.5
Raw vegetables	0.20	<0.001	60.0
Cooked vegetables	0.06	0.04	53.0
Raw or cooked vegetables	0.17	<0.001	58.5
Sugary drinks	0.25	<0.001	62.5
Cakes	0.02	0.53	51.0
Replacement of meals for snacks	-0.02	0.46	49.0

DISCUSSION

Individuals with better diet quality had a healthier diet from the perspective of eating markers, such as regular consumption of fish and no regular consumption of sugary drinks. These markers agreed by more than 50% with the levels of diet quality observed in the ESQUADA assessment.

Food markers signal the healthiness of a population's food consumption, contributing to food and nutritional surveillance[10,21,22] and the formulation and implementation of public policies[10,22]. It is observed that population surveys have included their evaluation in their protocols, even enabling the understanding of the temporal evolution of food consumption[10,23,24,25] and different cuts in the analysis[26]. In times of health emergency, Steele and collaborators[27] analyzed changes in markers of healthy and unhealthy eating when evaluated before and during the Covid-19 pandemic. However, the application of markers does not provide for the calculation of summary measures, such as scores, which limits the analysis of nutrition in its complexity, in addition to the conduction of studies on associated factors and health outcomes in cross-sectional or prospective approaches.

In turn, the application of ESQUADA allows the generation of continuous scores that can also be analyzed at five levels of diet quality: "very poor", "poor", "good", "very good" and "excellent"[12], expanding the possibilities for data exploration, as can be seen in cross-sectional studies already published. In these, ESQUADA was applied to investigate the associations between scores with metabolic risk and nutritional status[14] and food insecurity[28]. Furthermore, reapplication over time can contribute to understanding the forthcoming relationship between diet quality and health conditions. The use of diet quality indices referenced in national dietary guidelines has produced evidence of the association with risk factors for cardiovascular diseases[29], all-cause mortality rates[30], and incidence of hypertension and cardiovascular diseases[31].

Diet quality levels obtained with ESQUADA and food markers showed agreement more significant than 50% for identifying the consumption of natural and ultra-processed foods. In other words, compliance between the two approaches was observed in more than half of the individuals evaluated. In addition to assessing these markers, ESQUADA also makes it possible to evaluate shopping locations, the influence of marketing on food, and the customs of cooking and eating main meals[12]. On the other hand, the lack of statistical significance in ESQUADA's agreement with markers that include the consumption of cakes and the replacement of meals with snacks may be due to differences between the instruments regarding the writing of the questions. In this sense, the question about replacing meals with snacks is broader in ESQUADA by including ultra-processed, pre-ready-to-eat foods, such as lasagna and other industrialized preparations, while the markers only cover sandwiches, snacks,

and pizza, without including examples. Therefore, the use of ESQUADA provides surveys with a more comprehensive assessment of nutrition in light of the current paradigm of nutrition and food science[32] and the second version of the dietary guidelines for the Brazilian population[33], encompassing more cultural expressions, ways of eating, environmental influences food and the protection of a sustainable food system[32,33].

The analysis of the results of the markers in the dichotomization into "healthy" and "unhealthy", exemplifies a biologicalist and medicalizing nutritional perspective that classifies food based on the risk or protective factor for chronic diseases[34]. This dichotomized perspective can limit the understanding of food quality and distance itself from broader perspectives on healthy eating[32,33,34]. Through ESQUADA, with the cumulative description of the five levels, the diet quality is better as we observe the incorporation of healthier consumption and eating practices into the population's routine[12]. In this way, the description highlights the coexistence of healthy and unhealthy customs at the same dietary quality level. For example, individuals with "good" diet quality have a higher frequency of consumption of natural and minimally processed foods compared to those with "very poor" or "poor" diet quality; however, they still have the habit of consuming sugary drinks, absent in the "very good" and "excellent" levels[12]. This gradation between levels was possible with the application of Item Response Theory[34,35], making it possible to identify which individuals have better practices, as well as to study the effectiveness of an intervention in the evolution of diet quality.

It is also noteworthy that the items that make up the ESQUADA were identified based on their capacity to discriminate the diet quality[12,34]. The markers, in turn, signal food consumption that promotes health or is related to the incidence of diseases[10]. The presence of markers among the items that make up ESQUADA supports their relevance for evaluating eating habits. The agreement between the two approaches is based on the convergence between ESQUADA's more comprehensive assessment and the selection of indicator foods.

It is significant that, for this study, the object was the analysis of agreement between the instruments used in ISAD-PI. Thus, the diffusion of evidence on the convergence between the two approaches demonstrates the potential usage of ESQUADA in future studies, contributing to the food surveillance agenda, promoting adequate and healthy eating, and assuring food and nutritional security. Therefore, it is suggested to apply this instrument in different research designs to identify vulnerable groups and populations according to social and economic inequities, which indicate experiences of discrimination, historical and biographical contexts, social traumas, exposure to degraded ecosystems, in addition to classic socioeconomic measures[36]; as well as monitoring situations that pose a threat to public health, such as the Covid-19 pandemic[27].

Some limitations of the present study need to be discussed. The concomitant application of the ESQUADA questions and the markers may have influenced the agreement observed in this study. However, the analysis was not carried out directly based on the answer options, which are divergent, but after organizing the frequency of consumption in the database. Furthermore, the length of the questionnaire as a whole, which included other research modules, may have contributed to fatigue on the part of both the interviewer and the interviewee, with an impact on the quality of the interview and response. In these cases, interviewer training included guidance on stopping the interview after closing the open module, with a later schedule for continuation.

The following strengths of the study should be highlighted. The use of data from a population--based health survey strengthens the results of the comparison analysis between the instruments and the confirmation of agreement adds evidence of ESQUADA's validity. The results of this study reaffirm the possibility of using ESQUADA in health surveys to evaluate diet quality in a broader spectrum in light of the dietary guidelines for the Brazilian population and in line with the current paradigm of nutrition science and food. Furthermore, with the application of ESQUADA there are potential gains in

different cross-sectional and prospective analysis approaches, in the investigation of health outcomes and conditions related to food.

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