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ORIGINAL ARTICLE

Psychometric properties of Power of Food Scale in Iranian adult population: gender-related differences in hedonic hunger

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Abstract

Purpose The present study was performed to develop the Persian version of Power of Food Scale (PFS) questionnaire (PFS-P) and to assess the hedonic hunger in Iranian adult population. In addition, associations between individual differences, including sex and body mass index (BMI) and the appetitive motives measured by the PFS-P were assessed.

Methods Eight hundred and twenty participants were studied. The PFS-P, the International Physical Activity Questionnaire, the Three-Factor Eating Questionnaire, and a questionnaire pertaining to demographic characteristics were completed for all participants.

Results The Cronbach's alpha values for the factors "food available", "food present" and "food taste" were 0.87, 0.85, and 0.78, respectively. The intraclass correlation coefficient ranged from 0.80 to 0.97 for the factors of PFS-P. Good content, face, criterion, and construct validity were observed for the PFS-P. In addition, a good reliability was found for both aggregate score of the PFS-P and the scores of its three factors. Relatively strong associations were found between BMI and the PFS-P score ($r = 0.43$). The hedonic hunger was significantly higher in women than men ($p < 0.001$).

Conclusions The findings of the present study provide further evidence in support of the suitability of PFS as a valid instrument to measure hedonic hunger. PFS-P can be used as a valid and reliable measure to assess hedonic hunger in Iranian populations. In addition, a moderately strong correlation was observed between BMI and hedonic hunger scores. This study revealed that women may experience hedonic hunger more than men.

Level of evidence Level V, cross-sectional descriptive study.

Keywords Power of Food Scale · Hedonic hunger · Iranian population · Sex · Validation

Introduction

The obesity epidemic is a worldwide phenomenon that observed as a result of individuals' consuming more energy than they are expending [1]. The homeostatic and hedonic pathways are two complementary drives that regulate food intake. The former, in the case of energy depletion, controls energy balance by increasing the motivation to eat. In contrast, hedonic pathway can override the other through increasing the desire for the consumption of highly palatable foods during the periods of relative energy abundance [2]. The food environment results in the activation of a hedonic drive to eat, which provides large quantities of highly palatable, inexpensive foods [3, 4]. In addition, psychological processes such as thoughts, feelings, and motivations may be affected by the widespread availability of palatable foods and frequent exposure to food-related cues. This may be seen even when food intake is not imminent or underway. Although most people consume food when they are not homeostatically hungry, some experience more persistent preoccupation with palatable foods, defined as hedonic hunger [3, 4]. Individual differences in hedonic hunger may be a reason to why only certain subjects are chronically overeat [5].

The Three-Factor Eating Questionnaire (TFEQ), a widely used measure in the studies of eating behavior, Dutch Eating

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Behavior Questionnaire (DEBQ), and the Restraint Scale, are instruments to assess overeating in response to social, environmental, emotional and food stimuli. However, none of these measures is exclusively for hedonic hunger [6, 7]. The extent to which the food environment affects subjects' thoughts, feelings and behaviors is depend on individual differences. Therefore, a measure capable of assessing such differences and tapping into appetitive motives in combination with neuroscience and genetic studies may be useful for the further understanding of the underlying mechanisms of hedonic hunger. In this context, the Power of Food Scale (PFS) was developed in 2009 by Lowe et al., to measure individuals' differences in hedonic hunger [8]. Since the PFS does not contain any items that pertain to the actual consumption of food, the assessment of the appetitive aspects of eating by this measure is not dependent on food consumption. Therefore, the PFS can measure the psychological drive to palatable foods rather than the overconsumption of them [9]. This is an important difference between the PFS and other instruments. The PFS is considered as a measure of individual differences in thoughts, feelings and motivations related to appetite in environments where palatable foods are available [8].

According to Lowe et al., the PFS may be a useful tool to assess the hedonic impact of food environments replete with different palatable foods [8]. Using PFS, they have shown that people differ in the drive to consume highly palatable food within obesogenic food environments [7, 8].

In addition, from the clinical point of view, the PFS may be considered as a useful instrument to assess the effects of weight management program on the power of food over a subject susceptibility to the food environment. To date, the PFS questionnaire has been translated into different languages [9, 10] and used to study of hedonic hunger in university students [9], women with eating disorders [11], overweight/obese adults [12], undergraduate students [11], obese patients candidate for bariatric surgery [13, 14], and general healthy populations [10, 15]. For instance, Witt et al., in a study of the association between PFS scores and frequency of binge eating and assessing whether pre-treatment PFS scores predict weight change during treatment in participants with anorexia nervosa, restricting type, anorexia nervosa, binge–purge type, and bulimia nervosa, found that hedonic processes may be play an important role in stimulating binge eating. Furthermore, they concluded that hedonic appetite may facilitates weight restoration in anorexia nervosa [11]. In addition, the relationship between PFS scores and overeating [8, 16], and the experience of loss of control over eating [17] have been reported in several studies. Therefore, it can be stated that the construct of hedonic hunger in understanding eating behavior is important.

To the best of our knowledge, there is no study evaluating hedonic hunger in Iranian population. In addition, there are differences across different countries in the motivations to consume food, possibly because of the differences in ethnic, and cultural and social backgrounds. Besides, individual differences, including sex and body mass index (BMI) are of importance. Eating disorders are more common in women [18, 19] and the association between PFS and BMI is controversial. Some studies indicated that obese individuals have a greater drive to consume food for pleasure [20, 21]. Therefore, the present study was performed to investigate the following objectives:

1. To validate the Persian version of the PFS questionnaire (PFS-P) after translation of the original English version of the PFS into Persian, and use it to measure hedonic hunger in an Iranian population.
2. To assess whether individual differences, including sex and BMI are associated with the appetitive motives assessed by the PFS-P.

Materials and methods

Subjects and study design

This study was carried out in Tabriz city, the capital city of East Azerbaijan Province, North-west of Iran, during December 2016 to August 2017. Participants were recruited through announcements and flyer distribution in public areas of the city. The inclusion criteria were: between the ages of 19–50 years and living in Tabriz for at least 5 consecutive years. In addition, all female participants were also required to be pre-menopausal as identified by the self-reporting of regular menstrual cycles, and not pregnant or lactating at the time of the study. Subjects who had been participated in weight loss programs during last 6 months and those with the diagnosis of any psychotic disorders, substance abuse, alcoholism, or a serious medical illness such as cardiovascular and endocrine diseases were excluded from the study. To ensure that the participants had a similar hunger level at the time of completing the questionnaire, they were instructed to have breakfast about 7–8 a.m. on the day of visit and all questionnaires were completed about 11 a.m. on the same day. Although it is indicated that the hedonic hunger measured by the PFS represents a relatively stable construct and is not substantially affected by daily variations in hunger [22], participants who had not followed the instructions were not included in the study. The initial sample consisted of 1050 adults and after screening for eligibility according to the inclusion and exclusion criteria, 820 participants (540 women and 280 men) were included in the study. The PFS-P, the International Physical Activity Questionnaire (IPAQ) [23], the Three-Factor Eating Questionnaire (TFEQ) [24],

and a questionnaire pertaining to demographic characteristics were completed for all participants.

The aim of the study was described for the participants and they all signed an informed consent form before the commencement of the study. In addition, the protocol of the study was approved by the university ethic committee [IR.TBZMED.REC.1395.1013] and the study was performed in accordance with the Helsinki Declaration of 1964 as revised in 2000.

Anthropometric measurements

Body weight and height of the participants wearing light clothes but without shoes were measured after a 12-h fasting period. Weight was measured with a calibrated electronic scale (SECA Birmingham, UK) with an accuracy of 0.1 kg. A fixed stadiometer was used to measure height to the nearest 0.1 cm. BMI was calculated by dividing the participant's weight in kilograms by the square of his/her height in meter (kg/m^2).

Physical activity

The validated short form of the Persian version of the IPAQ [23, 25] was used to estimate the physical activity levels of the studied participants. The participants were then divided into inactive, moderately active and active groups according to their scores on the questionnaire.

PFS questionnaire

The PFS is a questionnaire consists of 15 items scored on a 5-point Likert-type scale with anchors 1: Do not agree at all to 5: Strongly agree. Higher scores indicate greater responsiveness to the food environment. Sample items include: "If I see or smell a food I like, I get a powerful urge to have some," "It seems like I have food on my mind a lot," and, "I think I enjoy eating a lot more than most other people." The PFS consists of three factors of "Food available", "Food present", and "Food tasted". The score of each factor is calculated by averaging the scores of all items (possible range = 1 to 5) within that factor. The aggregate score is calculated as the mean of the three factors (possible range = 1 to 5) [26].

Validity procedure

Translation process

According to the standardized cross-cultural translation guidelines project [27], the English version of the PFS questionnaire was translated into Persian by two independent native Persian speakers who were fluent in English and expert in food eating behavior. Once the translations were made, the translators discussed their translations to provide an agreed version. In the next step, the agreed version was back translated into English by a third translator who was not aware of the original English version. Then, the forward–backward and original versions were compared in order to obtain a final PFS-P.

Content and face validity

Content validity was assessed both qualitatively and quantitatively. For qualitative assessment, a ten-member team of researchers experienced in the field of nutrition and food behavior were asked to assess the Persian questionnaire in term of Persian grammar, using suitable words, and locating food items in their proper place and then scoring them. According to the team feedback, some modifications were made. For quantitative assessment, Content Validity Ratio (CVR) and Content Validity Index (CVI) were calculated. To assess the face validity, the questionnaire was given to 30 subjects and they were asked to assess the wording and structure of the questionnaire. Based on this survey, some required modifications were applied.

Reliability

The reliability of the PFS-P was assessed by the test–retest procedure. For this, 40 subjects (15 men and 25 women) completed the questionnaire twice, with a 2-week interval. Test–retest reliability and internal consistency were assessed. The intraclass correlation coefficient (ICC) and its confidence interval were obtained for each scale. For internal consistency, the Cronbach's alpha coefficient was calculated for each scale and for the whole questionnaire.

Construct validity

The exploratory factor analysis (EFA) was used to examine the factor structure of the PFS-P, applying principal axis factoring and oblimin rotation [28, 29]. An item was retained if it had a factor loading of 0.3. The values of more than 0.7 in the Kaiser–Meyer–Olkin (KMO) test and a p value of less than 0.05 in Bartlett's test were considered to have a satisfactory factor analysis [29]. In addition, confirmatory factor analysis (CFA) was used to assess the fitness between the model and observed data. In the CFA, the hypothesis was that the PFS-P possesses a factor structure similar to the original English version. The asymptotic covariance matrix was considered a weighted matrix. The input matrix was the covariance matrix of the data. The fit indices and reasonable values of them for the CFA were a chi-squared to degree of freedom (df) ratio of less than 5, root mean square error of approximation (RMSEA) of less than 0.08, and comparative

fit index (CFI), normed fit index (NFI), and incremental fit index (IFI) of more than 0.9 [29, 30].

Criterion validity

To assess the criterion validity of the PFS-P, the factors of "uncontrolled eating" and "emotional eating" of the TFEQ were used as a means for the validation of the PFS-P [31]. The scores of the PFS-P factors were compared with those of the TFEQ. The TFEQ is comprised of three factors measuring "cognitive restraint", "uncontrolled eating", and "emotional eating". Although the validity and reliability of the Persian version of the TFEQ have been previously studied [24], in the present study, we assessed its reliability in the studied participants. The Cronbach's alpha values for "cognitive restraint", "uncontrolled eating", and "emotional eating" were found to be 0.75, 0.85, and 0.82, respectively.

Statistical analysis

Data were analyzed using version 23.0 of the SPSS software and version 23.0 of the Amos software. Variables were expressed as mean ± SD and frequency. Skewness (absolute values more than 3) and kurtosis (absolute values more than 10) measures were used to assess the normality assumption of the quantitative data [32, 33]. The validity and reliability of the PFS-P were assessed as described above. Pearson correlation was used to assess the relationship between the PFS-P factors and other variables. To determine the relationship between BMI and PFS-P, linear regression analysis was used. A p value less than 0.05 was considered statistically significant.

Results

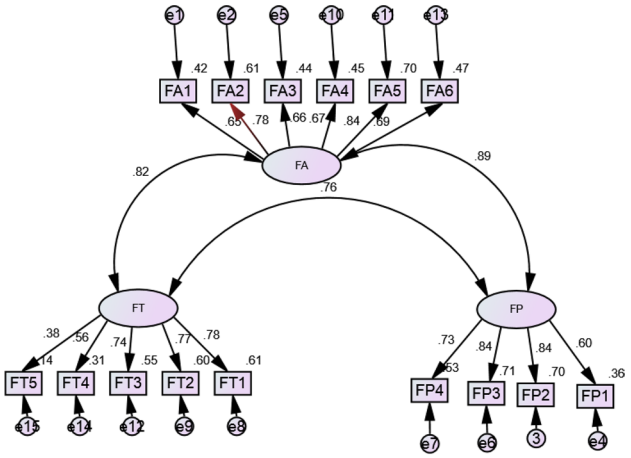
The mean age and BMI of the participants were 35.95 ± 8.62 years and 29.73 ± 5.98 kg/m^2, respectively. Six hundred and twenty-six (76.34%) of the participants were married and 333 (40.60%) had academic education. No statistically significant difference was observed between men and women as far as demographic variables were concerned. The assessment of the factorial structure of the PFS-P showed that the KMO measure of sampling adequacy was 0.936 indicating a high adequacy for the factor analysis. The Bartlett's test of sphericity was indicated to be highly significant ($\chi^2 = 6045.02$; $p < 0.001$), which confirmed the adequacy of the factor model.

Table 1 shows the rotated factor loadings. Principal axis factoring and oblimin rotation revealed a three-factor model with eigen values greater than 1.0. These three factors explained 65.01% of the total variance. Of 15 items of the questionnaire, six items measured the factor of "Food available", four items measured the factor of "Food present", and five items measured the factor of "Food taste". The CFA using a structural equation modeling procedure was performed afterward in a separate sample (100 men and 200 women). The three-factor model was entered into the CFA. The CFA factor loading is shown in Fig. 1. As can be seen in Table 2, CFA showed an acceptable model fit for PFS-P.

Table 1 Structure matrix of the PFS-P

Items	Eigenvalue (%variance explained)	Factors		
		FP	FT	FA
4. When I'm around fattening food I love, it's hard to stop myself from at least tasting it	7.22 (45.35)	0.859		
6. When I know a delicious food is available, I can't help myself from thinking about having some		0.831		
7. I love the taste of certain foods so much that I can't avoid eating them even if they're bad for me		0.727		
3. If I see or smell a food I like, I get a powerful urge to have some		0.578		
14. It's very important to me that the foods I eat are as delicious as possible	1.31 (6.01)		0.809	
9. When I eat delicious food I focus a lot on how good it tastes			0.722	
12. Hearing someone describe a great meal makes me really want to have something to eat			0.543	
8. Just before I taste a favorite food, I feel intense anticipation			0.532	
15. Before I eat a favorite food my mouth tends to flood with saliva			0.401	
11. I think I enjoy eating, a lot more than most other people	1.006 (4.03)			0.741
2. I get more pleasure from eating than I do from almost anything else				0.668
13. It seems like I have food on my mind a lot				0.847
5. It's scary to think of the power that food has over me				0.754
1. I find myself thinking about food even when I am not physically hungry				0.739
10. Sometimes, when I'm doing everyday activities, I get an urge to eat 'out of the blue' (for no apparent reason)				0.672

FA food available, *FP* food present, *FT* food tasted. Total explained variance: 65.01%



FA: food available, FT: food tasted, FP: food present

Fig. 1 CFA factor loading

Table 3 shows the correlations between the factors of PFS-P and the three factors of the TFEQ. In the examination of criterion validity, 691 out of 728 participants (95%), responded to the TFEQ. The scores of "uncontrolled eating" and the "emotional eating" were significantly correlated with the scores of PFS-P factors and its aggregate score. No significant correlation was found between the "cognitive control" and PSF-P aggregate score. These findings indicated the criterion validation of the PFS-P [34, 35]. In addition, relatively strong associations were found between BMI with the PFS-P aggregate score, the factor of "Food available" and the factor of "Food present". The association between BMI and mean PFS-P score is indicated in Fig. 1. There was a linear association between BMI and mean PFS-P Score (p value = 0.001) with a moderate model fit ($r^2 = 0.23$) (Fig. 2).

Table 4 indicates the hedonic hunger in men and women participants, the PFS-P aggregate score and the scores of the factors of "Food available" and "Food present", adjusting for potential confounding variables of age, BMI, and physical activity. As can be seen, the women reported significantly higher hedonic hunger than men ($p < 0.001$). In addition, the three factors of the TEFQ ("uncontrolled eating", "emotional eating", and "cognitive restraint") were significantly different between men and women.

Table 3 Pearson's correlations between the PFS-P with the TFEQ and BMI

PFS-P factors	CR	EE	UE	BMI
Food available	0.009	0.547*	0.619*	0.449*
Food present	− 0.071	0.438*	0.551*	0.420*
Food tasted	0.032	0.312*	0.405*	0.245*
Aggregate score	− 0.008	0.503*	0.604*	0.433*

CR cognitive restrain, *EE* emotional eating, *UE* uncontrolled eating, *BMI* body mass index

*$p < 0.01$

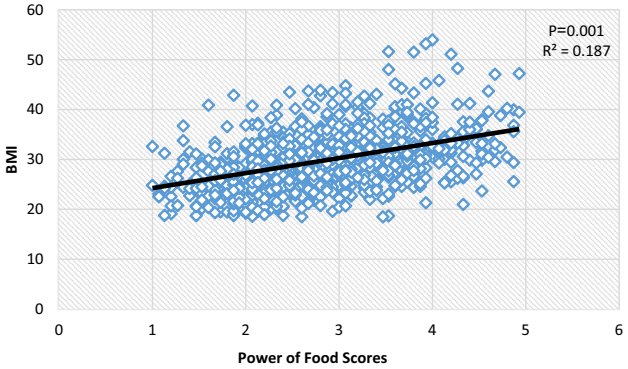


Fig. 2 Relationship between PFS-P score and body mass index (BMI)

The reliability analysis of the PFS-P showed the Cronbach's alpha values of 0.87 for the factor of "Food available", 0.85 for the factor of "Food present", and 0.78 for the factor of "Food taste". ICC ranged from 0.80 to 0.97 for all factors. These findings support the test–retest reliability of the PFS-P.

Discussion

The aim of the present study was to validate the Persian version of PFS questionnaire (PFS-P) and its use to assess hedonic hunger among Iranian adult population. In consistent with the original English version of the PFS

Table 2 Confirmatory factor analysis for PFS-P ($n = 300$)

Model	X^2	df	X^2/df	RMSEA (90% CI)	NNFI	CFI	NFI	IFI
	196.129	81	2.42	0.069 (0.057–0.081)	0.936	0.951	0.920	0.951

The relationships were all statistically significant $p < 0.001$

CFA Confirmatory Factor Analysis, *PFS-P* Power of Food Scale-Persian, *CFI* Comparative Fit Index, *IFI* Incremental Fit Index, *NFI* Normed Fit Index, *NNFI* Non-Normed Fit Index, *RMSEA* root mean square error of approximation, X^2 Chi square, *df* degree of freedom, X^2/df normed Chi square

Table 4 Comparison of the scores of the PFS-P factors and the TEFQ scores between men and women

Variables	Women (mean ± SD) (n = 540)	Men (mean ± SD) (n = 820)	p value[†]
PFS factors			
Food available	2.85 ± 1.06	2.19 ± 0.87	0.001
Food present	3.36 ± 1.05	2.86 ± 0.85	0.001
Food tasted	2.91 ± 0.84	2.59 ± 0.78	0.001
PFS aggregate score	3.0 ± 0.88	2.50 ± 0.69	0.001
TEFQ factors			
Uncontrolled eating	2.22 ± 0.58	1.98 ± 0.52	0.001
Emotional eating	2.19 ± 0.92	1.51 ± 0.56	0.001
Cognitive restraint	2.43 ± 0.60	2.30 ± 0.64	0.011
BMI	30.50 ± 6.62	28.36 ± 3.95	0.001
Physical activity			
Inactive	493 (91.3)	203 (72.5)	0.001
Minimally active	42 (7.8)	59 (21.1)	
HEPA active	5 (0.9)	18 (6.4)	

[†]Comparison were performed using analysis of covariance (ANCOVA), adjusted for BMI and physical activity levels

questionnaire, EFA proposed a three factor solution for the PFS-P. In addition, CFA confirmed fitting coefficients of the model. Cronbach's alpha coefficient of 0.92 demonstrated a high internal consistency of the PFS-P, which was similar to the other language versions, including the Portuguese (0.91) and Japanese (0.87). In addition, ICC of 0.80–0.97 confirmed the reliability of the PFS-P. Our study had adequate statistical power for factor analysis [36]. Previous studies revealed that PFS and TFEQ factors measure similar but different aspects of eating behaviors [21, 35]. A number of studies suggested that emotions can lead to hedonic eating [1, 37]. We found significant positive correlations between the scores of the PFS factors and its aggregate score with "uncontrolled eating" and "emotional eating". However, such a relationship was not observed for "cognitive restraint" [7, 9]. This confirms the criterion validity of the PFS-P.

The association between PFS and BMI is controversial. Some studies indicated that obese individuals have a greater drive to consume food for pleasure [20, 21]. In this regard, a number of previous studies have been reported a decreased hedonic eating following weight loss in the obese patient [14, 20, 21]. The relationship between PFS and body weight, however, in the general population is less consistent. Several studies did not find any correlation between PFS score and BMI in Japanese young adults [9], Canadian young adult women [38], and an international sample of healthy college students [8]. Lipsky et al., investigated PFS association with weight outcomes in a nationally representative cohort of US young adults. They reported that being overweight was positively correlated with "food available" and "food present", whereas no significant association was observed for "food tasted" and aggregate score [35]. Some studies reported that high hedonic huger is particularly related to the PFS factors that consider generally available and acutely present foods, however, the taste domain did not affect [31, 33]. In the present study, relatively strong correlations were observed between BMI and the PFS-P aggregated score as well as the factors of "Food available" and "Food present" (Table 4). Furthermore, a moderate correlation was found between the factor of "Food taste" and BMI. These findings further substantiate the notion that obesity is associated with an increased drive to eat rather than with enhanced feelings of pleasure while eating [36]. Meanwhile, the present study demonstrated a linear relationship between PFS-P and increasing BMI which is in agreement with Carpenter et al., study [39]. This indicates that PFS is a predictor value for BMI in obese patients. The inconsistencies in the relationship between PFS and BMI in different studies may be explained, at least in part, by the differences in studied populations. In most of the previous studies, young adults or college students who were in normal BMI range were studied [8, 9, 38]. In the present study, we studied participants with wide ranges of BMI from 18.5 to 53.9 kg/m^2, and age from 19 to 50 years. When both men and women participants were considered as a group, a significant correlation was observed between PFS-P scores and BMI. This strong correlation was still remained when the participants were divided into men and women. However, the correlation was weaker in men. (r = 0.190, p < 0.01). This may be due to the fewer number of male participants and their demographic characteristics such as occupational and literacy status and physical activity. In addition, a statistically significant difference was observed in the hedonic huger scores between men and women. Since eating disorders are more common in women, the majority of previous studies investigated hedonic hunger in female participants [16, 40–42] and some studies have examined both genders [7–9]. A number of researchers have reported that women are more likely than men to experience reward eating [18, 19, 43, 44]. In contrast, some studies found no differences between men and women [45, 46]. In the present study, statistically significant differences were observed in the scores of the factors of "Food available", "Food present", "Food tasted" and PFS-P aggregate score between men and women which indicated discrimination of PFS-P. Additionally, BMI and physical activity level were significantly different in both genders. Therefore, we considered physical activity level and BMI as potential confounders. After adjusting for these confounding variables, hedonic hungerwas still higher in women. This can be explained by the role of neural activity in response to food cues in brain reward-related areas which result in overeating and increased BMI in women [47, 48]. Fairly consistent evidence exists in favor of the notion that, women show higher neural

activation than men when exposed to food stimuli [19, 43, 47, 49]. Women are more reactive to visual food stimuli in comparison with men [33]. In contrast, few studies reported higher reactivity for men [19, 41, 50]. This discrepancy can be explained, at least in part, by the higher BMI of men in most of these studies [41].

One of the strengths of our study is its large sample size, especially for women participants, providing adequate statistical power for factor analysis. Moreover, in contrast to most of the previous studies restricted to young adults with normal BMI, in the present study, participants with wide ranges of age and BMI were studied. However, the present study had some limitations that need to be considered. First, the number of male and female participants were not equal. Second, the present study was carried out in Tabriz, one of the major city in the northwest of Iran, whereas there are several provinces in Iran with different cultures and thus the generalization of our findings is limited by these limitations. Therefore, more studies with larger sample sizes and in different parts of Iran are recommended to further assessing hedonic hunger in Iranian populations. In addition, it is recommended to evaluate the validity of PFS using measures of appetitive responsiveness not involving self-report.

Conclusions

The present study provides further evidence in support of the suitability of PFS as a valid instrument to measure hedonic hunger. PFS-P can be used as a valid and reliable measure to assess hedonic hunger in Iranian populations. The findings of this study suggest that hedonic hunger especially in the current obesogenic environment, in which palatable foods are available, would give rise to obesity. In addition, we observed gender differences in hedonic hunger, which may highlight documented sex differences in obesity and obesity-related health outcomes. An implication of this is the possibility that considering gender differences may be helpful in prevention and treatment options for obesity and disordered eating.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in this study were in accordance with the ethical standards of the Tabriz University of Medical Sciences and with the 1964 Helsinki declaration of 1964 as revised in 2000. This article does not contain any studies with animals performed by any of the authors.

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

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