Clinical Features of Gambling Disorder Patients with and without Food Addiction: Gender-related Considerations

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ABSTRACT

Background: Although food addiction (FA) is a debated condition and it is not currently recognized as a formal diagnosis, it shares features with other addictions, such as gambling disorder (GD)**.** However, the prevalence of FA in GD and the clinical correlates are incompletely understood, especially within women versus men. **Objectives:** To investigate FA in patients presenting with GD. **Method:** The sample included 867 patients diagnosed with GD (798 males and 69 females) attending a specialized behavioral addictions unit. **Results:** FA was observed in 8.3% of GD patients (18.8% of women, 7.4% of men). More psychopathology and harm avoidance, greater body mass indices and less self-directedness and cooperativeness were associated with FA. In women, FA was associated with a longer GD duration. In men, FA was associated with earlier GD onset, greater GD and problematic alcohol use severities. **Conclusion:** Among patients with GD, FA was associated with more psychopathology and gambling patterns suggestive of more protracted or severe GD. Screening for and addressing FA condition in patients with GD may help optimize preventive and therapeutic approaches. Future studies should consider testing guidelines to improve healthy eating habits, increase physical exercise and better manage stress and other negative emotions in order to target FA in GD.

***Keywords*:** Addictive behaviors; food addiction; gambling disorder; alcohol; gender;

INTRODUCTION

Gambling disorder (GD) is considered a behavioral addiction and defined as a persistent and recurrent maladaptive pattern of gambling behavior associated with impaired functioning in personal, social, and occupational domains (American Psychiatric Association, 2013; Fauth-Bühler et al., 2017; Marc N. Potenza et al., 2019). GD frequently co-occurs with other psychiatric disorders including substance use, mood, anxiety and personality disorders (Grant & Chamberlain, 2015; Karlsson et al., 2019; Kim et al., 2018; Petry et al., 2005; Tackett et al., 2017). Although food addiction (FA) is not a formal diagnostic entity, a possible association between GD and FA has been suggested (Jiménez-Murcia et al., 2017). The prevalence of FA has been estimated at 7.8% in individuals with GD, and an association between body mass index (BMI) and FA symptomatology has been described for patients with GD (Granero, Jiménez-Murcia, et al., 2018).

At least two frameworks have been proposed when conceptualizing FA: addictive-like eating and substance-based addiction models (Fernandez-Aranda et al., 2018; Hebebranda et al., 2014; Schulte et al., 2017). This lack of consensus may in part contribute to FA not being considered as a formal mental disorder in the current editions of the Diagnostic and Statistical Manual (DSM-5) or the International Classification of Diseases (ICD-11) (APA, 2013; WHO, 2020). The substance-based addiction framework purports that some foods, especially palatable ones with large amounts of processed sugars and fats, may promote both overeating and addictive-like behaviors by activating brain reward systems (Schulte et al., 2015a). Therefore, FA may show similarities with other addictions, such as substance use disorders (SUDs) (Gearhardt et al., 2011; Schulte et al., 2015b). Proposed similarities include a preoccupation with obtaining the desired substance, the development of tolerance, abstinence, excessive use, difficulties reducing consumption despite negative physical and psychological consequences and similar neural processes (Carter & Davis, 2010; Gearhardt et al., 2011; Volkow et al., 2011,Fletcher & Kenny, 2018; Gordon et al., 2018; Pursey et al., 2019).

Given GD's classification as a behavioral addiction, common features between FA and GD may exist (Jiménez-Murcia et al., 2017). Both are associated with difficulties in controlling behavior (Hardy et al., 2018; Saunders et al., 2017), impulsivity (Kandeger et al., 2019; Mestre-Bach, Steward et al., 2020), and impaired executive functions (Mestre-Bach, Fernández-Aranda, et al., 2020a; Steward et al., 2018). As with GD, psychopathology has been associated with FA (Burrows et al., 2018; Jiménez-Murcia et al., 2019). Finally, GD and FA may involve maladaptive emotional regulation, engaging in gambling or eating for negative reinforcement motivations; i.e., to alleviate negative emotions (Innamorati et al., 2017; Mestre-Bach, Fernández-Aranda, et al., 2020b).

Differences between GD and FA have also been described. For example, GD is more frequently observed among men, although the gender gap appears to be narrowing (Abbott et al., 2018; Subramaniam et al., 2015). Gender-related differences in types of gambling, age of onset and other features have been reported in GD (Zakiniaeiz et al., 2017). In contrast, FA is more frequently observed among women (Pursey et al., 2014). Women as compared with men are also more likely tendencies to engage in addictive behaviors and eating for negative reinforcement motivations that include coping with stress, depression and anxiety (Zakiniaeiz & Potenza, 2018). Thus, there is a need to consider gender in understanding how FA may relate to clinical features in GD patients.

Although these two clinical entities have begun to be studied together, gender, personality traits and psychopathology have been scarcely investigated in GD individuals with and without FA. Therefore, the present study aimed to assess the clinical correlates of FA among GD patients,

considering personality features, psychological state or substance consumption. Given potential gender-related differences, relationships were also examined in men and women separately. Our main hypothesis is that the presence of FA among GD would be associated with worse clinical profiles, greater psychopathology and more severe GD. We also anticipated more frequent FA among women (versus men) with GD.

METHODS

Participants:

The study sample consisted of 867 GD patients including 798 men and 69 women. Participants were referred for treatment to the Pathological Gambling Unit in the Psychiatry Department at a General University Hospital, in Spain, between May of 2016 and June of 2020. This hospital is part of the Spanish Public Assistance Network and of a Public University Campus, having its own research institute. It is the local reference center for a population of around 343,000 inhabitants and the territorial tertiary reference center for more than 2 million people. Participants were diagnosed according to the DSM-5 (American Psychiatric Association, 2013) criteria for GD by clinical psychologists and psychiatrists with more than 20 years of experience in the field of behavioral addictions and eating disorders. None met DSM-5 diagnostic criteria for any current eating disorder.

Measures:

The South Oaks Gambling Screen (SOGS) (Lesieur & Blume, 1987) is a 20-item screen for problem gambling behaviors and consequences during the prior twelve months. The total score reflects problem gambling severity, with a score of 4 or more indicating problem gambling. The Spanish validation of the scale achieved very good psychometric results in the adaptation study (test-retest reliability $R = 0.98$, internal consistency $\alpha = 0.94$ and convergent validity $R = 0.92$) (Echeburúa et al., 1994). The internal consistency for this scale in the study sample was adequate ($\alpha = 0.74$).

The Diagnostic Questionnaire for Pathological Gambling (Stinchfield, 2003) is a self-report questionnaire with 19 items coded in a binary fashion (yes-no) that permits assessing DSM-IV (American Psychiatric Association, 2010) and DSM-5 (American Psychiatric Association, 2013) diagnostic criteria for GD. It was used in the present study for assessing GD. Based on the DSM-5 taxonomy, several GD-related measures may be generated: the presence/absence of each DSM inclusion criterion, the presence/absence of GD diagnosis, a dimensional measure of problem gambling severity (total number of DSM criteria, obtained as the sum of the individual criteria), and GD severity grouped in four levels [non-problem gambling (0 criteria), problem gambling (for 1–3 criteria), mild GD (4–5 criteria), moderate GD (6–7 criteria) and severe GD (8–9 criteria)]. The Spanish adaptation of the questionnaire obtained satisfactory psychometric properties: internal consistency with a Cronbach's alpha equal to 0.95 for the combined sample, satisfactory convergent validity (moderate to large correlations with other measures of problem gambling severity), and high discriminative capacity (sensitivity = 0.92 and specificity = 0.99) (S. Jiménez-Murcia et al., 2009). The internal consistency for this scale in the study sample was good ($\alpha = 0.80$).

The Symptom Checklist-90-Revised (SCL-90-R) (Derogatis, 1994) is a 90-item self-report questionnaire measured on an ordinal 3-point scale that evaluates a broad range of psychological problems and symptoms of psychopathology by measuring nine primary symptom dimensions: Somatization, Obsession-Compulsion, Interpersonal Sensitivity, Depression, Anxiety, Hostility, Phobic Anxiety, Paranoid Ideation, and Psychoticism. It includes three global ratings, named global severity index (overall psychological distress), positive symptom distress index (the intensity of symptoms), and positive symptom total (self-reported symptoms). The global severity index can be used as a summary of the test. The validation of the scale in a Spanish population (Derogatis, 2002) obtained a mean internal consistency of 0.75 (coefficient alpha).

The internal consistency in the study was excellent for the global ratings (α = 0.98) and the one for the subscales range from adequate to excellent (α = 0.80 for Paranoid Ideation to α = 0.92 for Depressive).

The Temperament and Character Inventory-Revised (TCI-R) (Cloninger, 1999) is a questionnaire with 240 items scored on a 5-point Likert scale, which measures personality factors related to three character dimensions (Self-Directedness, Cooperativeness, and Self-Transcendence) and four temperament dimensions (Harm Avoidance, Novelty Seeking, Reward Dependence and Persistence). Evaluation of the Spanish revised version (Gutiérrez-Zotes et al., 2004) had an internal consistency of 0.87 (coefficient alpha). The internal consistency in this study for the subscales ranged from adequate to very good (α = 0.70 for Novelty Seeking to α = 0.87 for Self-Directedness).

The Yale Food Addiction Scale 2.0 (YFAS-2) (Gearhardt et al., 2016) is a 35-item self-report questionnaire for measuring FA during the prior year. The original 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 YFAS-2 is based on DSM-5 criteria for SUDs (American Psychiatric Association, 2013) and evaluates 11 symptoms. Two measurements may be calculated: (a) a continuous symptom count score reflecting the number of fulfilled criteria (ranging from 0 to 11), and (b) a FA 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 FA (present versus absent). Based on the revised DSM-5 taxonomy, it is possible to establish severity cut-offs: mild (2–3 symptoms), moderate (4–5 symptoms), and severe (6–11 symptoms). The Spanish validation of the YFAS-2 (Granero, Jiménez-Murcia, et al., 2018) generated an internal consistency of 0.94 (coefficient alpha). In this study, internal consistency for the total score was excellent (α = 0.96).

The Alcohol Use Disorders Identification Test (AUDIT) (Saunders et al., 1993) is a 10-item screening questionnaire for hazardous alcohol consumption. It includes questions about the amount and frequency of drinking, alcohol dependence, and problems caused by alcohol. A score of 8 or more is considered to indicate harmful alcohol use and a score of 12 or more in women (15 or more in men) is likely to indicate alcohol dependence. This questionnaire has shown adequate validity in Spanish samples (Delgado, 1996).

The Drug Use Disorders Identification Test (DUDIT) (Berman et al., 2003) is an 11-item self-administered instrument to identify non-alcohol drug use patterns and related problems in individuals likely to meet criteria for a substance dependence diagnosis. The total score can range from 0 to 44 (as a result of the sum of the 11 items scored from 0 to 4); higher scores reflect more severe drug use problem. The first nine items are scored on a 5-point Likert scale ranging from 0 to 4, and the last two are scored on 3-point scales (values of 0, 2, and 4).

Other variables, including sociodemographic variables and other gambling-related measures (e.g. age of onset and duration), were obtained via face-to-face clinical interviews. The interviews also assessed participants' educational attainment. Socioeconomic status was assessed using the Hollingshead Four Factor Index of Socioeconomic Status (Hollingshead, 2011).

Procedure:

All participants in our sample voluntarily sought treatment for GD. Experienced psychologists and psychiatrists conducted two face-to-face clinical interviews, before and after completing study instruments. The first visit was a clinical interview, in which the medical/psychiatric history was assessed, and the subsequent visit consisted of an interview to report the results of the tests and information about the treatment, according to their clinical characteristics and factors associated with GD.

The participants included in this study met criteria for GD and did not present other comorbid behavioral addictions and did not receive any compensation for participating in the study.

Statistical analyses:

Statistical analysis was conducted with Stata16 for Windows (Stata-Corp, 2019). Between-group comparisons for personality (TCI-R), psychopathology (SCL-90R), substance use and BMI measures were based on analysis of variance adjusted for age (ANCOVA) (gender was not considered as a covariate because results stratified for men and women were obtained). Effect sizes for mean differences were estimated through Cohen's *d* coefficient, poor-low for $|d|>0.20$, mild-moderate for $|d|>0.50$ and large-high for $|d|>0.80$ (Kelley et al., 2012). Between-group comparisons for categorical variables were based on logistic regression also adjusted for age. Type-I error related to multiple comparisons was controlled using the Finner's method, a family-wise procedure with higher power than a Bonferroni correction (Finner & Roters, 2001).

Path analysis was used to assess the set of relationships between gender, age, the personality domains of self-directedness and harm avoidance, FA severity, global psychopathological distress and gambling preference. Path analysis constitutes an extension of multiple regression modeling, used with the aim of estimating magnitudes and significance of simultaneous associations in a set of variables, including direct and indirect effects (mediational links) (Kline, 2005). This technique is currently used for both exploratory and confirmatory purposes, and therefore it contributes to theory testing and theory development (MacCallum & Austin, 2000). This study modeled path analyses through structural equation modeling (SEM), with the maximum-likelihood estimation method. Goodness of fit was assessed with standard indexes, and it was considered adequate fitting (Barrett, 2007) for: non-significant result in the chi-square test ($|^2$), root mean square error of approximation RMSEA<0.08, Bentler's Comparative Fit Index CFI>0.90, Tucker-Lewis Index TLI>0.90, and standardized root mean square residual SRMR<0.10. Global predictive capacity was estimated with the coefficient of determination (CD).

Ethics:

The present study was conducted in accordance with the latest version of the Declaration of Helsinki. The General University Hospital Clinical Research Ethics Committee approved the study, and signed informed consent was obtained from all participants (Ref: PR329/19).

RESULTS

Sample characteristics

Most patients were single (*n*=454, 52.4%) or married (*n*=313, 36.1%), achieved primary (*n*=460, 53.1%) or secondary (*n*=331, 38.2%) education levels, were of medium-low or low socioeconomic status (*n*=723, 83.4%) and were employed (*n*=527, 60.8%). Mean age was 40.5 years (SD=13.8). Most patients reported only non-strategic gambling (*n*=449; 51.8%), and 26.1% (*n*=226) and 22.1% (*n*=192) reported only strategic gambling and both gambling forms, respectively. Strategic gambling activities are those where the gambler can use knowledge of the game to influence or predict the outcome, while nonstrategic gambling implies little or no possibility of influencing the outcome (Potenza et al., 2001). The gambling activity reported as the main reason for seeking treatment in the sample was slot-machines (60.1%), followed by casino or gambling saloons (24.7%), sports-betting (16.0%), and lotteries (14.4%).

Comparison between patients with positive versus negative FA screening

Seventy-two participants (8.3%) screened positive for FA. FA was observed among 18.8% of women and 7.4% of men. Table 1 contains the comparison for individuals with negative versus positive FA screening, stratified by gender (separate comparisons were performed for women and men due the potential moderator role of gender). Among women, FA was associated with harm avoidance, less self-directedness and cooperativeness, greater psychopathology and higher BMI. Among men, FA was associated with harm avoidance and self-transcendence, less self-

directedness and cooperativeness, greater psychopathology, greater alcohol use problem severity and higher BMI.

--- Insert Table 1 ---

Table 2 includes the prevalence of patients outside the normative ranges for the main psychological variables of the study (estimates represent proportions of participants in subclinical or clinical severity levels). Among women, FA was associated with obesity, greater psychopathology and more self-directedness. Among men, FA was associated with higher GD severity, obesity, greater psychopathology, more self-directedness and harm avoidance and less cooperativeness.

--- Insert Table 2 ---

Table S1 (supplementary) contains the comparison between patients with negative versus positive FA screening for socio-demographics, gambling profile, and problem gambling severity measured as the total number of DSM-5 criteria for GD and SOGS scores. Among women, FA was associated with lower socioeconomic status, unemployment, non-strategic gambling preference, and longer durations of gambling problems. Among men, FA was associated with higher socioeconomic status, greater GD severity and earlier age of onset of gambling.

Figure 1 displays a radar chart with the profiles related to FA, separately for women and men. Standardized scores are plotted in this graphic to allow easy interpretation as original scales had different ranges.

--- Insert Figure 1 ---

Path analysis

Figure 2 displays a path diagram with standardized coefficients obtained in the path analysis (Table S2 includes the complete results for this model, including tests for direct, indirect and total effects). Only significant coefficients were retained in the final model. Only two personality domains were retained (self-directedness and harm avoidance) because the other TCI-R scales did not achieve significant effects. Adequate goodness-of-fit was achieved: χ^2=10.71 (p=.296), RMSEA=0.015 (95% confidence interval: 0.001 to 0.043), CFI=0.999, TLI=0.997, and SRMR=0.019. Global predictive capacity was also good (CD=0.299).

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FA severity level (defined as the YFAS-2 total score) was higher for women and participants with lower self-directedness scores and higher harm avoidance level. Both personality domains also showed mediational links between gender and age with FA severity: being female was associated with decreased self-directedness and increased harm avoidance, while older age was associated with increased harm avoidance. Path analysis also suggested that FA levels led to higher psychopathology, which also was directly related to lower self-directedness and higher harm avoidance. Gambling preference was also directly related to age, with older age linked to preferences for non-strategic gambling.

DISCUSSION

The present work studied among GD patients clinical features associated with FA in women and men. The prevalence of FA in the total sample was 8.3% (18.8% among women, 7.4% among men). Although no relation between FA and age was found, significant differences in socio-economic level and employment state were evidenced only among women. Additionally, women with FA to be of lower socioeconomic status and unemployed. Higher scores in general psychopathology and certain personality traits, namely higher harm avoidance and lower self-directedness and cooperativeness, were found in both genders. However, men with FA presented higher self-transcendence, although a numerical difference in the same direction with a similar effect size was observed in women, suggesting a similar relationship in the smaller female sample. Relationships between FA and longer duration of GD in women and between FA and both severities of GD and problematic alcohol use in men were observed. Regardless of gender,

FA was associated with a higher BMI and obesity. Association between FA and types of gambling were largely negligible. Implications are discussed below.

Although a higher prevalence of GD is described in men than women (Blanco et al., 2006; Husky et al., 2015), previous studies have reported that women are more likely to engage in FA behaviors (Schulte & Gearhardt, 2018) and experience abnormal eating and weight disorders (Jiménez-Murcia et al., 2019; Romero et al, 2019; Schulte & Gearhardt, 2018), with initial studies suggesting similar relationships in patients with GD (Granero et al., 2018; Jiménez-Murcia et al., 2017). Lower socioeconomic status has been associated with GD severity among women (Jiménez-Murcia et al., 2020). Higher psychopathology, particularly depressive and anxiety symptoms, and some specific personality features, such as low self-directedness and perseverance or high reward dependence, have been linked to FA in both medical and mental conditions (Brunault et al., 2018; Imperatori, 2014; Wolz et al., 2016). FA may impact global health, with a special influence on BMI and overweight/obesity (Murphy et al., 2014; Meseri et al., 2020). Our findings among GD patients suggest a poor socioeconomic context and work difficulties (e.g., unemployment), higher emotional vulnerability (e.g., anxiety and depressive symptoms, particularly for women) and poor adaptive coping strategies to deal with stress (e.g., higher harm avoidance and lower self-directedness and cooperativeness) may characterize GD patients with FA.

Both men and women with GD and FA appear to fit the emotionally vulnerable subtype from the pathway model proposed by Blaszczynski and Nower (2002), and also within the cluster 2-3 (moderate-functional clusters) described among FA individuals with obesity by Jiménez-Murcia (2019). In this group of patients, gambling and eating behaviors might represent potential elements of addiction as these behaviors are seen as strategies to relieve emotional discomfort they may experience in daily situations, usually perceived as threatening and stressful, or which they may not have the proper skills to manage adequately. Therefore, the identification of a vulnerable clinical profile at baseline among GD patients with FA suggests a need for early systematic identification of FA by clinicians. Although both genders have similarities, this subtype may be especially important among women, who appear more likely to experience FA, overweight/obesity and fewer socio-economic resources. Moreover, the creation and/or optimization of specific and individualized social and therapeutic approaches are needed, taking into account that the lack of social support, economic difficulties or physical limitations (e.g., related to obesity) may result in decreased access to medical services. As suggested in previous studies (Jiménez-Murcia et al., 2019), some approaches may target better nutritional and weight management, but also emotional regulation and problem-solving strategies to cope with stress may also be needed.

To the best of our knowledge, this is the first study that analyzes clinical correlates of FA in GD patients from a gender-informed perspective. The results suggest a negative influence of FA on GD prognosis that are both similar across genders and differ by gender. With respect to the latter, a longer duration of the GD was associated with FA in women, and in men, FA was associated with an earlier age of onset and higher severities of GD and problematic alcohol use. Of note, some of these differences (particularly with respect to relationships with GD severity) may also pertain to women, as evidenced by largely similar effect sizes and the smaller sample of women.

The clinical characteristics associated with FA have been reported as having deleterious impacts on the course of GD (del Pino-Gutiérrez et al., 2017; Susana Jiménez-Murcia et al., 2016; Valero-Solís et al., 2018). Low socioeconomic status or co-occurring psychopathology (e.g. depression, anxiety) may be particularly relevant to FA in women with GD. These factors could delay medical consultation for GD, resulting in a longer duration of GD when receiving a GD diagnosis. In the case of men, early age of gambling onset and problematic alcohol use appear particularly relevant. Previous studies have reported a relationship between FA and tobacco use among a male predominant sample with GD (Jiménez-Murcia et al., 2017). Apart from gambling

and food, men with GD and FA may also use alcohol as a mechanism to cope with stress and negative emotions.

FA was more prevalent among women (versus men) with GD. These results suggest that assessing for FA in treatment-seeking individuals with GD may be particularly helpful for women's health and useful in general for identifying vulnerable patients presenting with the potential for worse courses of GD. The detection and simultaneous treatment of co-occurring psychiatric concerns among GD patients is important. Our findings suggest that the design of specific protocols to detect FA is needed, as is the testing of treatment approaches used in other care settings for addressing FA in GD populations.

In considering the pathway analyses, relationships between gender and personality features with appear mediated by FA. Therefore, the results reinforcement the interpretations of a specific vulnerable group of GD patients (i.e., women with dysfunctional personality features) in whom FA may represent a maladaptive way of dealing with higher levels of psychological distress. Similar conclusions may extend to GD, as has been also proposed previously (Di Trani et al., 2017; Jiménez-Murcia et al., 2017), with poor emotional regulation contributing importantly to behavioral addictions (Estévez et al., 2017; Mestre-Bach, Fernández-Aranda, et al., 2020b). In this sense, the detection of FA among GD patients could lead to a greater emphasis on approaches to improve emotional regulation (e.g., with mindfulness-based or stress-reduction treatments) within GD treatment. The acquisition of adaptive emotional skills may be translated into a better stress management and reduced gambling and eating to manage such negative states.

A relationship between age and gambling preferences was found, with preferences for non-strategic gambling with older age, consistent with prior findings (Marc N. Potenza, Steinberg, et al., 2006). Among patients with FA the relationship with GD subtype was only indirect, and specifically in females. This result is consistent with previous works regarding GD samples (Assanangkornchai et al., 2016; Odlaug et al., 2011). Men (particularly younger ones) tend to prefer and have problems with strategic gambling, whereas women (particularly older ones) tend to prefer and have problems with non-strategic gambling (Moragas et al., 2015; Odlaug et al., 2011; M. N. Potenza et al., 2001; Potenza et al., 2006; Stevens & Young, 2010).

Strengths of this study, such as the large clinical sample, should be mentioned. To date, this is the first study to consider FA in GD patients in a gender-sensitive manner. As the sample consisted of patients treated at a specific unit, assessments were consistently conducted. However, study must limitations should also be mentioned. For instance, the treatment-seeking sample was from a region of Spain; as such, the findings may not generalize to non-clinical samples or those from other jurisdictions. The use of self-report assessments for psychiatric conditions may decrease reliability. Future studies should consider alternate assessments (e.g., structured clinical interviews). However, as FA remains a debated construct, its evaluation with a self-report measure is presently most reasonable.

CONCLUSIONS

In conclusion, this study characterizes the clinical profile of GD patients with and without FA from a gender-informed perspective. GD patients, especially women, with specific personality characteristics and psychopathology may be particularly prone to FA. Further, a lower socioeconomic status may also be relevant for women with GD to experience FA. Speculatively, the findings taken together suggest that GD patients may engage in FA behaviors to manage high levels of psychological distress. Alcohol and consumption, early age of onset, and severity of GD may contribute to a worse GD prognosis in the presence of FA, particularly in men. In women, a longer duration of GD was linked to FA, suggesting the need for enhancing early intervention efforts to improve women's health. Therefore, these results support the existence of a specific vulnerable group of GD patients and suggest the relevance of designing specific screening and treatment protocol to address FA in GD patients. Further studies are necessary to increase knowledge about FA and its influence not only in GD, but also in other addictive

disorders and mental health conditions. Addressing areas such as underlying mechanisms and neurobiological factors related to FA could be helpful for a better understanding of this condition and its clinical relevance.

Authors' Contribution

ME, IB, LM, GM-B and SJ-M contributed to the development of the study concept and design. RG performed the statistical analysis. ME, IB, MG-P, LM, AP-G, EC, BM-M and EV-M aided with data collection. ME, IB, LM, GM-B and SJ-M aided with interpretation of data and the writing of the manuscript. MNP, ANG, FF-A, and SJ-M revised the manuscript and provided substantial comments. FF-A and SJ-M obtained funding.

Funding Sources

First, we thank CERCA Programme / Generalitat de Catalunya for institutional support. This work was additionally supported by grants from the Ministerio de Ciencia, Innovación y Universidades (grant RTI2018-101837-B-100) and the Delegación del Gobierno para el Plan Nacional sobre Drogas (2017I067 and 2019I47), Instituto de Salud Carlos III (ISCIII) (PI17/01167) and co-funded by FEDER funds/European Regional Development Fund (ERDF), a way to build Europe. CIBERObn is an initiative of ISCIII. IB was partially supported by a Post-Residency Grant from the Research Committee of the University Hospital of Bellvitge (HUB; Barcelona, Spain) 2019-2020. LM is supported by a postdoctoral grant of the mexican institution Consejo Nacional de Ciencia y Tecnología (CONACYT). GMB was supported by a postdoctoral grant from FUNCIVA. The funders had no role in the study design, data collection and analysis, decision to publish or preparation of the manuscript. Dr. Potenza involvement was supported by the Connecticut Department of Mental Health and Addiction Services, the Connecticut Council on Problem Gambling and the National Center for Responsible Gaming.

Conflicts of Interest

Dr. Potenza has consulted for and advised Game Day Data, the Addiction Policy Forum, AXA, Idorsia, and Opiant Therapeutics; has received research support from the Veteran's Administration, Mohegan Sun Casino, and the National Center for Responsible Gaming (no the International Center for Responsible Gambling); has participated in surveys, mailings, or telephone consultations related to addictions, impulse-control disorders or other health topics; has consulted for law offices and the federal public defender's office in issues related to impulse-control and addictive disorders; has provided clinical care in the Connecticut Department of Mental Health and Addiction Services Problem Gambling Services Program; has performed grant reviews for the National Institutes of Health and other agencies; has edited journals and journal sections; has given academic lectures in grand rounds, CME events and other clinical/scientific venues; and has generated books or chapters for publishers of mental health texts. Other authors report no disclosures.

Ethics

The present study was carried out in accordance with the latest version of the Declaration of Helsinki. The Bellvitge University Hospital Clinical Research Ethics Committee approved the study, and signed informed consent was previously obtained from all participants (Ref: PR329/19).

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Table 1. *Associations between FA and clinical variables with the FA measures*

	Women						Men					
	FA– *(n=56)*		FA+ *(n=13)*				FA– *(n=739*		FA+ *(n=59)*			
	Mean	*SD*	*Mean*	*SD*	*p*	|*d*|	*Mean*	*SD*	*Mean*	*SD*	*p*	|*d*|
TCI-R Novelty seeking	108.3	12.2	106.4	8.8	.585	0.19	110.9	13.0	111.8	12.5	.371	0.07
TCI-R Harm avoidance	108.2	17.4	118.3	17.2	**.046***	**0.59†**	98.4	15.8	107.4	15.4	**.001***	**0.58†**
TCI-R Reward depend.	101.1	14.7	99.8	10.6	.763	0.11	97.3	13.8	95.4	16.1	.324	0.12
TCI-R Persistence	105.5	18.1	103.4	21.7	.729	0.10	108.2	18.5	105.1	22.7	.228	0.15
TCI-R Self-directedness	128.4	20.6	108.8	18.7	**.003***	**1.00†**	130.4	21.2	117.4	18.8	**.001***	**0.65†**
TCI-R Cooperativeness	137.7	12.2	129.3	13.8	**.035***	**0.65†**	129.6	15.6	122.9	18.8	**.002***	0.39
TCI-R Transcendence	62.7	13.7	67.4	11.2	.255	0.38	61.2	14.1	67.7	14.7	**.001***	0.46
SCL-90R Somatization	1.40	0.90	2.34	0.89	**.001***	**1.05†**	0.89	0.76	1.54	0.99	**.001***	**0.75†**
SCL-90R Obsessive/comp.	1.32	0.87	2.16	0.99	**.004***	**0.90†**	1.11	0.77	1.93	0.93	**.001***	**0.97†**
SCL-90R Interp. sensitive	1.21	0.85	2.32	0.84	**.001***	**1.32†**	0.97	0.80	1.74	0.95	**.001***	**0.87†**
SCL-90R Depressive	1.87	1.00	2.74	0.82	**.005***	**0.95†**	1.50	0.92	2.20	0.93	**.001***	**0.75†**
SCL-90R Anxiety	1.20	0.84	2.06	0.72	**.001***	**1.10†**	0.97	0.78	1.59	0.98	**.001***	**0.69†**
SCL-90R Hostility	0.90	0.78	1.67	0.73	**.002***	**1.02†**	0.94	0.84	1.53	1.10	**.001***	**0.61†**
SCL-90R Phobic anxiety	0.54	0.51	1.25	1.09	**.001***	**0.85†**	0.42	0.61	0.97	0.90	**.001***	**0.73†**
SCL-90R Paranoid	1.09	0.84	2.21	0.86	**.001***	**1.32†**	0.94	0.80	1.60	0.99	**.001***	**0.74†**
SCL-90R Psychotic	0.98	0.82	1.68	0.70	**.007***	**0.92†**	0.89	0.75	1.57	0.95	**.001***	**0.80†**
SCL-90R GSI score	1.28	0.72	2.13	0.65	**.001***	**1.24†**	1.03	0.68	1.72	0.83	**.001***	**0.91†**
SCL-90R PST score	51.20	20.16	65.91	15.96	**.018***	**0.81†**	46.42	21.96	62.03	18.86	**.001***	**0.76†**
SCL-90R PSDI score	2.08	0.60	2.89	0.61	**.001***	**1.33†**	1.85	0.56	2.37	0.71	**.001***	**0.82†**
Tobacco (cigarettes/day)	9.91	11.51	7.55	13.77	.531	0.19	9.45	10.90	9.31	13.12	.925	0.01
Alcohol (AUDIT total)	2.41	4.01	1.06	1.87	.254	0.43	5.20	5.68	7.25	8.31	**.011***	0.29
Drugs (DUDIT total)	1.25	4.02	0.10	0.00	.320	0.40	2.75	6.61	3.80	8.18	.247	0.14
Body mass index (kg/m^2)	27.43	5.96	33.43	6.89	**.002***	**0.93†**	26.08	4.35	30.34	6.87	**.001***	**0.74†**

Note. SD: standard deviation. FA–: food addiction negative screening. FA+: food addiction positive screening.

TCI-R: Temperament and Character Inventory – Revised.

SCL-90R: Symptom Checklist-90-Revised.

AUDIT: Alcohol Use Disorders Identification Test.

DUDIT: Drug Use Disorders Identification Test.

*Bold: significant parameter (.05 level). †Bold: effect size into the range mild-moderate (|*d*|>0.50) to large-high (|*d*|>0.80) .

Results adjusted by the covariate age.

Table 2. *Comparison of clinical measures by gender and FA status*

	Women						Men					
	FA– *(n=56)*		FA+ *(n=13)*				FA– *(n=739)*		FA+ *(n=59)*			
	n	*%*	*n*	*%*	*P*	|*d*|	*n*	*%*	*n*	*%*	*p*	|*d*|
GD (8-9 DSM-5 criteria)	30	53.6%	8	61.5%	.603	0.16	354	47.9%	42	71.2%	**.001***	**0.51†**
Obesity (BMI>30)	18	32.1%	9	69.2%	**.014***	**0.76†**	129	17.5%	32	54.2%	**.001***	**0.79†**
SCL-90R Somatization	22	39.3%	10	76.9%	**.013***	**0.78†**	288	39.0%	41	69.5%	**.001***	**0.62†**
SCL-90R Obsessive/comp.	24	42.9%	10	76.9%	**.027***	**0.71†**	304	41.1%	46	78.0%	**.001***	**0.77†**
SCL-90R Interp. sensitive	30	53.6%	11	84.6%	**.040***	**0.69†**	323	43.7%	48	81.4%	**.001***	**0.80†**
SCL-90R Depressive	30	53.6%	12	92.3%	**.010***	**0.94†**	439	59.4%	47	79.7%	**.001***	**0.50†**
SCL-90R Anxiety	17	30.4%	10	76.9%	**.002***	**0.97†**	321	43.4%	41	69.5%	**.001***	**0.53†**
SCL-90R Hostility	14	25.0%	10	76.9%	**.001***	**1.09†**	207	28.0%	31	52.5%	**.001***	**0.51†**
SCL-90R Phobic anxiety	13	23.2%	7	53.8%	**.028***	**0.64†**	196	26.5%	37	62.7%	**.001***	**0.75†**
SCL-90R Paranoid	23	41.1%	11	84.6%	**.005***	**0.94†**	219	29.6%	36	61.0%	**.001***	**0.64†**
SCL-90R Psychotic	30	53.6%	12	92.3%	**.010***	**0.94†**	363	49.1%	45	76.3%	**.001***	**0.57†**
SCL-90R GSI score	31	55.4%	13	100.0%	**.003***	**1.46†**	419	56.7%	50	84.7%	**.001***	**0.63†**
SCL-90R PST score	35	62.5%	11	84.6%	.128	**0.51†**	420	56.8%	48	81.4%	**.001***	**0.54†**
SCL-90R PSDI score	8	14.3%	8	61.5%	**.001***	**1.03†**	160	21.7%	31	52.5%	**.001***	**0.65†**
TCI-R Novelty seeking	30	53.6%	4	30.8%	.138	0.47	324	43.8%	22	37.3%	.328	0.13
TCI-R Harm avoidance	28	50.0%	7	53.8%	.803	0.08	263	35.6%	33	55.9%	**.002***	0.41
TCI-R Reward depend.	21	37.5%	6	46.2%	.565	0.18	260	35.2%	25	42.4%	.267	0.15
TCI-R Persistence	16	28.6%	6	46.2%	.220	0.37	267	36.1%	25	42.4%	.338	0.13
TCI-R Self-directedness	41	73.2%	12	92.3%	.142	**0.53†**	465	62.9%	47	79.7%	**.010***	0.37
TCI-R Cooperativeness	16	28.6%	6	46.2%	.220	0.37	277	37.5%	37	62.7%	**.001***	**0.51†**
TCI-R Transcendence	16	28.6%	4	30.8%	.875	0.05	286	38.7%	19	32.2%	.323	0.14

Note. SD: standard deviation. GD: gambling disorder.

FA–: food addiction negative screening. FA+: food addiction positive screening. BMI: Body Mass Index.

SCL-90R: Symptom Checklist-90-Revised.

TCI-R: Temperament and Character Inventory-Revised.

*Bold: significant parameter (.05 level). †Bold: effect size into the range mild-moderate (|*d*|>0.50) to large-high (|*d*|>0.80) .

Results adjusted by the covariate age.

Figure legends

Figure 1. *Radar chart (n=867)*

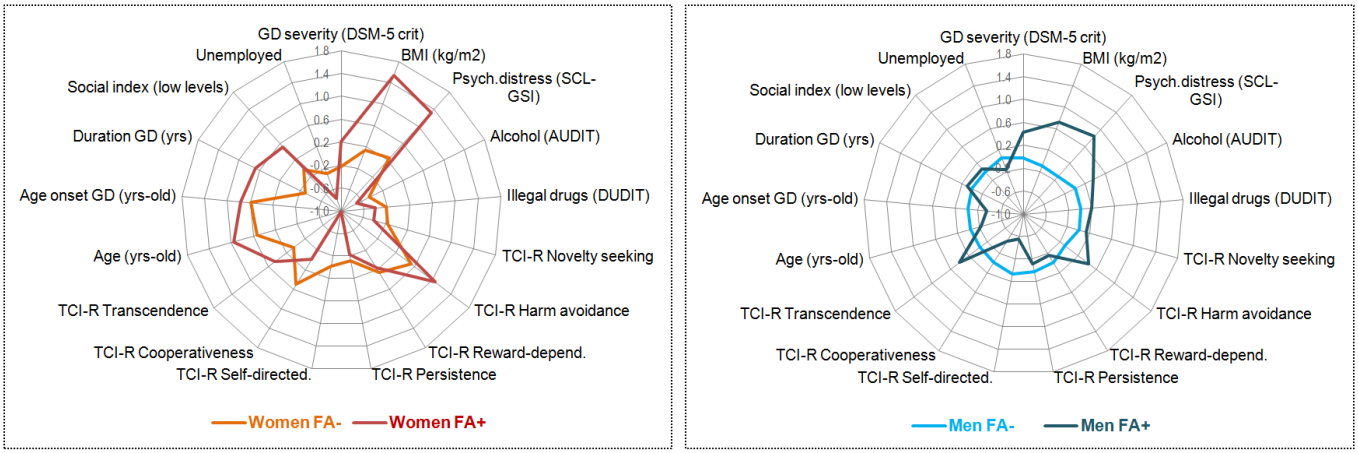
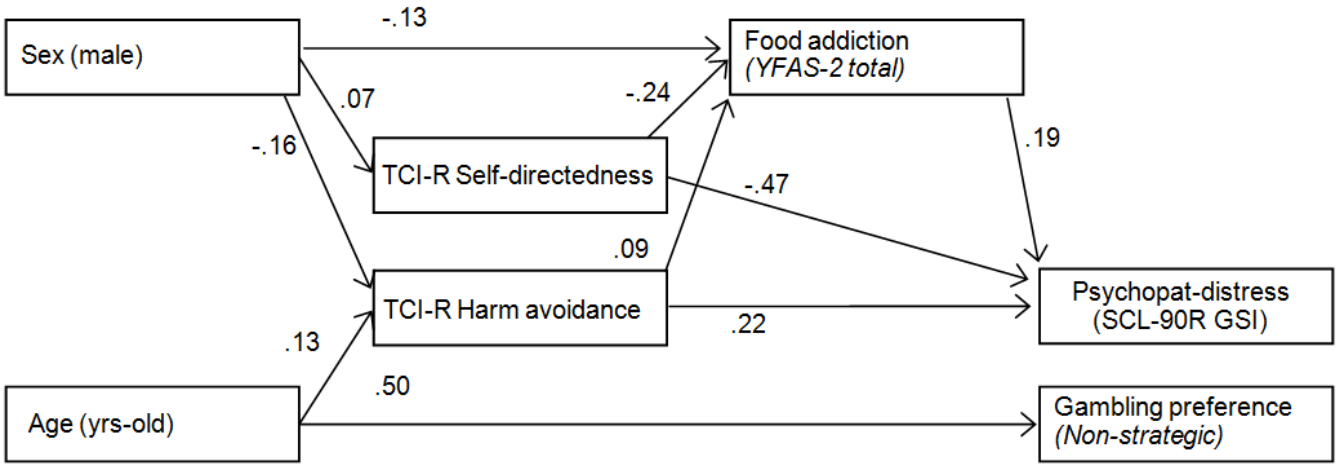


Figure 2. *Path diagram with the results of the structural equation model (n=867)*

Note. Only significant coefficients were retained in the model.



Supplementary material

Table S1. *Comparison of sociodemographics and gambling measures by gender and FA status*

		Women						Men					
		FA– *(n=56)*		FA+ *(n=13)*				FA– *(n=739)*		FA+ *(n=59)*			
		n	*%*	*n*	*%*	*p*	|*d*|	*n*	*%*	*n*	*%*	*p*	|*d*|
Civil status	*Single*	26	46.4%	7	53.8%	.890	0.15	387	52.4%	34	57.6%	.638	0.11
	Married	20	35.7%	4	30.8%		0.11	271	36.7%	18	30.5%		0.13
	Divorced	10	17.9%	2	15.4%		0.07	81	11.0%	7	11.9%		0.03
Education level	*Primary*	31	55.4%	10	76.9%	.348	0.46	385	52.1%	34	57.6%	.697	0.11
	Secondary	19	33.9%	2	15.4%		0.44	290	39.2%	20	33.9%		0.11
	University	6	10.7%	1	7.7%		0.10	64	8.7%	5	8.5%		0.01
Social	*Mean-high to high*	5	8.9%	0	0.0%	.326	**0.61†**	56	7.6%	2	3.4%	**.006***	0.19
	Mean	8	14.3%	1	7.7%		0.21	61	8.3%	11	18.6%		0.31
	Mean-low	15	26.8%	2	15.4%		0.28	292	39.5%	14	23.7%		0.34
	Low	28	50.0%	10	76.9%		**0.57†**	330	44.7%	32	54.2%		0.19
Employment	*Unemployed*	30	53.6%	10	76.9%	.124	**0.50†**	272	36.8%	28	47.5%	.104	0.22
	Employed	26	46.4%	3	23.1%			467	63.2%	31	52.5%		
		n	*%*	*n*	*%*	*p*	|*d*|	*n*	*%*	*n*	*%*	*p*	|*d*|
Gambling	Non-strategic	38	67.9%	12	92.3%	.190	**0.64†**	370	50.1%	29	49.2%	.614	0.02
	Strategic	6	10.7%	0	0.0%		**0.67†**	206	27.9%	14	23.7%		0.09
	Mixed	12	21.4%	1	7.7%		0.40	163	22.1%	16	27.1%		0.12
Gambling	Slot-machines	30	53.6%	6	46.2%	.630	0.15	446	60.4%	39	66.1%	.384	0.12
	Bingo	21	37.5%	5	38.5%	.949	0.02	40	5.4%	5	8.5%	.327	0.12
	Lotteries	10	17.9%	3	23.1%	.665	0.13	106	14.3%	6	10.2%	.374	0.13
	Casino	10	17.9%	0	0.0%	**.033***	**0.87†**	187	25.3%	17	28.8%	.552	0.08
	Cards	2	3.6%	0	0.0%	.498	0.38	31	4.2%	3	5.1%	.745	0.04
	Betting on sports	0	0.0%	0	0.0%	---	0.00	131	17.7%	8	13.6%	.417	0.11
	Internet	8	14.3%	1	7.7%	.525	0.21	189	25.6%	15	25.4%	.980	0.00
		Mean	*SD*	*Mean*	*SD*	*p*	|*d*|	*Mean*	*SD*	*Mean*	*SD*	*p*	|*d*|
DSM-5 criteria for GD		6.66	2.26	7.46	1.61	.232	0.41	7.03	1.86	7.86	1.09	**.001***	**0.55†**
SOGS total		9.93	3.88	11.46	3.55	.198	0.41	10.74	3.14	11.78	3.26	**.015***	0.32
Chronological age (years)		47.93	11.64	53.77	13.75	.120	0.46	39.96	13.77	37.31	12.36	.152	0.20
Age of onset (years)		35.13	12.15	37.20	11.50	.623	0.17	28.04	11.50	24.17	9.72	**.015***	0.36
Duration of GD (years)		3.73	3.33	9.69	10.04	**.001***	**0.80†**	5.57	6.23	6.12	5.66	.514	0.09

Note. SD: standard deviation. GD: gambling disorder.

FA–: food addiction negative screening. FA+: food addiction positive screening.

SOGS: South Oaks Gambling Screen.

*Bold: significant parameter (.05 level). †Bold: effect size into the range mild-moderate (|*d*|>0.50) to large-high (|*d*|>0.80).

Results adjusted by the covariate age.

Table S2. *Complete results obtained in the structural equation model: direct, indirect and total effects*

Direct effects		*Coefficient*	*SE*	*T-statistic*	*p*	*St.Coeff.*
YFAS2-total	TCI-R Harm avoidance	0.0144	0.0060	2.40	0.016	0.0901
	TCI-R Self dependence	-0.0289	0.0045	-6.38	<.001	-0.2350
	Gender	-1.2136	0.3157	-3.84	<.001	-0.1255
	Age (yrs-old)	0.0000	(no path)			0.0000
TCI-R Harm avoidance	Gender	-9.5756	2.0264	-4.73	<.001	-0.1584
	Age (yrs-old)	0.1573	0.0347	4.53	<.001	0.1325
TCI-R Self dependence	Gender	4.7216	2.6688	1.97	0.049	0.0700
Non-strategic gambling	Age (yrs-old)	0.0181	0.0011	17.02	<.001	0.5004
SCL90-R GSI	YFAS-total	0.0528	0.0072	7.36	<.001	0.1896
	TCI-R Harm avoidance	0.0098	0.0013	7.76	<.001	0.2206
	TCI-R Self dependence	-0.0160	0.0010	-16.28	<.001	-0.4690
	Gender	0.0000	(no path)			0.0000
	Age (yrs-old)	0.0000	(no path)			0.0000
Indirect effects		*Coefficient*	*SE*	*T-statistic*	*p*	*St.Coeff.*
YFAS2-total	TCI-R Harm avoidance	0.0000	(no path)			0.0000
	TCI-R Self dependence	0.0000	(no path)			0.0000
	Gender	-0.2744	0.1075	-2.55	0.011	-0.0284
	Age (yrs-old)	0.0023	0.0011	2.12	0.034	0.0119
TCI-R Harm avoidance	Gender	0.0000	(no path)			0.0000
	Age (yrs-old)	0.0000	(no path)			0.0000
TCI-R Self dependence	Gender	0.0000	(no path)			0.0000
Non-strategic gambling	Age (yrs-old)	0.0000	(no path)			0.0000
SCL90-R GSI	YFAS-total	0.0000	(no path)			0.0000
	TCI-R Harm avoidance	0.0008	0.0003	2.28	0.022	0.0171
	TCI-R Self dependence	-0.0015	0.0003	-4.82	0	-0.0446
	Gender	-0.2482	0.0640	-3.88	0	-0.0923
	Age (yrs-old)	0.0017	0.0004	3.96	0	0.0315
Total effects		*Coefficient*	*SE*	*T-statistic*	*p*	*St.Coeff.*
YFAS2-total	TCI-R Harm avoidance	0.0000	(no path)			0.0000
	TCI-R Self dependence	0.0000	(no path)			0.0000
	Gender	-0.2744	0.1075	-2.55	0.011	-0.0284
	Age (yrs-old)	0.0023	0.0011	2.12	0.034	0.0119
TCI-R Harm avoidance	Gender	0.0000	(no path)			0.0000
	Age (yrs-old)	0.0000	(no path)			0.0000
TCI-R Self dependence	Gender	0.0000	(no path)			0.0000
Non-strategic gambling	Age (yrs-old)	0.0000	(no path)			0.0000
SCL90-R GSI	YFAS-total	0.0000	(no path)			0.0000
	TCI-R Harm avoidance	0.0008	0.0003	2.28	0.022	0.0171
	TCI-R Self dependence	-0.0015	0.0003	-4.82	0	-0.0446
	Gender	-0.2482	0.0640	-3.88	0	-0.0923
	Age (yrs-old)	0.0017	0.0004	3.96	0	0.0315

Note. SE: standard error. StCoeff: standardized coefficient. Sample size: *n=867*.

SCL-90R: Symptom Checklist-90-Revised.

TCI-R: Temperament and Character Inventory-Revised.

YFAS: Yale Food Addiction Scale.