

ORIGINAL ARTICLE

Development and validation of an instrument to assess Brazilians' knowledge, perceptions, and behaviors toward salt and sodium

Alicia Tavares da Silva Gomes PhD^{1,2}  | Kamila Tiemann Gabe MS^{1,2}  |
Patricia Constante Jaime PhD^{2,3} 

¹Programa de Pós-Graduação em Nutrição em Saúde Pública, School of Public Health, University of São Paulo, São Paulo, SP, Brazil

²Center for Epidemiological Research in Nutrition and Health (NUPENS), School of Public Health, University of São Paulo, São Paulo, SP, Brazil

³Nutrition Department, School of Public Health, University of São Paulo, São Paulo, SP, Brazil

Correspondence

Alicia Tavares da Silva Gomes, Programa de Pós-Graduação em Nutrição em Saúde Pública, School of Public Health, University of São Paulo, Avenida Dr. Arnaldo, 715, 01246-904, São Paulo, SP, Brazil.
Email: alicia.tsg@gmail.com

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Abstract

This study aimed to develop and validate an instrument to assess Brazilian adults' knowledge, perceptions, and behaviors (KPB) toward salt and sodium. Based on a PAHO/WHO questionnaire, a new instrument was developed and evaluated by 11 experts, generating item and scale-level content validity indexes (I-CVI and S-CVI, respectively). Face validity was verified through a focus group with eight participants, followed by an operational test with 36 interviewees. Exploratory factor analysis (EFA) was used to determine the construct validity, and Cronbach's α coefficient was calculated to analyze instrument's reliability, using data collected via telephone from a probabilistic sample of 422 adults. The generated solutions were analyzed from theoretical and statistical significance perspectives, which supported the determination of the best model. Remaining items were scored, with higher scores related to healthier practices. A descriptive analysis was performed considering the data from the 422-adult sample. I-CVIs (0.73-1), S-CVIs (0.93; 0.97) and the interviewees' analysis indicated that items are representative and clear, in addition to being suitable for application to the target audience. Tests confirmed sample adequacy to perform the EFA (KMO = 0.82; Bartlett's sphericity test, $p < .001$). The final validated model, with 16 items, sufficiently explained the variance and presented good reliability (Cronbach's $\alpha = 0.81$; 95% CI 0.79 - 0.84). Women, older individuals, and with higher education had significantly higher scores, regardless of chronic diseases diagnosis ($p < .001$). This instrument is ready to be applied and easily reproduced, contributing to the assessment of KPB toward salt and sodium in Brazil.

KEYWORDS

diet/nutrition/hypertension, patient education, sodium

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1 | INTRODUCTION

Excessive sodium intake is associated with the occurrence of cardiovascular dysfunctions, premature deaths, and great costs to health systems from hospitalizations, outpatient care and medication for hypertension.^{1,2} Recent global estimations of salt intake indicate that populations are consuming approximately twice the recommended amount of 5 g/day,^{3,4} even though main dietary sources vary quite substantially depending on the region.⁵

Despite representing a worldwide public health problem, most individuals do not realize how high this consumption is,^{6,7} even with trends of household availability of sodium-rich products, such as ultra-processed foods, on the rise.⁸ The higher the contribution to total energy of ultraprocessed foods, the higher the sodium intake and the risk of developing chronic noncommunicable diseases, such as hypertension.^{9–11} Moreover, table salt is a major dietary source in several countries,⁵ for example, in Brazil, where in addition to salt-based condiments used for seasoning, it accounts for approximately 70% of all sources.¹²

Humans' capacity to recognize sodium and liking for salty foods is the result of the interaction between taste sensitivity and learned experiences, which can be modulated depending on level of exposure to dietary sodium throughout lifetime.¹³ In adults, consumer education and flavor enhancers increased acceptance of sodium-reduced products,¹⁴ and investigating individuals' knowledge, perceptions, and behaviors (KPB) toward salt and sodium can help to identify which population groups need further guidance and assistance, seeking an overall reduction in consumption.^{15,16}

National strategies for reducing sodium intake are being developed and implemented globally,^{17–19} and countries are exchanging inspiring experiences on this topic. Nevertheless, there is a need to produce up-to-date data for each context, and to also consider the assessment of populations' KPB toward salt and sodium.^{20,21} The produced data could support the elaboration of more effective social marketing-based strategies for salt reduction tailored by local contexts, as suggested by the World Health Organization.²² This kind of investigation is mainly performed in high income countries, and instruments should be validated prior to application, given cultural and social influences on these practices.^{23–25}

Brazil is a leader in Latin America for public policies related to food and nutrition, from the current food-based Dietary Guidelines for the Brazilian Population,²⁶ to national strategies for reducing sodium intake, such as consumer education, food reformulation, health promotion in school and work, food regulation, and healthcare initiatives.²⁷ However, until the writing of this article, there is no validated instrument able to assess KPB toward salt and sodium that was tested by rigorous psychometric evaluations, nor an instrument with such an objective developed and validated for the Brazilian population.

This work describes the development and validation of a country-specific tool designed to assess KPB toward salt and sodium in the Brazilian adult population, considering the evaluation of content, face, and construct validities, in addition to a reliability analysis, thought to be applied by telephone interviewing for population-based studies,

due to lower research costs, easier surveillance, and rapidity in data collection.

2 | METHODS

2.1 | Inspirational instrument

In 2013, a year dedicated to the fight against hypertension, the Pan-American Health Organization (PAHO/WHO) launched a document entitled "Salt-Smart Americas: A Guide for Country-Level Actions"²² to disseminate regional knowledge on recommendations, protocols, and guidelines to support local and national strategies to reduce sodium intake. One of these protocols, the *Questionnaire on Knowledge, Attitudes and Behavior toward Dietary Salt and Health*, has the main objective "to establish a baseline on consumer knowledge, behavior and labeling preference with respect to salt and sodium". This instrument was applied in Latin American countries,⁶ with available versions in English and Spanish, in addition to being designed, reviewed, and tested through focus groups under the coordination of a subgroup of specialists from the PAHO/WHO.

Considering the objective of this study, which is to develop an instrument able to assess KPB toward salt and sodium in the Brazilian adult population, this questionnaire was chosen to inspire the conception of the new instrument. Based on procedures suggested by literature in terms of cross-cultural adaptation,²⁸ chosen items were translated and adapted to the Brazilian context. Items on food labeling were adapted to contribute to current national discussions on this topic – since 2006, it is already mandatory to indicate the amount of sodium in milligrams per portion in packaged foods,²⁹ and new regulations to be applied are focused on front-of-package nutritional information.^{30,31}

Moreover, questions were added on the use of salt-based condiments and the consumption of food and beverages markers of a dietary pattern related to an excessive sodium intake in Brazil, such as soda, processed meat, chips, and pizza.³² The writing style of these items were inspired by national telephone surveys, for instance, the Surveillance System of Risk and Protection Factors for Chronic Diseases by Telephone Survey (Vigitel), which has been annually executed since 2006 by the Brazilian Ministry of Health.³³

2.2 | Content validity – expert panel

Eleven Brazilian professionals who were involved in scientific production related to salt and sodium intake or the Epidemiology of Chronic Diseases in the last 10 years (2008–2018) were invited, by electronic means, to participate in an expert panel, as literature recommends a sample size of six to twenty participants.³⁴ Experts completed an online assessment form hosted on the Google Forms platform, being asked to evaluate item's effective ability to represent the interest construct (KPB toward salt and sodium), and whether terms and language used, including the form of writing and wording presented, would be easily understood by the target audience.³⁴

Each item was scored from 1 to 4, with scores 3 and 4 validating the item as representative and/or clear. Then, item content validity index (I-CVI) was calculated, dividing the number of experts who scored the item as 3 or 4 by the total number of experts.³⁴ Moreover, scale-level content validity index (S-CVI) was calculated by the sum of all I-CVIs divided by the total number of items.³⁵ Experts also provided suggestions/comments regarding each item.

2.3 | Face validity – focus group

A qualitative approach was taken to evaluate instrument's face validity, as it allows raising and understanding, from a group of informants, their opinions, relevance, and values. Such technique involves a discussion that normally takes place in meetings with a small number of participants, ideally with eight to ten individuals, and generally with the presence of a moderator, who seeks to focus and deepen discussions, and two more observers following the same discussion group.³⁶

Aiming to recruit individuals with similar characteristics of the target population (Brazilian adults), a convenience sample of 8 adult Brazilians from São Paulo state, who agreed to attend the meeting in the arranged place and time, participated in this activity. Trying to reach a diverse group as much as possible, the sample included individuals from different age groups (min: 37 y; max: 57 y; mean: 49 y), with high ($n = 6$; 75%) and medium education ($n = 2$; 25%) levels, men ($n = 2$; 25%) and women ($n = 6$; 75%), and belonging to different social strata³⁷ (one upper class, five medium-high class, two medium-low class). Moreover, four (50%) individuals were married, six (75%) had children, and six (75%) were employed until the day of the focus group.

First, they self-completed the questionnaire and indicated how much they comprehended from each item, answering a 6-point Likert scale, starting with "1. I didn't understand anything" to "6. I understood perfectly and I had no doubts". Then, from a pre-established script elaborated from experts' comments, a moderator asked questions regarding items' contents (eg, what participants thought that the question is referring to, if participants had ambiguous ideas about the items). Also, participants could indicate if they had difficulties in answering questions referring to their experiences of self-completing the questionnaire. The audio from this discussion was recorded, transcribed, and analyzed by the main researchers of this study.

2.4 | Operational test (Pilot-testing)

In order to verify the applicability of the instrument through telephone interviewing, from item comprehension (eg, if it was necessary to clarify the question for better understanding, if respondent understood the content of what was being asked without further explanations), to rhythm and flow of the questionnaire, a researcher with extensive experience in application of Epidemiological surveys conducted 36 interviews with a convenience sample from São Paulo state (20 female; min: 21 y; max: 54 y; mean: 35 y), reaching the minimum required number of 30 participants for pilot-testing.²⁸ Interviews were per-

formed using online free tools (Skype or WhatsApp), which allowed a wider possibility for schedule agreements and audio recording. In the end, the researcher provided a detailed report on the instrument's performance.

2.5 | Construct validity and internal consistency reliability

This step aimed to identify the dimensionality of the construct "KPB toward salt and sodium" (latent variable), and the extent to which the set of items was correlated to this component (observed variables).^{38,39} An exploratory approach, using exploratory factor analysis (EFA), was adopted since there was no previous hypothesis regarding the number of latent variables represented by the questionnaire.

Data was collected from a probabilistic sample of residents of a medium-size municipality (Jundiá, São Paulo state), during business hours on weekdays between November 7th to December 4th in 2019. A company with great expertise in CATI methodology – Computer Assisted Telephone Interviewing – was hired, with a total number of 10 trained interviewers. This methodology was adopted to facilitate data collection management, aiming to reach pre-established quotas at constant research supervision. A sample size of 422 adults (20 y – 59 y) was considered appropriate to perform EFA, since it overcame the literature recommendation of a minimum of ten observations per variable (in this study: 24 items, minimum of 240 participants).³⁹

Considering the rationale of variance explanation and the fact that the number of items falls within the range of 20–50, the Kaiser–Guttman criterion, whose premise is to consider as significant factors those with eigenvalue > 1.00 (visualized in the scree plot), was adopted to determine the number of factors to be extracted.³⁹ Since items do not have equal response scales (the number of response categories varies from 2 to 6), items were scored as continuum data. The EFA was executed through the R package "Psych" and factors were extracted using the minimum residual ("minres") method.⁴⁰ The generated solutions were analyzed from theoretical and statistical significance perspectives, which supported the determination of the best model. Items with nonsignificant factor loadings, $< |0.3|$, were excluded.

To perform a reliability analysis, the internal consistency of the instrument was assessed by the Cronbach's α coefficient,⁴¹ which was calculated considering the data from the 422-adult sample, since sample size is greater than the required minimum of 300 individuals to perform such analysis.⁴² Coefficient values equal to or greater than 0.7 were considered satisfactory.⁴²

2.6 | Descriptive analysis

Considering the 422-adult sample, a descriptive analysis was performed using STATA version 16 (Stata Corp., College Station, TX, USA) and RStudio. Remaining items in the final EFA solution were scored according to the following rationale: lower scores are related to unhealthy practices, and possibly related to a higher sodium intake;

TABLE 1 Items in English and in Portuguese, and items' content validity indexes (I-CVIs) for representativeness and clarity (from expert panel)

Items in English	Items in Portuguese	I-CVI rep	I-CVI cla
1. In the past 30 days, how often have you controlled the amount of fat you consume?	Nos últimos 30 dias, com que frequência você controlou a quantidade de gordura que consome?	0.73	0.91
2. In the past 30 days, how often have you controlled the amount of salt you consume?	Nos últimos 30 dias, com que frequência você controlou a quantidade de sal que consome?	0.91	0.91
3. In the past 30 days, how often have you followed a healthy diet?	Nos últimos 30 dias, com que frequência você seguiu uma alimentação saudável?	0.82	1.00
4. How often do you have the habit of reading the nutrition facts table and / or the list of ingredients?	Com que frequência você tem o costume de ler a tabela nutricional e / ou a lista de ingredientes?	0.91	1.00
5. How often do you observe if there is information on food and beverages packaging labels, such as "no added salt", "low in salt", "light" and / or "free of trans-fat"?	Com que frequência você observa se há presença de informações nos rótulos das embalagens de alimentos e bebidas, tais como "sem adição de sal", "baixo teor de sal", "light" e / ou "sem gordura trans"?	0.91	1.00
6. How many days of the week do you usually eat some type of filled cookie?	Em quantos dias da semana você costuma comer algum tipo de bolacha recheada?	1.00	1.00
7. How many days of the week do you usually drink some type of soda?	Em quantos dias da semana você costuma tomar algum tipo de refrigerante?	0.91	1.00
8. How many days of the week do you usually eat some type of breaded or frozen industrialized hamburger?	Em quantos dias da semana você costuma comer algum tipo de empanado ou hambúrguer congelado industrializado?	1.00	1.00
9. How many days of the week do you usually eat some type of industrialized chips or grated potatoes?	Em quantos dias da semana você costuma comer algum tipo de salgadinho industrializado ou batata palha de pacote?	1.00	0.91
10. How many days of the week do you usually eat some type of: sausage, hot dog sausage, ham, mortadella, bacon or other salt cured meats?	Em quantos dias da semana você costuma comer algum tipo desses alimentos: linguiça, salsicha, presunto, mortadela, bacon ou demais embutidos?	1.00	1.00
11. When you cooked your meals at home, how often did you use some ready-to-use industrialized seasoning?	Quando você cozinhou as refeições em casa, com que frequência você utilizou algum tipo de tempero pronto industrializado?	1.00	0.91
12. What is your opinion on the following statement: "in general, I know which industrialized foods contain large amounts of sodium"?	Qual a sua opinião sobre a seguinte afirmação: "em geral, eu conheço quais são os alimentos industrializados que contêm grandes quantidades de sódio"?	0.73	0.91
13. In your opinion, how much salt do you think you consume daily?	Na sua opinião, quanto sal você acha que consome diariamente?	1.00	1.00
14. In general, how do you assess your health?	Em geral, como você avalia a sua saúde?	0.91	0.91
15. Did you know that there is a limit of 5 g of salt that we can consume per day?	Você sabia que existe um limite de 5 g de sal que podemos consumir por dia?	1.00	1.00
16. How many days of the week do you usually eat some type of pizza?	Em quantos dias da semana você costuma comer algum tipo de pizza?	0.91	0.91
17. Considering your diet in the past 30 days, how often did you cook lunch or dinner at home?	Considerando sua alimentação nos últimos 30 dias, com que frequência você cozinhou o almoço ou o jantar em casa?	1.00	1.00
18. What is your opinion on the following statement: "the nutritional information on food and beverages' labels is sufficient and clear"?	Qual a sua opinião sobre a seguinte afirmação: "as informações nutricionais nos rótulos de alimentos e bebidas são suficientes e claras"?	0.82	0.91
19. Considering your diet in the past 30 days, how often did you add salt to the food already served on plate, for lunch or dinner?	Considerando sua alimentação nos últimos 30 dias, com que frequência você adicionou sal à comida já servida no prato, no almoço ou no jantar?	0.91	1.00
20. What is your opinion on the following statement: "I would like labels to inform if food and beverages have large amounts of sodium"?	Qual a sua opinião sobre a seguinte afirmação: "eu gostaria que os rótulos informassem se alimentos e bebidas possuem grandes quantidades de sódio"?	0.91	1.00
21. What is your opinion on the following statement: "having a diet with too much salt can cause health problems"?	Qual a sua opinião sobre a seguinte afirmação: "ter uma alimentação com muito sal pode causar problemas de saúde"?	1.00	1.00

(Continues)

TABLE 1 (Continued)

Items in English	Items in Portuguese	I-CVI rep	I-CVI cla
22. What is your opinion on the following statement: "I would like food and beverages with large amounts of sodium to have a clear warning on the front of the package"?	Qual a sua opinião sobre a seguinte afirmação: "eu gostaria que os alimentos e bebidas com grandes quantidades de sódio tivessem um aviso claro na frente da embalagem"?	0.91	1.00
23. What is your opinion on the following statement: "controlling the amount of salt or sodium that I consume is important for my health"?	Qual a sua opinião sobre a seguinte afirmação: "controlar a quantidade de sal ou sódio que eu consumo é importante para minha saúde"?	1.00	1.00
24. Could you tell if there is any difference between salt and sodium?	Você saberia dizer se existe alguma diferença entre sal e sódio?	1.00	1.00

I-CVI rep – Item Content Validity Index for representativeness.

I-CVI cla – Item Content Validity Index for clarity.

and higher scores are related to healthy practices, and possibly related to a lower sodium intake. Global scores were calculated, and a Kolmogorov–Smirnov normality test was performed to assess normal distribution.

The Student *t*-test was performed to investigate scores mean differences between groups. Pearson's correlation coefficient (*r*) was used to compare scores across ages (continuous). Multiple linear regression models were estimated considering scores as the dependent variable (continuous), and sex, age, and education as explanatory variables, also controlled by hypertension diagnosis and for all diagnosis (hypertension, diabetes, high cholesterol, other cardiovascular diseases). Residuals were analyzed to check homoscedasticity. A 5% level of significance was considered for all statistical tests.

The Committee for Ethics in Research of the School of Public Health of the University of São Paulo approved this research (protocol number: 89670918.0.0000.5421). These protocols are in accordance with the Declaration of Helsinki. Participants who agreed to participate in this study could withdraw this decision at any step of the research, and there was no financial compensation, remuneration or reimbursement resulting from participation.

3 | RESULTS

3.1 | Content validity

As described in Table 1, experts evaluated most items as representative and clear, with S-CVI for representativeness equal to 0.93 and for clarity equal to 0.97, and only two items presenting I-CVI < 0.8 in representativeness (items 1 and 12). Nevertheless, both items were kept in for further analysis.

3.2 | Face validity

Participants faced no difficulties in answering questions nor self-completing the questionnaire, even though item comprehension varied from "3. I understood almost everything, but I had some doubts" to "6. I understood perfectly and I had no doubts". Items' contents were

understood as expected, with highlights to some of the participants comments:

- Participants connected the idea of "controlling the amount of salt" with all sources of sodium, not only table salt: "So for you to also control your salt intake a little, it would be (necessary) to take care of the industrialized (food intake)".
- Changing the expression "high levels of sodium" for "large amounts of sodium" provided better understanding: "large amounts of sodium," these are simpler words, we understand better".

3.3 | Operational test

All interviews have been started and completed with an average duration of 15m15s (± 2 m), and participants had no difficulties in comprehension and answering questions. The instrument proved to be suitable for application by telephone interviews.

3.4 | Construct validity and internal consistency reliability

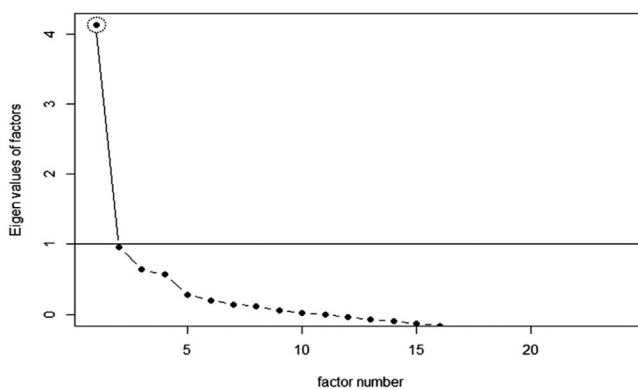
Tests confirmed sampling adequacy to perform the EFA (KMO = 0.82; Bartlett's sphericity test, $p < .001$) – sample characteristics are described in Table 2. One factor with eigenvalue > 1.00 was identified in the scree plot, providing evidence that the instrument can be treated as a single measure (Figure 1). In the EFA (Table 3), an initial 24-items one-factor solution returned eight nonsignificant items and explained 17% of data variance. These items were excluded and then a new 16-items solution was run, returning a significant and stable solution. This final model explained 24.1% of the variance and presented theoretical plausibility. In the internal consistency analysis, Cronbach's α was equal to 0.81 (95% CI 0.79 – 0.84), indicating a good reliability.

3.5 | Descriptive analysis

Sample global scores followed a normal distribution (Kolmogorov-Smirnov test, p value = .47), ranging from 15 to 62. A significant weak

TABLE 2 Sociodemographic characteristics of the Brazilian adult sample (no. = 422)

Variables	no. (%)
Age groups (years)	
20-29	108 (25.60)
30-39	126 (29.85)
40-49	108 (25.60)
50-59	80 (18.95)
Sex	
Male	210 (49.76)
Female	212 (50.24)
Education	
Low/Basic	57 (13.51)
Medium	226 (53.55)
Higher education (university degree or higher)	139 (32.94)
Marital status	
Married/Domestic partnership	230 (54.50)
Single/Divorced/Widow	192 (45.50)
Hypertension diagnosis	
Yes	69 (16.35)
No	341 (80.81)
Only during pregnancy	12 (2.84)
Diabetes diagnosis	
Yes	34 (8.06)
No	378 (89.57)
Only during pregnancy	10 (2.37)
High cholesterol diagnosis	
Yes	77 (18.25)
No	345 (81.75)
Other cardiovascular diseases diagnosis	
Yes	29 (6.87)
No	393 (93.13)

**FIGURE 1** Scree plot from the exploratory factor analysis (EFA), with one identified factor with eigenvalue > 1.00 (circled)

positive correlation between age and scores was found ($r = 0.30$, $p < .001$). Average differences between groups were significantly different (Table 4), with only two nonsignificant differences: individuals with and without diabetes and other cardiovascular diseases diagnosis ($p = .1428$ and $p = .6727$, respectively).

Multiple linear regression models (Table 5) demonstrated that sex, age and education are significant factors associated with global scores ($p < .001$), even when controlled by hypertension diagnosis ($p < .001$) and for all diagnosis – hypertension, diabetes, high cholesterol, other cardiovascular diseases ($p < .001$). Moreover, all models were statistically significant ($p < .001$), with R^2 ranging from 0.1706 (model 1) to 0.1730 (model 3).

4 | DISCUSSION

In this study, we described the development and validation of an instrument designed to assess practices – knowledge, perceptions and behaviors (KPB) – toward salt and sodium in Brazilian adults. This instrument is meant to be used by researchers interested in evaluating these aspects in the Brazilian population. From our best acknowledgment, this is the first questionnaire with such an objective to be tested considering content, face, and construct validities, providing enough evidence of instrument's quality. Also, we present a step-by-step process for researchers interested in developing and validating questionnaires with similar objectives, in addition to presenting a developed instrument which could contribute to items' inspiration for new instruments.

The choice of using an instrument that already was applied in the Latin America as an inspiration for the new one reduced the possibilities of having items that could be considered non representative or clear for the target audience, as it was confirmed by the results from the experts' panel. The qualitative approach taken for assessing items' content in addition to the operational test, provided results to make improvements to reach better comprehension and applicability of the questionnaire. EFA contributed to the identification of items with significant factor loadings that could be, altogether, used as a single measure with good reliability, hence the proposed scoring system. Foreign instruments with similar objectives, using quantitative methods, were also developed based on previous literature, including the PAHO/WHO questionnaire,⁴³ experts' assessments and tested by pilot studies.^{20,21} However, authors did not mention if nor how construct validity or reliability tests were performed. As showed in this study, it is highly recommended to consider rigorous psychometrics evaluations to develop consistent and reliable instruments.

Regardless of disease diagnosis, women, older individuals and with a higher level of education had significant higher average scores, possibly indicating a lower sodium intake. The most recent salt intake estimations available from The Brazilian National Health Survey in 2013,⁴⁴ analyzed by urinary sodium and creatinine concentrations, identified that the mean salt intake was higher in males (9.63 g/day; 95%CI 9.52 – 9.74) than in females (9.08 g/day; 95%CI 8.99 – 9.17), even

TABLE 3 Items in English with response categories, and factor loadings from initial and final solutions of the exploratory factor analysis (construct validity)

Items in English	Response Categories (Scores)	FL Model 1	FL Model 2
1. In the past 30 days, how often have you controlled the amount of fat you consume?	Never (0); Rarely (1); Sometimes (2); Frequently (3); Always (4)	0.69*	0.69*
2. In the past 30 days, how often have you controlled the amount of salt you consume?	Never (0); Rarely (1); Sometimes (2); Frequently (3); Always (4)	0.66*	0.64*
3. In the past 30 days, how often have you followed a healthy diet?	Never (0); Rarely (1); Sometimes (2); Frequently (3); Always (4)	0.60*	0.60*
4. How often do you have the habit of reading the nutrition facts table and / or the list of ingredients?	Never (0); Rarely (1); Sometimes (2); Frequently (3); Always (4)	0.58*	0.57*
5. How often do you observe if there is information on food and beverages packaging labels, such as “no added salt”, “low in salt”, “light” and / or “free of trans-fat”?	Never (0); Rarely (1); Sometimes (2); Frequently (3); Always (4)	0.56*	0.55*
6. How many days of the week do you usually eat some type of filled cookie?	Never (5); Almost never (4); 1–2x/week (3); 3–4x/week (2); 5–6x/week (1); Every day including Saturday and Sunday (0)	–0.53*	–0.53*
7. How many days of the week do you usually drink some type of soda?	Never (5); Almost never (4); 1–2x/week (3); 3–4x/week (2); 5–6x/week (1); Every day including Saturday and Sunday (0)	–0.52*	–0.52*
8. How many days of the week do you usually eat some type of breaded or frozen industrialized hamburger?	Never (5); Almost never (4); 1–2x/week (3); 3–4x/week (2); 5–6x/week (1); Every day including Saturday and Sunday (0)	–0.49*	–0.50*
9. How many days of the week do you usually eat some type of industrialized chips or grated potatoes?	Never (5); Almost never (4); 1–2x/week (3); 3–4x/week (2); 5–6x/week (1); Every day including Saturday and Sunday (0)	–0.46*	–0.48*
10. How many days of the week do you usually eat some type of: sausage, hot dog sausage, ham, mortadella, bacon or other salt cured meats?	Never (5); Almost never (4); 1–2x/week (3); 3–4x/week (2); 5–6x/week (1); Every day including Saturday and Sunday (0)	–0.42*	–0.40*
11. When you cooked your meals at home, how often did you use some ready-to-use industrialized seasoning?	Never (4); Rarely (3); Sometimes (2); Frequently (1); Always (0)	–0.38*	–0.40*
12. What is your opinion on the following statement: “in general, I know which industrialized foods contain large amounts of sodium”?	I disagree (0); I don't agree nor disagree (1); I don't know if agree or disagree (2); I agree (3)	0.38*	0.38*
13. In your opinion, how much salt do you think you consume daily?	A little (0); The normal quantity (1); A lot (2)	0.37*	0.36*
14. In general, how do you assess your health?	Too bad (0); Bad (1); Regular (2); Good (3); Too good (4)	0.34*	0.36*
15. Did you know that there is a limit of 5 g of salt that we can consume per day?	No, I didn't know (0); Yes, I knew (1)	0.34*	0.33*
16. How many days of the week do you usually eat some type of pizza?	Never (5); Almost never (4); 1–2x/week (3); 3–4x/week (2); 5–6x/week (1); Every day including Saturday and Sunday (0)	–0.32*	–0.33*
17. Considering your diet in the past 30 days, how often did you cook lunch or dinner at home?	Never (0); Rarely (1); Sometimes (2); Frequently (3); Always (4)	0.27	–
18. What is your opinion on the following statement: “the nutritional information on food and beverages' labels is sufficient and clear”?	I disagree (2); I don't agree nor disagree (1); I agree (0)	0.27	–
19. Considering your diet in the past 30 days, how often did you add salt to the food already served on plate, for lunch or dinner?	Never (4); Rarely (3); Sometimes (2); Frequently (1); Always (0)	0.20	–

(Continues)

TABLE 3 (Continued)

Items in English	Response Categories (Scores)	FL Model 1	FL Model 2
20. What is your opinion on the following statement: "I would like labels to inform if food and beverages have large amounts of sodium"?	I disagree (0); I don't agree nor disagree (1); I agree (2)	0.19	-
21. What is your opinion on the following statement: "having a diet with too much salt can cause health problems"?	I disagree (0); I don't agree nor disagree (1); I agree (2)	0.13	-
22. What is your opinion on the following statement: "I would like food and beverages with large amounts of sodium to have a clear warning on the front of the package"?	I disagree (0); I don't agree nor disagree (1); I agree (2)	0.13	-
23. What is your opinion on the following statement: "controlling the amount of salt or sodium that I consume is important for my health"?	I disagree (0); I don't agree nor disagree (1); I agree (2)	0.10	-
24. Could you tell if there is any difference between salt and sodium?	No, there is no difference (0); I don't know if there is any difference (1); Yes, there is a difference (2)	0.07	-

FL Model 1 - Factor loadings for Initial Solution in the Exploratory Factor Analysis.

FL Model 2 - Factor loadings for Final Solution in the Exploratory Factor Analysis.

*Significant factor loading (> |0.3|).

TABLE 4 Average scores, 95% confidence interval, and *p* value of Student *t*-tests, according to groups (no. = 422)

Variables	Average Score	95% CI	<i>p</i>
Sex			
Male (no. = 210)	39.55	38.37 - 40.73	<.001*
Female (no. = 212)	43.01	41.80 - 44.22	
Education			
Low/Basic/Medium (no. = 283)	39.83	38.80 - 40.86	<.001*
Higher education (no. = 139)	44.25	42.82 - 45.68	
Hypertension diagnosis			
Yes (no. = 81)	43.14	41.29 - 44.98	.0385*
No (no. = 341)	40.00	39.88 - 41.81	
Diabetes diagnosis			
Yes (no. = 44)	43.16	40.70 - 45.62	.1428
No (no. = 378)	41.07	40.16 - 41.98	
High cholesterol diagnosis			
Yes (no. = 77)	43.35	41.53 - 45.18	.0251*
No (no. = 345)	40.83	39.86 - 41.79	
Other cardiovascular diseases diagnosis			
Yes (no. = 29)	41.97	39.21 - 44.72	.6727
No (no. = 393)	41.24	40.34 - 42.14	

*Significant statistical difference ($p < .05$).

though no important differences were observed in terms of age and education. A previous study with young adults identified higher scores for salt-related knowledge in females and older age,⁴⁵ and education has been reported to be independently associated with global cardiovascular risk.⁴⁶ Moreover, participants in this study who received a hypertension or high cholesterol diagnosis had significantly higher scores, possibly due to lifestyle changes as recommended by most

recent nonpharmacological guidelines.⁴⁷ These results may indicate instrument's convergent validity,³⁸ but also suggest the need for studies investigating individuals' KPB toward salt and sodium and actual sodium intake, since there has been reported contrasting results in literature.⁴⁸

Taking into account the final version of the instrument with 16 items, it is possible to affirm that questions regarding the intake of dietary

TABLE 5 Multiple linear regression models considering global score as dependent variable, and sex, age, and education as explanatory variables (model 1), controlled by hypertension diagnosis (model 2) and for all diagnosis (model 3) (no. = 422)

Explanatory variables	Model 1				Model 2				Model 3			
	β	<i>p</i> value (β)	<i>p</i> value (F partial)	R ²	β	<i>p</i> value (β)	<i>p</i> value (F partial)	R ²	β	<i>p</i> value (β)	<i>p</i> value (F partial)	R ²
Sex (Men)	-3.34012	<.001*	<.001*	0.1706	-3.36123	<.001*	<.001*	0.1708	-3.36945	<.001*	<.001*	0.1730
Age (years)	0.23108	<.001*			0.23450	<.001*			0.23465	<.001*		
Education (higher)	3.96506	<.001*			3.95937	<.001*			3.94898	<.001*		

Model 1: Only explanatory variables (noncontrolled model).

Model 2: Model 1, controlled by hypertension diagnosis.

Model 3: Model 1, controlled by all diagnosis (hypertension, diabetes, high cholesterol, other cardiovascular diseases).

*Significant statistical difference ($p < .05$).

markers of a high sodium diet, such as chips or cured meats, and items on other practices indirectly related to sodium intake, such as paying attention to nutritional information available on package labels, are equally relevant when considering KPB toward salt and sodium. Interestingly, some items in the final solution of the EFA analysis are related to fat intake (items 1 and 5 from Table 3, for instance), and also correlate to the construct “KPB toward salt and sodium.” This result may be explained by the fact there are intersections in main dietary sources of sodium and fat concerning ultraprocessed foods, which, by definition, are industrial formulations with unbalanced nutritional composition, commonly rich in sodium, fat, and sugar.²⁶ In addition, food reformulation voluntary agreements between the Brazilian Ministry of Health and the industry to reduce sodium content in processed and ultraprocessed foods include categories with high fat content, such as dairy spreads, margarines, and cookies.⁴⁹

Some limitations should be acknowledged in this study: this instrument was developed to be applied via telephone interviewing considering population-based studies, if researchers may want to apply using a different method, a new operational test is advised; the sample considered for the EFA analysis is not representative for the whole country, and linguistic changes may be necessary; test-retest and inter/intra interviewer agreement reliability tests were not performed. Additional reliability analysis, alongside further convergent validity analysis, should be performed in future studies. On the other hand, the strengths overcome such limitations, as it is the first validated instrument to provide, as a unique measure, a global score on KPB toward salt and sodium in Brazil.

5 | CONCLUSION

The developed instrument proved to be valid and capable of assessing Brazilian adults' knowledge, perceptions and behaviors (KPB) toward salt and sodium, as content, face and construct validities were successfully assessed, with good reliability. Remaining items in the final model were able to, altogether, establish a score for these practices. Thus, this instrument is ready to be applied and easily reproduced, contributing

to the assessment of KPB toward salt and sodium in the Brazilian adult population.

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CONFLICT OF INTEREST

Authors report no conflict of interest.

ORCID

Alicia Tavares da Silva Gomes PhD  <https://orcid.org/0000-0003-0454-8666>

Kamila Tiemann Gabe MS  <https://orcid.org/0000-0001-5138-9552>

Patricia Constante Jaime PhD  <https://orcid.org/0000-0003-2291-8536>

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