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Evidence of the validity of the Food and Nutritional Security Scale for adolescents (ESANa)

Marjorie Rafaela Lima do Vale (https://orcid.org/0000-0002-1384-5710) [1]
Walberto Silva dos Santos (https://orcid.org/0000-0001-6816-0105) [2]
José Airton de Freitas Pontes Junior (https://orcid.org/0000-0003-2045-2461) [3]
Renata Belizário Diniz (https://orcid.org/0000-0002-3757-6789) [3]
Maria Marlene Marques Ávila (https://orcid.org/0000-0002-8511-2524) [3]

Abstract *This study aimed to develop a valid and reliable scale for assessing food and nutritional insecurity, specifically in adolescents. The initial version of the scale consisted of two subscales: perception of food insecurity and perception of nutritional security. The items were submitted to content analysis (n = 4) by a group of food and nutrition security experts, and semantic analysis (n = 20) by a group of adolescents conveniently sampled from the target population. After adjustments, the final version of the scale was applied to adolescent students (n = 425) aged 12 to 18 years (m = 14.32±0.96; CV = 6.7%). A two-factor model was the most appropriate after performing exploratory factor analysis. The subscales showed modest values of the alpha coefficient (0.69 and 0.60, respectively). Daily consumption of fruits, vegetables and soft drinks was significantly associated with higher scores in the food and nutrition security perception scale. Therefore, it is recommended to combine food access-based items with other aspects related to attitudes and behaviors towards healthy eating in order to achieve a more accurate picture of adolescent's needs and better guide public policies.*

Key words *Validation studies, Food and Nutritional Security, Adolescent*

[1] Universidade de Alberta. 116 St & 85 Ave, Edmonton, AB T6G 2R3. Alberta Canadá. marjorievale@ualberta.ca
[2] Universidade Federal do Ceará. Fortaleza CE Brasil.
[3] Universidade Estadual do Ceará. Fortaleza CE Brasil.

Introduction

Adolescence is a period of progressive biological, cognitive, social and emotional development[1]. In developing countries such as Brazil, it is not uncommon for adolescents to be vulnerable to Food and Nutritional Insecurity (InSAN)[2]. Being in InSAN means not having physical or financial access to quality food regularly or lacking the capacity to choose and consume healthy foods that ensure the exercise of an active and healthy life[3]. Thus, planning interventions to promote food and nutritional security among adolescents is essential, since being in InSAN has been associated with deleterious short- and long-term effects, including symptoms of discomfort, distress and sadness[4], lower psychosocial functioning[5], weight gain and consequent comorbidities[6].

Currently, several methods facilitate InSAN[7] estimated level. The most commonly used tool for tracking InSAN at the household level is based on a head of household-reported food and nutritional insecurity perception scale. Recently, given the arguments that individuals within the same household can experience different levels of food insecurity[8], the adaptation and validation of this scale for individual use has been proposed.

National and international references of studies of validation and application of this type of scale specifically with adolescents[9] are currently available. Despite favorable arguments for the validity of this scale among the adolescent population, one of the criticisms related to its use includes the fact that the use of commonly applied items among adults would result in concerns regarding the validity of the instrument and its findings, since experiences of InSAN lived by adolescents are unique in terms of content and context[10]. Besides, there are also criticisms related to the fact that the content of the presented items retrieves a subjective component related to the experience of hunger, unemployment, risks of unmet needs and lack of access to food on a daily basis[11]. This conception is, to a certain extent, contrary to the understanding that food and nutritional security results not only from food availability and supply but also the consumption of these foods, to ensure adequate nutritional status[12] and necessary for an active and healthy life.

Thus, the development of perceptual scales focused on identifying not only financial accessibility to healthy foods but also the identification of attitudes and feeding practices is fundamental to guide better the use of resources used in public policies to make them more effective. Because of such arguments, this study aimed to develop a valid and reliable scale for assessing food and nutritional insecurity, specifically in adolescents.

Material and methods

This is a methodological study[13] for the elaboration and proposal of a food and nutritional security assessment scale for adolescents (ESANa).

Sampling

The following parameters were used to calculate the sample size: the total number of adolescent ninth-graders enrolled in the urban area of Fortaleza in 2012 (32,977 students), 95% confidence interval, a maximum tolerable error of 5%, and estimated food insecurity prevalence (21.3%)[14]. As the sampling unit selection process was by conglomerates, the size initially calculated was multiplied by two (sample design effect - DEFF). Considering the estimated sample size and the number of students per school, nine elementary schools (5 public and 4 private) were selected with probability proportional to size.

The cluster sampling process was used for practical feasibility reasons (time and cost). The procedure was carried out in two stages: (a) choice of schools; (b) random selection of classes within schools. All students from each selected class were invited to participate in the study. Also, since it is a validation of an instrument, the recommendation of ten or more participants by the number of items was met[15].

Data collection

Data were collected from May to August 2014. The ESANa was administered collectively in classrooms with the presence of a researcher for any clarification required. The students were also given a form of socioeconomic and food habits classification with adaptations[16]. Students who showed agreement had their weight and height measured.

Concerning weight measurement, adolescents were informed about the need to take any material from the pockets of their school uniform, as well as to take off socks and shoes. A G-TECH scale with a 150 kg capacity and 100-gram precision was used. Height was measured with the teenager standing erect, arms outstretched along the body, head held high and staring at a fixed point at eye level, barefoot and head prop-

free[17]. The instrument used was a Sanny Personal Caprice stadiometer. The BMI value was obtained by calculating the weight in kilograms divided by the squared height and classified as per the criteria of the World Health Organization[18].

Instrument development

The construction of the ESANa was guided by an individual perception of food and nutritional insecurity. Concerning the construction of items, a review of the literature on the subject was carried out and items of existing instruments considered[19-21]. The initial version of the scale consisted of two subscales, containing nine and six items (Table 1) related to food insecurity and nutritional security. The difference between the food and nutritional domains was based on the design proposed by the Brazilian Action for Nutrition and Human Rights (ABRANDH), in which the food domain builds on the sufficient and stable production and access to food, and the nutritional domain incorporates elements related to the choice and consumption of healthy foods[22].

Content analysis

The content adequacy check was carried out by a group of four food and nutritional security experts. Participants' expertise was evaluated using a modified version of the criteria proposed by Fehring[23], which included the accomplishment of works, academic projects and publications on food and nutritional security, totaling fourteen points. The experts were all female, with an area of activity in different Brazilian geographic locations (North and Northeast) and abroad (Canada), and obtained an average score of 8 ± 2.34 points. The experts were selected using the snowball technique[24]. Aspects related to clarity, practical relevance and theoretical relevance were evaluated using a Likert scale of 1 to 5 points. The data obtained were used to estimate the Content Validity Coefficient (CVC)[25].

Semantic analysis

The understanding of the proposed items and instructions was evaluated by four groups of adolescents from public and private schools. We aimed to keep homogeneous groups to avoid controversy and constraints[26]. The groups consisted of five to six adolescents selected by convenience. Adolescents were asked to give their opinion about the comprehension of the response format and content of the items (e.g., "In your own words, what is being asked here? Is there something you find confusing or difficult to understand?"). Adjustments and corrections were made at the end of each group. New groups were conducted until no further suggestions were made by adolescents. In the end, a total of three groups were conducted with students from public schools and one group with students from private schools.

Psychometric analysis

The adequacy of the data matrix to perform the factorial analysis was evaluated using two markers KMO (Kaiser-Meyer-Olkin)[27] and Bartlett's sphericity test (BST)[28]. The number of factors extracted was guided by the criteria of Kaiser (Eigenvalues)[25] and Cattell (Screeplot)[29].

An exploratory factor analysis (EFA) was performed after selecting the number of factors to be extracted. Concerning the selection of items, a factor loading > 0.30[30] was considered. Furthermore, the corrected total item correlation with the respective factor and the Cronbach's alpha coefficient were verified.

Finally, the scores were classified as low, medium and high, using cut-off points based on the 25, 50 and 75 percentiles, and the classification obtained was correlated with socioeconomic variables, nutritional status and food consumption by Kendall tau and Mann-Whitney tests. The level of significance was set at 0.05. All analyses were performed using different packages of the R software, 1.0.136 - © 2009-2016 RStudio, Inc.

This research was approved by the Research Ethics Council of the State University of Ceará, as per the precepts of Resolution 196/96 of the CNS/MS[31].

Results

The final sample consisted of 425 adolescents, mostly female (53.9%), with ages ranging from 12 to 18 years (m = 14.32±0.96, CV = 6.7%). The sociodemographic characteristics are shown in Table 1.

Content analysis

Table 2 shows the content validity coefficient values. All the items evaluated were adequate regarding issues of practical pertinence and theoretical relevance, meaning that the items were

Table 1. Sociodemographic characteristics (n = 425).

Variables	N	%	Mean (Standard Deviation)
Gender			
Female	229	53.88	
Male	196	46.12	
Age			
12 –| 14	283	66.59	
15 –| 17	136	32	14.32 (±0.96)
>18	3	0.71	
School			
Public	239	56.24	
Private	186	43.76	
Household head schooling			
Illiterate	3	0.71	
Up to 4th grade	35	8.24	
Elementary School	63	14.82	
Secondary School	112	26.35	
Higher Education	91	21.41	
Number of people < 18 years in the household			
Up to 3 residents	392	92.24	
4-6 residents	29	6.82	1.85 (±1.10)
>7 residents	1	0.24	
ABEP classification*			
A1	3	0.71	
A2	26	8.47	
B1	58	13.65	
B2	75	17.65	
C1	56	13.18	
C2	32	7.53	
D	4	0.94	
E	0	0	

*Household income (R$) broken down by socioeconomic class (R$): A1 (14,366), A2 (8,099), B1 (4,558), B2(2,327), C1 (1,391), C2 (933), D (618) and E (403)29.

Source: Elaborated by the authors. Fortaleza, 2015.

adequate to measure the construct evaluated in the population in question. Items 6 'I eat a lot in a meal as there might be no more the next day' and 8 'I skip meals' were considered unclear. We chose to reformulate the items after the semantic analysis stage with the adolescents.

Semantic analysis

In the semantic evaluation stage with adolescents, terms such as "healthy meals" were described as "fruits/vegetables/greens/a balanced meal", showing that adolescents had a good understanding of the term employed[32]. Among the suggested reformulations, item 4 was reformulated to read 'The lack of food in my house causes me concern', item 6 new sentence read 'I eat a lot in a meal because there may be no more after', item 12 was split into two 'I look at the expiration date of the food before eating' and 'I read the nutritional information that is on the food label', as well as item 13, which was split into 'I care if the foods I eat are healthy' and 'I care if the foods I eat are contaminant/dirt-free'.

Psychometric analysis

The final version of the scale with fifteen items was then applied and the results described below. Because of the non-functioning of some response categories presented (categories with less than 5% of the observed responses), and in

Table 2. Initial items of the ESANa submitted to content analysis (n = 4).

Items	Clarity	Practical relevance	Theoretical relevance
Food insecurity perception scale			
Q1. I eat healthy meals.	0.85	1.00	1.00
Q2. I have to work to afford money to eat.	0.90	0.80	0.95
Q3. I spend the whole day without eating.	0.80	1.00	1.00
Q4. I worry about the lack of food in my house.	1.00	0.90	0.90
Q5. I'm hungry, but I have nothing to eat.	1.00	1.00	1.00
Q6. I eat a lot in a meal as there might be no more the next day.	0.75[1]	0.86	1.00
Q7. I have few food options daily.	0.80	0.95	1.00
Q8. I skip meals.	0.70[1]	0.90	0.85
Q9. I eat at relatives and friends because I don't have food at home.	1.00	0.90	0.90
Nutrition Security Perception Scale			
Q10. I consider myself careful with my health.	0.85	1.00	1.00
Q11. I read health texts and information.	1.00	0.70[1]	0.80
Q12. I read the label of the foods I eat.	0.90	0.80	0.80
Q13. I care about the quality of the food I eat.	0.90	0.90	0.95

Clarity: considers the language used in the items considering the respondent population. Practical relevance: considers whether the item was evaluated in order to measure the concept of interest in the population for which the instrument is intended. Theoretical relevance: considers the level of association between the item and the theory. The content validity coefficient (CVC) was considered adequate when greater than 0.80. 1Item below the established CVC (0.80).

Source: Elaborated by the authors. Fortaleza, 2015.

order to obtain a more parsimonious solution, the original response format of 7 points (1 = never, 2 = rarely, 3 = sometimes, 4 = half of the time, 5 = most of the time, 6 = often and 7 = always) was reorganized into a 4-point solution, where adjacent categories 4 = half of the time, 5 = most of the time, 6 = often and 7 = always collapsed into a single category, 4 = often or always.

Exploratory Factor Analysis

The values observed in Bartlett's sphericity test [χ^2 2 (14) = 799.42 (p <0.001)] and Kaiser-Meyer-Olkin - KMO (0.72) confirmed the adequacy of the matrix for conducting factor analyses[25]. The Kaiser criterion identified the existence of three factors with eigenvalues higher than 1.0[27]. The scree plot[29] highlighted the existence of two factors. Considering the modest increment observed in the variance explained by the solution of three factors and the greater theoretical coherence of the simpler model, the two-factor solution was chosen and used in the subsequent analyses.

The exploratory factor analysis with varimax rotation was then performed, fixing the extraction of two factors (Table 3). The *varimax* rotation was chosen considering the low correlation between the factors (r = -0.09). The factor loadings observed indicated that the first factor grouped nine nutritional safety-related items. Item 9 "I skip meals" was removed because it had a factor loading < 0.30, and an increase of 0.1 in the alpha coefficient if it was deleted. Its removal resulted in a range of factor loadings of |31| and |82|. Reliability for this scale was estimated at 0.69. The second factor grouped six food insecurity-related items. The initial factor loadings for this factor ranged from |0.50| to |0.73|. Cronbach's alpha for this factor was estimated at 0.60, and 0.62 for the full scale.

Table 4 summarizes the cut-off points used and the distribution of adolescents interviewed. Cut-off points were delimited using the 25, 50 and 75 percentiles. For example, a total of 5 points on the food insecurity scale were classified as low risk, since this value is below the 25th percentile, showing that only 25 for every 100 adolescents in this population will have scored below 5 points.

As can be seen in Table 5, while about 30% of adolescents had low scores in the nutritional security scale, only 19% had a high food insecurity risk. Also, adolescents with low scores on the nu-

tritional security scale reported significantly consuming fewer vegetables and fruits and more soft drinks daily compared to those who scored higher. While not statistically significant, low scores on the nutritional security scale were also observed among overweight adolescents from public schools and whose heads of household had lower schooling. On the other hand, adolescents at high risk of food insecurity had lower, albeit not significant prevalence of overweight.

Discussion

The estimated food insecurity in individuals under 18 years of age is recurrently obtained indirectly through the perception of a respondent responsible for the household. However, the use of this approach hinders a positive association of food insecurity (evaluated at the household level) identified with consequences related to food consumption and nutritional status (individual level)[33].

Thus, studies aimed at measuring food insecurity through self-reporting by adolescents have been conducted and obtained satisfactory results concerning construct validity and reliability[6,33] also in Brazil[9]. However, the validated instruments have a limited perspective of the concept of food security, focusing only on financial access to food, neglecting the nutritional component, reinforcing the unique nature of this study.

Regarding the psychometric characteristics of the presented scale, the high values of the content validity coefficient attributed by the experts indicated that the items were conceptually related to the phenomenon of food and nutritional insecurity. Empirically, the proposed conceptual structure was confirmed, considering that most of the evaluated items evidenced clear saturations in only one factor and satisfactory corrected item-total correlation values. Only items "I spend the whole day without eating" and "I skip meals" were grouped in factors other than initially planned. This may be justified because food restriction behaviors are relatively common among adolescents for reasons other than physical or financial access to food, justifying the relevance of redesigned food and nutrition security measures for this context.

Table 3. Factor loadings. Corrected item-total correlation and alpha coefficient of ESANa items. (n = 425).

Items	F1	F1	h2	CITC	Alpha if deleted
Q18. I care if the foods I eat are healthy.	0.82		0.679	0.664	0.60
Q13. I read the nutritional information that is on the food label.	0.64		0.412	0.616	0.63
Q16. I care about the quality of the water I drink.	0.56		0.334	0.548	0.65
Q19. I look at the expiration date of the food before eating.	0.52		0.272	0.554	0.65
Q1. I eat healthy meals.	0.52		0.269	0.422	0.65
Q14. I care if the foods I eat are contaminant/dirt-free.	0.47		0.223	0.546	0.66
Q12. I read texts or see programs with information about food.	0.42		0.179	0.541	0.66
Q3. I spend the whole day without eating.	-0.34		0.140	0.076	0.68
Q9. I skip meals.	-0.26		0.089	0.177	0.69
Q5. I'm hungry, but I have nothing to eat.		0.73	0.555	0.589	0.53
Q7. I eat a lot in a meal because there may be no more after.		0.70	0.495	0.702	0.49
Q8. I have few food options daily.		0.68	0.469	0.692	0.52
Q10. I eat at relatives and friends because I don't have food at home.		0.63	0.434	0.428	0.58
Q4. The lack of food in my house causes me concern.		0.60	0.361	0.654	0.56
Q2. I have to work in order to eat.		0.50	0.255	0.368	0.61
Eigenvalue	2.60	2.57			
Proportional variance	0.17	0.17			

CITC: Corrected item-total correlation. *Items with correlation < 0.2 and increment of 0.1 on the alpha value were deleted. Values in bold indicate that the factor loadings were higher than 0.30, and, therefore, the item was maintained in the said factor.

Source: Elaborated by the authors. Fortaleza, 2015.

For example, in a population survey conducted in 2003 with a representative sample of households from different socioeconomic levels of the city of Campinas, Panigassi et al.[34] found that even in food secure households – that is, with guaranteed access to food – food consumption was qualitatively inadequate, where about 26.3% of respondents did not eat even a single fruit daily. There was also an inverse relationship between sweets and soft drinks consumption and food insecurity, with lower consumption among households with higher food insecurity. Among adolescents, a study of 573 schoolchildren from Rio Grande do Sul showed an association between knowledge in nutrition and eating habits and obesity, indicating that children with less knowledge and less healthy eating habits were five times more likely to be obese (OR = 5.3; 1.1-24.9)[35]. Thus, it can be seen that both access to healthy foods and food-related knowledge and attitudes interfere in the consumption and nutritional status of individuals.

Regarding the internal consistency, the subscales evaluated showed modest values of the alpha coefficient (0.69;0.60) and lower than the customarily desired value (0.70). Reasons for the low reliability found in the food security scale may be related to the low variability in partic-

Table 4. Mean, standard deviation and percentile classification (n = 425).

	n	%
Nutrition Security Perception Scale (M=22.18; sd=3.88)		
Low (<20 points)	129	30.3
Medium (20 to 25 points)	215	50.6
High (>25 points)	81	19.1
Food insecurity perception scale (M=7.95; sd=2.69)		
Low (<6 points)	197	46.3
Medium (6 to 9 points)	139	32.7
High (>9 points)	89	21

Source: Elaborated by the authors. Fortaleza, 2015.

Table 5. Prevalence of food insecurity and nutritional security by sociodemographic, consumption and nutritional status variables (n = 425).

Sociodemographic, consumption and nutritional status variables	Nutritional security				Food insecurity			
	Low	Medium	High	p-value[a]	Low	Medium	High	p-value[a]
School type								
Public	29.3	51.5	19.2	0.66[b]	41.4	35.9	22.6	0.03[b]
Private	31.7	49.5	18.8		52.7	28.5	18.8	
Schooling								
Illiterate	35.5	49.2	15.3	0.29[a]	42.7	33.9	23.4	0.36[a]
Up to 4th grade	34.3	54.3	11.4		40	37.1	22.9	
Elementary school	23.8	65.1	11.1		52.4	22.2	25.4	
Secondary school	29.4	42	28.6		43.7	40.2	16.1	
Higher education	27.5	51.7	20.8		52.7	27.5	19.8	
Nutritional status								
Underweight	25	75	0	0.53[a]	75	25	0	0.82[a]
Eutrophic	28.5	51.2	19.6		44.1	34.9	21	
Overweight	32.6	50	17.4		46.5	30.2	23.3	
Daily consumption of fruits								
Yes	28.9	50	21.1	0.009[b]	47.9	31.6	20.5	0.09[b]
No	40.5	57.1	2.4		33.3	40.5	26.2	
Daily consumption of vegetables								
Yes	19.9	52.5	27.6	<0.001[b]	50.9	27.5	21.6	0.16[b]
No	43.3	48.1	8.6		40.6	39.1	20.3	
Daily consumption of soft drinks								
Yes	32.1	52.6	15.3	0.001[b]	47.6	32.7	19.7	0.22[b]
No	23.1	41.5	35.4		41.5	32.9	25.6	

[a] Kendall tau correlation test. [b] Mann-Whitney U test.

Source: Elaborated by the authors. Fortaleza, 2015.

ipants' responses and the reduced number of items used. Also, alpha values higher than 0.60 have been considered sufficient in newly constructed questionnaires[36], possibly due to an anticipation of issues related to participants' definition and understanding of the instrument. Thus, additional cognitive interviews with adolescents are suggested in order to solve potential problems related to the understanding of the items or the proposed response format and to maximize the quality of information obtained[37]. Other studies evaluating the reliability of food insecurity scales for adolescents found alpha values of 0.77[6] and 0.48[33].

Conclusion

It is verified that the psychometric characteristics of ESANa show values within the required standards, indicating, therefore, the feasibility of combining items based on access to food with others related to attitudes and feeding practices. This study was based on the need to provide an instrument to better guide the elaboration of policies and programs to promote food and nutritional security since the proposed specific scales for the food and nutritional components allow the identification of strategic areas of performance. The classification of adolescents at high risk of food insecurity indicates the need to implement emergency programs or strategies for coping with hunger. The classification of adolescents with a low perception of nutritional security suggests the need for educational programs that promote knowledge, attitudes and practices consistent with the adoption of healthy food.

Despite the merits of ESANa, some limitations may be mentioned. First, the fact that data from students from nine schools in five of the six administrative regions of the city were collected from different socioeconomic strata was not enough to ensure more heterogeneity of the sample, thus limiting any generalization. Second, the reliability of the instrument was also lower than desired, suggesting additional cognitive interviews with adolescents to solve potential issues related to the comprehension of the items or the response format adopted.

Collaborations

MRL Vale: responsible for the concept and design of the study, data collection, analysis and interpretation, writing, review and final approval of the manuscript. WS Santos: responsible for the review of the design of the study, data analysis and interpretation, and review and final approval of the manuscript. JA Pontes Junior: responsible for the review of data analysis and interpretation, and review and final approval of the manuscript. RB Diniz: responsible for the review and final approval of the manuscript. MMM Ávila: responsible for the review of the design of the study and data interpretation, and review and final approval of the manuscript.

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