Food Addiction Correlates with Psychosocial Functioning More Than Metabolic Parameters in Patients with Obesity

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Abstract

Aim: To investigate the association of food addiction (FA) with the psychosocial functioning and metabolic parameters in obese patients seeking weight-loss treatment.

Methods: Two hundred twenty-four obese patients (male/female: 28/196) with a mean age of 44.5 ± 13.4 years and body mass index (BMI) of 41.6 ± 7.2 were included in the study. After receiving sociodemographic data and medical history, detailed physical examination, including anthropometric measurements, was performed by an experienced physician. Blood samples were taken after 8–12 hr of fasting. The presence of FA was evaluated by using Yale Food Addiction Scale (YFAS). Psychological evaluation was performed by using a self-reported Patient Health Questionnaire-9 (PHQ-9) and health-related quality of life using the 36-item short-form health survey (SF-36).

Results: Seventy-two of 224 (32.1%) patients met the criteria for FA, according to YFAS. The mean age of patients with FA was younger compared with patients without FA ($P < 0.001$). There was no statistically significant difference between the patients with and without FA in terms of BMI, fat percentage, and waist circumference ($P = 0.440$, $P = 0.644$, and $P = 0.144$, respectively). The depression frequency was significantly higher (61.1%, $P < 0.001$), while the SF-36 score of mental health was lower ($P = 0.027$) in patients with FA than in the patients without FA. Age- and sex-adjusted mean fasting plasma glucose level was lower in patients with FA ($P = 0.021$), but serum insulin levels, HOMA-IR (homeostasis model assessment of insulin resistance), HbA1c (hemoglobin A1c), lipid parameters, and vascular adiposity index were comparable.

Conclusions: We found that FA frequency was very high in obese patients seeking treatment for weight loss, and it correlates with psychosocial functioning more than metabolic parameters.

Keywords: obesity, food addiction, depression, metabolic parameters, insulin resistance

Introduction

OBESITY IS ONE of the most common chronic disorders, and its prevalence is increasing worldwide. Obesity is a multifactorial disease involving genetic, biological, environmental, psychological, and sociocultural factors that contribute to its pathogenesis.¹ The concept of food addiction (FA) as an explanation for the rise in obesity rates has become increasingly popular in recent years. FA, although considered a very controversial concept, is a behavioral addiction that is characterized by the compulsive overeating

of palatable (e.g., high fat and high sugar) foods that markedly activate the brain's reward circuitry.²

Depression and anxiety may also affect food choice and calorie intake. Overeating and obesity are often associated with depression and anxiety in humans.^{3,4} Individuals with depressive mood show preference for consuming palatable foods to alleviate their negative feelings.⁵ Although palatable foods can provide some relief of negative emotions and mood for a short period of time, chronic consumption of high-calorie foods ultimately leads to obesity, which in turn promotes vulnerability to depression and anxiety.⁶

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It is well known that central obesity and related metabolic changes correlate positively with depression.⁷ However, the effect of FA on metabolic parameters such as insulin resistance and dyslipidemia is scarce. In this study, we aimed to investigate (i) the frequency of FA and depression in obese patients who apply to our specialized tertiary obesity outpatient clinic, (ii) the relation of FA to psychosocial factors such as depression and health-related quality of life (HRQOL), and (iii) the association of FA with the metabolic parameters.

Methods

Subjects

A total of 242 patients with a body mass index (BMI) $\geq 30 \text{ kg/m}^2$, who were admitted to our obesity center within the last 6 months, were included in this study. The age range for patients was 18–65 years. Patients with the diagnosis of hypothyroidism, Cushing syndrome, hypogonadism, history of bariatric surgery and substance abuse, ongoing medical treatment with antiobesity drugs, pregnancy and breast feeding, dementia, and presence of any psychotic symptoms were excluded. The study was performed in accordance with the Declaration of Helsinki and with the approval of the local ethics committee (2011-KAEK-25 2019/09-19).

In our tertiary obesity center, patients were routinely evaluated with the multidisciplinary approach. After receiving sociodemographic data, family and personal medical history, detailed physical examination, including anthropometric measurements, was performed by an experienced physician upon admission. Venous blood samples were taken after 8–12 hr of fasting for basal laboratory examination. Patients' dietary habits, basal metabolic rates (BMRs), and daily calorie needs were evaluated by a trained dietician, while exercise history was reviewed by a sports physician. Psychological evaluation and determination of self-reported Patient Health Questionnaire-9 (PHQ-9), Yale Food Addiction Scale (YFAS), and HRQOL using a 36-item short-form health survey (SF-36) were made by an experienced psychologist.

Measures

Anthropometric measures. After ~15 min of rest in an upright sitting position, arterial blood pressure was measured two times, and the average of measurements was recorded. Tanita® instruments device was used for the measurement of weight and body fat ratio. Weight (kilograms) divided by height (meters) squared calculation was done for the determination of BMI. Waist circumference (WC) and neck circumference (NC) were measured with flexible tape measure.

Dietary habits and physical activity. Detailed eating habits were questioned, and participants were asked to complete daily food consumption diary and scale the amount of food they received in 3 days. After collecting 3-day 24-hr dietary recall, daily calorie intake was determined by the same dietician.⁸ Each patient's BMR was calculated according to the revised Harris-Benedict Equation $[(\text{BMR (male)} = (10 \times \text{weight (kg)}) + (6.25 \times \text{height (cm)}) - (5 \times \text{age (years)}) + 5), (\text{BMR (female)} = (10 \times \text{weight (kg)}) + (6.25 \times \text{height (cm)}) - (5 \times \text{age (years)}) - 161)]$.⁹ Daily calorie requirement was estimated by multiplying BMR with a coefficient for patients' physical activity level. Exercise type, frequency, and duration were asked and noted by a sports physician.

Laboratory measurements. The serum fasting plasma glucose (FPG), insulin, total cholesterol, triglyceride (TG), high-density lipoprotein (HDL) cholesterol, alanine aminotransferase, aspartate aminotransferase, and creatinine levels were determined with an Olympus AU 2700 autoanalyzer (Olympus Diagnostics, GmbH, Hamburg, Germany) by using the commercially available assay kits. The Friedewald¹⁰ was used for the calculation of low-density lipoprotein (LDL) cholesterol levels. A cation exchange high performance liquid chromatography (HPLC) method was used for the determination of hemoglobin A1c (HbA1c) levels. Homeostasis model assessment of insulin resistance (HOMA-IR) index was calculated using the formula: $\text{HOMA-IR} = \text{fasting glucose levels [mg/dL]} \times \text{fasting insulin levels [mU/mL]} / 405$. Adipose tissue dysfunction was evaluated with visceral adiposity index (VAI), which is an index that significantly correlates with all metabolic syndrome factors, cardio/cerebrovascular events.¹¹ VAI was calculated for male $[\text{VAI} = [\text{WC}/(39.68 + (1.88 \times \text{BMI}))] \times (\text{TG (mmol/L)}/1.03) \times (1.31/\text{HDL (mmol/L)})]$ and female $[\text{VAI} = [\text{WC}/(36.58 + (1.89 \times \text{BMI}))] \times (\text{TG (mmol/L)}/0.81) \times (1.52/\text{HDL (mmol/L)})]$ participants.

Metabolic syndrome diagnosis was confirmed if three or more of the National Cholesterol Education Program-Adult Treatment Panel III (NCEP ATP III) criteria exist.¹²

Yale Food Addiction Scale. Participants' FA was evaluated with a validated version of YFAS, which is a 25-item dichotomous and Likert-type format questionnaire, which is developed according to substance dependence criteria in the DSM-IV-TR.^{13,14} The scale questions resemble the substance dependence symptoms such as tolerance, withdrawals, anxiety in social situations, and difficulty lowering or quitting the use of substance. The measure was scored using a symptom count ranging from 0 to 7, indicating the number of dependence symptoms. FA status was diagnosed with three or more dependence symptoms in addition to satisfying criteria for clinically significant distress or impairment. For the clinically significant impairment or distress criteria, patients were required to answer affirmatively to one of the two questions from the YFAS. Both FA status and FA symptom score (clinically significant impairment/stress was not included) were used in the statistical analysis of this study.

Patient Health Questionnaire-9. PHQ-9 is a self-administered questionnaire that consists of nine Likert-type questions used for monitoring the severity of depression in primary care.^{15,16} The score ≥ 10 had high specificity (88%) and sensitivity (88%) for major depression compared with mental health professional assessment,¹⁷ and this cutoff value was used for this study.

Short-form health survey (SF-36). SF-36 is a comprehensive, consistent, easily administered, and self-reported measure of HRQOL. SF-36 was used to evaluate the participants' quality of life by the aspect of general health perceptions, physical functioning, vitality, body pain, physical role functioning, emotional role functioning, social role functioning, and mental health.^{18,19} Lower subscales indicate decreased HRQOL.

Statistical analysis

Statistical analyses were performed using the IBM SPSS Statistics 22 program. Continuous data distribution was assessed with the Shapiro-Wilk test of normality. The

Mann–Whitney *U* test or independent sample *t*-test was used, when appropriate, to determine differences between the two independent groups. Variables are given as mean $\pm$ standard deviation. Pearson's chi-squared test, Fisher's exact chi-squared test, and Fisher–Freeman–Halton test were used for comparison of categorical variables, and data were given with frequency and percentage values. Relations between the FA symptom score and the other continuous variables were examined by Spearman's correlation coefficient. Binary logistic regression analysis was performed to evaluate the risk factors for FA with multivariate models. $\alpha=0.05$ was considered as statistically significant.

Results

FA and sociodemographic characteristics of patients

Two hundred twenty-four obese patients (male/female: 28/196) with a mean age of 44.5 ± 13.4 years and BMI 41.6 ± 7.2 were included in the study. Seventy-two of 224 (32.1%) patients met the criteria for FA. The mean FA symptom score was 4.29 ± 1.07 in patients with FA and 2.62 ± 1.33 in patients without FA. The mean age of patients with FA was younger compared with patients without FA (39.3 ± 12.3 years vs. 47.0 ± 13.2 years; $P < 0.001$). There was a negative correlation between the FA symptom score and age ($P = 0.008$, $r = -0.177$). Gender distribution was comparable, and FA frequency was similar in male and female patients (respectively; 21.4% vs. 33.7%, $P = 0.279$) (Table 1).

The mean BMI (41.0 ± 6.7 kg/m² vs. 42.0 ± 7.4 kg/m²; $P = 0.44$), body fat ratio, WC, and NC were similar between the groups. There was no statistically significant correlation

between BMI and the FA symptom score ($P = 0.118$, $r = -0.105$). When obese patients were categorized as class I ($30 \leq \text{BMI} < 35$), class II ($35 \leq \text{BMI} < 40$), and class III ($\text{BMI} \geq 40$) obesity according to the WHO classification,²⁰ the FA frequency was similar in different BMI categories ($P = 0.474$). The mean systolic blood pressure of patients without FA was higher compared with patients with FA (137.2 ± 20.9 mmHg vs. 127.8 ± 17.8 mmHg, $P = 0.002$), but there was no statistically significant difference in terms of diastolic blood pressure.

There was no statistical difference between university graduates and nonuniversity graduates (43.1% vs. 28%; $P = 0.074$) in terms of FA frequency. FA was observed more frequent among single patients compared with married ones ($P = 0.006$). Alcohol (9.9% vs. 4.1%, $P = 0.125$) and tobacco usage (22.5% vs. 20.9%, $P = 0.948$) were not significant. Family history of obesity in first-degree relatives was significantly higher in patients with FA (74.1%) compared with the patients without FA (60.4%, $P = 0.038$) (Table 1).

FA, depression, and HRQOL

The depression frequency was significantly higher in patients with FA according to the PHQ-9 ($P < 0.001$) (Table 2). The average score on the PHQ-9 was 11.1 ± 5.4 , with 61.1% of the patients with FA endorsing moderate or higher depressive symptoms while it was 8.2 ± 5.4 , with 34.2% in patients without FA. Patients who had more FA symptoms also had higher PHQ-9 scores ($P = 0.001$, $r = 0.217$). Logistic regression analysis revealed that the PHQ-9 score remained significant after adjustment for age ($P = 0.001$). A one-unit increase in PHQ-9 score was associated with a 1.093-fold increased risk of FA (95% CI for OR: 1.035–1.154). There was no significant correlation between BMI and PHQ-9

TABLE 1. CHARACTERISTIC AND OBESITY-RELATED CO-MORBIDITIES OF PATIENTS ACCORDING TO THE FOOD ADDICTION STATUS

	Patients with FA (n=72)	Patients without FA (n=152)	P
Male/female, n (%)	6/66 (8.3/91.7)	22/130 (14.5/85.5)	0.279
Age, year	39.3 ± 12.3	47.0 ± 13.2	<0.001
Marital status			
Single, %	32.4	15.3	0.006
Married, %	67.6	84.7	
Education			
University graduate, %	43.1	46.9	0.075
Nonuniversity graduate, %	56.9	43.1	
Family history of obesity, %	74.1	60.4	0.038
Weight, kg	161.5 ± 7.4	160.0 ± 9.6	0.838
BMI, kg/m ²	41.0 ± 6.7	42.0 ± 7.4	0.440
Fat percentage, %	53.8 ± 8.9	53.2 ± 9.4	0.644
WC, cm	118.1 ± 15.5	121.3 ± 14.2	0.144
NC, cm	39.4 ± 3.6	40.2 ± 3.8	0.268
SBP, mmHg	127.8 ± 17.8	137.2 ± 20.9	0.002
DBP, mmHg	78.3 ± 11.1	81.9 ± 10.9	0.165
Diabetes mellitus, %	23.6	33.6	0.175
Dyslipidemia, %	15.3	21.7	0.341
Hypertension, %	26.4	42.1	0.033
Established CVD, %	4.2	15.1	0.030
Metabolic syndrome, %	54.4	76.9	0.001

Continuous variables are given as mean $\pm$ standard deviation. P values in **bold** indicate a statistically significant result.

BMI, body mass index; CVD, cardiovascular disease; DBP, diastolic blood pressure; FA, food addiction; NC, neck circumference; SBP, systolic blood pressure; WC, waist circumference.

TABLE 2. DEPRESSION FREQUENCY AND HEALTH-RELATED QUALITY OF LIFE ACCORDING TO THE FOOD ADDICTION STATUS OF PATIENTS

	Patients with FA	Patients without FA	P
Depression frequency, n (%)	44 (61.1)	51 (34.2)	<0.001
PHQ-9 score	11.1±5.4	8.2±5.4	<0.001
SF-36 physical function	66.7±28.1	70.5±24.9	0.458
SF-36 role physical	48.8±44.9	61.9±42.4	0.029
SF-36 role emotional	46.8±44.3	62.0±43.9	0.012
SF-36 vitality	37.2±19.9	45.4±22.4	0.016
SF-36 mental health	49.1±17.8	59.9±18.0	<0.001
SF-36 social functioning	62.3±34.7	77.2±27.6	0.003
SF-36 body pain	58.7±26.4	64.3±26.5	0.161
SF-36 general health	44.0±22.0	53.6±20.4	0.002

Continuous variables are given as mean±standard deviation. P values in **bold** indicate a statistically significant result.

PHQ-9, Patient Health Questionnaire-9; SF-36, short-form health survey.

score ($P=0.598$, $r=0.031$). When obese patients were categorized as class I to III according to BMI, the percentage of patients with and without depression was similar in different BMI categories ($P=0.686$). There was no significant difference in terms of depression frequency between university graduates and nonuniversity graduates (38.2% vs. 42.0%; $P=0.562$). Depression frequency was not different according to marital status ($P=0.645$).

In univariate analysis, patients with FA scored lower on all SF-36 subscales ($P<0.05$) except for physical function and body pain (Table 2). A higher FA score was negatively correlated with SF-36 score of vitality ($P=0.046$, $r=-0.316$), mental health ($P=0.009$, $r=-0.177$), and social functioning ($P=0.011$, $r=-0.172$). All SF-36 subscales were also negatively correlated with the PHQ-9 score ($P<0.05$). Logistic regression analysis was performed to see the difference between the groups in terms of SF36 subscale scores that would remain significant after adjustment for age (Model was statistically significant, $P<0.001$). Only mental health was significant after adjusting for age ($P=0.027$). A one-unit decrease in mental health subscale score was associated with a 1.027-fold increased risk of FA (95% CI for OR: 1.003–1.051).

FA, obesity-related co-morbidities, and metabolic parameters

Obesity-related cardiometabolic co-morbidities in patients with and without FA were found similar between the two groups in terms of diabetes (23.6% vs. 33.6%) and dyslipidemia (15.3% vs. 21.7%), except hypertension (26.4% vs. 42.1%; $P=0.033$) and established cardiovascular disease (4.2% vs. 15.1%, $P=0.030$). The frequency of metabolic syndrome (76.9%) was significantly higher in patients without FA compared with patients with FA (54.4%, $P=0.001$, Table 1).

After excluding patients using glucose and lipid lowering agents, mean age of patients with FA was still significantly lower while there was no significant difference in anthropometric variables of patients with and without FA. Mean

FPG level was lower in patients with FA compared with patients without FA (96.0±11.6 mg/dL vs. 102.3±13.7 mg/dL, $P=0.004$), whereas serum insulin levels ($P=0.292$), HOMA-IR ($P=0.149$), HbA1c ($P=0.276$), and thyroid stimulant hormone ($P=0.390$) were not different between the two groups. Serum mean LDL cholesterol and HDL cholesterol levels were not different between the groups, but TG level was higher in patients without FA than the patients with FA (151.2±76.7 vs. 120.9±61.2, $P=0.013$). Also, there was a negative correlation between the FA symptom score and FPG ($r=-0.244$, $P=0.004$) and TG ($r=-0.232$, $P=0.010$). No significant difference was found in patients with and without FA in terms of VAI (3.3±1.4 vs. 3.8±2.6, $P=0.136$). Logistic regression analysis revealed that FPG, but not TG, remained statistically different between the groups after the adjustment for age and sex (respectively; $P=0.021$ and $P=0.115$) (Table 3).

FA, dietary habits, and physical activity status

Resting metabolic rate and daily calorie need were 1744.1±262.8 and 2415.1±388.6 kcal/day in patients with FA while those were 1683.9±288.2 and 2312.2±412.7 kcal/day, respectively, in patients without FA, and the difference was statistically significant ($P=0.049$ and $P=0.030$). According to the collected 3-day food intake records of patients, daily calorie intake was slightly higher in patients with FA than in the patients without FA (1977.1±512.0 vs. 1899.2±547.9), but the difference was not significant ($P=0.210$). The frequencies of patients skipping meals and consuming regular snacks were not different in patients with and without FA ($P=0.125$ and $P=0.552$). The number of snacks in a day was positively

TABLE 3. METABOLIC PARAMETERS OF PATIENTS WITH AND WITHOUT FOOD ADDICTION

	Patients with FA	Patients without FA	P
Age, years	38.5±12.5	43.0±13.2	0.027
FPG, mg/dL	96.0±11.6	102.3±13.7	0.004
Insulin, mU/L	20.4±16.8	19.9±10.6	0.292
HOMA-IR	4.6±3.8	5.2±3.2	0.149
HbA1c, %	5.4±0.8	5.7±0.6	0.276
TChol, mg/dL	198.0±40.1	198.1±41.4	0.837
LDL-C, mg/dL	121.5±38.1	121.2±36.3	0.479
HDL-C, mg/dL	52.4±11.5	47.8±12.4	0.331
TG, mg/dL	120.9±61.2	151.2±76.7	0.013
ALT, U/L	22.9±21.0	23.1±15.7	0.582
Cr, mg/dL	0.69±0.14	0.74±0.15	0.068
TSH, μ IU/mL	3.0±3.2	2.4±2.1	0.390
VAI	3.3±1.4	3.8±2.6	0.136

Continuous variables are given as mean±standard deviation. P values in **bold** indicate a statistically significant result.

Metabolic parameters were assessed after excluding patients using antihyperglycemic and lipid lowering drugs.

ALT, alanine aminotransferase; Cr, creatinine; FPG, fasting plasma glucose; HbA1c, hemoglobin A1c; HDL-C, high-density lipoprotein cholesterol; HOMA-IR, homeostasis model assessment of insulin resistance; LDL-C, low-density lipoprotein cholesterol; TChol, total cholesterol; TG, triglyceride; TSH, thyroid stimulant hormone; VAI, visceral adiposity index.

TABLE 4. DIETARY HABITS AND PHYSICAL ACTIVITY OF PATIENTS ACCORDING TO THE FOOD ADDICTION STATUS

	Patients with FA	Patients without FA	P
Basal metabolic rate, kcal	1744.1 ± 262.8	1683.9 ± 288.2	0.049
Daily calorie needs, kcal	2415.1 ± 388.2	2312.2 ± 412.7	0.030
Total daily calorie intake, kcal	1977.1 ± 512.0	1899.2 ± 547.9	0.210
Patients skipping meals, <i>n</i> (%)	44 (62.9)	101 (73.2)	0.125
Skipped meals, <i>n</i> (%)			
Breakfast	15 (34.1)	33 (31.7)	0.803
Lunch	21 (47.7)	52 (50)	
Dinner	2 (4.5)	2 (1.9)	
Variable	6 (13.6)	17 (16.3)	
Patients consuming snacks, <i>n</i> (%)	38 (55.9)	70 (51.5)	0.552
Exercise frequency, <i>n</i> (%)			
None	53 (85.5)	121 (88.3)	0.871
1–2 days/week	4 (6.5)	6 (4.4)	
3–4 days/week	3 (4.8)	5 (3.6)	
5–7 days/week	2 (3.2)	5 (3.6)	
Exercise duration, <i>n</i> (%)			
None	53 (85.5)	121 (88.3)	0.702
30–60 min/week	7 (11.3)	11 (8)	
90–120 min/week	2 (3.2)	3 (2.2)	
>150 min/week	0 (0)	2 (1.5)	

Continuous variables are given as mean ± standard deviation. P values in *bold* indicate a statistically significant result.

correlated with the FA symptom score ($P=0.032$, $r=0.219$). Weekly exercise frequency and duration of patients were also not different between the two groups ($P=0.871$ and $P=0.802$) (Table 4).

Discussion

FA term has been used as an abnormal pattern of excessive consumption of palatable and highly processed foods similar to addiction triggered by traditional addictive substances. Although it is a controversial issue, it is recommended by some authors that FA is considered as a separate phenotype of obesity.²¹ Preliminary evidence suggests that dopaminergic brain circuits commonly associated with substance dependence are also implicated in abnormal eating behaviors.^{22,23} YFAS was developed in 2009 to assess FA. YFAS applies the criteria of DSM-IV for substance dependence on food and eating behaviors.¹³ Population studies using YFAS are reporting the FA prevalence ranged from 5.4% to 56.8%.^{24,25} The weighted mean prevalence of FA diagnosis was 19.9% in the adult population according to the recently published meta-analysis, and the prevalence found higher in overweight/obese individuals (24.9%) compared with healthy weight individuals (11.1%).²⁶

The frequency of FA was 31% in obese patients admitted to our tertiary obesity center, which was quite high compared with the general population studies.^{13,27} But the reported high prevalence was closer to the studies investigating the obese participants who were seeking obesity treatment.^{21,28,29} Although most of our patients were women, FA frequency was not statistically different between the genders ($P=0.279$). In the majority of the studies, FA frequency was found higher in females.^{26,28,30} The difference between genders needs to be elicited whether it is due to the less admittance of males or to the more sensitive reward pathways in women that make them more susceptible to FA as previously reported.³¹

In some studies, it was reported that FA is more frequent in older individuals, and the frequency is correlated with a

variety of anthropometric measures such as BMI.^{25–27} The mean age of patients with FA was younger, but the anthropometric variables were not different between the groups in this study. The reason for the reportedly more FA frequency in elderly individuals has been associated with the repeated exposure to palatable foods diminishing the brain dopamine-mediated reward circuits leading to overeating and FA by some authors.^{2,26} In contrast to this hypothesis, young generations being exposed to more processed foods compared with older ones who consumed more natural foods in our country might be the reason for increased FA frequency in younger patients.

In this study, we observed that FA status had a close relationship with psychosocial functioning. It has been shown that there was a bidirectional relationship between depression and obesity.³² Macht et al.⁵ reported that depressive mood could change individuals' food preferences and increased consumption of palatable foods to alleviate negative feelings. Both rewarding and hedonic effects of foods may cause positive emotional reactions that play a major role in overeating.^{33,34} As a screening test, the PHQ-9 has been shown to have sensitivity and specificity in a general practice setting but does not provide a clinical diagnosis of depression.¹⁷ Therefore, some degree of measurement error was possible in the reported depression rates. But the doubled depression rates in our patients with FA still point to the close association between the depressive symptoms and FA. Similar to our results, a significant positive relationship was shown between FA, mental health, and depressive symptoms in some previous studies,^{30,35} although it is not yet clear whether FA is the cause or result of the depressive mood.

While the relationship between psychosocial functioning and FA has been investigated more extensively, little attention was paid to the metabolic status and hormonal changes of patients with FA.^{36,37} There is evidence indicating the association between insulin signaling, dopamine-mediated reward circuits, and FA.^{36,37} Nelder et al.³⁸ reported that in adult males despite not meeting the criteria for a FA

diagnosis, YFAS symptom scores correlated positively with HOMA-B and serum TG levels while inversely with the serum HDL cholesterol levels. In postmenopausal women but not in premenopausal women, serum TG levels were positively correlated with YFAS symptom scores. However, they found no significant difference between BMI-matched individuals with and without FA in terms of insulin resistance and lipid profiles.³⁸ In this study, after adjustment for age and sex, mean serum insulin, HbA1c, lipid parameters, HOMA-IR, and VAI measurements were not statistically different between the two groups while FPG was lower in patients with FA. Lower FPG levels might be related to the higher insulin secretion due to the compensatory mechanism to the food addicted behaviors, although we did not find any significant change in serum insulin levels. In addition, the frequencies of obesity-related cardiometabolic co-morbidities were not found higher in patients with FA in this study.

As far as we know, this is the first study evaluating both psychosocial functioning and the metabolic parameters of patients with obesity according to the FA status in the literature. There are some limitations to this study. First of all, we did not measure binge eating disorder. It has been reported that in populations with eating disorders, the prevalence of FA was more frequent.²⁴ Second, we did not use the recently developed YFAS 2.0 based on the published DSM-V. YFAS 2.0, compared with the originally developed YFAS, has an increased number of addictive symptoms and lower threshold values for diagnosis of FA.⁴⁰

In conclusion, we found that the frequency of FA was very high in obese patients who were referred to a specialized tertiary obesity center. The results of this study also indicate that FA was associated with high depression rates and lower quality of life scores, but not with the metabolic parameters except FPG. FA in the development of obesity, characteristics of patients with FA, and their responses to weight-loss treatments need to be investigated in large prospective studies to yield better prevention and treatment strategies.

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