



GENDER-BASED EVALUATION OF THE RELATIONSHIP BETWEEN FOOD ADDICTION, EATING BEHAVIORS, AND METABOLIC INDICATORS IN INDIVIDUALS WITH OBESITY

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Abstract

Objective: This study aimed to investigate the gender-specific associations between food addiction (FA), eating attitudes, emotional eating, insulin resistance, and nutritional status in individuals with obesity.

Methods: A cross-sectional study was conducted with 240 individuals with obesity (149 women, 91 men). Participants were assessed using the Modified Yale Food Addiction Scale Version 2.0 (mYFAS 2.0), Emotional Eater Questionnaire (EEQ), Eating Attitudes Test-26 (EAT-26), and Food Craving Questionnaire-Trait-reduced (FCQT-R). Anthropometric measurements were obtained and biochemical markers including fasting blood glucose, insulin, glycated hemoglobin (HbA1c), Homeostatic Model Assessment for Insulin Resistance (HOMA-IR), vitamin D, and cortisol levels were analyzed.

Results: Food addiction was identified in 54.2% (n=130) of the participants, with a significantly higher prevalence in women than in men (65.8% vs. 35.2%, $p<0.001$). Individuals with FA demonstrated significantly higher levels of food craving and loss of control over eating ($p<0.001$). Among women with FA, HOMA-IR values were significantly higher ($p=0.004$), while vitamin D levels were significantly lower ($p=0.035$) compared with women without FA. In men with FA, visceral fat percentage was significantly higher than in non-addicted men ($p<0.001$).

Conclusion: Food addiction is highly prevalent among individuals with obesity, particularly among women, and is associated with gender-specific psychological and metabolic alterations. These findings highlight the importance of incorporating gender-sensitive approaches into the assessment and management of obesity-related eating behaviors and metabolic risk.

Keywords: Obesity, Food Addiction, Feeding Behavior, Emotional Eating.

Introduction

Obesity is a global public health problem characterized by excessive adipose tissue accumulation and driven by a complex interaction of genetic, environmental, behavioral, and psychosocial factors.¹ In recent years, food addiction has emerged as a relevant construct in obesity research, offering a neurobehavioral framework to explain compulsive overeating and persistent weight gain. Food addiction is defined by impaired control over the consumption of highly palatable foods and activation of reward-related neurobiological pathways similar to those observed in substance use disorders.² At the neurobiological level, food addiction is closely linked to dysregulation of the mesolimbic dopamine system.³ Repeated exposure to energy-dense, highly palatable foods stimulates dopaminergic signaling within the mesolimbic reward system, leading to reward desensitization and reinforcement of excessive food intake.⁴ This process is strongly associated with maladaptive eating behaviors, particularly emotional eating and ineffective cognitive restraint. Emotional eating, often triggered by negative affect, serves as a compensatory coping mechanism and contributes to a self-perpetuating cycle of disordered eating.⁵ Beyond behavioral alterations, food addiction is increasingly recognized as a contributor to metabolic dysfunction. Insulin resistance, a central feature of obesity, may be exacerbated by dietary patterns characteristic of food addiction, including frequent consumption of high-glycemic index foods.⁶ In parallel, vitamin D deficiency—commonly observed in individuals with obesity—has been associated with impaired insulin sensitivity and altered metabolic regulation, suggesting a potential interaction between micronutrient status and addictive-like eating behaviors.⁷ Although the relationships between obesity, eating behaviors, and insulin resistance are well established, the gender-specific metabolic and behavioral correlates of food addiction remain poorly understood. In particular, evidence regarding the interaction between food addiction, insulin resistance, and vitamin D status is limited, especially in Turkish adults with obesity.⁸ Therefore, this study aimed to evaluate the prevalence of food addiction and its gender-based associations with eating behaviors, anthropometric characteristics, and key metabolic markers, including insulin resistance (HOMA-IR) and vitamin D levels. We hypothesized that food addiction is associated with adverse metabolic outcomes and that these associations differ between men and women.

Methods

This cross-sectional study included individuals with obesity who applied to a private health consultancy center in Istanbul between March and June 2024. Participants were referred to a dietitian following a clinical diagnosis of food addiction made by a psychiatrist or psychologist. All individuals met the criteria for obesity according to World Health Organization (WHO) guidelines. The required sample size was calculated using an a priori power analysis conducted with G*Power software (version 3.0.10).⁹ To detect a medium effect size (Cohen's $d=0.70$) between two independent groups (individuals with obesity with and without food addiction) for primary outcome variables—including mYFAS 2.0, FCQT-R, EAT-26, EEQ, and HOMA-IR—a total sample size of 240 participants was required (power=0.95, $\alpha=0.05$). Among the 240 participants enrolled,

54.2% ($n=130$) were identified as having food addiction at varying severity levels, while 110 participants constituted the non-addicted comparison group.

Anthropometric assessments included body weight, height, waist circumference, and segmental body composition analysis using bioelectrical impedance analysis (BIA). Body mass index (BMI) was calculated as weight divided by height squared (kg/m^2).¹⁰ BMI and waist circumference classifications were performed according to World Health Organization criteria to evaluate abdominal obesity and cardiometabolic risk.¹¹ Food addiction severity was assessed using the validated Turkish version of the Modified Yale Food Addiction Scale Version 2.0 (mYFAS 2.0). General food craving tendencies were evaluated using the Food Craving Questionnaire-Trait Reduced (FCQT-R).¹² Eating disorder risk was screened using the Eating Attitudes Test-26 (EAT-26), with scores ≥ 20 indicating clinically significant risk. Emotional eating behaviors were assessed using the Emotional Eater Questionnaire (EEQ), which measures eating responses to emotional stimuli.

Venous blood samples were collected after an overnight fast of at least 8 hours. Fasting blood glucose (FBG) and glycated hemoglobin (HbA1c) levels were classified according to American Diabetes Association criteria. Serum insulin concentrations were measured using a chemiluminescence immunoassay (CLIA). Metabolic status was primarily evaluated using the Homeostatic Model Assessment for Insulin Resistance (HOMA-IR), calculated using the following formula:

$$\text{HOMA-IR} = \frac{\text{fasting glucose (mg/dL)} \times \text{fasting insulin (}\mu\text{U/mL)}}{405}$$

Serum 25-hydroxyvitamin D [25(OH)D] levels were categorized as deficient (<20 ng/mL), insufficient (20–29 ng/mL), or sufficient (≥ 30 ng/mL). Morning serum cortisol levels were measured to account for circadian rhythm-related variations.¹⁴ Statistical analyses were performed using IBM SPSS Statistics version 29.0. Descriptive statistics are presented as mean \pm standard deviation for continuous variables and as frequencies and percentages for categorical variables. Data normality was assessed using the Kolmogorov–Smirnov test. Between-group comparisons were conducted using the Mann–Whitney U test for continuous variables and the Chi-square test or Fisher–Freeman–Halton exact test for categorical variables, as appropriate. The internal consistency of the assessment instruments was evaluated using Cronbach's alpha coefficient. A two-tailed p value < 0.05 was considered statistically significant.

Ethical approval for this study was obtained from the Lokman Hekim University Institutional Ethics Committee in accordance with institutional guidelines and the principles of the Declaration of Helsinki for research involving human participants (Protocol No. 2024/041; January 30, 2024; Kod No. 2024041).

Results

Socio-demographic Characteristics and Food Addiction Prevalence

Female participants were significantly older than male participants (39.77 ± 6.77 vs. 38.30 ± 6.91 years, $p=0.011$) and were more likely to be married or living with their family. However, no significant associations were observed between sociodemographic variables—including education level and

occupation—and food addiction (FA) status. The overall prevalence of FA in the study population was 54.2% (n=130). A significant gender disparity was identified, with 65.8% of women meeting the FA criteria compared to 35.2% of men ($\chi^2=21.32$, $p<0.001$) (Figure 1).

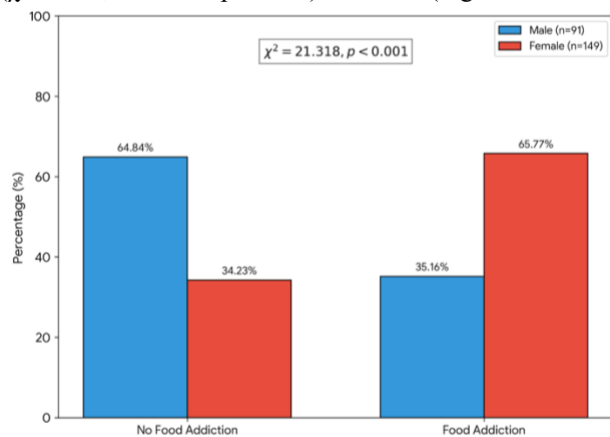


Figure 1. Prevalence of Food Addiction According to Gender
 Note: Values are presented as number (percentage). Group comparisons were performed using the Chi-square test. A p value<0.05 was considered statistically significant.

Participants with FA, irrespective of gender, exhibited significantly higher levels of food craving, eating-related preoccupation, and loss of control compared with non-FA participants ($p<0.001$) (Table 1). Scores on the Emotional Eater Questionnaire (EEQ) were also markedly higher among individuals with FA in both women and men ($p<0.001$). A

distinct gender-specific psychological pattern emerged: women with FA reported significantly greater feelings of guilt following emotional eating ($p=0.001$), whereas this association was not statistically significant in men ($p=0.205$) (Table 2). Furthermore, women scored significantly higher than men on the Eating Attitudes Test-26 (EAT-26) total score ($p<0.05$) as well as on the oral control subscale ($p<0.01$) (Table 3).

Metabolically, individuals with FA of both genders exhibited significantly higher fasting glucose levels compared with those without FA ($p<0.001$). However, distinct gender-specific patterns emerged with respect to insulin resistance and micronutrient status. Women with FA demonstrated significantly higher HOMA-IR values (4.55 ± 3.29) than women without FA (3.09 ± 1.79), alongside significantly lower serum vitamin D concentrations (20.17 ± 9.48 ng/mL vs. 24.26 ± 11.02 ng/mL). In contrast, these associations were not observed among men. No significant differences were identified between FA and non-FA groups for HbA1c, fasting insulin, or cortisol levels (Table 4).

Regarding anthropometric measures, FA status was not significantly associated with body mass index (BMI) or waist circumference. However, sex-specific differences emerged. Men with FA exhibited a significantly higher waist-to-height ratio ($p=0.030$) and a greater visceral fat percentage ($p<0.001$) compared with men without FA. In contrast, among women, FA status was strongly associated with classification in the “treatment required” category based on waist-to-height ratio ($p<0.001$) (Table 5).

Table 1. Food Craving Questionnaire (FCQT-R) scores by food addiction status and gender

Parameters	Food Addiction Status	Male				Female			
		$\bar{X} \pm S$	Median (Min-Max)	t-U	p	$\bar{X} \pm S$	Median (Min-Max)	t-U	p
Preoccupation with Eating	No Food Addiction	19.07±14.16	20.0 (8.0-28.0)	474.00	0.000	19±3.03	19.0 (7.0-28.0)	962.00	0.000
	Food Addiction	45.66±13.87	37.0 (9.0-41.0)			50.06±2.5	51.0 (7.0-44.0)		
Loss of Control overeating	No Food Addiction	21.25±4.82	22.0 (7.0-28.0)	357.5	0.000	19.06±5.7	20.0 (8.0-27.0)	650.50	0.000
	Food Addiction	51.81±3.72	52.0 (9.0-37.0)			51.85±3.6	52.0 (9.0-38.0)		
Food Craving	No Food Addiction	27.97±6.25	28.0 (15.0-90.0)	430.50	0.000	28.86±5.63	29.0 (15.0-90.0)	804.50	0.000
	Food Addiction	52.38±4.78	53.5 (15.0-90.0)			53.72±2.91	54.0 (15.0-90.0)		

t:Independent Samples T-Test; U: Mann-Whitney U Test . **p<0.01

Table 2. Emotional Eater Questionnaire (EEQ) scores by food addiction status and gender

Parameters	Male						Female					
	$\bar{X} \pm S$	Median (Min-Max)	$\bar{X} \pm S$	Median (Min-Max)	U	p	$\bar{X} \pm S$	Median (Min-Max)	$\bar{X} \pm S$	Median (Min-Max)	U	p
Uncontrollable urge to eat	9.31±5.4	9.0 (0.0-18.0)	13.5±3.72	13.0 (4.0-18.0)	514.00	0.000	8.27±4.58	7.0 (2.0-18.0)	11.21±3.19	12.0 (5.0-18.0)	1529.00	0.000
Type of food	3.54±1.74	4.0 (1.0-6.0)	4.88±1.07	5.0 (2.0-6.0)	532.50	0.000	2.8±1.52	2.0 (1.0-6.0)	4.02±1.22	4.0 (2.0-6.0)	1302.50	0.000
Guilt	3.03±1.52	3.0 (0.0-6.0)	3.38±1.3	3.0 (0.0-6.0)	795.50	0.205	2.65±1.4	2.0 (0.0-6.0)	3.37±1.3	3.0 (1.0-6.0)	1683.00	0.001
Emotional Eating	15.88±7.73	16.0 (1.0-30.0)	21.75±5.37	21.0 (7.0-30.0)	492.50	0.000	13.73±6.73	12.0 (3.0-30.0)	18.6±4.88	18.0 (9.0-30.0)	1329.00	0.000

U: Mann-Whitney U Test

Table 3. Eating Attitudes Test (EAT-26) scores by food addiction status and gender

Parameters	Food Addiction Status	Male		Female		t-U	p
		$\bar{X} \pm S$	Median (Min-Max)	$\bar{X} \pm S$	Median (Min-Max)		
Dieting	No Food Addiction	9.0±6.95	10.0 (0.0-27.0)	9.63±8.42	7.0 (0.0-36.0)	U=500	< 0.05
	Food addiction	8.5±7.07	7.5 (0.0-19.0)	11.11±8.47	10.0 (0.0-36.0)	U=750	0.21
	U p	908 0.764					
Bulimia and Food Preoccupation	No Food Addiction	3.7±3.92	3.0 (0.0-18.0)	3.5±5.06	2.0 (0.0-18.0)	U=850	0.45
	Food addiction	2.3±2.71	2.0 (0.0-12.0)	4.3±5.34	2.0 (0.0-18.0)	U=880	0.95
	U p	759 0.115					
Oral Control	No Food Addiction	1.4±5.53	0.0 (0.0-9.0)	2.4±3.32	2.0 (0.0-12.0)	U=500	< 0.01
	Food addiction	0.4±1.04	0.0 (0.0-4.0)	2.7±3.46	2.0 (0.0-12.0)	U=620	< 0.01
	U p	758 0.049					
EAT-26 Total	No Food Addiction	13.2±9.57	10.0 (0.0-48.0)	14.7±14.14	11.0 (0.0-63.0)	U=900	0.70
	Food addiction	10.9±7.35	10.0 (2.0-24.0)	17.0±13.96	14.0 (0.0-63.0)	U=680	< 0.05
	U p	825 0.321			2130 0.139		

Independent Samples T-Test; U: Mann-Whitney U Test

Table 4. Metabolic and endocrine markers by food addiction status and gender

Parameters	Male				Female				U	p		
	No Food Addiction (n=59)		Food Addiction (n=32)		No Food Addiction (n=51)		Food Addiction (n=98)					
	$\bar{X} \pm S$	Median (Min-Max)	$\bar{X} \pm S$	Median (Min-Max)	$\bar{X} \pm S$	Median (Min-Max)	$\bar{X} \pm S$	Median (Min-Max)				
Fasting	95.22±14.59	92 (77-162)	114.68±37.4	110 (77-292)	496.5	0.000	97.96±12.8	95 (77-138)	115.52±38.2	104.5 (78-292)	1,679.0	0.001
Homa IR	3.25±3.01	2.6 (0.3-21.4)	3.67±2.32	3.4 (0.3-12.5)	774.0	0.157	3.09±1.79	2.8 (0.3-6.9)	4.55±3.29	3.7 (0.8-21.4)	1,772.5	0.004
HbA1C	5.76±0.59	5.6 (4.9-9)	6.11±1.47	5.9 (3.8-12.65)	756.0	0.117	5.95±0.7	5.8 (4.9-9)	6.45±1.45	6 (5-12.6)	2,060.0	0.078
Insulin	13.44±12.43	11.6 (1.7-91.4)	12.71±6.36	11.15 (1.7-35.3)	865.5	0.514	13.28±6.42	12 (1.7-30.3)	16.01±11.03	13.8 (3.4-91.4)	2,205.0	0.239
Vit. D	19.16±9.32	18.6 (4.8-43)	19.47±9.11	19.8 (8.3-38.6)	914.0	0.803	24.26±11.0	21.9 (6.6-45.3)	20.17±9.48	19.3 (4.8-45.3)	1,971.5	0.035
Cortisol	9.11±3.62	8.4 (4.2-20.7)	10.35±5.07	8.8 (4.3-20.7)	850.0	0.434	9.54±3.54	8.9 (4.2-19.9)	11.01±5.67	9.65 (4.3-40.7)	2,120.5	0.130

Note. $\bar{X} \pm S$ = Mean ± Standard Deviation; HOMA-IR = Homeostatic Model Assessment for Insulin Resistance; HbA1c = Glycated Hemoglobin; Vit. D = Vitamin D; U = Mann-Whitney U test statistic; p=significance value. The Mann-Whitney U test was used for two-group comparisons.

Table 5. Body mass index, waist circumference, and waist-to-height ratio risk categories by food addiction status and gender

Parameters	Male (n=91)				Female (n=149)				F	p		
	No Food Addiction		Food Addiction		No Food Addiction		Food Addiction					
	S	%	S	%	S	%	S	%				
BMI Group												
Obese Class I (30.0-35.9 kg/m ²)	43	72.8	8	25.0			40	78.4	43	43.8		
Obese Class II (35-39.9 kg/m ²)	10	16.9	10	31.2	F=8.062 C=17.414	0.00	8	15.6	35	35.7	F=4.651 C=14.861	0.00
Obese Class III (≥40 kg/m ²)	6	10.1	14	43.7			3	5.8	20	20.4		
Waist Circumference Risk Status												
Low Health Risk (M: <94; F: <80 cm)	0	0.0	0	0.0			3	5.8	0	0.0		
High Health Risk (M: ≥94 - <102; F: ≥80 - <88 cm)	8	13.5	0	0.0	F= inf C=3.216	0.047 0.073	9	17.6	32	32.6	F=0.635 C=0.939	0.264 0.332
Severe health risk (M: ≥102; F: ≥88 cm)	51	86.4	32	100.0			39	76.4	66	67.3		
Waist-to-Height Ratio Risk Status												
At-Risk (<0.4)	0	0.0	0	0.0			0	0.0	0	0.0		
Normal (0.4 - <0.5)	11	18.6	3	9.3	F=2.215 C=0.750	0.363 0.387	21	41.1	13	13.2	F=4.577 C=13.295	0.000 0.000
High-Risk (≥0.5 - <0.6)	45	76.2	20	62.5			19	37.2	22	22.4		
Requires Treatment (≥0.6)	3	5.0	9	28.1			11	21.5	63	64.2		

C: Chi-Square Test of Independence; F: Fisher's Test



Discussion

This study demonstrates that FA among individuals with obesity is associated with a clinically meaningful risk profile encompassing both eating behaviors and metabolic indicators, with these associations differing substantially by gender. The observed FA prevalence of 54.2% in the present sample is notably higher than the 15–40% range typically reported in obese populations¹⁵, suggesting that FA constitutes a distinct and clinically relevant phenotype rather than a secondary behavioral feature.¹⁶ The higher prevalence of FA observed among women aligns with findings from previous meta-analyses and large population-based studies.¹⁷ Moreover, evidence supporting the measurement invariance of the modified mYFAS 2.0 indicates that this disparity reflects a true gender-related difference rather than a measurement artifact.¹⁸ Collectively, these findings support the notion that FA in women is characterized by heightened cognitive–emotional conflict, particularly manifesting as a cycle of emotional eating followed by guilt. This interpretation is reinforced by the significantly higher guilt scores reported by women with FA following emotional eating ($p=0.001$), a relationship that was not evident in men ($p=0.205$). In contrast, the pattern observed in men—characterized by lower cognitive restraint and a tendency to “surrender” to eating impulses—suggests gender-specific behavioral manifestations of FA. The strong association between FA and maladaptive eating behaviors, including emotional eating, loss of control, and heightened cravings, supports the conceptualization of FA as an addiction-like construct driven by reward-seeking mechanisms and impaired impulse control.^{19–21} Notably, significantly higher scores for food craving and preoccupation with eating ($p<0.001$) underscore craving as a core feature of FA, in line with evidence demonstrating that food-related cues robustly activate the brain’s reward circuitry.²² Although emotional eating was positively associated with FA in both genders,^{23–25} women exhibited significantly higher levels of uncontrolled eating, whereas men demonstrated a negative association between FA and cognitive restraint.²⁶ These findings highlight distinct gender-specific behavioral profiles, suggesting that FA in women may be more closely linked to dysregulated eating control, while in men it may reflect diminished regulatory restraint. From a metabolic perspective, significantly higher fasting glucose levels observed in both male and female participants with FA ($p<0.001$) indicate that FA is associated with an elevated cardiometabolic risk profile.^{15,27} However, a clear gender-specific divergence emerged with respect to insulin resistance. Women with FA exhibited significantly higher Homeostatic Model Assessment for Insulin Resistance (HOMA-IR) values ($p=0.004$), suggesting a more pronounced physiological dysregulation.²⁸ In contrast, the absence of a significant association in men ($p=0.157$) may reflect a transient metabolic buffering effect, potentially attributable to higher skeletal muscle mass and differences in insulin sensitivity.²⁹ Similarly, significantly lower serum vitamin D concentrations in women with FA ($p=0.035$) further support previously reported links between vitamin D deficiency and impaired insulin sensitivity.^{30–31} With regard to body composition, men with FA demonstrated significantly higher visceral fat percentages ($p<0.001$), a well-established marker of cardiometabolic risk.³² In women, however, the metabolic burden of FA appeared to manifest predominantly through disruptions in insulin signaling and micronutrient status rather than through visceral adiposity. Taken together, these

findings indicate that food addiction represents a heterogeneous construct in which both behavioral and metabolic components differ substantially by gender. Collectively, the results underscore the need to move beyond “one-size-fits-all” approaches and toward personalized, multidisciplinary, and gender-sensitive intervention strategies. Routine assessment of FA in clinical practice is therefore warranted, integrating psychological interventions with metabolic risk management to optimize long-term outcomes.³

Conclusion

This study underscores that FA is highly prevalent among individuals with obesity and exhibits marked gender-specific differences. Behavioral patterns vary substantially by sex; men are more likely to relinquish cognitive control overeating behaviors, whereas women experience a pronounced conflict between attempts at dietary restraint and episodes of uncontrolled eating. These findings challenge the validity of “one-size-fits-all” treatment models in obesity management and highlight the necessity for a paradigm shift toward personalized, multidisciplinary, and gender-sensitive intervention strategies. Effective management of FA should therefore move beyond generalized recommendations to address distinct behavioral phenotypes and associated metabolic risks, thereby facilitating more effective and sustainable long-term health outcomes.

Conflict of Interest: The authors declare no conflicts of interest. Compliance of Ethical Statement: Approval for the study was obtained from the Lokman Hekim University Clinical Research Ethics Committee (Protocol No. 2024/041; January 30, 2024).

Ethical Approval: Ethical approval for this study was obtained from the Lokman Hekim University Institutional Ethics Committee in accordance with institutional guidelines and the principles of the Declaration of Helsinki for research involving human participants (Protocol No. 2024/041; January 30, 2024; Kod No. 2024041).

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