Risk patterns in Food Addiction: a Mexican population approach

Lucero Munguía[1], Susana Jiménez-Murcia[1,2,3], Eduardo Valenciano-Mendoza[1], Roser Granero[4], Anahí Gaspar-Pérez[1], Rebeca M. E. Guzmán-Saldaña[5], Manuel Sánchez-Gutiérrez[6], Gilda Fazia[7], Laura Gálvez[1], Ashley N Gearhardt[8], Fernando Fernández-Aranda[1,2,3].

[1]Department of Psychiatry, Universitary Hospital of Bellvitge -IDIBELL, Barcelona, Spain.
[2]Clinical Sciences Department, School of Medicine, Barcelona University, Barcelona, Spain.
[3]CIBER Physiopatology, Obesity and Nutrition (CIBERobn), Health Institute Carlos III, Madrid, Spain.
[4]Department of Psychobiology and Methodology, Autonomous University of Barcelona, Barcelona, Spain.
[5]Academic area of Psychology, Autonomous University of Hidalgo State, Hidalgo, Mexico.
[6]Health Sciences Institute, Autonomous University of Hidalgo State, Hidalgo, Mexico.
[7]Department of Medical and Surgical Sciences, Magna Graecia University, Catanzaro, Italy.
[8]Department of Psychology, University of Michigan, USA.

Abstract

Background: Food addiction (FA) is a construct that has gained interest in recent years but its relevance in Mexican population is still unexplored. **Aims:** The present study has the aims of explore FA in a community of Mexican population, as well as identifying the risk patterns associated with it, in relation to the different etiological factors that have been described such as impulsivity, emotional regulation and eating styles. Furthermore, to identify a predictive model of FA severity. **Methods:** The sample consisted of 160 female and male university students of Pachuca city in México, who volunteered to the current study. Assessment included multidimensional measures for FA, eating disorder severity, eating disorder styles, emotional regulation and impulsivity. **Results:** A screening of FA-probable was registered for 13.8% of the sample, while 8.1% met criteria for FA-present. The FA-present group differed from FA-absent in the impulsivity levels and in emotional eating style. Patients with FA-present differed from FA-probable in the impulsivity levels. Differences between FA-probable versus FA-absent were found in the restrained eating style. Path-analysis evidenced that FA severity was directly associated with older age, worse eating style profile and higher impulsivity levels, and indirectly related with the ED symptom levels. **Conclusions:** Our findings suggest that it is possible to establish a specific predictive model of the development of FA and its severity in Mexican population, in order to implement adequate prevention and treatment strategies.

Key words: Food Addiction, Eating Disorders, Obesity, Mexico.

Introduction

Obesity has become a worldwide priority condition, considering the high levels of prevalence and the different chronic disease associated with it. In addition, obesity is associated with poorer quality of life and implies high public health costs (Dietz, 1998; Lee et al., 2016; Reilly & Kelly, 2011; Rtveladze et al., 2014).

Mexico is becoming the country with the second place of obesity worldwide (Dávila-Torres, De Jesús González-Izquierdo, & Barrera-Cruz, 2015), with 75.2% obesity and overweight in adult population, 38.4% obesity and overweight in adolescent population and 35.6% in children (Instituto Nacional de Salud Pública, Secretaría de Salud, & Instituto Nacional de Estadística y Geografía, 2018). Despite the prevention strategies implemented at the national level, and that around 60% of the population report being aware of them (Instituto Nacional de Salud Pública & Secretaría de Salud, 2016), the prevalence rates keep increasing, and demonstrates the need to continue delving into the study of the variables that might be involved in its development that could lead to better prevention and treatment approaches.

Food addiction (FA) has become a topic of special interest as one of the key factors that might explain the processes or behaviours that contribute to the development and maintenance of obesity and certain eating disorders (A. N. Gearhardt, Boswell, & White, 2014). Present higher levels of FA have been recently found as the most prominent psychosocial predictor of failure to lose weight in a diet-based weight-loss intervention (Fielding-Singh, Patel, King, & Gardner, 2019). In spite of its importance, FA has been little explored in Mexican population.

The FA model has been conceptualized by taking into account the similarities between the mechanisms involved in substance use disorders (SUD) and the consumption of certain foods described as potentially addictive (Schulte, Avena, & Gearhardt, 2015), as sugary, salty, fatty and processed foods (Guerrero Pérez et al., 2018). Including the search and compulsive consumption of these foods despite their negative consequences (Sevinçer, Konuk, Bozkurt, & Coşkun, 2016), the presence of tolerance, withdrawal and a persistent desire or failure to cut down (Pursey, Stanwell, Gearhardt, Collins, & Burrows, 2014), and the activation in the same brain areas (A. Gearhardt, Corbin, & Brownell, 2009; A. Gearhardt, Grilo, DiLeone, Brownell, & Potenza, 2011).

A strong association between FA and impulsivity has been largely described in the literature (Brunault et al., 2018; Pivarunas & Conner, 2015; Wolz et al., 2016). Although there is no consensus on which sub-dimensions are specifically involved, positive and negative urgency, lack of perseverance, lack of premeditation, motor and attentional impulsivity, rash impulsivity, among others, have been mentioned to be related with FA behaviours (Kidd & Loxton, 2021; Maxwell, Gardiner, & Loxton, 2020; Minhas et al., 2021).

Another factor associated with FA is emotion regulation, which refers to the way individuals experience and express their emotions (Monell, Clinton, & Birgegård, 2018). High rates of emotion dysregulation have been found in FA. Even though the precise role of this construct needs to be further explored, FA behaviours could be used to cope negative emotions (Wolz, Granero, & Fernández-Aranda, 2017), related with an emotional eating style (Van Strien, Frijters, Bergers, & Defares, 1986).

As previously mentioned, FA has been little studied in Mexico, even though research on the impact of high palatable and hyper-caloric foods on neural plasticity has gained interest (Cruz-Carrillo et al., 2020; Morin et al., 2017; Muñoz-Escobar, Guerrero-Vargas, & Escobar, 2019).

As well, the Yale Food Addiction Scale was validated for Mexican population (Valdés-Moreno, Rodríguez-Márquez, Cervantes-Navarrete, Camarena, & de Gortari, 2016), and the relationship between body mass index and FA was evaluated in children (Rodríguez Santaolaya et al., 2019). However, no exploration of the prevalence of FA in Mexican adult population or any study of the related variables and its interaction-mediation for it development has been done.

Therefore, the aim of the present study was to explore FA in a sample of healthy Mexican population in order to identify population at risk of FA. A second aim was to identify patterns associated with the presence and the risk of FA, in relation to the different etiological factors described above: impulsivity, emotional regulation and eating styles. Finally, to identify a predictive model of FA severity, as a third aim.

We hypothesized that the presence of FA in our sample will be similar to the prevalence rates found in healthy population in the United States and Spain, ranged from 11% to 40% (A. Gearhardt et al., 2009; Granero et al., 2014). Also, we hypothesized that risk for FA would be positively associated with the variables proposed, specifically higher levels of impulsivity, emotion dysregulation, and emotional and external eating styles.

To our knowledge, this will be the first study that explores FA in Mexican population and identifies factors associated with being at high risk for FA, which would provide a better characterization of the FA construct in Mexico.

Materials and methods

Participants:

261 undergraduate students of the Faculty of Psychology from Pachuca city (Mexico), between 19 to 21 years old, were invited to participate in the study, and only those whom accepted the invitation were considered for the assessment. The final sample consisted of 160 participants (n=121 female; 39 male), with an average age of 20.1 years old (SD = 1.7). Participants were recruited as volunteers, and all of them provided signed informed consent. No compensation for participating in the study was given. Assessed by a questionnaire adapted from the structured clinical interview DSM-5 for ED: SCID-5 (First, Williams, Karg, & Spitzer, 2015), only 8 participants reported to have had a lifetime ED (5 BN, 1 AN, 1 AN and BN, and 1 that do not provided the diagnoses).

Assessment:

Besides a specific socio-demographic questionnaire, which includes clinically relevant variables, the following instruments were used. As well, Table S1 (supplementary material) includes the descriptive for all the measures of the study. Table S2 (supplementary material) includes the correlation matrix for the variables of the study.

Eating Disorder Inventory-2 (EDI-2) (Garner, 1998)**,** is a 91-item multidimensional self-report questionnaire that assesses psychological and behavioural characteristics relevant to eating disorders. It consists of eleven subscales answered on a six-point Likert scale: drive for thinness, body dissatisfaction, bulimia, ineffectiveness, perfectionism, interpersonal distrust, interoceptive awareness, maturity fears, asceticism, impulse regulation and social insecurity. The internal consistence of the EDI-2 total score in our sample was α=0.928. The Spanish version of this questionnaire was used because the only validation of it for Mexican population was done only for women (García-García, Vázquez-Velázquez, López-Alvarenga, & Arcila-Martínez, 2003).

Yale Food Addiction Scale 2.0 (YFAS 2.0 (A. Gearhardt, Corbin, & Brownell, 2016)**,** has been validated in Spanish population (Granero et al., 2018), is a 35-item self-report questionnaire for measuring addictive eating behaviours during the previous 12 months. This original instrument (YFAS) was based on the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR) (American Psychiatric Association, 2010) criteria for substance dependence and was adapted to the context of food consumption. The YFAS2.0, is based on DSM-5 (American Psychiatric Association, 2013) and evaluates 11 symptoms. The score produces two measurements: (a) a continuous symptom count score that reflects the number of fulfilled diagnostic criteria (ranging from 0 to 11), and (b) a food addiction threshold based on the number of symptoms (at least 2) and self-reported clinically significant impairment or distress. This final measurement allows for the binary classification of food addiction (present versus absent). Also, based on the revised DSM-5 (American Psychiatric Association, 2013) taxonomy, it is possible to establish severity cut-offs: mild (2–3 symptoms), moderate (4–5 symptoms), and severe (6–11 symptoms). The original YFAS was validated for Mexican population (Valdés-Moreno et al., 2016), however, the YFAS 2.0 has not been validated yet, for which the Spanish validation of the scale was used. The internal consistency of the YFAS-2 in our sample was α=0.950.

The FA severity groups were calculating as follow: FA absent, those who do not have any diagnostic criteria in the YFAS 2.0; FA probable, those who meet 1 diagnostic criteria and those with two or more criteria but that do not present clinical deterioration; and FA present, those who have 2 diagnostic criteria and also present clinical deterioration. This way, FA probable group will correspond to the clinic concept of the high-risk or sub-threshold, patients who do not strictly meet the diagnostic criteria of a taxonomy but who show symptoms. Subthreshold psychiatric symptoms do not meet the full criteria for a concrete disorder in a reference diagnostic taxonomy (such as the Axis-I disorders within the DSM), but course with clinical significant impairment. In some cases, subthreshold symptoms are more common than their respective Axis-I disorders, and empirical research has suggested that these groups are associated with increased disability and many other negative consequences (Rai, Skapinakis, Wiles, Lewis, & Araya, 2010). Even this categorization has not been used before in FA, it has been done taking as a reference the distinction of high-risk group of subjects in contrast with a formal diagnostic, in other addictive process. According the new taxonomy of the DSM-5 (American Psychiatric Association, 2013)for Gambling disorder, it is necessary to present at least 4 symptoms for a formal diagnosis. However, even it have not been established from empirical evidence, some studies related with gambling assessment have evaluated if those people that present 1 to 3 symptoms could form a high-risk group called problematic gamblers (Stinchfield, 2014).

Difficulties in Emotion Regulation Strategies (DERS) (Gratz & Roemer, 2004), is a 36-item scale used for the evaluation of emotion dysregulation. The DERS consists of six subscales: non acceptance of emotional responses, difficulties engaging in goal-directed behaviour when having strong emotions, impulse-control difficulties, lack of emotional awareness, limited access to emotional regulation strategies, and lack of emotional clarity. Participants are asked to respond to each item using a five-point Likert scale ranging from 1 (almost never) to 5 (almost always). Higher scores indicate greater problems with emotion regulation. The DERS scale was validated for Mexican adolescents (Marin, Robles, González -Forteza, & Andrade, 2012), however, the factorial structure of the original scale was not replicated, and for the specific research purposes of this study, the Spanish validation (Wolz et al., 2015) that contains the originals 36 items was used, instead of the 24 items scale validated for Mexican population. The internal consistence of the DERS total score in our sample was α=0.946.

The UPPS-P (S. Whiteside & Lynam, 2001), has been validated in Spanish population (Verdejo-García, Lozano, Moya, Alcázar, & Pérez-García, 2010), is a 59-item self-report that includes five subscales: negative urgency (NU), the lack of perseverance (LP), the lack of premeditation (LPM), sensation seeking (SS) and positive urgency (PU), that are used to measure five distinct dimensions of impulse behaviour. Each item is rated on a 4-point Likert scale ranging from 1 “strongly agree” to 4 “strongly disagree.” Participants are asked to consider acts during the last 6 months. The internal consistency values for the different UPPS-P scales in our sample are, NU: 0.867, LP: 0.744, LPM: 0.807, SS: 0.779, PU: 0.922. The Spanish version of the questionnaire was used being that it is not validated for Mexican population.

The Dutch Eating Behaviour Questionnaire (DEBQ) (Van Strien et al., 1986), has been validated in Spanish population (Cebolla, Barrada, van Strien, Oliver, & Baños, 2014), is 33 item self-report questionnaire to assess specific eating behaviours such as: emotional eating (eating in response to emotional signals such as depression and anxiety) that includes 13 items, external eating (eating in response to external food-related factors such as the sight or smell of food) includes 10 items, and restrained eating (dietary control to lose weight) includes 10 items. Participants are asked to respond using a five-point Likert scale ranging from 1 (never) to 5 (very often). The internal consistency values for the different DEBQ scales in our sample are, DEBQ emotional: 0.949, DEBQ external: 0.899, and DEBQ restrained: 0.902. The Spanish version of the questionnaire was used, being that it is not validated yet for Mexican adult population.

Procedure

Undergraduates in the second year of their degree were invited to participate as volunteers in the study during school hours, and only those whom accepted were considered for the assessment. The questionnaires were answered individually in a group evaluation, supervised by three experienced psychologists. A total of six group evaluations were done, due to the sample were divided in smaller groups in order to guaranty the privacy of the participants during the assessment. The participants had enough space between them during the session, so they were not aware of other participants answering, not been possible that group members’ answers could influence each other. Each group session had two hours of duration. Being that the scales used for the assessment were validated for Spanish population and

not for Mexican, the psychologists that assisted the evaluation were in charge to answer any question regarding the conceptualization of the phrases or words. In this regard, the psychologists were advised by colleagues from Spain. In accordance with the Declaration of Helsinki, the present study was approved by the proper local Ethics Committee, and signed informed consent was asked to the participants.

Statistical analysis

Statistical analysis was carried out with Stata16 for windows. The comparison of the means registered in the eating style (DEBQ), emotion dysregulation (DERS) and impulsivity (UPPS-P) profile was based on analysis of covariance (ANCOVA) adjusted for the participants sex, age and the eating severity (EDI-2 total). The inclusion of the covariates sex, age and eating severity was done to avoid potential biases in the results due the confounding role of these variables in the study: since the objective of the work was to obtain the *specific contribution* of the FA on the eating style, emotion regulation and impulsivity, and previous researches have suggested the potential association between these variables with FA (Granero et al., 2014; Jiménez-Murcia et al., 2017; Pursey et al., 2014), the statistical control was required. For these ANCOVA procedures, Finner's method (a family wise error rate procedure which allows more powerful than the classical Bonferroni correction) was used to control increase in Type-I error due to multiple statistical tests (Finner, 1993). In addition, due the low sample size and the consequent low statistical power to identify the relationships in the data, effect size for the mean differences was measure with Cohen's-*d* (which is interpreted as a standardized measure of the mean difference not-depending on the sample size) (effect size was considered low-poor $|d|>0.20$, moderate-medium for $|d|>0.5$ and large-high for $|d|>0.8$; (Kelley & Preacher, 2012).

A predictive model of the FA severity group was obtained through multinomial logistic regression. This model constitutes a generalization of binary logistic regression to multiclass problems (categorical criteria with more than two levels), and therefore it allows to predict the probabilities of the different levels of a categorically distributed dependent variable considering a set of independent variables. This procedure was employed in this work for obtain a predictive model for a variable defined with three categories (FA absent, FA probable and FA present). The parameters of the model are interpreted close to log-odds achieved in a logistic regression with two levels of the outcome variable (Agresti, 2018). The multinomial regression was adjusted in two blocks: a) first block entered and fixed the participants' sex, age and eating severity (defined as covariates in this analysis); and b) the second block tested and automatically selected the most relevant predictors of the FA group through STEPWISE procedures (due the low sample size of the groups, significant and quasi-significant contributors were retained as relevant). Goodness-of-fit of the model was assessed with the deviance chi-square test (non-significant result is interpreted as adequate fit for the model) and the likelihood ratio test applied to the -2 Log Likelihood test (significant result is interpreted as adequate fitting).

Pathways analysis was used to estimate the magnitude and significance of the relationships between the variables of the study with the FA severity level, including direct and indirect effects (mediational links). This analysis was used in this work as a case of structural equation modelling (SEM), using the maximum-likelihood estimation (MLE) method of parameter estimation (Kline, 2005). A latent

variable was defined as a measure of the eating style defined by the DEBQ scores, and a latent variable was defined measuring the impulsivity levels based on the UPPS-P scale scores (the two latent variables were defined with the aim to simplify data structure and to facilitate a more parsimonious interpretation and fitting). Goodness-of-fit was evaluated using standard statistical measures: the root mean square error of approximation (RMSEA), Bentler's Comparative Fit Index (CFI), the Tucker-Lewis Index (TLI), and the standardized root mean square residual (SRMR). Adequate model fit was considered for the following criteria (Barrett, 2007): RMSEA<0.08, TLI>0.9, CFI>0.9 and SRMR<0.1.

Results

Association between FA severity group with eating style, emotion dysregulation and impulsivity

Table 1 contains the results of the ANCOVA (adjusted for eating severity, sex and age) comparing the mean scores in the eating styles (DEBQ), emotion dysregulation (DERS) and impulsivity levels (UPPS-P) between the FA severity groups: absent (78.1%), probable (13.8%), and present (8.1%). Table S3 (supplementary material) includes the results of ANCOVA models excluding the adjustment by the ED severity levels.

Figure 1 shows the radar-chart with the z-standardized means. As a whole, the most dysfunctional profile was registered for the group who met the screening of FA-present, followed by FA-probable. Comparison between FA-absent versus FA-probable reported differences in the eating style, and most clearly in the emotional and restraint domains. FA-present differed from both FA-absent and FA-probable in eating style (emotional and external scales), emotion dysregulation (in the impulse-control difficulties and lack of emotional awareness domains) and impulsivity (lack of premeditation and negative urgency).

- Insert Table 1 and Figure 1-

Predictive model of the FA measures

Table 2 contains the results of the multinomial regression model with the most relevant predictors of the FA severity group in the study, after adjusted by sex, age and ED severity levels (these covariates were fixed in the first block-step). This model indicated that higher levels of restrained eating increased the odds of FA-probable compared to FA-absent. FA-present was more probable compared to FA-absent for patients with higher impulsivity levels (positive and negative urgency) and higher level in emotional eating style. And compared to FA-probable, the odds of FA-present is higher with patients with higher levels in positive and negative impulsivity. Results obtained in the deviance chi-square test (p=.998) and the likelihood ratio test indicate adequate fit for the model (p<.001). (Table S4, supplementary, includes the result of the multinomial regression without considering the EDI-2 total score as a covariate).

- Insert Table 2 -

Pathways analysis

Figure 2 shows the path-diagram with the standardized coefficients obtained in the SEM (Table S5, supplementary material, contains the complete results for the model, including test of direct, indirect

and total effects). Only significant parameters were retained in the final model (sex was excluded due the lack of relations with the other variables). Adequate fitting was achieved for all the fit statistics (RMSEA=0.078, CFI=0.946, TLI=0.912 and SRMR=0.057).

- Insert Figure 2 -

The three DEBQ scales (emotional, external and restrained) positively and significantly contributed on the latent variable defined as a measure of the eating style, while on the impulsivity latent variable the sensation seeking score did not significantly contributed. The results of the SEM indicated that FA severity level was directly associated with older age, worse eating style profile and higher impulsivity levels. The ED severity did contribute to FA through the mediational paths of DEBQ eating style and impulsivity: the higher the EDI-2 total score the more dysfunctional the DEBQ eating and the higher the impulsivity levels, and the higher scores in these two latent variables were associated with a higher FA total score.

Discussion

Research on FA has increased in the last few years (Fernandez-Aranda, Karwautz, & Treasure, 2018), however, it has been little studied in Mexican population. The present study aimed to explore FA in healthy Mexican population, identifying individuals endorsing FA and in risk of develop it. Furthermore, we investigated factors that are associated with FA based on the presence and mediation-interaction of the key factors based on the prior the literature in other countries, specifically, impulsivity, emotional regulation and eating styles.

As we first hypothesized, the prevalence of FA in our sample was similar to the ranges reported in healthy population that goes from 11% to 40% (A. Gearhardt et al., 2009; Granero et al., 2014, 2018; Meule, Vögele, & Kübler, 2012; Meule, 2011); particularly considering other samples of undergraduates, where prevalence's of FA have been of 8.8% in Germany (Meule et al., 2012) and 11.4% in the U.S.A. (A. Gearhardt et al., 2009), which is coincident with our findings, being that 13.8% of the participants exhibit probable FA and 8.1% showed a clear presence of it.

Regarding our second objective, three groups were defined by FA severity: FA-present, FA-probable and FA-absence. As we hypothesized, between the FA-absence and FA-present groups we found statistically significant differences, being these high levels of emotion dysregulation and impulsivity, specifically in impulse control difficulties of the DERS subscale, and negative urgency and lack of premeditation of the UPPS, and, in the emotional and external eating style in the FA-present group. While FA-probable, imply middle levels of emotion dysregulation between the 3 groups, and the highest levels of lack of perseverance, and restrictive eating style, finding statistically significant differences in emotional and restrictive eating styles between FA-probable and FA-absent groups.

These results are in accordance with previous studies. Negative urgency and low levels of task persistence (lack of perseverance) were shown to be significantly and directly associated with FA (Murphy, Stojek, & MacKillop, 2014). In undergraduates, negative urgency, impulsivity when under distress, and emotion dysregulation positively predicted high scores on the YFAS (Pivarunas & Conner, 2015).

It has already been hypothesized that FA behaviours serve as a way to regulate negative emotions (Dingemans, Danner, & Parks, 2017), in a similar way that the behaviour (eating in this case) is use to relieve negative emotional states, in other addictions (Davis et al., 2011; Granero et al., 2014, 2018; Jiménez-Murcia et al., 2017; Pedram et al., 2013). In addition, it has been found that the association between the presence of FA and higher emotional dysregulation is similar in eating disorders patients and in healthy controls (Carlson et al., 2018).

The emotional and the external eating, which reflect a tendency to get triggered by external cues associated with highly palatable food, were found in FA present group. In the case of Mexican population, the consumption of highly palatable food has been a particular concern. Mexicans consume unnatural, high-sugar drinks (over 80% of the population), highly palatable food (over 60% of the population), and high-calorie street food (over 20% of the population) at high levels (Instituto Nacional de Salud Pública et al., 2018). This is consistent with the FA model that specifically posits that highly palatable foods with high levels of refined carbohydrates (like sugar) and fat have the greatest addictive potential and are the most likely to trigger addictive eating (Schulte et al., 2015). A greater sensitivity to cues for these highly palatable foods for individuals with FA, may influence to the difficulty in adhering to other healthy food choices (A. Gearhardt et al., 2009).

Regarding the predictive value of the variables in FA severity, interesting results were found. While to go from FA-absence to FA-probable the restrictive eating style discriminates as predictor, for FA-presence impulsivity (negative and positive urgency) and emotional eating style appear as relevant predictors.

Both, negative and positive urgency UPPS subscales represent the emotional related aspects of impulsivity defined as the tendency to act rashly when experience extreme emotional states (Cyders, M. A., & Smith, 2008; S. P. Whiteside & Lynam, 2001). In this line, for FA-present, our results are confirmatory that impulsivity is highly associated with FA, that could be a predictor of it severity (Wolz et al., 2016), and that it is related with the way to cope with emotions, in its positive and negative urgency domains (Maxwell et al., 2020; Minhas et al., 2021). The predictive value of the emotional eating style for FA-presence made possible to hypothesize that the over intake of certain foods respond as well to states of emotional excitement, like anger, fear or anxiety (Turton, Chami, & Treasure, 2017; Van Strien et al., 2013).

However, even if the emotional eating style was a predictor for FA-presence, for FA-probable was the restricted eating style the one that has the highest predictive values. In Mexican population it has been already probed the relation between food and eating related problems with body image discomfort, and, as a consequence, that diets are chosen as the most common way to lose weight (Caamaño et al., 2016; Peña & Moral, 2012), what might exacerbate the symptoms of FA related with tolerance, withdrawal and craving once changes in food choices are done; as well, restrain could be used to manage the drive for certain foods. In both circumstances, it could be possible to hypothesize that this restraint could result into an addictive process. It has been shown that restrained eating may lead to overate once self-control is undermined (Herman & Polivy, 2005), and that to abstain from addictive foods may trigger to more disordered eating (Wilson, 2010). In relation with this last phenomenon further research is needed.

Besides what has already been mentioned, based on the significance of the relationship between variables in the study of the severity of FA, a worse eating profile, including the three eating styles (restricted, emotional, and external), impulsivity levels and older age have a direct and significant contribution, which is in accordance with previous studies mentioned above, but not the emotion dysregulation as it was hypothesized.

Strength and limits

As was aforementioned, this is the first study carried out in Mexican population that claim for the search of the clinical variables associated with FA in population with FA and in risk of its development as well. However, the present findings must be considered taking into account its limitations: the small size of the sample, as well as the fact that the sample was collected from only one state of Mexico, which in turn may compromise the generalization of the results. In the same line, the study was performed only in population of a specific range of age. Further studies should be considered larger and inclusive samples. As well, the lack of proper validations of the scales used for the assessment of the variables.

Conclusions

According our findings the relationship between FA and the variables involved in the study, are in line with previous literature in other countries, that show coincidences between FA and other addictive processes. Furthermore, the present study contributed by providing an initial specific predictive model of the development of FA and its severity in Mexican population, considering the role of impulsivity and, mainly, the contribution and effect of the three eating styles (emotional, restricted and external) in FA severity. These findings may be particularly relevant in order to implement adequate prevention and treatment strategies.

What is already known on this subject?

Food addiction (FA) has become a topic of special interest as one of the key factors that might explain the processes or behaviours that contribute to the development and maintenance of obesity and certain eating disorders. It has been related with different etiological factors associated as well with other addictive process as impulsivity and emotion regulation.

What does this study add?

To our very own knowledge, this will be the first study that explores FA in Mexico. An initial specific predictive model of the development of FA and its severity in Mexican population has been identified, with special relevant results related with the presence and mediation-interaction of the different eating styles on FA in Mexico.

Declarations

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Conflict of interest

The authors have no conflicts of interest to declare that are relevant to the content of this article.

Authors' contributions

Conceptualization: LM, SJ-M, FF-A; Methodology: RG; Formal analysis: RG; Data collection and investigation: LM, EV-M, AGP, GF, LG; Writing - original draft preparation: LM, SJ-M, EV-M; RG, FF-A; Writing - review and editing: LM, SJ-M, EV-M; RG, ANG, FF-A; Funding acquisition: LM, SJ-M, FF-A; Resources: LM, SJ-M, FF-A; Supervision: LM, SJ-M, RMEG-S, MS, ANG, FF-A.

Data aviability

The datasets generated during and/or analysed during the current study are not publicly available due to ethical restrictions in order to protect the confidentiality of the participants, but are available from the corresponding author on reasonable request.

Ethics approval

In accordance with the Declaration of Helsinki, the present study was approved by the proper local Ethics Committee, and signed informed consent was asked to the participants.

Informed consent

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

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Table 1 *Comparison between the groups based on the food addiction severity: ANOVA adjusted by eating severity, sex and age*

	FA: Absent *n=125*		FA: Probable *n=22*		FA: Present *n=13*		Absent vs Probable		Absent vs Present		Probable vs Present	
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*	*p*	|*d*|	*p*	|*d*|	*p*	|*d*|
Eating styles: DEBQ												
Emotional	20.77	7.37	24.97	11.10	33.44	14.52	**.029***	0.45	**<.001***	**1.10**†	**.006***	**0.66**†
External	24.81	6.50	26.87	8.87	31.91	8.66	.216	0.27	**.003***	**0.93**†	.059	**0.57**†
Restrained	18.14	7.24	22.39	7.95	19.92	7.60	**.008***	**0.56**†	.434	0.24	.332	0.32
Emotion dysregulation: DERS												
Non acceptance emotions	12.92	6.11	13.33	6.29	14.11	7.19	.728	0.07	.477	0.18	.674	0.12
Goal directed behaviour	12.71	4.61	13.20	4.24	14.23	5.30	.621	0.11	.277	0.31	.506	0.22
Impulse control difficulties	11.82	4.14	12.20	6.05	16.81	6.75	.701	0.07	**.001***	**0.89**†	**.004***	**0.72**†
Lack emotional awareness	16.36	4.92	16.11	4.21	13.59	4.74	.814	0.05	.069	**0.57**†	.137	**0.56**†
Limited access emotion regul.	16.78	6.43	18.23	8.29	19.72	7.66	.247	0.20	.102	0.42	.456	0.19
Lack of emotional clarity	12.16	3.95	12.31	3.95	10.61	5.02	.846	0.04	.161	0.34	.168	0.37
Total score	82.76	22.76	85.38	26.58	89.08	28.23	.513	0.11	.269	0.25	.561	0.14
Impulsivity: UPPS-P												
Lack of premeditation	22.40	5.30	23.98	4.82	25.35	4.30	.200	0.31	.095	**0.61**†	.485	0.30
Lack of perseverance	20.72	4.59	22.51	3.47	20.94	6.47	.102	0.44	.887	0.04	.366	0.30
Sensation seeking	33.93	6.65	33.10	7.89	32.55	8.88	.610	0.11	.551	0.18	.830	0.07
Positive urgency	28.26	8.49	30.05	11.72	31.13	10.58	.383	0.17	.326	0.30	.739	0.10
Negative urgency	26.89	6.77	28.75	6.75	34.24	8.29	.217	0.27	**.001***	**0.97**†	**.023***	**0.73**†

Note. FA: food addiction. SD: standard deviation. *Bold: significant comparison (.05 level).

†Bold: effect size into the mild-moderate (|*d*|>0.50) to the high-large range (|*d*|>0.80).

Table 2 *Predictive model of the food addiction severity group: multinomial logistic regression adjusted by eating severity, sex and age*

	FA-probable vs FA-absent				FA-present vs FA-absent				FA-present vs FA-probable			
	B	*SE*	*p*	*OR*	*B*	*SE*	*p*	*OR*	*B*	*SE*	*p*	*OR*
First block (covariates)												
Sex (0=Female; 1=Male)	-0.650	0.721	.367	0.522	0.005	1.225	.997	1.005	0.655	1.345	.626	1.925
Age (years-old)	0.199	0.146	.172	1.221	-0.442	0.438	.312	0.643	-0.642	0.443	.147	0.526
Eating severity: EDI-total	-0.002	0.011	.850	0.998	0.004	0.020	.834	1.004	0.006	0.021	.766	1.006
ΔR^2= .130												
Second block												
UPPS-P Negative urgency	0.060	0.062	.332	1.061	0.323	0.109	**.003***	1.382	0.264	0.116	**.023***	1.302
UPPS-P Positive urgency	-0.007	0.045	.884	0.993	-0.170	0.074	**.022***	0.844	-0.163	0.079	**.039***	0.849
DEBQ Emotional	0.059	0.031	.057	1.061	0.129	0.050	**.010***	1.138	0.070	0.049	.152	1.072
DEBQ Restrained	0.080	0.035	**.022***	1.084	0.080	0.068	.236	1.084	0.000	0.070	.998	1.000
ΔR^2= .156												
Model fitting	Deviance chi-square test: χ^2=145.578, *p*=.998											
	-2 Log Likelihood: Intercept only = 203.942; Final = 145.578											
	Likelihood Ratio Test: χ^2=58.364, p<.001											

Note. FA: food addiction. *Bold: significant parameter (.05 level). Stepwise procedure.

ΔR^2: increase/change in Nagelkerke's pseudo R^2 coefficient. Sample size: *n*=160.

Figure legends

Figure 1 *Radar-chart (z-standardized means are plotted) (n=160)*

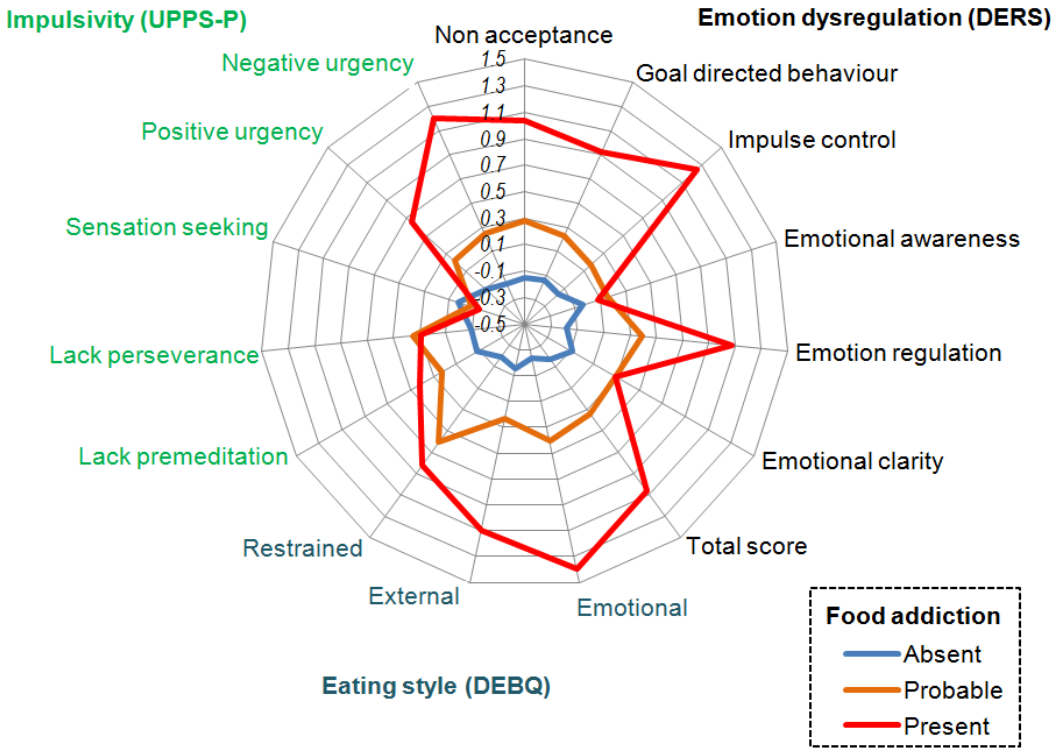

Figure 2 *SEM: standardized coefficients*

Note. Continuous line: significant parameter ($p \leq 0.05$). Dash line: non-significant parameter ($p > 0.05$).

Sample size: *n=160*