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Anxiety symptoms and emotional eating are independently associated with sweet craving in young adults

Fernanda Rodrigues de Oliveira Penaforte[a,d,*], Maria Clara Santos Minelli[a], Lucilene Rezende Anastácio[b], Camila Cremonezi Japur[c,d]

[a] Department of Nutrition/PostGraduate Program in Psychology, Universidade Federal do Trângulo Mineiro, Av. Frei Paulino, 30. Bairro Abadia, CEP 38025-180 Uberaba, MG, Brazil

[b] Department of Food Sciences, Faculty of Pharmacy, Universidade Federal de Minas Gerais, Av. Presidente Antônio Carlos, 6627. Campus Pampulha, CEP 31270-901 Belo Horizonte, MG, Brazil

[c] Division of Nutrition and Metabolism, Department of Health Sciences. Ribeirão Preto Medical Scholl. Universidade de São Paulo. Av. Bandeirantes, 3900. Bairro Monte Alegre, CEP 14049-900 Ribeirão Preto, SP, Brazil

[d] Laboratory of Eating Practices and Behavior (PratiCA), Universidade de São Paulo, Av. Bandeirantes, 3900. Bairro Monte Alegre, CEP 14049-900 Ribeirão Preto, SP, Brazil

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ABSTRACT

Sweet craving (SC), defined as a strong desire for sweet foods, seems to be closely related to negative emotions, such as anxiety and unhealthy eating behaviors. The objective was to investigate factors that are associated with SC and to assess the relationships among SC, anxiety symptoms, and eating behavior in university students. This was a cross-sectional study involving 300 students of both sexes (20.5 ± 4.4 years) who were freshmen in a Brazilian public university. Eating behavior was evaluated using the Three Factor Eating Questionnaire, anxiety symptoms were assessed using the Beck Anxiety Inventory, SC was identified by a yes/no question ("Have you had a very strong desire to eat sweet food over the last three months?"), and characterized by the Questionnaire for Assessment of Sweet Substance Dependence. Individuals with SC scored significantly higher for uncontrolled eating (UE), emotional eating (EE), and anxiety symptoms. Logistic regression analysis revealed that anxiety symptoms are independently associated with SC. In conclusion, negative emotions, like anxiety, and eating guided by these emotions can contribute to the SC phenomenon.

1. Introduction

Food craving is defined as an intense desire to consume a specific food or food group (Preedy et al., 2011), encompassing a psychological or physiological motivational state and the intention to satisfy it (Araujo et al., 2008). It differs from hunger in its intensity and the specificity of the desired food (Cepeda-Benito et al., 2000; Pelchat, 2002). Although it is not synonymous with overeating or uncontrolled eating (UE), food craving is associated with them, especially for the foods being restricted (Hill, 2007; Rodríguez-Martín and Meule, 2015). Verzijl et al. (2018) have suggested that attempts to restrain eating may activate food craving, thereby increasing the risk of overeating, since food craving has emerged as a significant indirect effect of the association between restrained eating and both emotional eating (EE) and UE.

When the food craving is specifically for sweets, the term used is sweet craving (SC), which is a strong desire for or a difficulty in resisting sweet foods (Weingarten and Elston, 1991).

An innate preference for sweet foods because of their pleasant taste and source of energy is well established (Reed and McDaniel, 2006; Saper et al., 2002). However, genetic variations generate different perceptions of sweet taste, which can influence sweet taste preference and intake (Reed and McDaniel, 2006). Sweet taste preference is mediated by opioid peptide action in brain reward areas that regulates both sweet taste preference and sensitivity to mood alteration following sweet food intake. This leads to greater desire for this type of food and the associated sensation of reward and pleasure resulting from sugar consumption (Loxton and Tipman, 2017; Polk et al., 2017; Singh, 2014; Yanovski, 2003).

However, regular consumption of sweet foods reduces brain reward

* Corresponding author at: Department of Nutrition/PostGraduate Program in Psychology, Universidade Federal do Trângulo Mineiro, Av. Frei Paulino, 30. Bairro Abadia, CEP 38025-180 Uberaba, MG, Brazil.

E-mail addresses: fernanda.penaforte@uftm.edu.br (F.R.d.O. Penaforte), mac.minelli@gmail.com (M.C.S. Minelli), lucilene@farmacia.ufmg.br (L.R. Anastácio), camilajapur@usp.br (C.C. Japur).

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system responsiveness over time and leads to the need to consume even greater amounts to achieve the same level of pleasure, thereby reinforcing the constant search for these foods (Burger and Stice, 2012; Fulton, 2010; Stice et al., 2010) and consequently promoting more frequent craving episodes and UE.

The triggers of SC episodes may be biological in nature, such as hunger or food restriction (Massey and Hill, 2012; Moreno-Domínguez et al., 2012; Polivy et al., 2005); psychological/subjective in nature, such as premenstrual syndrome (Yen et al., 2010); related to stress (Macedo and Díez-Garcia, 2014); or related to anxiety (Christensen and Pettijohn, 2001; Fulton, 2010).

Anxiety is a natural condition of human life, responsible for preparing us for situations of threat and danger (Clark and Beck, 2012). In trigger situations for anxiety, individuals can call on a range of perceived settling or soothing coping repertoires in order to produce behavioral changes that help the body to cope with anxiety symptoms. However, some may experience disproportionate or maladaptive anxiety in spite of the triggering situations (Barlow and Durand, 2008; Craske et al., 2009), which affects their psychosocial functioning and health (Balestrieri et al., 2010).

Relationships between anxiety, SC, and EE can be partially explained by the hypothesis of self-medication, in which an individual has a desire to consume certain types of foods that evoke pleasure, such as sweets, as a coping mechanism to combat negative emotions (Liu et al., 2007; Wardle et al., 2000; Yanovski, 2003). In this situation, food choices are based on hedonic factors (Christensen and Pettijohn, 2001; Fulton, 2010; Parylak et al., 2011). Sweet craving appears to be closely linked to the opioid system that regulates the hedonic response to sweets (Parker and Crawford, 2007). In this sense, the literature points out that negative emotions such as anxiety commonly interfere with food intake, redirecting food choices to energy-dense ``comfort foods'' such as sweet-tasting foods (Dallman et al., 2003; Gibson, 2006; Zellner et al., 2006).

Hence, in the context of SC it is important to consider the interaction between the biological and psychological factors inherent in this phenomenon. On the one hand, physiological responses to the consumption of sweet foods may affect their future consumption (Burger and Stice, 2012; Fulton, 2010; Stice et al., 2010); on the other, motivations of an emotional nature can direct food intake (Canetti et al., 2002; Rozin, 1990).

Studies have shown that most people have experienced food craving episodes, with estimates varying from 52% to 97% (Christensen and Pettijohn, 2001; Gendall et al., 1997; Gilhooly et al., 2007; Weingarten and Elston, 1990). These episodes have negative repercussions for body weight, such as weight gain and obesity (Abiles et al., 2010; Chao et al., 2014; Franken and Muris, 2005; Potenza and Grilo, 2014), and for eating behavior, such as the development of binge eating and other eating disorders (Burton et al., 2007; Chao et al., 2016; Pelchat, 2002; Tiggemann and Kemps, 2005; White and Grilo, 2005). These studies highlight the negative effects of food craving on health, especially in terms of eating behavior and weight gain, indicating that they should be better understood given the public health importance of these disorders.

Although the literature on food craving is growing, to the best of our knowledge no studies have specifically examined SC and its relationship to anxiety symptoms and eating behavior in the Brazilian population. In the present study, we investigated factors associated with SC and examined associations between SC, anxiety symptoms, and eating behavior in Brazilian university students. We hypothesized that anxiety symptoms and unhealthy eating behaviors (e.g., EE, UE, and cognitive restriction) would be associated with SC, and that individuals with SC would present higher scores on anxiety symptoms and unhealthy eating behaviors.

2. Methods

2.1. Subjects

This cross-sectional study involved 300 male and female university students who were enrolled as freshmen in the school of Health Sciences in a Brazilian public university. The inclusion criteria were that they were aged 17 years or older and had no self-reported mental disorders, eating disorders, or diagnosed endocrine disorders. The exclusion criteria included being pregnant or breastfeeding, taking medication known to affect appetite or emotional state, and having received nutritional counseling in the six months prior to the study (to minimize bias in the evaluation of eating behavior).

The mean age of participants was 20.5 ± 4.4 years, and 73.0% of the study group was female. Mean body mass index (BMI) was 23.5 ± 4.5 $kg.m^{-2}$, with 63.7% of individuals classified as being of normal weight and 28.3% as overweight (BMI ≥ 25.0 $kg.m^{-2}$).

To calculate sample size, we took into account the total number of students enrolled in the school of Health Sciences in 2016 (n = 567), the unknown prevalence (50%), tolerable error and sample replacement for a 5% refusal rate, and a 95% confidence interval. This yielded a required total sample ranging from 230 to 306 students (95% and 99% confidence intervals, respectively). The achieved power was 81% and α was 3.9%, estimated by the software GPower version 3.1. This estimate was made on the basis of the achieved sample size and the proportion with (n = 127, 42.3%) and without (n = 173, 57.7%) SC, and a 5% α error probability in Fisher's exact test.

The study was approved by the Federal University of Triângulo Mineiro Ethics Committee (number 2773), and all participants signed an informed consent form.

2.2. Procedures

The invitation to participate in the study was issued in classrooms and data collection performed in one stage. After receiving an explanation of the aims and procedures of the study, students who met the inclusion criteria and agreed to participate signed an informed consent form. They then completed a set of self-report questionnaires (TFEQ-R21, Beck Anxiety Inventory, SC identification, and the Questionnaire for Assessment of Sweet Substance Dependence), while their weight and height were measured in order to calculate their BMI ($kg.m^{-2}$).

2.3. Measures

2.3.1. Eating behavior

Eating behavior was assessed using the TFEQ-R21 validated in Portuguese (Medeiros et al., 2017). This is a self-report questionnaire composed of 21 items (20 four-answer questions and one eight-point Likert scale question) evaluating three types of eating behavior: six items on cognitive restriction (CR), which is the tendency to restrict food intake for body weight control; six items on emotional eating (EE), defined as the tendency to consume food as a way of coping with negative feelings (e.g., loneliness, anxiety, depression); and nine items on uncontrolled eating (UE), referring to the tendency to lose control of eating in response to external stimuli (Natacci and Ferreira Junior, 2011). A total score for each behavior (0 to 100 points) was computed, as described elsewhere (Natacci and Ferreira Junior, 2011), with higher scores indicating higher intensity of the behavior.

2.3.2. Anxiety symptoms

The Beck Anxiety Inventory (Beck et al., 1998), translated and validated in Portuguese (Cunha, 2001), was used to assess anxiety symptoms. This instrument is a 21-question Likert scale questionnaire used to measure the severity of anxiety symptoms. Participants were instructed to rate the intensity of 21 anxiety symptoms experienced in the last week. Each answer was scored on a scale of 0 to 3 (0 = “not at

all;" 1 = "mildly, but it didn't bother me much;" 2 = "moderately-it wasn't pleasant, but I could stand it;" 3 = "severely, I almost couldn't stand it"). The items were summed to obtain total scores ranging from 0 − 63, with scores ≥ 11 indicating the presence of anxiety symptoms (11 − 19 indicating mild to moderate symptoms; 20 − 30 indicating moderate symptoms; and 31 − 63 indicating severe symptoms).

2.3.3. Sweet craving (SC)

SC was identified by an affirmative response to the question, "Have you had a very strong desire to eat sweet food over the last three months?" adapted by Macedo and Díez-Garcia (2014) from the question originally proposed by Weingarten and Elston (1991), "Have you had a strong desire to eat a certain type of food over the last three months?". The Questionnaire for Assessment of Sweet Substance Dependence (Rosa et al., 2008) was then administered to all participants to characterize differences in behaviors between affirmative and non-affirmative responders to the SC question, and to measure the presence of behaviors related to SC.

2.3.4. Body mass index (BMI)

Body weight was measured to the nearest 0.1 kg using the Filizola® electronic scale. Standing height was measured to the nearest 0.5 cm. BMI was calculated and classified according to the cutoff points proposed by the World Health Organization (WHO, 1998).

2.4. Statistical analysis

Analyses of data were performed using the Statistical Package for Social Sciences (SPSS) software version 17.0. Numerical variables were assessed for normality using the Kolmogorov-Smirnov test, and presented as means and standard deviations. Categorical data were presented as percentages. Univariate analyses were carried out using the Student's *t*-test or the Mann Whitney test, the chi-square test or the Fisher exact test, and the Pearson or Spearman correlation test. The level of significance was set at 5%.

Multivariate analysis was performed using multiple logistic regression to identify variables independently associated with SC. Entry of the variables into the model was based on a p-value < 0.1 in the univariate analysis. The model was then adjusted using the backward stepwise method, in which each variable with the highest p-value was eliminated and only those with $p < 0.05$ remained. Goodness of fit of the model was assessed using the Hosmer-Lemeshow test.

3. Results

3.1. SC, anxiety symptoms, and eating behavior

SC was identified in 42.3% ($n = 127$) of subjects, while anxiety symptoms were detected in 81.1% of participants with SC and 42.2% without SC ($p < 0.001$). Subjects with SC vs. without SC were 3.13 times more likely to report anxiety symptoms (OR: 3.13; 95% CI: 1.83 − 5.36; $p < 0.001$). Prevalence of SC was higher in women (48.4%; $n = 106$) than in men (25.9%; $n = 21$), the former being 2.68 times more likely than the latter to report SC (OR: 2.68; 95% CI: 1.52 − 4.70; $p < 0.001$).

Individuals with SC scored higher for UE (55.2 ± 18.9 vs. 40.9 ± 19.8; $p < 0.001$), EE (62.2 ± 27.9 vs. 37.3 ± 26.4; $p < 0.001$), and anxiety symptoms (19.5 ± 11.2 vs. 14.3 ± 8.7; $p < 0.001$) than did those without SC. No differences were found for CR scores or BMI between participants with and without SC (Table 1).

3.2. SC characterization

Subjects with SC, compared with those without, gave significantly more affirmative answers in relation to the following: sweet intake in order to feel better or improve mood; the need for higher intakes of sweets to experience the same effect on mood; the presence of any physical symptoms or unsuccessful attempts to reduce or stop eating sweets; eating more than intended when starting to eat sweets; spending more than two hours thinking about or trying to acquire sweets; and, continuing to eat despite knowing that it could be harmful (Table 2).

Table 1
Body mass index, eating behavior and anxiety symptoms in university students with and without sweet craving.

	Students without sweet craving ($n = 173$)	Students with sweet craving ($n = 127$)	p-value
BMI (kg.m^{-2})	23.3 ± 4.2	23.8 ± 4.9	0.493
Eating behavior score			
Uncontrolled eating	40.9 ± 19.8	55.2 ± 18.9	< 0.001*
Cognitive restriction	39.3 ± 22.6	36.1 ± 22.7	0.216
Emotional eating	37.3 ± 26.4	62.6 ± 27.9	< 0.001*
Anxiety symptoms (BAI score)	14.3 ± 8.7	19.5 ± 11.2	< 0.001*

* $p < 0.05$; Student's *t*-test or Mann-Whitney test. BAI: Beck Anxiety Inventory.
Data presented as mean ± standard.

Table 2
Assessment of sweet substance dependence in university students with and without sweet craving.

Questions	Students with sweet craving ($n = 127$)	Students without sweet craving ($n = 173$)	p-value
1. Have you ever eaten sweets to feel better or to improve your mood?			
Yes	92.1%	56.6%	< 0.001*
2. Have you noticed that you needed larger amounts of sweets to get the same effect?			
Yes	51.2%	9.8%	< 0.001*
3. Did you have any physical symptoms when you reduced or stopped eating sweets?			
Yes	28.3%	5.8%	< 0.001*
4. When you started eating sweets, did you eat more than you intended to?			
Yes	83.5%	43.4%	< 0.001*
5. Have you tried, without success, to reduce or stop eating sweets?			
Yes	52.0%	19.7%	< 0.001*
6. On the days when you ate sweets, did you spend more than two hours thinking about or trying to acquire them?			
Yes	29.1%	8.1%	< 0.001*
7. Have you reduced your daily/leisure activities to eat sweets?			
Yes	0.8%	2.9%	0.199
8. Did you continue eating sweets even though you knew they were harmful to you?			
Yes	67.0%	28.3%	< 0.001*

* Qui-Square or Fisher *t* test.

3.3. Explanatory model for SC

The multivariate logistic regression model for SC included sex, eating behavior scores for UE and EE, and anxiety symptoms (univariate analyses in Table 3). The final multivariate logistic regression model that best predicted SC in these university students was able to predict 78.7% of cases, with an adequate fit (Hosmer-Lemeshow test: 0.356). Anxiety symptoms and EE were independently associated with SC (Table 3). Students with anxiety symptoms were 2.71 times more likely to present with SC than did those without anxiety symptoms. In the case of EE, the group with SC vs. without SC reported significantly higher scores on this eating behavior in the univariate analysis. Nevertheless, EE remained in the logistic model with an OR of 0.98.

3.4. Correlations

Significant positive correlations of anxiety symptoms with UE scores ($r = 0.287$; $p < 0.001$) and EE scores ($r = 0.241$; $p < 0.001$) were found, while no significant correlations were observed between anxiety

Table 3
Variables inserted on multivariate logistic regression model (univariate analyses) and variables independently associated to sweet craving, according to the multivariate logistic regression model.

Univariate analyses Variables insert on multivariate logistic regression model	Sweet craving		*p* value
	No	Yes	
Sex			
Women (*n* = 219; 73.0%)	65.3% (*n* = 113)	83.5% (*n* = 106)	< 0.001*
Men (*n* = 81; 27.0%)	34.7% (*n* = 60)	16.5% (*n* = 21)	
Total (*n* = 300)	100% (*n* = 173)	100% (*n* = 127)	
Uncontrolled eating score	40.9 ± 19.8	55.2 ± 18.9	< 0.001*
Emotional eating score	37.3 ± 26.4	62.6 ± 27.9	< 0.001*
Anxiety symptoms			
No (*n* = 97; 32.3%)	42.2% (*n* = 73)	18.9% (*n* = 24)	< 0.001*
Yes (*n* = 203; 67.7%)	57.8% (*n* = 100)	81.1% (*n* = 103)	
Total (*n* = 300)	100% (*n* = 173)	100% (*n* = 127)	

Multivariate analyses Variables independently associated to sweet craving	OR	95%CI	*p*-value
Anxiety	2.71	1.44–5.09	0.002*
Emotional eating	0.98	0.97–0.991	< 0.001*
Intercept	0.07		0.001

* $p < 0.05$; Qui-square test; *t* Student test; multivariate logistic regression.

symptoms, CR scores, and nutritional status.

4. Discussion

This study expands the literature on SC and associated factors, demonstrating more anxiety symptoms and higher scores for EE and UE in individuals with SC, and finding that anxiety increases 2.71-fold the likelihood of presenting with SC.

The most widely accepted hypothesis for the biological relationships between SC, emotional eating, and negative mood is the self-medication hypothesis (Loxton and Tipman, 2017; Polk et al., 2017; Singh, 2014; Yanovski, 2003). Christensen and Pettijohn (2001) observed that more than two-thirds of carbohydrate cravers (especially for sweets) reported feelings of anxiety and depression prior to their craving episodes that were not detected among protein cravers. The authors also found a significant positive correlation between carbohydrate cravers' ratings of craving intensity and all the negative moods assessed, as other studies have (Krishnan et al., 2016; Macedo and Diez-Garcia, 2014; Yen et al., 2010).

However, the pleasure derived from eating sugar-rich foods is short-lived and hence would not produce true, long-lasting benefits for mood (Macht and Mueller, 2007; Parker et al., 2006). In this sense, another perspective—the psychosocial hypothesis of craving—when applied to SC, suggests that SC is also related to the external stimuli of food, and that sensorial experience (taste, flavor, texture) is crucial in this process (Burton et al., 2007; Michener and Rozin, 1994; Parker et al., 2006). Furthermore, eating to deal with negative emotions, such as anxiety, could be viewed as a learned response (Ruderman, 1983), with sensorial and physiological qualities, that is strongly reinforced socially. In this context, it is important to highlight the symbolic role of food. Since childhood we have learned that sweet foods symbolize affection and care, and that consuming these foods is a way of coping with negative feelings and adverse situations (Wansink et al., 2003).

In addition to higher rates of anxiety symptoms and EE scores, higher rates of UE were also observed in subjects with SC in the univariate analyses in the present study. There is evidence that food craving is positively associated with overeating (Burton et al., 2007), which is probably related to UE and EE (Verzijl et al., 2018). Masheb and Grilo (2006) found that anxiety was the emotion most often cited by participants in response to overeating. Similarly, Penaforte et al. (2016), examining stress and eating behavior, found that the group with the highest level of stress also presented higher scores on EE and UE. Goodman et al. (2018) also pointed out in their study that individuals with binge-eating disorders and higher sweet preference were more likely to binge-eat compared with those with a lower sweet preference.

The multivariate model for SC indicated that lower EE scores might be associated with a higher occurrence of SC (OR = 0.98). It is important to point out that some studies found no association between negative emotions, such as anxiety and stress, and eating behavior (Bellisle et al., 1990; Grunberg and Straub, 1992; Zellner et al., 2007). However, in the present study this interpretation is not consistent with data from the univariate analysis, in which individuals with SC scored significantly higher (62.6 ± 27.9) than individuals without SC (37.4 ± 26.4) on EE. Therefore, the most plausible hypothesis for the permanence of EE as a ``protection factor" for SC in the model is that this variable is important for adjusting anxiety—e.g., in the presence of anxiety, but not with higher scores on EE, the probability of SC occurring increases.

We observed no difference in CR scores between the groups with and without SC. This is in spite of the fact that there is consistent evidence showing that food restriction has extremely negative repercussions for eating behaviors because of the cognitive and behavioral changes as a result of the restriction acting as a strong trigger for food craving episodes, especially for the foods being restricted (Burton et al., 2007; Cepeda-Benito et al., 2003; Massey and Hill, 2012; Verzijl et al., 2018).

Although this was not the main objective of our study, it is important to point out that women showed a 2.68-fold higher likelihood of reporting SC. Previous studies have shown that food craving (Cepeda-Benito et al., 2003; Lafay et al., 2001), and particularly SC (Chao et al., 2016), episodes are more common among women than men. The effects of negative mood, such as stress and anxiety, on food consumption seems to be different between men and women, with a higher consumption of sweets and fast food reported in stressed women that is not observed in men (Mikolajczyk et al., 2009; Zellner et al., 2007).

While the body of literature on food craving and SC is growing, there are still many gaps in our understanding. From a psychological perspective, craving is a hypothetical construct. Thus, its definition suffers from the problems inherent in hypothetical constructions, which by definition are neither observable nor directly measurable (Weingarten and Elston, 1990). The subjectivity of craving means that it is not easily detected, and so subjective self-reporting appears to be the most viable method for its assessment (Rodríguez-Martín and Meule, 2015). In this sense, the ability to identify food craving strongly depends on the self-reports and perceptions of the individual being assessed. Some questionnaires are available that assess food craving, such as the Food Craving Inventory (White et al., 2002) and which is one of the most widely used in the field. However, research on specific food craving, such as SC, is limited because there is no instrument that specifically measures SC. Previous studies that have examined craving for specific foods have used instruments comprising a single question about the craving (``Do you crave chocolate?") and a yes or no answer (Michener and Rozin, 1994; Rozin et al., 1991), similar to that used in the present study. Others have created a craving record to capture detailed information about the subjective experience of participants' food cravings, such as context, intensity, the nature of the food craved, and subsequent behavior (Massey and Hill, 2012; Waters et al., 2001).

The current study provides new and clinically important information on associations between SC, anxiety symptoms, and eating behavior in Brazilian university students. The large size of the sample of university students and the lack of other studies on this subject in Brazil are additional strengths of the study. However, the study has some limitations that should be considered when interpreting the findings:

this was a cross-sectional study, so we cannot make inferences about causality among the variables; our sample was predominantly female and of normal weight; a sweet taste test was not performed; and, because of the specific population evaluated (Brazilian university students), the findings may not be generalizable to other cultural groups. Additionally, the yes/no format of our instrument for detecting SC (``Have you had a strong desire to eat sweet food over the last three months?") provides a dichotomous variable that is dependent on subjectivity and self-report. Although simple, the question appeared sufficiently sensitive given that most of the affirmative responses to SC recorded by it were confirmed by the Questionnaire for Assessment of Sweet Substance Dependence. Similar findings were reported by Macedo and Diez-Garcia (2014).

In conclusion, our results indicate that anxiety symptoms and EE were independently associated with SC, and that individuals with SC presented higher scores for UE, EE, and anxiety symptoms than did those without SC. Because of the complexity of SC, which involves biological, behavioral, and psychosocial factors, further quantitative and qualitative studies are needed to improve its detection and characterization in terms of the severity of craving, the amount and type of sweets consumed during craving episodes, their triggering factors, and the types of circumstances or conditions that are likely to be a factor prior to and after craving episodes (e.g., where, with, whom, and previous mood).

Conflict of interest

All authors declare that they have no conflicts of interest.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.psychres.2018.11.070.

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