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INVESTIGATION ARTICLE

Transcultural adaptation and validation of the Child Three-Factor Eating Questionnaire (CTFEQr17) into Brazilian Portuguese

Adaptación transcultural y validación del Cuestionario de Comportamiento Alimentario de Tres Factores para Niños (CTFEQr17) al portugués brasileño

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Abstract

The Three-Factor Eating Questionnaire is a commonly utilized instrument for evaluating elements of human eating behaviours. A version of this questionnaire, the Child Three-Factor Eating Questionnaire (CTFEQr17), was specifically developed for a paediatric population. This study focused on translating and validating the CTFEQr17 into Brazilian Portuguese for use with children and adolescents, and it was developed in three main stages: translation and expert review, a pilot test with 47 participants to evaluate comprehension, and psychometric validation in a sample of 249 participants. The study found that participants over the age of 10 understood the scale well. An initial Confirmatory Factor Analysis demonstrated excellent fit indices, but factor loadings indicated necessary adjustments. Following refinement, the CTFEQr-16 was obtained, showing good internal consistency and fit (Cronbach's alpha = 0.84). Convergent and discriminant validity were confirmed through specific analyses, and the scale effectively distinguished between different BMI (body mass index) categories. The Brazilian version of the CTFEQr16 showed satisfactory content validity and was comprehensible to children and adolescents, confirming its strong factor structure and high reliability. This makes it a valuable tool for future research and clinical practice in the Brazilian paediatric population.

Keywords: obesity; eating behaviours; validation; Three-factor Eating Questionnaire.

Resumen

El Cuestionario de Comportamiento Alimentario de Tres Factores es un instrumento comúnmente utilizado para evaluar elementos de los comportamientos alimentarios humanos. Una versión de este cuestionario, el Cuestionario de Comportamiento Alimentario de Tres Factores para Niños (CTFEQr17), fue desarrollada específicamente para una población pediátrica. Este estudio se enfocó en traducir y validar el CTFEQr17 al portugués brasileño para su uso en niños y adolescentes, y se desarrolló en tres fases principales: traducción y revisión por expertos, prueba piloto con 47 participantes para evaluar la comprensión, y validación psicométrica en una muestra de 249 participantes. El estudio encontró que los participantes mayores de 10 años comprendieron bien la escala. Un Análisis Factorial Confirmatorio inicial demostró excelentes índices de ajuste, pero las cargas factoriales indicaron ajustes necesarios. Tras el refinamiento, se obtuvo el CTFEQr-16, con buena consistencia interna y ajuste (alfa de Cronbach = 0,84). La validez convergente y discriminante se comprobó a través de análisis específicos, y la escala diferenciaba eficazmente entre distintas categorías de IMC (Índice de masa corporal). La versión brasileña del CTFEQr16 demostró tener validez de contenido y fue comprensible para niños y

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adolescentes, confirmando su estructura factorial fuerte y alta fiabilidad. Esto la convierte en una herramienta valiosa para investigaciones futuras y práctica clínica en la población pediátrica brasileña.

Palabras clave: obesidad; comportamientos alimentarios; validación; Cuestionario de comportamiento Alimentario de Tres factores.

Introduction

Childhood obesity has been emerging as a public health issue around the world. In Brazil, there has been a significant increase in the prevalence of overweight and obese children (Santos et al., 2023). As children gain excess weight, they are at heightened risk of developing a range of comorbidities and health conditions that can persist in adolescence and adulthood. These may include type 2 diabetes (American Diabetes Association, 2000), dyslipidemia, hypertension, non-alcoholic fatty liver disease, obstructive sleep apnea, psychological disturbances, reduced quality of life (Leung et al., 2024) and premature death (Leung et al., 2024; Xu et al., 2018). It is known that overweight and obesity in child development arise from a multifaceted set of factors, including biological characteristics, personal traits, psychological factors, lifestyle, dietary, environmental influences, and socioeconomic status (Shaban Mohamed et al., 2022).

Considering psychological and behavioural factors, Herman and Mack's model of eating behaviour suggests that obese individuals' eating habits are linked to specific patterns of control over food intake, addressing when, what, and how much they consume. However, this control is frequently undermined by a heightened sensitivity to food stimuli, making individuals more reactive to the presence and appeal of food around them (Herman & Mack, 1975).

Building on these ideas, Stunkard and Messick (1985) later proposed a revised model that emphasizes cognitive control in eating behaviour, highlighting the role of decision-making, self-regulation, and awareness in managing food intake. The authors also acknowledge the coexistence of dietary disinhibition, where conflicts arise between dietary goals and responses to food cues.

Aligned with the model proposed by Herman and Mack, Laessle et al. (1989) developed the Three-Factor Eating Questionnaire (TFEQ), a 51-item instrument specifically designed to assess three dimensions of eating behavior: cognitive restraint, disinhibition, and hunger. "Cognitive Restraint" involves efforts to control food intake, such as planning meals and counting calories. "Disinhibition" measures the tendency to overeat in response to food cues or emotional situations. "Hunger" assesses the physiological drive to eat, with frequent and intense hunger leading to consumption. The TFEQ's three-factor structure was consistently observed across diverse groups, including dieters and obese individuals, demonstrating its robustness. Additionally, it exhibited high reliability and construct validity, correlating well with weight, BMI (body mass index), and self-reported eating behaviours.

Karlsson et al. (2000) shortened version of the TFEQ by studying a larger sample of obese individuals, enhancing the tool's robustness and sensitivity. While "cognitive restraint" remained a distinct factor, "disinhibition" and "hunger" merged, suggesting that intense hunger can overpower attempts at cognitive control, acting as disinhibition. This indicates that, for obese individuals, hunger can make it difficult to resist eating, even when trying to control intake. The study also identified a distinct "emotional eating" factor, highlighting the role of negative emotions in driving eating behaviours in this group.

Analyzing the short 21-item version (TFEQ-R21), Cappelleri and colleagues (2009) evaluated the validity of the model in a clinical sample of adults with obesity, compared to a control group without obesity. In this study, the TFEQ-R21 did not fit the clinical trial data adequately. Consequently, three items from the Cognitive Restraint domain were removed, resulting in the revised TFEQ-R18V2. This 18-item version demonstrated a robust factor structure, with items in the domains of Cognitive Restraint, Uncontrolled Eating, and Emotional Eating exhibiting good statistical cohesion. Furthermore, it showed good reliability, with Cronbach's alpha coefficients of 0.84 for Uncontrolled Eating, 0.92 for Emotional Eating, and 0.70 for Cognitive Restraint.

Considering a significant increase in the prevalence of obesity in the global population, including children, Bryant et al. (2018) developed and validated a child-friendly version of the Three-Factor Eating Questionnaire (TFEQ), called the CTFEQr17. Through Exploratory Factor Analysis, the CTFEQr17 retained the three-factor structure of the original: cognitive restraint (CR), uncontrolled eating (UE), and emotional eating (EE). It showed good internal consistency (Cronbach's alpha of 0.85), indicating that the items reliably measure the intended concepts. The robustness of the model was observed through its translation and validation for French-speaking Canadian children and adolescents using a 17-item questionnaire [$\chi 2 /df$: 0.9; *CFI*: 1.000; *RMSEA*: 0.000 (90% *CI*: 0.000, 0.032); AIC: -126.050], and for Spanish children and adolescents using a 21-item questionnaire [$\chi 2/df$: 0.95; *NNFI*: 1.004; *CFI*: 1.000; *RMSEA*: 0.000 (90% *CI*: 0.000, 0.031); *AIC*: -195.379] (Frappier et al., 2022; Martín-García et al., 2016, respectively).

In Brazil, the TFEQ-R21 version was translated and adapted for the adult population, possessing adequate psychometric properties (de Medeiros et al., 2017). The model demonstrated a good fit to the data ($\chi 2/df$ = 2.24, *CFI* = 0.97, *TLI* = 0.96, *RMSEA* = 0.05). The instrument demonstrated strong discriminant and convergent validity, effectively distinguishing and accurately measuring the intended concepts. Additionally, there was a positive correlation between body mass index (BMI) and both cognitive restraint (rs = 0.449, $p < 0.001$) and emotional eating (rs = 0.112, p = 0.023), indicating that individuals with higher BMI are more likely to restrict food intake to control weight and to eat in response to emotions.

The use of Three-Factor Eating Questionnaire for adults has been utilized in clinical research on obesity and nutritional intervention (Biagio et al., 2020), risk factors associated with post-operative bariatric surgery (Bardal et al., 2016), and studies investigating stress on eating behaviour (Penaforte et al., 2016; Souza et al., 2020). Nevertheless, the child and adolescent version of the instrument has not yet been validated in Brazil. Recognizing the need for psychological tools to assess eating behaviour in Brazil's paediatric population, this study aimed to translate and validate the Child Three-Factor Eating Questionnaire (CTFEQ-17) for children and adolescents of both sexes.

Method

Study design

This study employed a cross-sectional psychometric design and was conducted with children and adolescents to validate the Brazilian version of the Child Three-Factor Eating Questionnaire (CTFEQr17). Data were collected in 2023. The methodological framework consisted of several key stages, including translation and cultural adaptation of the instrument, psychometric evaluation of the scale's factor structure, and a comparative analysis of eating behaviors between participants with and without childhood obesity.

Participants and sample size

In this study, a convenience sample of 296 children and adolescents from elementary and secondary schools in Bahia, Brazil, were enlisted. The study estimated a minimum sample of 200 participants to conduct the Confirmatory Factor Analyses, which were calculated considering a minimum ratio of 10 participants for each item and the proportion for the number of factors (Boateng et al., 2018). Children or adolescents with previous diagnosis of eating disorders, received nutritional or psychological assistance were not included in the sample. For semantic validity, children with reading difficulties were excluded from participation.

Stages of the study

Stage 1 - Translation and cross-cultural adaptation into Brazilian Portuguese of CFETQr17. The translation of the original scale into Brazilian Portuguese of CFETQr17 was performed by a specialized company using both a bilingual and a native translator. Following the translation, a panel of six experts familiar with the construct assessed the content validity of the questionnaire, evaluating the adequacy of the translations and the effectiveness of the items in measuring the intended construct.

To assess content validity, the study utilized the Content Validity Index (CVI) to measure consensus among judges regarding the relevance, clarity, and translation quality of the items (Polit et al., 2007; Yusoff, 2019). The evaluation included the item-level content validity index (I-CVI), which represents the proportion of judges rating an item as relevant (scores of 1-4). It also featured a scale-level content validity index based on the average (S-CVI/ave), calculated as the average of I-CVI scores for all items, reflecting the overall relevance assessed by experts. Additionally, the universal agreement index (S-CVI/UA) was considered, indicating the proportion of items rated 3-4 in relevance by all judges, with values close to 1 indicating high agreement. A cut-off score of above 0.83 was used for CVI, suitable for the six expert judges involved (Polit et al., 2007).

Stage 2 - Preliminary pilot testing. In Stage 2, a pilot test was conducted with a small sample to ensure children and adolescents understood all items. A group of 47 participants aged 9 to 17, deemed acceptable for questionnaire validation studies (Perneger et al., 2015). Participants were asked to read each item, explain their interpretation, and respond with 'YES' or 'NO' to indicate comprehension. The scale's comprehension was assessed by calculating the percentage of 'YES' responses, helping to establish an appropriate age cut-off for accurate responses. The final version underwent back-translation by an independent translator and was compared with the original, as recommended by Bryant et al. (2018).

Stage 3 - Psychometric validation of CFETQr17. At this stage, the research was conducted on a sample of 249 participants from public elementary and secondary schools in Bahia state. The data collection took place from 2023 to 2024. The participants were instructed to respond to the CFETQr17 scale along with the ERQ and ChEAT-26. During this stage, weight and height measurements were taken for anthropometric calculations. After a 14-day interval, 50 participants were randomly selected from the original sample and responded again to the CFETQr17 scale for test-retest reliability.

Instruments

Sociodemographic questionnaire. It was a structured sociodemographic questionnaire, created by the authors, aimed at obtaining information about age, gender, school grade, and race.

Child Three-Factor Eating Questionnaire (CTFEQr17). A Brazilian Portuguese version of the CTFEQ is a twenty-one-item self-reported questionnaire developed by Bryant et al. (2018). This questionnaire assesses Uncontrolled Eating (UE), an eight-item facto (e.g., Sometimes when I start eating, it seems I can't stop); Emotional Eating (EE), a six-item factor (e.g., I start to eat when I feel worried); and Cognitive Restraint (CR), a three-item factor (e.g., I eat small portions of food to help control my weight). Items 1–16 are measured on a four-point Likert scale (ranging from 1 = Almost never to 4 = Always) and item 17 on a four-point scale (ranging from 1 = only at meals to 4 = almost all the time).

Children's Eating Attitudes Test (ChEAT). The validated Brazilian version of the Children's Eating Attitudes Test (Pinheiro & Jiménez, 2012) features 26 self-completion questions on a four-point Likert scale (0 = Never to 3 = Always). It is composed of three subscales, each assessing distinct factors of eating behaviour related to eating disorders (ED): Diet and Bulimia (DIB -13 items; e.g., I stay away from eating when I am hungry), Concern with Food (CWF-6 items; e.g., think about food a lot of the time), and Oral Self-control (OSC -7 items; e.g., I feel that others pressure me to eat). It is considered that scores greater than 21 are indicative of risky eating behaviour for ED.

Emotional Regulation Questionnaire (ERQ). The emotional regulation questionnaire, validated for the Brazilian population, was applied to assess components of emotional activation and regulation (Gouveia et al., 2018). It includes 10 items across three factors on a 7-point Likert scale (ranging from 1 = Strongly disagree to 7 = Strongly agree): Cognitive Reassessment (CREA; e.g., "I control my emotions by changing the way I think about the situation I'm in") with 4 items; Redirection of Focus Attention (RFA; e.g., "When I want to feel more positive emotion, I change the way I'm thinking about the situation") with 3 items; and Emotional Suppression (ESU; e.g.,

"I keep my emotions to myself") with 3 items. Cognitive reassessment and redirection of attention are adaptive emotional regulation responses, while emotional suppression is non-adaptive and linked to negative behaviours. High scores indicate a propensity to use that specific regulation strategy.

Anthropometrics measurements. An assessment evaluated individuals' nutritional status by measuring body mass and height. Body mass was recorded using a portable Omron digital scale with 100g precision and 200kg capacity, and height was measured with a portable stadiometer accurate to 0.1cm and a maximum height of 2.20m. Age and sex-specific BMI z-scores from the World Health Organization were used for classification (Roberge et al., 2021). The BMI Z-score was calculated by dividing the weight (kg) by the height squared (m^2) and converting it according to normative stratification for ages 0–19, considering age and sex (Flegal & Cole, 2013). Participants were categorized as underweight (BMI Z-score < -2), eutrophic (-2 ≤ BMI Z-score < 1), overweight (1 ≤ BMI Z-score < 2), or obese (BMI Z-score ≥ 2).

Data collection procedure

The study adhered to ethical guidelines and received approval (Nº 6.470.421) from the Ethics Committee of Federal University of Southern Bahia, aligning with the standards set by the Comissão Nacional de Ética em Pesquisa in Brazil (CONEP) and the Helsinki Declaration. Municipal and state schools received guidance and invitations to partake in the research. Formal invitations were extended by the school coordinators to the participants, providing an explanation of the research. Prior to their participation in the study, the guardians of the children and adolescents were provided with written informed consent after receiving explanation of the research aims. Parents provided permission via an informed consent form, and children and adolescents gave their agreement to participate by completing an age-appropriate assent form. Throughout all study procedures, ethical considerations regarding potential risks and benefits were carefully observed. In cases where children or adolescents were identified as exhibiting potentially risky eating behaviors or other relevant conditions during data collection, parents or legal guardians were informed and guided to seek support from local child health and social assistance services, ensuring appropriate care when necessary.

Data Analysis

Descriptive statistics summarized data from the sample population, analyzing sex, education level, age, and zBMI classification as independent variables, while zBMI and scores from applied scales were treated as dependent variables. In the semantic validation phase, a Multivariate Analysis of Variance (MANOVA) compared average item comprehension percentages across groups of 9-year-olds, 10-year-olds, and children over 11, with Tukey's *post hoc* test used for pairwise comparisons.

To evaluate factor structure, Structural Equation Modelling, specifically Confirmatory Factor Analysis (CFA), was employed to examine the reflective model of CTFEQr17 developed by Bryant et al. (2018). Measures of sampling adequacy, including the Kaiser-Meyer-Olkin (KMO) test and Bartlett's test of Sphericity, assessed data suitability for factor analysis (Kaiser, 1974). The CFA utilized Diagonally Weighted Least Squares (DWLS) for ordinal variables, with fit indices such as the Chi-square Test (χ^2) and the ratio (χ^2/df) evaluated for model appropriateness, targeting a ratio less than 3 for a good fit (Schermelleh-Engel et al., 2003). The Root Mean Square Error of Approximation (RMSEA) was reported, with values between .01 and .08 indicating a close-fitting model (Alavi et al., 2020). Incremental fit indices, including the Comparative Fit Index (CFI) and Tucker-Lewis Index (TLI), assessed the hypothesized model against a null model (Goretzko et al., 2024), with values above 0.90 considered indicative of good fit (Xia & Yang, 2019). Missing data were handled using Pairwise deletion for the DWLS estimator (Katsikatsou et al., 2022).

Internal consistency was evaluated using Cronbach's alpha, where values ≥ 0.70 were deemed satisfactory. Test-retest reliability was assessed through the intra-class correlation coefficient using a two-way mixed effect model to examine variations over time (Koo & Li, 2016; Schuck, 2004).

Construct validity included convergent validity was assessed through Average Variance Extracted (Fornell & Larcker, 1981) with values above 0.50 indicating good validity. Pearson's correlations evaluated the relationships between the scores of boys and girls on the CTFEQr17's CR, EE, and UE factors and the three factors of the Emotional Regulation Questionnaire. Concurrent validity was tested against scores from the UE, EE, and RC factors related to diet and bulimia, concern with food, and oral self-control factors from the Children's Eating Attitudes Test.

Discriminant validity was examined with the Heterotrait-Monotrait Ratio of Correlations (HTMT), targeting values below 0.85 to 0.90 for distinctiveness (Henseler et al., 2015), calculated using Henseler's HTMT calculator (https://www.henseler.com/htmt.html). The magnitude of latent traits between sex and BMI categories was evaluated using a two-way ANOVA (Héberger & Kollár-Hunek, 2019). Effect sizes were calculated using partial eta squared (ηp2) for ANOVA, categorized as small (0.20), moderate (0.50), and large (0.80) (Lakens, 2013)

Structural equation modelling was conducted with Jasp® Software and the lavaan R package, while analysis of variance was performed using Statistica® software, adopting a significance level of $p < 0.05$.

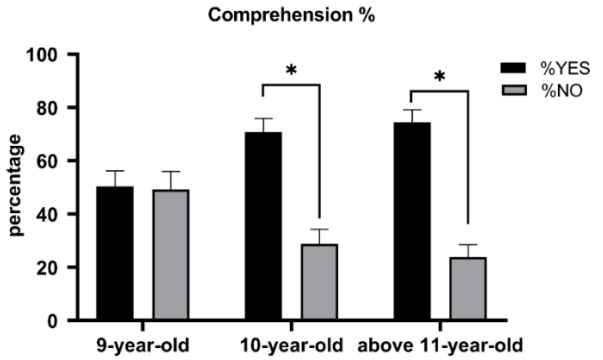
Results

Stage 1 - Content validity

At this stage, we observed an S-CVI/Ave index with an average of 0.98 and an S-CVI/UA of 0.94. In terms of clarity, the analysis revealed an S-CVI/Ave value of 0.98 and an S-CVI/UA value of 0.88. Translation quality reached the maximum score of 1.0 for both S-CVI/Ave and S-CVI-UA. As a result, we found that all CVI indices were classified as excellent (Shi et al., 2012), and the scale demonstrated satisfactory cross-cultural adequacy properties.

Stage 2 - Pilot study for semantic validity

In the pilot test, a Multivariate Analysis of Variance (MANOVA) was used to compare the average percentages of item comprehension on the scale. The statistical analysis observed a group effect [F (2,44) = 4.45, p = 0.01, ηp^2 = 0.15], a comprehension percentage effect for comparisons between YES and NO [F (1,44) = 22.7, p = 0.001, ηp^2 = 0.27], and an interaction between groups and comprehension percentage [F (2,44) = 4.572, p = 0.01, ηp^2 = 0.12]. Tukey's *post hoc* correction observed that there are no significant differences between the percentages of YES and NO for the 9-year-old group. However, we observe significant differences in the comprehension percentages between the 10-year-old group and those above 11-year-old (Figure 1).



Note: *p < 0.01 for comprehension difference in the 10-year-old and above 11-year-old groups. MANOVA statistical analysis for comparisons between groups and comparisons of percentages in Mean ± SEM YES vs No for each group, followed by Tukey's *post hoc* test correction.

Figure 1. Relative comprehension percentages of the total 17 items on the CTFEQ-17 scale for the 9-year-old, 10-year-old, and above 11-year-old groups.

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Stage 3 - Psychometric validation of CFETQr17

In this study, 249 students were distributed between elementary (78%) and high school (22%). The gender percentage was 49,80 % for boys and 50,20 % for girls, while the average age was 14.2 ± 3.2 (SD) for girls and 13.8 ± 3.7 (SD) for boys. Group comparisons were conducted considering the independent variables for sex and BMI category. The 249 participants were sub-allocated into the following groups considering the BMI category: Underweight (F = 5, M = 3), Eutrophic (F= 78, M = 97), Overweight (F = 28, M = 10), and Obesity (F = 14, M = 14).

Sampling adequacy

Regarding sampling adequacy, the overall value of KMO statistics was 0.835, which indicates that sampling is adequate, and the factor analysis is appropriate for the data. Bartlett's test of sphericity observed is significant $\chi^2 = 1302.41$ ($p < 0.001$), suggesting that the correlation matrix has significant correlations among at least some of the variables. We reject the hypothesis that the correlation matrix is an identity matrix (Table 1).

Table 1. Factor loadings of the CTFEDQr-17 as coded from the model by Bryant et al. (2018)

Item	Item content	UE	EE	CR
i-3	Sometimes when I start eating, it seems I can't stop	0.785		
i-6	When I am next to someone who is eating, I also feel like eating	0.670		
i-8	I often get so hungry that I feel like I could eat loads of food without getting full	0.668		
i-9	When I am hungry, I feel like to have to eat all of the food on my plate in one go, without stopping	0.656		
i-12	When I smell or see my favourite food, I find it hard to stop myself from eating it, even if I've just finished a meal	0.646		
i-13	I'm always hungry enough to eat at any time	0.642		
i-15	When I see something that looks delicious, I get so hungry that I have to eat it right away	0.615		
i-17	How often do you feel hungry?	0.387		
i-2	I start to eat when I feel worried		0.701	
i-4	When I am sad, I usually eat too much		0.848	
i-7	When I feel angry, I need to eat.		0.838	
i-10	When I feel lonely, I make myself feel better by eating		0.722	
i-14	If I feel nervous, I try to calm myself down by eating		0.849	
i-16	When I feel really upset, I want to eat.		0.824	
i.1	I eat small portions of food to help control my weight			0.792
i.5	I don't eat some kinds of food because they can make me fat			0.882
i.11	I eat less than I want at meal times to stop myself putting on weight			0.926

CR, cognitive restraint; UE, uncontrolled eating; EE, emotional eating.

Factorial analysis

The Chi-squared test indicated a significant result with $\chi^2 = 173.545$ ($df = 116$) at $p < 0.01$, and the ratio (χ^2/df) was 1.49. The *RMSEA* value was 0.04 (90% *CI*: 0.03, 0.06), suggesting a good model fit. Incremental fit indices were employed, with the Comparative Fit Index (*CFI*) at 0.94 and the Tucker-Lewis Index *(TLI*) at 0.92, confirming the adequacy of the model. Factor covariance was observed between cognitive restraint (CR) vs. emotional eating (EE) [Estimated z-value = 0.20, p = 0.02] and EE vs. uncontrolled eating (UE) [Estimated z-value = 0.643, $p = 0.001$], but not between CR vs. UE [Estimated z-value = 0.04, p = 0.73].

Examining factor loadings, excellent adequacy was found for the CR factor (items i-1, i-5, and i-11) and for EE (items i-2, i-4, i-7, i-10, i-14, and i-16), with standardized values greater than 0.7 (Yana et al., 2015). The UE factor

(items i-3, i-6, i-8, i-9, i-12, i-13, i-15, and i-17) showed good factor loadings above 0.6, except for item i-17, which had a weak loading below 0.4 (Guadagnoli & Velicer, 1988).

Following the removal of item i-17, the final set of 16 items yielded a refined model with improved absolute fit indices: χ^2 = 139.157 (*df* = 101), ratio (χ^2/df) = 1.37, *p* = 0.13; *RMSEA* = 0.03 (90% CI: 0.01–0.04), indicating that the three-factor, 16-item model fits well (Figure 2). Incremental fit indices also improved, with *CFI* = 0.995 and *TLI* = 0.994 after removing item 17.

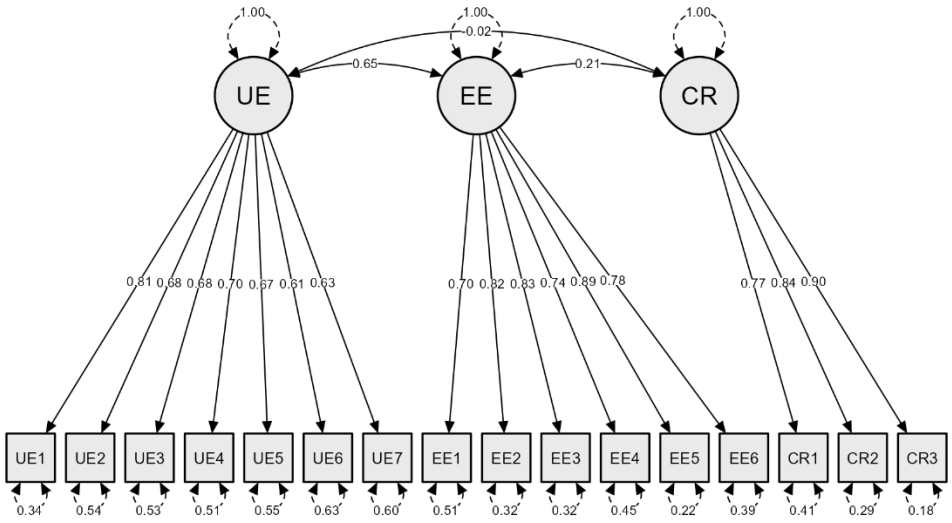


Figure 2. Confirmatory factor analysis of the Brazilian version of the Child Three-Factor Eating Questionnaire with a 16-item model, standardized factor loadings, and residual variances. Covariance for UE – EE and CR – EE (p < 0,05).

Reliability

To evaluate reliability, Cronbach's alpha was calculated, showing an overall score of 0.841, with specific scores of 0.845 for cognitive restraint (CR), 0.858 for emotional eating (EE), and 0.793 for uncontrolled eating (UE). These values indicate adequate internal consistency, all exceeding the satisfactory threshold of 0.7 (Taber, 2018). The study also utilized the Intraclass Correlation Coefficient (ICC) to assess the consistency and reproducibility of the results across time, yielding an ICC of 0.80 for the total scale [*ICC* = 0.80, 95% *CI* 0.59 - 0.91, *p* < 0.001]. The ICC values for the CR factor were 0.70 [*ICC* = 0.70, 95% *CI* 0.36 - 0.86, *p* < 0.001], for the EE factor 0.87 [*ICC* = 0.87, 95% *CI* 0.72 - 0.94, *p* < 0.001], and for the UE factor 0.74 [*ICC* = 0.74, 95% *CI* 0.46 - 0.88, *p* = 0.001]. These observed ICC values are considered satisfactory (Koo & Li, 2016), indicating that the scale exhibits fair consistency and reproducibility.

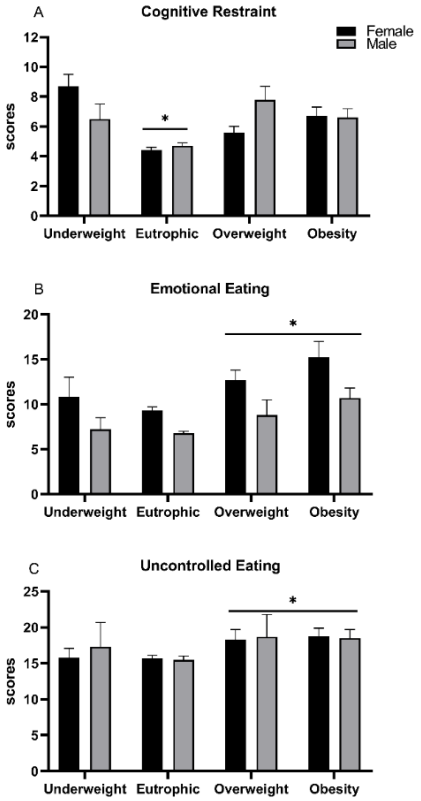
Construct validity

Convergent validity was tested using Average Variance Extracted (AVE), revealing satisfactory values for the cognitive restraint (CR) factor (AVE = 0.668) and emotional eating (EE) factor (AVE = 0.506), indicating that a significant proportion of items represent the variance of the measure (Fornell & Larcker, 1981). However, the uncontrolled eating (UE) factor showed a below-threshold AVE of 0.468, suggesting that observed differences are likely due to measurement error rather than variances explained by the construct (Cheung et al., 2023).

Convergent validity was also assessed in relation to emotional expression, as emotional eating and disinhibition are often influenced by stress or emotional dysregulation. A weak positive correlation was found between the emotional suppression (ESU) and emotional eating (EE) (*r* = 0.20, *p* = 0.03), and between ESU and uncontrolled eating (UE) (*r* = 0.20, *p* = 0.04). However, no significant correlations were noted for the cognitive reassessment (CREA) and redirection of focus attention (RFA) factors with EE, UE, and cognitive restraint (CR) (p < 0.5).

Concurrent validity analysis revealed a positive correlation between UE and CWF components in males (r = 0.34, p = 0.01) and between CR and DIB in females (r = 0.54, p = 0.01), while other correlations involving EE, UE, and ChEAT factors were not significant (p > 0.05).

Discriminative validity was tested using the HTMT, an estimator of the correlation between latent variables. Reliable distinctions were observed in pairs of CR vs EE, *HTMT* = 0.219; CR vs UE, *HTMT* = 0.04; and EE vs UE = 0.598. Besides, comparisons among participants considering the variables of sex and BMI category were used to verify the ability to discriminate scores on the scale. Considering the CR factor, the analysis did not reveal significant differences for the effect of sex [F (1,241) = 0.07, p = 0.78] or sex x BMI category interaction [F (3,241) = 1.78, p = 0.15]. However, an effect of the BMI category was observed [F (3,241) = 11.79, p = 0.001, ηp^2 = 0.14]. The Tukey correction for BMI category effect revealed that the scores for participants with ideal weight were lower compared to participants classified as obese, overweight, and underweight (Figure 3A).



Note: * p < 0.01 for the Eutrophic group when compared to Underweight, Overweight, and Obesity in Cognitive Restraint (Figure 3A), * p < 0.01 for Overweight and Obesity groups when compared to the Eutrophic group in Emotional Eating (Figure 3B); and * p < 0.01 for Overweight and Obesity group compared to the Eutrophic group in Uncontrolled Eating (Figure 3C). Two-way ANOVA for sex and BMI category and MEAN ± SEM scores of CR, EE, and UE followed by Tukey's *post hoc* test.

Figure 3. Comparing among groups of BMI categories for underweight, eutrophic, overweight, and obesity classifications for male and female subjects.

The analysis found no interaction effect between sex and BMI category on the Emotional Eating factor [F (3,241) = 0.632, p = 0.59]. However, significant effects of sex [F (1,241) = 17.33, p = 0.001, $\eta p2$ = 0.17] and BMI category [F (3,241) = 12.12, p = 0.001, $\eta p2$ = 0.15] were observed. *Post hoc* Tukey tests revealed that overweight and obese participants scored higher than those in the eutrophic category (Figure 3B).

For the UE factor, no significant sex effect was noted [F (1,241) = 0.100, p = 0.88], and there was no interaction

between sex and BMI category [F (3,241) = 0.150, p = 0.92]. Nonetheless, a significant effect of BMI category was identified [F (3,241) = 3.62, p = 0.01, $\eta p2$ = 0.11], with *post hoc* tests showing that obese and overweight individuals had higher scores than those classified as eutrophic (Figure 3C).

Discussion

The study aimed to cross-culturally adapt and validate the Child Three-Factor Eating Questionnaire (CTFEQr17) for Brazilian children and adolescents through three distinct stages. First, content validation was achieved via a panel of judges who assessed the scale's quality, relevance, and clarity in Brazilian Portuguese. Next, a pilot experiment tested semantic validation to ensure cultural appropriateness and comprehensibility for the target population. In the third stage, the study examined the scale's psychometric properties, focusing on the model's structure, fit, and the relationship of the tested variables to the hypothesized construct.

Content validity is a crucial step in adapting measurement scales for child and adolescent populations, ensuring rigor and quality in the construction of measures tailored to these populations (Boateng et al., 2018; Shi et al., 2012; Stewart et al., 2005). During the content validity assessment, the evaluation panel noted excellent Content Validity Index scores for the Brazilian Portuguese translation, indicating that the items were clear, relevant, and of good quality. This ensures that the translated scale accurately reflects the intended construct and is suitable for the target population.

Cross-cultural suitability was tested in a pilot study with the target population, revealing significant comprehension differences for participants aged above 10 years but not for those aged 9 years, suggesting this age range as the cut-off for scale indication.

For the psychometric properties of the original CTFEQr-17, data indicated suitable values for the Kaiser-Meyer-Olkin measure and Bartlett's test. A confirmatory factor analysis reproduced the three-factor structure and demonstrated good model fit indices in the chi-square test and RMSEA.

Analysing factor loadings revealed satisfactory values for items related to cognitive restraint (CR) and emotional eating (EE). However, the uncontrolled eating (UE) factor showed a satisfactory structure for most items, except for item 17, which had weak factorial loading and high residual variance, indicating it may not effectively reflect the construct. A similar issue was noted in the Turkish version, where item 17 had the lowest factor loading in the UE domain (Demir et al., 2021). All three factors had satisfactory Cronbach's alpha values, but the UE factor demonstrated the lowest reliability. Recommendations for item retention based on statistical or theoretical criteria were made to refine the model (Wieland et al., 2017). After item 17 was removed, the final 16-item model showed improved absolute fit indices, indicating a good fit with the hypothesized model, as well as enhanced incremental fit indices confirming its distinction from a null model. Adjustments with item refinement have been observed in other studies adapting the CTFEQr-17 (Bryant et al., 2018; Frappier et al., 2022).

Regarding Convergent validity, the observed AVE values were above 0.5 for CR and EE, while the UE factor was below 0.5, indicating less than half the observed variation could be explained (Cheung et al., 2023). Possible explanations include weak correlations among UE items or low factorial loads indicating that these items do not provide much information about the latent variable. While the factorial loads for UE items were statistically adequate, substantial residual variance may be attributed to measurement error or the latent variable's complexity (Ximénez, 2009). This suggests that UE scale items may not fully capture all variance, indicating the need for item refinement to remove trivial items (Floyd & Widaman, 1995). Evidence for the need for refinement was also reported in the study by Cappelleri et al. (2009) for the 21-item version of the scale.

Despite the observed variance being below expectations for the uncontrolled eating (UE) factor, we tested the hypothesis that correlations with constructs measuring emotional aspects could relate to the emotional eating (EE) and UE factors, which are commonly linked to eating patterns associated with emotional states and distress

(Braden et al., 2023; Cifuentes et al., 2022; Dakanalis et al., 2023; Fernández et al., 2022). Our findings indicated positive correlations between reported suppressed emotions and both EE and UE, supporting the scale's effectiveness in assessing aspects of suppressed emotions that may lead to maladaptive responses such as anxiety, distress, and substance abuse (Amstadter, 2008; Fernández et al., 2022; Hoover et al., 2022; Stellern et al., 2023).

Concurrent validity was further supported by correlations between the UE factors of the CTFEQr-17 and the concern with food (CWF) factor of the Children's Eating Attitudes Test, suggesting a relationship between concerns about time spent on food and eating habits. Notably, a correlation was observed for girls between the CR factor and Dietary Restraint Behaviour (DIB), indicating that both scales reflect food intake and weight concerns. Other studies have noted a higher prevalence of cognitive dietary restraint behaviour among female subjects (Anglé et al., 2009; Bryant et al., 2018; Cappelleri et al., 2009; Legget et al., 2023).

We investigated whether the instrument was sensitive enough to detect differences in factor scores among groups classified in different BMI categories. For the CR factor, groups in the overweight, obesity, and underweight categories had higher scores compared to eutrophic participants, regardless of sex. Notably, high CR scores were particularly prevalent among girls in the underweight group, though no statistical differences were found between sexes. Previous studies have highlighted the impact of restrictive eating behaviours aimed at weight control, influenced by factors such as gender, education, and age (Banna et al., 2018; Lawless et al., 2021; McLean & Barr, 2003; Nakamura et al., 2021). Our study also found high CR scores in participants classified as overweight and obese, suggesting that cognitive dietary restraint patterns are common in these samples. Evidence indicates that restrictive eating patterns are associated with obesity-related characteristics, alongside emotional eating and heightened hedonic expectations for food. In a highly obesogenic environment, individuals with these traits must exert cognitive efforts to control caloric intake to maintain their ideal weight (Anderson et al., 2020; Apfeldorfer & Zermati, 2001; de Lauzon-Guillain et al., 2006; Rogers, 1999).

Regarding uncontrolled eating, a statistically significant increase in scores was observed for participants classified as overweight and obese. A study involving a large sample of obese and non-obese participants did not find differences in emotional eating (EE) and uncontrolled eating (UE) scores; however, positive correlations with weight gain were noted (Cappelleri et al., 2009). Conversely, research on clinical samples with eating disorders indicated that the TFEQr-18 scale effectively detected differences in UE and EE scores, with higher scores in those diagnosed with Bulimia Nervosa and Binge Eating Disorder (Rossi et al., 2024). High cognitive restraint (CR) scores were also noted in cases of Anorexia Nervosa, Bulimia, and Binge Eating, demonstrating the scale's ability to discriminate among clinical groups and conditions associated with emotional states. Reichenberger et al. (2020) provided psychometric and experimental evidence supporting the link between emotional states and emotion-based behaviour. Furthermore, therapeutic models focused on managing emotional regulation have proven effective in maintaining weight and addressing obesity (Smith et al., 2023).

Conclusion

Our study supported the three-factor structure of the Child Three-Factor Eating Questionnaire. However, we identified a refined and reduced 16-item model, which yielded a robust factor structure and good internal reliability. Evidence levels for convergent, concurrent, and discriminative validity were satisfactory for Brazilian Portuguese children and adolescents. This study makes a significant contribution by offering the validation of the CTFEQr-16 for the Brazilian population, thus making it accessible for researchers and clinicians to understand the mechanisms of human eating behaviour in the paediatric population. This, in turn, can aid in developing strategies to effectively manage weight and treat obesity.

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