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ORIGINAL ARTICLE

The Brazilian version of the three-factor eating questionnaire-R21: psychometric evaluation and scoring pattern

Anna Cecília Queiroz de Medeiros[1,2] · Maria Emilia Yamamoto[1] · Lucia Fatima Campos Pedrosa[3] · Claudio Simon Hutz[4]

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Abstract
Purpose This study aimed to evaluate the psychometric properties and scoring pattern of the Brazilian version of the three-factor eating questionnaire-r21 (TFEQ-R21).
Methods Data were collected from 410 undergraduate students. Confirmatory factor analysis was conducted to examine the factor structure of the TFEQ-R21. Convergent and discriminant validity also was assessed. Cluster analysis was performed to investigate scoring patterns.
Results In assessing the quality setting, the model was considered satisfactory ($\chi^2/gl = 2.24$, CFI = 0.97, TLI = 0.96, RMSEA = 0.05). The instrument was also considered appropriate in relation to the discriminant and convergent validity. There was a positive correlation between body mass index and the dimensions of cognitive restraint ($r_s = 0.449$, $p < 0.001$) and emotional eating ($r_s = 0.112$, $p = 0.023$). Using cluster analysis three respondent profiles were identified. The profile "A" was associated with appropriate weight, the "B" was characterized by high scores in cognitive restraint dimension, and the cluster "C" focused individuals who had higher scores on the uncontrolled eating and emotional eating dimensions.
Conclusions The Brazilian version of TFEQ-R21 has adequate psychometric properties, and the identified response profiles offer a promising prospect for its use in clinical practice, in weight loss interventions.

Keywords Eating behavior · Three-factor eating questionnaire · BMI · Psychometrics

Introduction

In Brazil, approximately 48 % of the population is overweight, and reducing this percentage by 2022 is one of the priorities of the national healthcare system. However, receiving and administering treatments for obesity is still a daily challenge for patients and healthcare professionals [1].

The difficulties include both the adhesion to and/or monitoring programs for weight loss and the maintenance of a clinically useful weight loss in the long term [2]. So, a better understanding of the behaviors associated with obesity appears to be essential to change this scenario.

From this perspective, the three factor eating questionnaire (TFEQ) was developed by Stunkard and Messick to access cognitive restraint, disinhibition and susceptibility to hunger, in adults [3]. Originally consisting of 51 items, later studies have developed reduced and psychometrically improved versions of TFEQ, with 18 (TFEQ-18) [4], 21 (TFEQ-21) [5] and 29 items [6]. These reduced versions are quite similar, composed from the TFEQ-51 items and access three main eating behaviors: emotional eating (EE), uncontrolled eating (UE) and cognitive restraint (CR).

CR is characterized as the limitation (cognitive and self-imposed) of food intake in order to control body weight [7].

✉ Anna Cecília Queiroz de Medeiros
annacqm@yahoo.com.br

[1] Laboratory of Evolution of the Human Behavior, Graduate Program in Psychobiology, Department of Physiology, Federal University of Rio Grande do Norte, Natal, Brazil

[2] Health Sciences College of Trairi/FACISA, Federal University of Rio Grande do Norte, Rua Vila Trairi, s/n, Centro, Santa Cruz, Rio Grande do Norte 59200-000, Brazil

[3] Department of Nutrition, Federal University of Rio Grande do Norte, Natal, Brazil

[4] Department of Psychology, Federal University of Rio Grande do Sul, Porto Alegre, Brazil

The UE behavior is the tendency to lose control over eating when feeling hungry or when exposed to external cues (e.g., very palatable food), even in the absence of physiological hunger [5]. Finally, the EE scale measures the susceptibility to eat in response to emotional stress and negative mood states [8].

An important difference in the TFEQ elaboration process was the inclusion of obese and non-obese persons, in various contexts (i.e. free-eating and weight control programs) [3]. This improved the TFEQ applicability and interpretation as a useful tool for better understanding of body weight management issues, which was confirmed in later studies in large samples [4, 5, 9].

Currently, complete and reduced versions of the TFEQ have been used in studies in Swiss [5], German [6], British [10], Finnish [11], Spanish [12], Thai [13], French [9], Greek [14], American and Canadian populations, with consistent results. In Brazil, preliminary results indicate that there is great potential for using the TFEQ-21 version in nutrition oriented programs that focus on weight control [15].

Thus, the present study was designed to perform a confirmatory factor analysis of the Brazilian version of the TFEQ-21, aiming to evaluate its psychometric qualities and investigate possible scoring patterns.

Methods

The study sample consisted of 433 undergraduate students from the Federal University of Rio Grande do Norte who volunteered to participate after learning about the study through publicity. Before soliciting volunteers, the study was approved by the University Research Ethics Committee and informed consent was obtained from all of the individual participants. The criteria for inclusion in the study was proof of current age as 18 or older. Exclusion criteria included prior history of eating disorders, and being pregnant and/or breastfeeding.

The anthropometric evaluation consisted of measuring the weight and height of each participant and calculating the body mass index (BMI) [16]. Weight was estimated using a portable digital scale with 150 kg capacity and height was estimated using an anodized aluminum stadiometer with 210 cm capacity. All weight and height measurements were estimated twice and, in the case of any discrepancy, a third estimate was made.

The TFEQ-21 consisted of 21 items divided into three domains: CR; uncontrolled eating and emotional eating [4]. The average obtained from the sum of the questions for each domain was converted to a scale ranging from 0 to 100 [17]. As suggested by previous studies [6, 9, 18], the sample was dichotomized into higher and lower scores in each TFEQ dimensions, according to the medians obtained in this study. Participants in the study were also asked if they were on any kind of diet.

The confirmatory factor analysis (CFA) was conducted using Mplus software (version 6.0) and using the WLSMV (robust weighted least squares) method to estimate the model [19]. The fit quality was evaluated according to the following parameters: χ^2/gl (excellent $\leq$3, acceptable <5), CFI (excellent $\geq$0.96), TLI (excellent $\geq$0.95) and RMSEA (adequate $\leq$0.06) [19, 20].

To evaluate convergent validity, the average variance extracted (AVE) was calculated, where values greater than or equal to 0.5 were considered satisfactory. The consistency of the scale was evaluated according to the compound reliability and Cronbach's α criteria, whereby values greater than or equal to 0.70 were considered to be adequate. Discriminant validity was investigated from an evaluation of correlations between instrument dimensions (adequate $\leq$0.80), as well as an evaluation of the AVE, the value of which must be greater than the square of the correlation between dimensions [21].

The results are presented as percentages, absolute and median values (interquartile range), as recommended [22]. The correlation between variables was investigated using Spearman's correlation test; and the association between categorical variables by using Pearson's Chi squared test. For comparisons between groups, Mann–Whitney and Kruskal–Wallis tests (with Bonferroni correction) were used.

Cluster analysis was performed in the Statistical Package for the Social Sciences (SPSS) program (version 20), using the K-means algorithm, suitable for large datasets. The K-means clustering process starts by selecting initial cluster centers used for a first round of classification [21, 23]. The observations are then successively reassigned on the basis of the Euclidean distance between the cases and the cluster centers [21]. Cluster affiliations can change in the course of the process, which is repeated until centroids do not significantly change location [23]. Clustering variables were the final scores of the three TFEQ dimensions. The K-means method was applied with the number of clusters varying from 2 to 4. Cluster solutions were evaluated based on the interpretability of the solution [23], the Davies–Bouldin index [24, 25] and the Calinski–Harabasz index [24, 25].

Results

The study sample consisted of 66.8 % (n = 274) female and 33.2 % (n = 136) male participants, with a mean age of 21.0 (SD = 3.1) years and BMI of 23.1 (4.6) kg/m^2. With respect to the total sample of volunteers, 31.0 %

($n = 127$) were considered overweight, according to their BMI ($\geq$25.0 kg/m^2), and 20.2 % ($n = 83$) reported to be on some kind of diet.

All of the TFEQ-21 items showed a corrected item-total correlation coefficient (CCIT-c) greater than 0.30 and all response options were used for all items. According to the Cronbach α parameter, the internal consistency of all domains was considered to be adequate (UE $\alpha = 0.83$; EE $\alpha = 0.92$, and CR $\alpha = 0.83$). The results (χ^2/gl = 2.24, CFI = 0.97, TLI = 0.96, and RMSEA = 0.05) indicate that the obtained model presented a good fit (Fig. 1). The dimensions correlations are all significant ($p < 0.01$).

In the assessment of convergent validity, with respect to extracted variance (EV), only the uncontrolled eating dimension (0.43) presented results less than 0.50 (EE = 0.76; RC = 0.55). However, all of the dimensions showed satisfactory compound reliability performance (EE = 0.95; UE = 0.87; CR = 0.87). Regarding the discriminant validity, a satisfactory result for all dimensions was observed, where correlations were less than 0.80 (Fig. 1) and EV values were greater than the squared correlations.

In addition, when comparing those study participants who were on a diet [$n = 83$; EE = 45.8 (29.2); UE = 55.6 (25.0); CR = 70.8 (25.0)] and those who were not on diet [$n = 326$; EE = 45.8 (25.0); UE = 55.6 (20.2); RC = 50.0 (25.0)], a statistical difference was only detected in the Cognitive Restriction dimension ($p < 0.001$).

The sample of women [$n = 274$; EE = 50.0 (29.2); UE = 55,6 (19,5); CR = 54.2 (29.1)], compared to the sample of men [$n = 136$; EE = 37.5 (29.2); UE = 55,6 (24,4); CR = 50.0 (29.2)], showed significantly higher scores in the EE ($p < 0.001$) and CR ($p = 0.01$) dimensions.

A correlation was detected between BMI and the EE ($r_s = 0.112$, $p = 0.023$) and CR ($r_s = 0.449$, $p < 0.001$) dimensions, but not with UE ($r_s = -0.004$; $p = 0.930$).

According to the results of the Davies–Bouldin index and Calinski-Harabasz index, the optimal number of clusters was 3, which agreed with the evaluation of interpretability of the solutions. Convergence was achieved after seven iterations. The characterization of the three groups obtained in the cluster analysis is shown in Table 1. Cluster A was associated with both adequate weight [χ^2 (2) = 15.807, $p < 0.001$] and increased prevalence of individuals classified as Lower scores on EE [χ^2 (2) = 211.847, $p < 0.001$] and CR [χ^2 (2) = 246.376, $p < 0.001$] scales. Also, Cluster A showed lower BMI values compared to the patterns of B and C ($p < 0.001$)

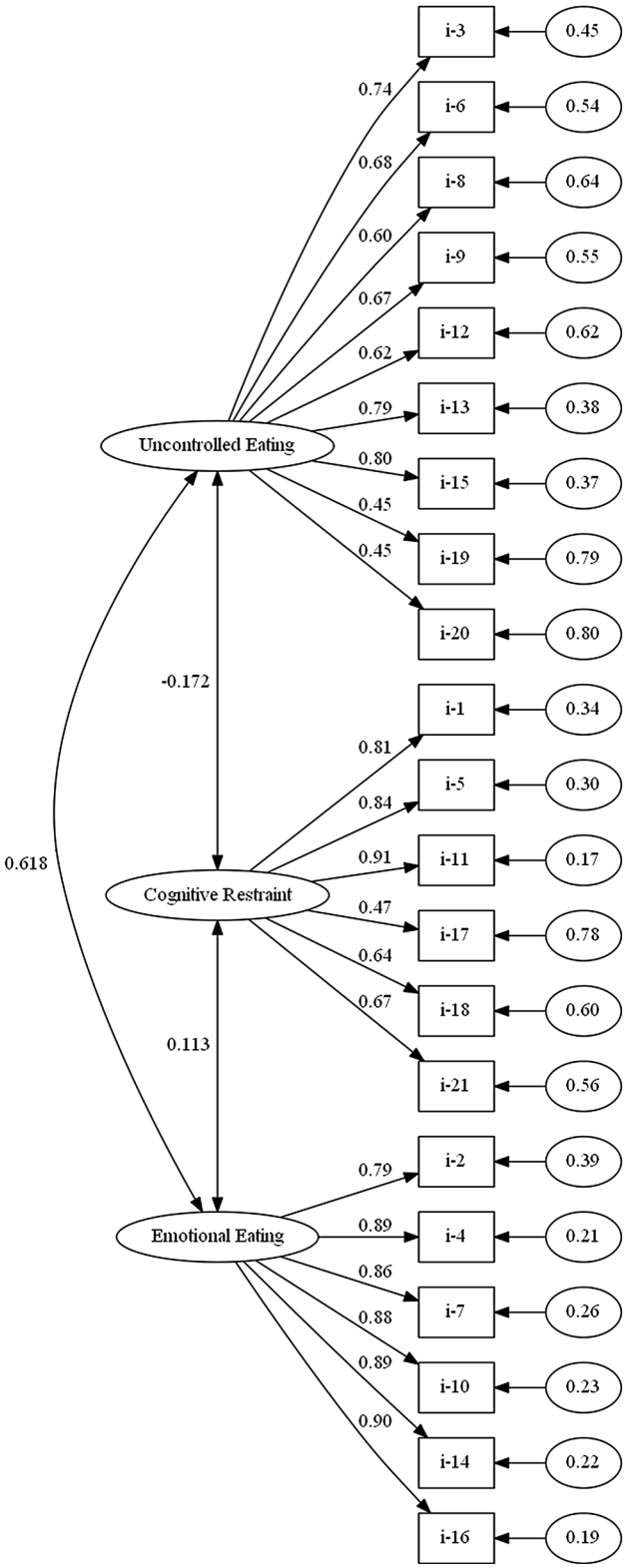

Fig. 1 Confirmatory factor analysis of the Brazilian version of the three-factor eating questionnaire-R21, standardized weights

Table 1 Participant characteristics by cluster of the scoring patterns identified from the three-factor eating questionnaire-R21

	Cluster		
	Cluster A ($n = 165$)	Cluster B ($n = 123$)	Cluster C ($n = 122$)
Demographics			
Age (years)	20.9 (2.90)	21.3 (3.29)	20.8 (3.20)
Sex			
Male	69 (41.8 %)	38 (30.9 %)	29 (23.8 %)
Female	96 (58.2 %)	85 (69.1 %)	93 (76.2 %)
Dieting**			
Dieters	14 (8.5 %)	46 (37.7 %)	23 (18.9 %)
Non-dieters	151 (91.5 %)	76 (62.3 %)	99 (81.1 %)
TFEQ-21 dimensions			
Emotional eating**	33.3 (16.7)[a]	41.7 (20.8)[b]	70.8 (16.7)[c]
EE lower	139 (84.2 %)	82 (66.7 %)	0 (0.0 %)
EE higher	26 (15.8 %)	41 (33.3 %)	122 (100 %)
Uncontrolled eating**	52.8 (19.4)[a]	50.0 (16.7)[a]	66.7 (17.4)[b]
UE lower	112 (67.9 %)	95 (77.2 %)	29 (23.8 %)
UE higher	53 (32.1 %)	28 (22.8 %)	93 (76.2 %)
Cognitive restraint**	41.7 (16.7)[a]	75.0 (12.5)[b]	54.2 (16.7)[c]
CR lower	155 (93.9 %)	1 (0.8 %)	67 (54.9 %)
CR higher	10 (6.1 %)	122 (99.2 %)	55 (45.1 %)
Anthropometric variables			
BMI (kg/m^2)	21.9 (3.9)[a]	24.3 (3.9)[b]	23.5 (5.5)[b]
Nutritional status**			
Healty weight	132 (80.0 %)	74 (60.2 %)	77 (63.1 %)
Overweight	33 (20.0 %)	49 (39.8 %)	45 (36.9 %)

Results are shown as median (range interquartile) and as *n* (%), except Age [mean (standard deviation)]

Categorical variables: asterisks indicate $p < 0.01$ at Pearson Chi square test. Continuous variables: different superscripts letters within the same line indicate group differences [Kruskal–Wallis and Mann–Whitney (with Bonferroni correction)]. Significance level adopted was $p < 0.05$ and $p < 0.017$

BMI Body mass index

clusters. Cluster B was characterized by the highest proportion of dieters [χ^2 (2) = 37.246, $p < 0.001$] and individuals with high CR [χ^2 (2) = 246.376, $p < 0.001$]. Cluster C was associated with individuals that presented high EE and UE, with higher scores on EE and UE when compared to clusters A and B.

Discussion

The results of the current study demonstrate that the 21-item three-factor structure of the Brazilian version of the TFEQ-R21 showed adequate internal consistency, convergent and discriminant validity. The results of CFA analyses indicates a good fit to the data, better than those found in the English (18 items) [4] and German (29 items) [6] versions. In addition, also Cappelleri et al. [4] and Lofler et al. [6] studies, all items presented a load factor >0.40.

Another indication of the good quality of the Brazilian version of the TFEQ-R21 was the difference in scores when comparing those participants who report being or not being on a diet, only in relation to the CR scores. It should be noted that cognitive restriction behavior cannot be characterized merely by the "on a diet" response. According to Lowe et al. [26], restrained eaters are best characterized as "weight watchers" and, unlike dieters, do not restrict their food intake in relation to specific weight loss [26]. However, previous studies also found higher CR scores in self-declared dieters [12, 27] and a relationship between dietary restraint and self-reported dieting [28].

Consistent with other studies, a tendency of larger TFEQ scores was identified among females, compared to men [4, 9, 13, 29, 30]. It is well established that women generally have higher scores than men in questionnaires about eating behaviors [7]. According to the socio-cultural model of eating disorders, this could be due largely to the fact that women suffer greater social pressures

regarding the maintenance of body weight in almost all cultures [31].

Correlations were found between BMI and the EE and CR dimensions, as in the Finnish sample [32]. Other studies have reported positive correlations between BMI and all dimensions of the TFEQ [9, 10], while others only between BMI and RC [5] or BMI and UE [27]. This variability in the relationship between BMI and TFEQ dimensions is due in part to the BMÍs limited capacity an indicator of body fat percentage or central obesity [13, 33]. Another important point to explain BMI results is the intrinsic sample profile. Population characteristics such as age [30], prevalence of obesity and chronic diseases [4], socio cultural context [7], sexual rate [9, 11] and pregnancy [33], can act as modifiers of the association between BMI and eating behaviors evaluated by TFEQ.

Following the suggestions of the TFEQ authors [3], and considering the clinical applicability of the instrument, there is some value in building profiles that allow the categorization of respondents, which facilitates decision-making in clinical practice.

In the current study, according to TFEQ scores, it was possible to identify three respondent profiles. Cluster A was associated with adequate weight and lower TFEQ scores, compared to the other profiles. Cluster B was characterized by high scores in the CR dimension, while cluster C grouped individuals who had higher scores in EE and UE dimensions.

Although results of intervention studies suggest a relationship between weight loss and concomitant increase in CR scores [34, 35], in the long term this does not seem to occur and might be related to future weight gain [26]. Also, increased CR seems to predispose episodes of loss of control and excessive consumption of food, tending towards the occurrence of compulsive eating episodes [8, 36]. Thus, it seems reasonable to presume something like a "homeostatic pressure" that must be maintained by restrictive cognitive behavior. So when maintained at optimal levels, CR may be a good weight control indicator while very high levels can indicate excessive homeostatic pressure.

From this perspective, overweight individuals presenting scoring pattern type A (low scores in the three dimensions), could benefit from a small increase in CR scores, suggesting possible success of a "diet" approach (since dieting is associated with increased CR scores [26]).

On the other hand, overweight individuals from cluster B could be benefited by interventions which are not focused on restrictive/rigid dietary plans, but which are more qualitative. Sensory-based nutrition interventions [37] combined with increased physical activity appear to be viable alternatives to modulate body weight without exacerbating restrained eating behavior.

Long-term interventions, including both support group meetings and individual monitoring, as conducted in Batra et al. [38] study, appears to be a viable alternative for dealing with overweight in cluster C individuals (higher scores in dimensions EE and UE). Mindfulness-based interventions can also be useful [39]. However, it is extremely important to monitor/prevent a possible increase in CR scores.

Finally, an important point to note was the progressive increase in the EE scores in clusters A to B to C, which is in agreement with the assumption that EE behavior is positively related to CR and UE [4]. From this perspective, an emotional support and the development of skills to handle dysphoric mood states can be a great differential to achieve a healthy body weight [8].

Thus, our findings indicate that it is important to evaluate not only the individual scores of each dimension, but the combination or proportion of increased values score.

Although the population survey was only composed of undergraduate students, which constitutes the principal limitation of the study, our findings are consistent with previous research [5, 9, 13, 15, 29] and include information about actual dietary restraint. Furthermore, the use of measured anthropometric data, instead of weight and height self-reports, decreases potential biases.

The results presented here confirm the validity of the Brazilian version of the TFEQ-R21, which was considered adequate to assess the behaviors of CR, UE and EE. Also, the instrument discriminated between dieters and non-dieters.

The response patterns approach suggests a promising perspective about the interpretation of the TFEQ-R21 scores. However, a longitudinal follow-up is needed to check the stability of patterns identified in this study as well to assess how changes in eating habits affect and/or are driven by these patterns. Thus, it is suggested that further studies are needed to better understand the behavior profiles obtained here, in order to facilitate the decision-making, as well as the development and monitoring of strategies to control body weight, in the context of clinical practice.

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Compliance with ethical standards

Ethical approval The research was approved by the Ethic in Research Committee from the Federal University of Rio Grande do Norte and all procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent in writing was obtained from all individual participants included in the study.

Conflict of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

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