PSYCHOMETRIC PROPERTIES OF THE THREE FACTOR EATING QUESTIONNAIRE (TFEQ-R21) IN MIDDLE-AGED WOMEN

PROPRIEDADES PSICOMÉTRICAS DO THREE FACTOR EATING QUESTIONNAIRE (TFEQ-R21) EM MULHERES DE MEIA-IDADE

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Abstract: Eating behaviour can exert a substantial influence on the development of obesity, a condition intricately linked with a spectrum of comorbidities (e.g., cancer, cardiovascular diseases, endocrine disorders). Obesity is more prevalent among middle-aged women, particularly during menopause, coinciding with an increase in the incidence of disordered eating behaviours. This study aims to identify the factor structure and psychometric properties of the Portuguese version of the Three Factor Eating Questionnaire (TFEQ-R21) in middle-aged women. A total of 1895 middle-aged Portuguese women (*M*=52.22 years, *SD*=5.10) completed a sociodemographic questionnaire alongside the TFEQ-R21, comprising 21 items distributed across three dimensions (cognitive restraint, uncontrolled eating, and emotional eating). Descriptive analyses, construct and criterion validities, and reliability were performed using the R-Lavaan. The three-factor structure model presented a good fit (Comparative Fit Index=0.97; Tucker-Lewis Index=0.97; Root mean square error of approximation=0.08 (*p*<.001); Standardized root mean square residual=0.07). The TFEQ-R21 attests to its convergent validity (average variance extracted: 0.41<*AVE*<0.80) and reliability (Cronbach´s *α*: 0.82<*α*<0.96, and McDonald´s omega: 0.66<*ω*<0.92). The TFEQ-R21 tool has shown evidence of validity and reliability, displaying invariance between obese and normative women when assessing eating behaviour among middle-aged women. It offers valuable utility within the domain of weight management interventions, facilitating the identification and mitigation of dysfunctional eating behaviours, especially during this life stage.

Keywords: Eating behaviour, Instrument validation, Middle-aged women, Obesity, TFEQ-R21, Weight management.

Resumo: O comportamento alimentar pode exercer uma influência substancial no desenvolvimento da obesidade, uma condição intrinsecamente ligada a um espetro de comorbilidades (e.g., cancro, doenças cardiovasculares, endócrinas). A obesidade é mais prevalente nas mulheres de meia-idade, particularmente durante a menopausa, coincidindo com um aumento da incidência de comportamentos alimentares disfuncionais. Este estudo tem como objetivo identificar a estrutura fatorial e as propriedades psicométricas da versão portuguesa do Three Fator Eating Questionnaire (TFEQ-R21) em mulheres de meia-idade. Um total de 1895 mulheres portuguesas de meia-idade (*M*=52,22 anos, *DP*=5,10) preencheram um questionário sociodemográfico e o TFEQ-R21, composto por 21 itens, distribuídos por três dimensões (restrição cognitiva, descontrolo alimentar e

alimentação emocional). Foram realizadas análises descritivas, validade de construto, de critério, e fiabilidade, através do R-Lavaan. O modelo de estrutura de três fatores apresentou um bom ajustamento (Comparative Fit Index=0,97; Tucker-Lewis Index=0,97; Root mean square error of approximation= 0,08 (*p*<0,001); Standardized root mean square residual=0,07). O TFEQ-R21 apresenta evidências de validade convergente (variância extraída da média: 0,41<*VEM*<0,80) e fiabilidade (*α* de Cronbach: 0,82<*α*<0,96, e ómega de McDonald: 0,66<*ω*<0,92). O TFEQ-R21 apresentou evidências de validade e fiabilidade com invariância entre mulheres com e sem obesidade, na avaliação do comportamento alimentar em mulheres de meia-idade. É um instrumento útil no domínio das intervenções de gestão de peso, facilitando a identificação e a atenuação de comportamentos alimentares disfuncionais, especialmente durante esta fase da vida.

Palavras-Chave: Comportamento alimentar, Gestão de peso, Mulheres de meia-idade, Obesidade, TFEQ-R21, Validação de instrumento

Middle-aged women, typically aged between 45 and 65 years, form a high-risk demographic group, primarily due to the onset of menopause (which typically occurs around the age of 51 in European women; Kozakowski et al., 2017). Menopause results from a decline in estrogen production, rendering these women more susceptible to the onset of specific diseases, particularly cardiovascular disease (Colpani et al., 2018). Additionally, another significant risk factor is weight gain during middle-aged, leading sometimes to the subsequent development of obesity. It is noteworthy that this age group exhibits the highest prevalence of obesity (Hales et al., 2020). This can be attributed to a variety of factors, including behavioural changes (e.g., reduced physical activity, and changes in eating patterns). Existing literature has demonstrated a strong correlation between middle-aged and/or the menopausal transition/post-menopause with an increased prevalence of eating disorders, including emotional eating, cognitive restraint, and uncontrolled eating (Černelič-Bizjak et al., 2022; Janjetic et al., 2019). Furthermore, emotional states experienced during this period, such as anxiety, stress, and depression, have been associated with changes in eating behaviour (Choi et al., 2021; Janjetic et al., 2019; Mason et al., 2019). In line with this body of evidence, it is also well-established that interventions psycho-social aimed at improving eating behaviour result in a higher incidence of weight loss in women, especially when compared to those who make no changes in eating behaviours (Mason et al., 2019).

Previous validations of this widely used questionnaire have been conducted (e.g., Cappelleri et al., 2009; Cardoso & Pimenta, 2020; Duarte et al., 2018; Martín-García et al., 2016). However, due to the specific nature of eating behaviour during the menopausal years and the absence of this characteristic in previously tested samples (e.g., Cardoso & Pimenta [2020] validated it with adults with type I diabetes; Cappelleri et al. [2009] and Duarte et al. [2018] validated with a sample of both men and women; Martín-García et al. [2016] validated with a sample of children and adolescents), there is a gap in our understanding. Considering the potential benefits of a healthy lifestyle (e.g., improvements in eating behaviour) to mitigate the development of certain diseases and reduce mortality among middle-aged women (Colpani et al., 2018), this study aims to explore the psychometric properties of the Three Factor Eating Questionnaire (TFEQ-R21) in middle-aged women.

METHOD

Participants

Using a non-probabilistic sampling method, 1,895 middle-aged Portuguese women from the general community were included. Eligibility criteria included (i) sex (women), (ii) having

Portuguese nationality or dual nationality, (iii) falling within the 45-65 age range, (iv) demonstrating literacy skills, and (v) having internet access.

Material

Participants completed a sociodemographic questionnaire that included self-reported information on demographic factors (e.g., annual income), health-related factors (e.g., psychological disease), and lifestyle factors (e.g., engagement in physical activity/exercise). For BMI calculation (weight [kg]/height[m]^2), weight and height information were asked. Additionally, participants filled out the TFEQ-R21, which has been previously validated for particular Portuguese samples (Cardoso & Pimenta, 2020; Duarte et al., 2018). The TFEQ-R21 assesses eating behaviour and consists of 21 items grouped into three distinct dimensions: (i) Cognitive restraint (6 items; e.g., "I deliberately choose small helpings to control my weight"), (ii) Uncontrolled eating (9 items; e.g., "Sometimes when I start eating, I just can't seem to stop"), and (iii) Emotional eating (6 items; e.g., "When I feel sad, I often eat too much"). Items 1 through 20 are rated on a 4-point Likert scale, while item 21 is rated on an 8-point Likert scale. It is worth noting that the TFEQ-R21 has demonstrated good psychometric properties in previous studies (e.g., Cappelleri et al., 2009; Cardoso & Pimenta, 2020; Duarte et al., 2018; Martín-García et al., 2016).

Procedure

The sample for this study was recruited through online dissemination on social media platforms (e.g., Facebook). Participants were provided with informed consent, a clear explanation of the study´s objectives, as well as the contact details of the principal investigator.

This study, a part of the ME-WEL (Menopause and WEight Loss) project, has obtained approval from the Ethics Committee of Ispa – Instituto Universitário (reference D/024/01/2020). It adheres to the ethical standards outlined by the American Psychological Association (2003) and the Portuguese Psychologist Association (2011).

Data analysis

Descriptive statistics (means [*M*], standard deviations [*SD*], and medians [*Me*]), as well as measures of item sensitivity (skewness [*Sk*] and kurtosis [*Ku*]), were performed. Values of *Sk* and *Ku* higher than 3 and 10, respectively, indicated considerable deviations from a normal distribution (Marôco, 2021).

The confirmatory factor analysis (CFA) was conducted using the diagonally weighted least squares (DWLS) estimation method. Model fit assessment was carried out based on several indices, including the Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), and Standardized Root Mean Square Residual (SRMR). Adequate model fit was indicated by CFI and TLI higher than 0.9, along with RMSEA (with a 90% confidence interval) and SRMR values below 0.08 (Marôco, 2021). The model was refined using the modification indices, to verify the correlation between the item errors, through Langrage multipliers - LM > 11 ($p < 0.001$; Marôco, 2021). Convergent validity was evaluated using the Average Variance Extracted (*AVE*), with values ≥ 0.5 considered acceptable (Marôco, 2021). To assess discriminant validity, squared correlations between factors were compared with their respective AVE. To establish discriminant validity, the AVE should exceed the square of the correlation between factors (Marôco, 2021). Internal consistency was assessed through Cronbach's alphas (*α*), and composite reliability was determined using McDonald's omega (*ω*). Acceptable values for these measures were considerable to be ≥ 0.7 (Marôco, 2021).

A multigroup analysis to examine the measurement invariance of the model in two distinct groups: a clinical group consisting of women with obesity and a non-clinical group comprised of women with normal weight. This analysis aimed to determine if differences in scale scores were attributed to variations in the underlying dimensions, rather than other factors (e.g., the interpretation of the items). Since the number of women with normal weight (n=804) was not equal to the number of women with obesity (n=413), the group of normal weight was adjusted randomly to ensure an equal number of participants in both groups. Configural, metric, scalar, and strict invariances were tested (Marôco, 2021). In line with the criteria established by Cheung and Rensvold (2002) and Rutkowski and Svetina (2014), the model was considered invariant when the values of ΔCFI $\leq$ 0.01, and ΔRMSEA $\leq$ 0.02, respectively. Following this assessment and after confirming the normality and homogeneity of variance, Student´s t-tests with a 95% confidence interval were conducted to determine the mean difference between women with normal weight and women with obesity.

All analyses were conducted using IBM SPSS Statistics software (v. 28) and R (v.4.2.3; R Core Team, 2020), through RStudio (v.2023.06.1+524; RStudio Team, 2020) with R-Lavaan package (v.0.6.15; Rosseel, 2012) and the semTools package (Jorgensen et al., 2022).

RESULTS

Participants

Table 1 presented the characteristics of the 1,895 participants. Furthermore, these women experienced menopause at around 48 years of age (M=48.3 years; SD=24.10). The majority were non-smokers (74.6%), consumed alcohol (53.2%), and drank coffee (87.4%).

Items' distributional properties

All items on the TFEQ-R21 showed no sensitivity issues ($-0.32 \leq Sk \leq 0.55$; $-1.12 \leq Ku \leq 0.24$). The average scores for TFEQ items ranged between 1.95 (SD=0.93) for item 9 ("I'm always so hungry that it's hard for me to stop eating before I finish the food on my plate") and 2.73 (SD=0.95) for item 17 ("How often do you avoid "stocking up" on tempting foods?"); and $2.00 \leq Me \leq 3.00$.

Evidences of validity related to the internal structure

Since the initial CFA goodness-of-fit indices could be improved (CFI=0.969, TLI=0.965, SRMR=0.076, RMSEA=0.091, p(RMSEA$\leq$0.05) < 0.001, 90% CI]0.088; 0.091[), correlations between items` errors were performed: 8-9, 17-18, and 17-21. All factor loadings were higher than 0.5, except for item 17 (λ=0.42), 18 (λ=0.45), 20 (λ=0.45), and 21 (λ=0.49). However, none of these items were removed from the model because (i) the removal of these items did not yield a substantial improvement in the model's overall fit, indicating that their inclusion did not adversely affect the model's validity, and (ii) these items had a factor loading close to the 0.5 limit.

Thus, the final model presented a good fit (CFI=0.974, TLI=0.970, SRMR=0.070, RMSEA=0.084, p(RMSEA$\leq$0.05) < 0.001, 90% CI]0.081; 0.086[). Convergent validity was confirmed (Table 2), however, the Cognitive restraint dimension showed marginal convergent validity (AVE=0.43). Lastly, out of the three possible comparisons, only one did not demonstrate discriminant validity (Uncontrolled eating and Emotional eating; r^2=0.83).

Reliability

The dimensions displayed good reliability in terms of internal consistency (0.82 ≤α≤ 0.96) and composite reliability (0.67 ≤ω≤ 0.92; Table 2).

Table 1. Characterization of Participants

	n	***%***
Age *(M, SD)*	(52.22, 5.10)	
Relationship status		
In a relationship	1.525	80.5
Single	370	19.5
Parity		
No children	239	12.6
1 or 2 children	1.436	75.8
3 or more children	219	11.6
Highest education level obtained		
Primary school	9	0.5
Middle school	27	1.4
High school	589	31.1
College degree	1.097	67
Professional status		
Active	1.540	81.3
Inactive (e.g., retired)	355	18.7
Annual household income		
Until 10.000€	322	17
Between 10.001 and 20.000€	545	28.8
Between 20.001 and 37.500€	581	30.7
Higher than 37.501€	408	21.5
Menopausal status		
Pre-menopause	465	24.5
Peri-menopause	356	18.8
Post-menopause	1.074	56.7
Body Mass Index (BMI) Status		
Underweight (BMI ≤ 18.5 kg/m²)	17	0.9
Normal weight (18.5 kg/m² < BMI ≤ 24.9 kg/m²)	805	42.5
Overweight (25 kg/m² < BMI ≤ 29.9 kg/m²)	660	34.8
Obesity (BMI ≥ 30 kg/m²)	413	21.8
Recent disease		
Yes	368	19.4
No	1.527	80.6
Recent psychological problem		
Yes	324	17.1
No	1.571	82.9
Physical Activity/Exercise		
Yes	1.259	66.4
No	239	33.6

Table 2. The average variance extracted and reliability analysis of TFEQ-R21

	Cognitive restraint	**Uncontrolled eating**	**Emotional eating**
α	0.82	0.91	0.96
ω	0.67	0.90	0.92
AVE	0.43	0.56	0.80

Notes. *α*=Cronbach's alphas; ω=McDonalds' Omega; AVE= Average Variance Extracted.

Criterion validity

To assess whether the TFEQ-R21 discriminated eating behaviours in middle-aged women with two different weight classes – a non-clinical group (normal weight, *n*= 430) and a clinical group (obesity, *n*= 430), discriminant criterion validity was performed. Initially, a multigroup analysis was performed, and the model demonstrated scalar/strong invariance between these two different groups (|ΔCFI ≤ 0.02|, |ΔRMSEA < 0.01|; Table 3). Using a T-student´s test, it was determined that only the total score of Cognitive Restraint in women with normal weight (*M*= 2.66, *SD*= 0.65) was marginally significantly higher than in women with obesity (*M*= 2.58, *SD*= 0.65), (*t*(824)= 1.84, *p*= .007; 95% C.I., -.01;.17).

Table 3. Criterion Validity, through Multigroup Confirmatory Analysis

Model	X²	Df	X²/df	p	CFI robust	RMSEA robust	ΔCFI	ΔRMSEA
Configural	1482.9	372	3.99		0.972	0.085		
Thresholds	1516.5	411	3.69	0.08	0.971	0.082	-0.001	-0.003
Metric	1528.4	429	3.56	0.89	0.972	0.079	0.002	-0.003
Scalar	1528.4	429	3.56		0.972	0.079	0.000	0.000

Notes. χ2=chi-square; *df*=degrees of freedom; *p*=statistical significance

DISCUSSION

Middle-aged women are particularly susceptible to weight gain, which plays a significant role in the development of obesity and related health issues (Colpani et al., 2018). Eating behaviours, including emotional eating, cognitive restraint, and uncontrolled eating, significantly contribute to this vulnerability. These behaviours are often exacerbated by emotional states, such as anxiety and stress (Choi et al., 2021; Janjetic et al., 2020). Accurately understanding and measuring these eating behaviours are essential for informing public health interventions and clinical strategies aimed at preventing and managing obesity, a global health concern. To help in this path, the TFEQ-R21 was employed, and its psychometric properties were evaluated in a sample of middle-aged Portuguese women.

No sensitivity issues were observed with the TFEQ-R21 items, indicating their robustness and appropriateness for assessing eating behaviour. The CFA of the three-factor structure demonstrated that the original structure, as observed in previous studies (Cardoso & Pimenta, 2020; Duarte et al., 2018), was confirmed in this specific sample. Moreover, the final model demonstrated a good fit. Some items, specifically items 17, 18, 20, and 21, had factor loadings below the recommended threshold, as seen in previous studies (e.g., Cappelleri et al., 2009; Cardoso & Pimenta, 2020; Duarte et al., 2018). Furthermore, in the study by Cappelleri and colleagues (2009), items 17, 18, and 21, which belonged to the Cognitive restraint dimension, were removed. These authors subsequently developed a revised version, an 18-item questionnaire known as TFEQ-R18V2, which demonstrated satisfactory measurement properties. In contrast, in the present study, it was decided not to eliminate these items. This decision was informed by multiple factors, as explained in the results section. Furthermore, these items hold theoretical relevance and contribute with valuable information for the overall assessment of eating behaviour (e.g., item 20 – "How often do you feel hungry?" [Uncontrolled eating], item 17 – "How often do you avoid "stocking up" on tempting foods?" [Cognitive restraint]). Removing them would reduce the Cognitive Restraint dimension to only three items. Notably, and despite that, which will be discussed further below, the factor loadings in Cappelleri et al.´s (2009) study were lower than what was observed in this study (e.g., item 17, λ=0.32). While some recent studies have employed the TFEQ-R18V2 (e.g., Fahrenkamp et

al., 2019), the present study retained the TFEQ-R21, considering its frequent application in the literature, and maintaining its original structure allows for comparisons with other samples.

The TFEQ-R21 showed evidence of convergent validity, as observed in other studies (Cappelleri et al., 2009; Duarte et al., 2018). However, the Cognitive restraint dimension presented limited convergent validity (with an AVE value below the recommended threshold), in line with the findings of Martín-García et al. (2016). This outcome may be attributed to the potential weakness in the relationship between the items and the Cognitive restraint dimension. The items within this dimension may not strongly relate to Cognitive restraint and may not effectively measure the intended construct. Previous research has highlighted the heterogeneous nature of this construct, marked by ongoing debate and a lack of scientific consensus on its definition and measurement (Julien-Sweerts et al., 2019). On one hand, a systematic review showed that some literature suggests Cognitive Restraint may lead to energetic, emotional, and behavioural dysregulation (e.g., altered internal perception of hunger, increased disinhibition, lower self-esteem). On the other hand, some studies have shown it as a behaviour associated with weight loss and improved eating habits (Julien-Sweerts et al., 2016). Additionally, a detailed item analysis reveals potential interpretations. For instance, items 1 - "I deliberately choose small helpings to control my weight", item 5 - "I don't eat some foods because they make me fat", and item 11 - "I consciously restrict how much I eat during meals to avoid gaining weight" all belong to Cognitive restraint dimension and did not exhibit low factor loadings. These items seem to focus specifically on Cognitive restraint as a behaviour intended for weight management. Conversely, items related to Cognitive restraint that demonstrated low factor loadings, such as item 17 – "How often do you avoid "stocking up" on tempting foods?", item 18 - "How likely are you to make an effort to eat less than you want?", and item 21 - "On a scale from 1 to 8, where 1 means no restraint in eating and 8 means total restraint, what number would you give yourself?" should be discussed. Item 17 mentions "tempting foods", and item 21 mentions "no restraint" and "total restraint". These items may be perceived as ambiguous or unclear. The terms used in these items are somewhat subjective and may be interpreted differently by different participants. The item 18 could be perceived as focusing more on an individual's motivation to achieve a specific goal, directing it toward a motivational aspect. Studies have demonstrated associations between eating behaviours, motivation, and self-control (Bongers & Jansen, 2016; Verstuyf et al., 2012) though they are not the same, so a clear definition is needed. It is important to have this construct well defined as there are studies suggesting that increasing Cognitive restraint can be an effective domain to work in the field of obesity/weight loss intervention (Julien-Sweerts et al., 2016, 2019).

Despite the other dimensions (Uncontrolled eating and Emotional eating) demonstrating satisfactory AVE, discriminant validity between these two dimensions was not found, in line with previous research (Cardoso & Pimenta, 2020; Duarte et al., 2018). This suggests a strong association between these two dimensions, possibly indicating shared eating-related concerns, difficulties in self-control, a tendency to attribute overeating to negative emotions, or responsiveness to cues (Bongers & Jansen, 2016). A recent study has confirmed the strong relationship between these two constructs (Černelič-Bizjak et al., 2022). Several studies have indicated that middle-aged women with obesity and symptoms of anxiety tend to exhibit higher levels of both emotional eating and uncontrolled eating (Hussenoeder et al., 2021; Janjetic et al., 2020).

The TFEQ-R21 showed good evidences of reliability in terms of internal consistency and composite reliability. A criterion validity analysis was conducted to assess the TFEQ-R21's ability to discriminate eating behaviours between two groups: women with normal weight and women with obesity. However, the TFEQ-R21 only showed marginal discriminative ability ($p<.10$) for the Cognitive restraint dimension across the two different weight classes of middle-aged women. It indicated that women with obesity showed lower CR (with marginally significance) in comparison to their normal-weight counterparts. In contrast, in an earlier study, criterion validity was

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established for all dimensions when comparing obesity vs. normal weight groups (Cappelleri et al., 2009). This analysis is crucial because individual variations in eating behaviour are expected, to some extent, to account for variations in obesity (Černelič-Bizjak et al., 2022). However, these results may have an explanation within this specific sample. Middle age is a unique phase in a woman's life, marked not only by biological and hormonal changes but also by lifestyle changes, including alterations in eating behaviours that can impact weight management (Leitão et al., 2023a). In a study conducted by this research team, which compared women who experienced weight gain during menopause with those who maintained a healthy weight, it became evident that certain barriers to weight management were common to both groups, such as food availability and food cravings, regardless of the different weight outcomes (Leitão et al., 2023a). What may truly differentiate the two groups is cognitive restraint, as evidenced in this study – women with normal weight exhibited more restrictive behaviours and cognitions compared to women with obesity. The inability of TFEQ-R21 to discriminate between Emotional eating and Uncontrolled eating in these two weight groups can be attributed to this factor: at this life stage, regardless of weight experiences (loss, maintenance, or increase) and BMI, there appears to be a heightened tendency for these behaviours, as corroborated by findings in other studies (Leitão et al., 2023a, 2023b).

While this study has yielded significant findings, it is important to acknowledge several limitations that should be considered. The online nature of the study may introduce self-selection bias and may hinder the researchers' ability to address participants' doubts in real-time, which could affect data quality. Furthermore, the fact that it is a convenience sample limits the generalizability of the findings. Lastly, the sample bias is worth noting, as a majority of the participants were post-menopausal women with higher qualifications, which could potentially influence their eating behaviours. Recognizing and addressing these limitations is vital, as they can impact the interpretation of the study's findings and offer valuable insights for future research efforts.

In conclusion, the findings offer compelling evidence of the TFEQ-R21´s reliability and validity in assessing eating behaviours among middle-aged women. These results hold substantial value for researchers and healthcare professionals, providing invaluable insights for future research and clinical applications, especially within the context of weight management interventions. Ongoing research and refinement in the assessment of eating behaviour, particularly among middle-aged women, remain imperative, as these behaviours can persist independently of BMI. The fact that most middle-aged women feel unprepared for menopause and lack information about its potential consequences, including changes in weight and alterations in eating behaviours (Leitão et al., 2023a, 2023b), underscores the ongoing necessity for a comprehensive understanding of the multifaceted nature of eating behaviour within this critical high-risk group.

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