Cukurova Medical Journal
ÇUKUROVA ÜNİVERSİTESİ TIP FAKÜLTESİ

Cukurova Med J 2026;51(1):41-54
DOI: 10.17826/cumj.1779344

RESEARCH

Food addiction and treatment adherence in type 2 diabetic patients

Tip 2 diyabet hastalarında yeme bağımlılığı ve tedavi uyumu

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Abstract

Purpose: This study aimed to examine the impact of food addiction on treatment adherence in patients with type 2 diabetes.
Materials and Methods: The study included a total of 176 patients with type 2 diabetes, including 103 women and 73 men. Data were collected using a Sociodemographic and Clinical Data Form, the Yale Food Addiction Scale (YFAS), and the Morisky Medication Adherence Scale-8 (MMAS-8).
Results: Food addiction was identified in 11.9% (n = 21) of the patients with type 2 diabetes who participated in the study. No significant association was found between food addiction levels and treatment adherence among patients with type 2 diabetes. Patients who reported adhering to their diet and participating in regular physical activity demonstrated significantly higher medication adherence. Food addiction levels were significantly lower in patients without a history of psychiatric illness than in those with such a history.
Conclusion: The findings of this study indicate that food addiction does not significantly impact medication adherence among patients with type 2 diabetes, whereas dietary adherence and regular physical activity significantly improve medication adherence. Further research with larger sample sizes and long-term follow-up is needed to elucidate more clearly the potential effects of food addiction on treatment adherence in individuals with type 2 diabetes.
Keywords:. Type 2 diabetes, psychiatric comorbidities, food addiction, treatment adherence

Öz

Amaç: Bu çalışma yeme bağımlılığının tip 2 diyabet hastalarında tedavi uyumuna etkisini incelemeyi amaçlamaktadır.
Gereç ve Yöntem: Toplam 176 tip 2 diyabetli hasta (103 kadın, 73 erkek) çalışmaya dahil edilmiştir. Veriler Sosyodemografik ve Klinik Veri Formu, Yale Yeme Bağımlılığı Ölçeği (YFAS) ve Morisky Tedavi Uyumu Ölçeği-8 (MMAS-8) uygulanarak elde edilmiştir.
Bulgular: Çalışmaya katılan tip 2 diyabet hastalarının %11.9'unda (n = 21) yeme bağımlılığı tespit edilmiştir. Tip 2 diyabet hastalarında yeme bağımlılığı düzeyleri ile tedavi uyumu arasında anlamlı bir ilişki bulunamamıştır. Medikal tedavi uyumu, diyetine dikkat ettiğini ve düzenli fiziksel aktivite yaptığını belirten hastalarda anlamlı derecede yüksek çıkmıştır. Psikiyatrik hastalık öyküsü olmayan hastalarda, öyküsü olanlara kıyasla yeme bağımlılığı düzeyleri anlamlı derecede daha düşük tespit edilmiştir.
Sonuç: Bu çalışmanın bulguları, tip 2 diyabet hastalarında yeme bağımlılığının tedavi uyumu üzerinde anlamlı bir etkiye sahip olmadığını düşündürmektedir; buna karşın diyet uyumu ile düzenli fiziksel aktivitenin tedavi uyumunu anlamlı düzeyde artırdığını göstermektedir. Tip 2 diyabetli bireylerde yeme bağımlılığının tedavi uyumuna olası etkilerinin daha net biçimde ortaya konabilmesi için daha geniş örneklemlerle ve uzun dönemli takipleri içeren ileri araştırmalara ihtiyaç vardır.
Anahtar kelimeler: Tip 2 diyabet, psikiyatrik komorbiditeler, yeme bağımlılığı, tedavi uyumu

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Received: 05.10.2025 Accepted: 11.01.2026

INTRODUCTION

Type 2 diabetes mellitus (T2DM) is a systemic disease that develops due to insulin insufficiency and/or insulin resistance, leading to elevated blood glucose levels. According to the International Diabetes Federation (IDF) 2025 Atlas, approximately 11.1% of the adult population aged 20–79 years (i.e. one in every nine adults) is estimated to have diabetes[1]. According to data from the World Health Organization (WHO), the prevalence of diabetes among adults was reported to be approximately 14% as of 2022[2]. It is also known that more than 90% of all diabetes cases worldwide are type 2 diabetes[1]. Treatment adherence is critically important in the management of this common disease. Improved treatment adherence can prevent acute complications, delay the onset of chronic complications, and reduce both healthcare costs and mortality[3].

Food addiction is defined as an individual's loss of control over certain foods (especially highly processed foods), excessive and repetitive consumption of these foods, and the continuation of this behavior despite psychological, physical or social harms[4]. Although eating addiction has not yet been defined in DSM-V, it is measured by instruments such as the Yale Food Addiction Scale (YFAS and YFAS 2.0)[5]. It is more prevalent in individuals with high BMI (body mass index) and in women (prevalence ≈ 25% in obese individuals and ≈ 10% in individuals with normal BMI)[6]. In addition, a 10% increase in ultra-processed food consumption is associated with a 12% increase in the risk of type 2 diabetes[7]. A recent systematic review and meta-analysis found that the prevalence of food addiction among individuals with type 2 diabetes is approximately 30%, and there is a strong association between food addiction and type 2 diabetes[8].

Individuals who exhibit binge eating behaviors have heightened reward sensitivity and impulsivity[9]. They tend to make rapid decisions and prefer immediate gratification over long-term goals. Consequently, in patients with diabetes and coexisting food addiction, adherence to behavioral modifications such as diet and exercise may be impaired. Repeated consumption of high glycemic index foods in these individuals also leads to blood glucose fluctuations[10], which can impair treatment response through mechanisms such as endothelial dysfunction, increased oxidative stress, and inflammation[11]. Reduced treatment response may result in loss of motivation and non-adherent behaviors, complicating lifestyle modifications and increasing the likelihood of neglecting pharmacological therapy. Psychiatric disorders commonly comorbid with food addiction, such as depression and anxiety, may further negatively affect treatment adherence[12].

Food addiction in patients with type 2 diabetes may contribute to treatment failures despite standard interventions. Symptoms of food addiction, including the development of tolerance, have been linked to poor glycemic control (elevated HbA1c) in these patients[13]. Complications such as neuropathy, nephropathy, retinopathy, and depression are also observed more frequently in type 2 diabetic patients with food addiction[14]. Therefore, identification and intervention of food addiction in these patients are critically important. Psychotherapeutic interventions aim to control binge-eating episodes and modify eating behaviors[15].

Despite the growing body of literature on type 2 diabetes and food addiction, no study to date has specifically investigated how these two major health issues affect treatment adherence. The aim of this study was to examine the relationship between food addiction levels and treatment adherence in patients with type 2 diabetes.

Based on the existing literature, we hypothesized that food addiction and lifestyle-related factors such as dietary adherence, physical activity, and psychiatric comorbidity would be associated with medication adherence in patients with type 2 diabetes.

MATERIALS AND METHODS

Sample

A total of 176 volunteers (103 women and 73 men), aged 18 years and older, who had been diagnosed with type 2 diabetes for at least one year, were using medication, and had completed all questionnaires and scales in full, were included in the study. Fourteen individuals were excluded due to unwillingness to participate (n = 6), incomplete questionnaire data (n = 5), or a diagnosis of type 2 diabetes for less than one year (n = 3).

An a priori power analysis using G*Power (v3.1.5) indicated that at least 175 participants were required to achieve 95% power with an effect size of 0.25 and an alpha level of 0.05.

Participants were included in the study if they were willing to participate, were aged 18 years or older, had completed all questionnaires and scales in full, and had a confirmed diagnosis of type 2 diabetes for at least one year with ongoing medication use. Participants were excluded if they were unwilling to participate, were under 18 years of age, had incomplete questionnaire or scale data, or had a diagnosis of type 1 diabetes.

Procedure

The study employed a cross-sectional, descriptive-correlational design. The study was approved by the Ethics Committee of Haydarpaşa Numune Training and Research Hospital on 2 August 2021 (approval number: 2021/217). Written informed consent was obtained from all participants prior to their inclusion in the study. Questionnaires were administered to participants through face-to-face interviews, and all data were collected between 2 September 2021 and 2 December 2021 at the Family Medicine outpatient clinics of Haydarpaşa Numune Training and Research Hospital. Data collection was conducted in person by the principal investigator, a resident physician in family medicine. Completion of the questionnaires required approximately 10–15 minutes per participant. The study was carried out over a three-month period, and data collection was terminated once the predetermined sample size was reached. Paper-based data were subsequently digitized for statistical analysis. Only participants' sociodemographic characteristics and scale scores were included in the statistical analyses. All procedures were performed in accordance with ethical principles and confidentiality standards.

Measures

Sociodemographic data were obtained from participants using an information form prepared by the researchers. Food addiction was assessed using the Yale Food Addiction Scale (YFAS). Treatment adherence was evaluated with the Morisky Medication Adherence Scale-8 (MMAS-8).

Sociodemographic Information Form

This form collected data on participants' age, height, weight, gender, duration of type 2 diabetes, type(s) of antidiabetic medications used, presence of chronic comorbidities, history of psychiatric disorders, as well as information regarding dietary adherence and engagement in regular physical activity.

Morisky Medication Adherence Scale

Morisky and colleagues first developed and validated a 4-item medication adherence scale, the Morisky-Levine-Green Medication Assessment Questionnaire (MLG-MAQ), in 1986 in a study involving 400 patients with hypertension. In 2008, Morisky applied the 8-item Morisky Medication Adherence Scale (MMAS-8) to a sample of 1,400 patients and found a Cronbach's alpha of 0.83, indicating good reliability of the scale[16]. This scale, which is widely used to assess medication adherence in patients with diabetes, consists of 8 items. A total score of 8 indicates high adherence, scores of 6–7 indicate moderate adherence, and scores below 6 indicate low adherence. The Turkish version of the MMAS-8, adapted and published by Sayıner et al., was published in 2014 and demonstrated a Cronbach's alpha of 0.89[17].

Yale Food Addiction Scale (YFAS)

The YFAS was developed by Gearhardt and colleagues based on the diagnostic criteria for substance dependence outlined in the DSM-IV-TR[4]. In the reliability analysis of the scale adapted into Turkish by Bayraktar and colleagues in 2012, the Cronbach's Alpha value was found to be 0.93[18]. The scale consists of 25 items, and a diagnosis of food addiction requires meeting at least three out of seven diagnostic criteria in addition to the presence of clinically significant impairment or distress. In this study, participants who met at least three diagnostic criteria of the scale and exhibited clinically significant symptoms were considered to have food addiction.

Statistical analysis

In the study, demographic variables such as gender, marital status, and educational level were summarized using frequency (n) and percentage (%). The normality of continuous variables (age, height, weight, BMI, YFAS scores, and MMAS-8 scores) was assessed both graphically and with the Shapiro–Wilk test. Except for age, all continuous variables demonstrated non-normal distributions; therefore, descriptive statistics were presented as median (interquartile range, IQR). Mean ± standard deviation values were also reported for descriptive purposes. Comparisons of YFAS and MMAS-8 scores across categorical variables such as educational level and marital status were performed using the Kruskal–Wallis non-parametric analysis of variance, followed by Bonferroni-adjusted pairwise comparisons.

Mann–Whitney U tests were used to compare YFAS and MMAS-8 scores by gender, presence of chronic diseases, history of psychiatric disorders, smoking status, and alcohol use. For categorical variables and food addiction classification, cross-tabulations were created and evaluated using frequency (n), percentage (%), and chi-square (χ^2) test statistics. Mann–Whitney U tests were also employed to compare BMI and MMAS-8 scores between participants with and without food addiction. Spearman's non-parametric correlation coefficients were calculated to examine relationships between YFAS and MMAS-8 scores, as well as age and BMI. All statistical analyses were performed using IBM SPSS Statistics version 21.0 and Microsoft Excel 2007. A p-value <0.05 was considered statistically significant.

Table 1. Demographic and general characteristics of participants

Variables			**n (%)**
Sex	Female		103 (58.5)
	Male		73 (41.5)
Marital Status	Married		140 (79.5)
	Single		11 (6.3)
	Widowed		25 (14.2)
Education Status	Elementary- Secondary Education		125 (71.0)
	High School		28 (15.9)
	University Graduate		23 (13.1)
How many years have you had diabetes?	1-5 years		64 (36.4)
	6-10 years		37 (21.0)
	11 years and above		75 (42.6)
Type of diabetes medication(s) used	OAD only		126 (71.6)
	Insulin only		15 (8.5)
	OAD with insulin		35 (19.9)
Number of medication(s) used	1 medication		74 (42.0)
	2 medications		58 (33.0)
	3 medications		16 (9.1)
	4 medications		21 (11.9)
	5 medications		7 (4.0)
Regular check-ups for your illness	Yes		119 (67.6)
Any other diagnosed diseases	Yes		135 (76.7)
Type of diagnosis?	Hypertension	No	76 (43.2)
		Yes	100 (56.8)
	COPD/Asthma	No	157 (89.2)
		Yes	19 (10.8)
	Cardiovascular Disease	No	129 (73.3)
		Yes	47 (26.7)
	Malignancy	No	162 (92.0)
		Yes	14 (8.0)
	Others	No	127(72.2)
		Yes	49 (27.8)
Presence of psychiatric disorder?	Yes		31 (17.6)
Type of psychiatric disorder?	Anxiety disorder		11 (35.5)
	Depression		19 (61.3)
	Bipolar disorders		1 (3.2)
Smoking	Yes		35 (19.9)
Alcohol Use	Yes		14 (8.0)
Dietary adherence	Yes		89 (50.6)
Regular physical exercise	Yes		79 (44.9)
	No		97 (55.1)
Food addiction classification	No Food Addiction		155(88.1)
	Food Addiction		21 (11.9)

OAD: Oral Antidiabetic; COPD: Chronic Obstructive Pulmonary Disease

RESULTS

The mean age of the participants in this study was 59.47±11.12 years, with a minimum age of 29.0 and a maximum age of 84.0 years. Of the participants 58.5% (n=103) were female and 41.5% (n=73) were male. Other sociodemographic characteristics of the participants are given in Table 1.Participants' age and body mass index averages, YFAS and MMAS-8 scores are given in Table 2.

Table 2. Descriptive statistics

Variable	Mean±SD	Median(IQR)	Minimum-Maximum
Age (years)	59.47±11.12	60.0 (14.0)	29.0; 84.0
BMI (kg/m2)	30.70±6.16	29.7 (8.0)	19.6; 50.1
Yale Food Addiction Scale Score	3.03±0.75	3.0 (0.0)	1.0; 6.0
Morisky Treatment Adherence Scale Score	6.19±1.89	7.0 (3.0)	1.0; 8.0

SD: Standard Deviation; IQR: Interquartile Range; BMI: Body Mass Index

Among all participants, 11.9% (n=21) were found to have food addiction, with a prevalence of 12.6% (n=13) in women and 11.0% (n=8) in men. No statistically significant difference was found between genders in terms of food addiction (χ^2=0.112, p=0.737). Among those with food addiction, only 23.8% reported adhering to a diet, whereas 54.2% of those without food addiction reported dietary adherence. A statistically significant difference was found between food addiction and dietary adherence (χ^2=6.830, p=0.009). The associations between food addiction, dietary adherence and body mass index are presented in Table 3.

Table 3. Comparison of dietary adherence according to food addiction classification

Variables	Food Addiction Classification			
	Participants without food addiction n (%)	Participants with food addiction n (%)	Test statistic	
			χ^2	P Effect Size
Dietary Adherence				
Yes	84 (54.2)	5 (23.8)	6.830	**0.009** **0.197**
No	71 (45.8)	16 (76.2)		
BMI Classification				
Normal	29 (93.5)	2 (6.5)	3.488	0.175
Pre-Obese	56 (91.8)	5 (8.2)		
Obese	70 (83.3)	14 (16.7)		

χ^2:Chi-Square Test Statistic; BMI: Body mass index

No statistically significant associations were observed between food addiction and variables including age, height, weight, educational status, duration of diabetes, smoking or alcohol use, regular medical follow-up, engagement in regular physical activity, body mass index (BMI), or MMAS-8 scores (p>0.05).

The mean YFAS score was 2.89±0.65 among individuals reporting dietary adherence, compared to 3.18±0.83 among those without dietary adherence. A statistically significant difference in YFAS scores was observed between the two groups according to dietary adherence (z=2.384; p=0.017). The mean YFAS score was 2.97±0.68 among participants engaging in regular physical activity, compared to 3.08±0.81 among those not engaging in regular physical activity. No statistically significant difference was observed between the groups (z=0.387; p=0.698). Additionally, no statistically significant difference was observed in mean YFAS scores across BMI categories (χ^2=0.392; p=0.822). The distribution of YFAS scores according to dietary adherence, regular physical activity, and BMI categories is presented in Table 4.

Table 4. Comparison of Yale Food Addiction scale scores across variable groups

Variables		Yale Food Addiction Scale Score		Test Statistic*		
		Mean±SD	**Median (IQR)**	**Z ;χ2**	**p**	**Effect Size**
Dietary adherence	Yes	2.89±0.65	3.0 (0.0)	z=2.384	**0.017**	**0.39**
	No	3.18±0.83	3.0 (0.0)			
Regular physical exercise	Yes	2.97±0.68	3.0 (0.0)	z=0.387	0.698	
	No	3.08±0.81	3.0 (0.0)			
BMI Classification	Normal	3.00±0.89	3.0 (0.0)	χ2 =0.392	0.822	
	Pre-obese	3.02±0.46	3.0 (0.0)			
	Obese	3.06±0.87	3.0 (0.0)			

z:Mann-Whitney U Test Statistic, χ^2:Kruskal-Wallis Test Statistic; SD: Standard deviation; IQR: Interquartile Range; BMI: Body Mass Index

A statistically significant relationship was found between participants YFAS scores and the presence of a psychiatric disorder (z=2.251; p=0.024). The mean YFAS score of individuals with a known psychiatric disorder was significantly higher than that of individuals without a psychiatric disorder. The relationship between YFAS scores and the presence of a psychiatric disorder is presented in Table 5.

Table 5. Comparison of Yale Food Addiction scale scores according to variable groups

Variable		**Yale Food Addiction Scale Score**		**Test Statistic***		
		Mean±SD	Median (IQR)	Z	p	Effect Size
Psychiatric disorder	Yes	3.35±0.88	3.0 (1.0)	z=2.251	0.024	0.52
	No	2.96±0.71	3.0 (0.0)			

z: Mann-Whitney U Test Statistic; SD: Standard deviation; IQR: Interquartile Range

Table 6. Distribution of problematic foods by food addiction status

Foods causing difficulties	**Food Addiction Classification**		
	Participants without food addiction n (%)	**Participants with food addiction n (%)**	**Test Statistic p***
Sugar/Sweets			
No	154 (99.4)	18 (85.7)	0.005
Yes	1 (0.6)	3 (14.3)	
Bread			
No	128 (82.6)	9 (42.9)	<0.001
Yes	27 (17.4)	12 (57.1)	
Pasta			
No	148 (95.5)	16 (76.2)	0.007
Yes	7 (4.5)	5 (23.8)	
French Fries			
No	146 (94.2)	10 (47.6)	<0.001
Yes	9 (5.8)	11 (52.4)	
Pizza/Lahmacun/Döner			
No	151 (97.4)	17 (81.0)	0.008
Yes	4 (2.6)	4 (19.0)	
Coke/Soda			
No	151 (97.4)	17 (81.0)	0.008
Yes	4 (2.6)	4 (19.0)	

χ2: Chi-Square Test Statistic * Fisher's Exact Test

All individuals with food addiction reported experiencing problems with at least one of the specified food items, whereas 51% of individuals without food addiction reported no problems with any of the specified foods. The distribution of problematic food consumption among individuals with and without food addiction is presented in Table 6.

In the pairwise comparisons of YFAS scores according to the type of diabetes medication, a statistically significant difference was found between the group using both oral antidiabetics (OAD) and insulin and the group using only OAD (p=0.006). The mean YFAS score of patients using only OAD was significantly higher compared to those using both OAD and insulin. Statistically significant differences in YFAS scores were observed according to the number of medications used. Patients using five medications had significantly lower YFAS scores compared with those using one, two, or three medications (p = 0.021, p = 0.009, and p = 0.007, respectively). The comparisons of YFAS scores according to diabetes medication type and number of medications are presented in Tables 7 and 8.

Table 7. Comparisons of Yale Food Addiction Scale scores according to type and number of medications used

		Yale Food Addiction Scale Score		**Test Statistic***	
		Mean±SD	**Median (IQR)**	**Mean±SD**	**Median (IQR)**
Type of Diabetes Medication Used	Oral tablets only	3.17±0.73	3.0 (0.0)	$\chi2$ =12.160	**0.002**
	Insulin only	2.73±0.59	3.0 (0.0)		
	Oral tablets with insulin	2.68±0.76	3.0 (1.0)		
Number of Medication(s) Used	1 medication	3.05±0.64	3.0 (0.0)	$\chi2$ =16.324	**0.003**
	2 medications	3.14±0.74	3.0 (0.0)		
	3 medications	3.37±0.96	3.0 (0.7)		
	4 medications	2.76±0.62	3.0 (0.5)		
	5 medications	2.00±1.00	2.0 (2.0)		

z: Mann–Whitney U Test Statistic , χ^2= Kruskal–Wallis Test Statistic; SD: Standard deviation; IQR: Interquartile Range

Table 8. Pairwise comparisons of Yale Food Addiction Scale scores according to type and number of medications

Type of Diabetes Medication Used	**p**
OAD with insulin- Insulin only	1.000
OAD with insulin- OAD only	0.006
Insulin only- OAD only	0.108
Number of Medication(s) Used	p
5 medications -4 medications	0.662
5 medications -1 medication	0.021
5 medications -2 medications	0.009
5 medications -3 medications	0.007
4 medications -1 medication	0.940
4 medications -2 medications	0.370
4 medications -3 medications	0.252
1 medication -2 medications	1.000
1 medication -3 medications	1.000
2 medications -3 medications	1.000

Pairwise group comparisons were performed using Dunn's post-hoc analysis with Bonferroni correction following the Kruskal–Wallis test.
OAD: Oral Antidiabetic

The mean MMAS-8 score was 6.09±1.79 among female participants and 6.33±2.01 among male participants. Based on the Morisky Medication Adherence classification, 32.6% (n=57) of individuals demonstrated low adherence, 32.0% (n=56) moderate adherence, and 35.4% (n=62) high adherence. No statistically significant differences were observed in the prevalence of food addiction across the Morisky adherence categories (χ^2=2.088, p=0.352). The comparisons of MMAS-8 scores with relevant demographic and clinical variables are presented in Table 9.

Table 9. Comparison of Morisky Treatment Adherence scale scores according to variable groups

Variable		MMAS Score		Test Statistics*	
		Mean±SD	**Median (IQR)**	**Z ;χ2**	**p**
Sex	Female	6.09±1.79	6.5 (3.0)	z=1.290	0.197
	Male	6.33±2.01	7.0 (3.0)		
Marital Status	Single	6.22±1.87	7.0 (3.0)	χ2 =2.725	0.256
	Married	5.36±2.06	6.0 (3.0)		
	Divorced	6.40±1.80	7.0 (3.0)		
Education Status	Elementary- Secondary Education	6.09±1.87	6.0 (3.0)	χ2 =2.801	0.246
	High School	6.21±2.13	7.0 (3.7)		
	University Graduate	6.77±1.51	7.5 (3.0)		
Years of Diabetes	1-5 years	6.25±1.71	6.5 (3.0)	χ2 =0.349	0.840
	6-10 years	6.13±1.72	7.0 (3.0)		
	11 years or above	6.17±2.10	7.0 (3.0)		
Type of medication used	OAD only	6.23±1.83	7.0 (3.0)	χ2 =1.526	0.466
	Insulin only	6.67±1.49	7.0 (3.0)		
	OAD with Insulin	5.86±2.16	7.0 (4.0)		
Number of Medication(s) Used	1 medication	6.47±1.68	7.0 (3.0)	χ2 =3.149	0.533
	2 medications	6.09±2.00	7.0 (3.0)		
	3 medications	6.06±1.48	6.0 (2.7)		
	4 medications	5.71±2.19	7.0 (2.5)		
	5 medications	6.00±2.58	7.0 (4.0)		
Regular Check-Up	Yes	6.39±1.75	7.0 (3.0)	z=1.854	0.064
	No	5.77±2.06	6.0 (4.0)		
Comorbid Physical Ilness	No	6.32±1.71	7.0 (3.0)	z=0.259	0.795
	Yes	6.16±1.93	7.0 (3.0)		
Comorbid Psychiatric Disorder	Yes	6.03±1.72	6.0 (4.0)	z=0.905	0.365
	No	6.23±1.91	7.0 (3.0)		

z:Mann-Whitney U Test Statistics, χ^2=Kruskal-Wallis Test Statistics; MMAS: Morisky Medication Adherence Scale OAD: oral antidiabetic SD: Standard deviation IQR: Interquartile Range

Table 10. Comparison of Morisky Medication Adherence scale scores across variable groups

Variables		MMAS Score		Test Statistics*		
		Mean±SD	**Median (IQR)**	**Z ;χ2**	**p**	**Effect Size**
Do you follow a healthy diet?	Yes	6.69±1.65	7.0 (2.0)	z=3.656	**<0.001**	**0.56**
	No	5.67±1.96	6.0 (4.0)			
Do you engage in regular physical activity?	Yes	6.62±1.74	7.0 (3.0)	z=2.959	**0.003**	**0.42**
	No	5.84±1.92	6.0 (3.7)			
BMI Classification	Normal	6.61±2.01	8.0 (2.0)	χ2=7.467	**0.024**	**0.18**
	Pre-obese	6.43±1.77	7.0 (2.7)			
	Obese	5.87±1.87	6.0 (3.7)			

z = Mann-Whitney U Test Statistics; χ2 = Kruskal-Wallis Test Statistics
MMAS: Morisky Medication Adherence Scale BMI: Body mass index SD: Standard deviation IQR: Interquartile Range

A statistically significant difference was found in MMAS-8 scores according to participants' dietary adherence ($z = 3.656$; $p < 0.001$). The mean MMAS-8 score was significantly higher among individuals who reported adhering to their diet compared with those who did not. A statistically significant difference was also found in 'MMAS-8' scores based on regular physical activity status ($z=2.959$; $p=0.003$). Individuals who engage in regular physical activity had higher 'MMAS-8' scores. According to BMI classification, a statistically significant difference was found in individuals' 'MMAS-8' scores ($\chi^2=7.467$; $p=0.024$). The distribution of MMAS-8 scores according to dietary adherence, regular physical activity, and BMI categories is presented in Table 10. As presented in Table 11, pairwise comparisons of MMAS-8 scores across BMI categories demonstrated a significant difference between individuals with obese and normal BMI ($p=0.044$).

Table 11. Pairwise comparisons of Morisky Medication Adherence Scale scores by BMI classification

BMI	p
Obese vs pre-obese	0.143
Obese vs normal	**0.044**
Pre-obese vs normal	1.00

Pairwise group comparisons were performed using Dunn's post-hoc analysis with Bonferroni correction following the Kruskal–Wallis test. BMI: Body mass index

A weak but statistically significant positive correlation was found between the MMAS-8 scores and age (Spearman's correlation coefficient = 0.213, p = 0.005). As age increased, MMAS-8 scores also increased. A very weak but statistically significant negative correlation was observed between the MMAS-8 scores and BMI (Spearman's correlation coefficient = −0.161, p = 0.034). No statistically significant relationship was found between the MMAS-8 scores and the YFAS scores ($p > 0.05$). The correlations between MMAS-8 scores and BMI, age and YFAS scores are presented in Table 12.

Table 12. Correlation between Morisky Medication Adherence Scale scores and other continuous variables

	Morisky Medication Adherence Scale Score	
Variable	Spearman's Correlation Coefficient	p
Age	0.213	0.005
BMI	-0.161	0.034
YFAS Score	-0.045	0.554

Spearman Correlation Analysis; BMI: Body mass index YFAS: Yale Food Addiction Scale

DISCUSSION

In this study, the prevalence of food addiction among patients with Type 2 diabetes was found to be 11.9%. Correlation analysis revealed a weak positive relationship between age and MMAS-8 scores, while a weak but statistically significant negative association was observed between body mass index (BMI) and medication adherence. No significant relationship was found between food addiction and medication adherence, and the effect size was negligible. However, patients who reported adhering to dietary recommendations exhibited significantly lower levels of food addiction. Furthermore, individuals who adhered to both dietary recommendations and regular physical activity demonstrated significantly higher MMAS-8 medication adherence scores.

In our study, the prevalence of food addiction was calculated as 11.9% among all participants, 11.0% in males, and 12.6% in females. The mean YFAS (Yale Food Addiction Scale) score was 3.03±0.75. In comparison, a study conducted in China involving 312 newly diagnosed Type 2 diabetes patients and 312 healthy controls reported a food addiction prevalence of 8.6% among patients with Type 2 diabetes (7.6% in males and 10.1% in females), with a mean YFAS score of 3.6±0.8[19]. Similarly, a meta-analysis by Pursey et al., which included 25 studies, found food addiction rates ranging from 5.4% to 56.8%, with an overall pooled prevalence of 19.9%. The mean YFAS symptom score across studies was 2.8±0.4, with reported values ranging between 1.8 and 4.6[6].

Type 2 diabetes is most commonly seen in middle-aged and older individuals. The mean age of the type 2 diabetes patients participating in our study was 59.47±11.12 years. Although food addiction may emerge during young adulthood, the prevalence of Type 2 diabetes in this age group is relatively low, reducing the likelihood of the two conditions co-occurring. It has been suggested that the coexistence of Type 2 diabetes and food addiction is most common among middle-aged adults (40–60 years)[20].

No significant relationship was found between food addiction and age or gender in our study. A study conducted in China reported that food addiction decreases with advancing age but is independent of gender[19]. Yu et al. and Obregon et al., in their studies involving 965 and 292 university students respectively, reported a higher prevalence of food addiction among females[21,22]. In a meta-analysis by Pursey et al., the prevalence of food addiction was approximately twice as high in females compared to males (12.2% vs. 6.4%)[6].

In a literature review by Colosia et al. on the global prevalence of obesity and hypertension in patients with type 2 diabetes, the prevalence of obesity was over 30% in 38 of the 44 studies and exceeded 50% in 14 of them[23]. In our study, the prevalence of obesity was 47.7%, which is considerably higher than that in the general population, and obese individuals demonstrated significantly lower medication adherence. There is substantial evidence suggesting that food addiction contributes to the rising prevalence of obesity in the general population. In our study, medical treatment adherence was significantly lower among obese patients with type 2 diabetes. This finding highlights a critical risk factor for both acute and chronic complications, emphasizing the need for targeted interventions to improve adherence in this population.

In our study, a significant association was found between food addiction and dietary adherence. Patients with food addiction exhibited markedly lower rates of adherence to their diet compared with those without food addiction. Similarly, in a study conducted with 300 patients with type 2 diabetes, dietary adherence was significantly lower in the group with food addiction than in the group without food addiction[3].

In our study, no significant relationship was found between food addiction and BMI. However, in contrast to our findings, numerous studies have reported that individuals with higher BMI are more susceptible to food addiction and tend to exhibit higher food addiction symptom scores[6,24-26]. For instance, a meta-analysis by Pursey et al. (2014) demonstrated that the prevalence of food addiction was approximately twice as high in pre-obese and obese individuals compared to those with normal BMI (24.9% vs. 11.1%)[6]. Although our study did not identify such an association, other studies have also failed to detect a significant relationship between food addiction and BMI[27,28]. Furthermore, it has been noted that the positive association between food addiction and type 2 diabetes weakens after adjustment for BMI, suggesting that while BMI/obesity may play a causal role in this relationship, it is not the sole determinant[20].

Highly processed foods are well known to have the strongest association with binge eating type behaviors. In our study, a statistically significant difference was observed between individuals with and without food addiction in terms of problematic food consumption, particularly for sugar/confectionery, bread, pasta, French fries, hamburger, pizza/lahmacun/döner, and cola/soda. Among participants with food addiction, the five most frequently reported problematic foods were bread (57.1%), French fries (52.4%), pasta (23.8%), pizza/lahmacun/döner (19.0%), and cola/soda (19.0%). Similarly, in the study conducted by Celebi et al., the foods most commonly triggering excessive eating urges included bread (54.3%), chocolate (52.1%), pizza (52.1%), cake/pastry (47.9%), and French fries (42.9%)[29].

In our study, the prevalence of psychiatric comorbidity among patients with type 2 diabetes was 17.6%, including 10.8% with depression and 6.25% with anxiety disorders. Previous research has suggested that elevated blood glucose levels may contribute to the development of anxiety and depressive symptoms [30]. In a study by Ali et al., depression was reported to be significantly more common in patients with type 2 diabetes than in the general population, with a prevalence of 27.05% among diabetic patients compared with 11.1% in healthy controls[31]. Similarly, Papelbaum et al. reported a depression prevalence of 18.6% among individuals with type 2 diabetes[32]. In the present study, although no statistically significant difference was observed in the prevalence of food addiction between patients with and without a psychiatric diagnosis, a significant difference was detected in

YFAS scores between the two groups. Individuals with a history of psychiatric illness had significantly higher YFAS scores compared with those without such a history. Supporting our findings, an Australian study involving 334 patients with type 2 diabetes found that individuals with food addiction had significantly higher anxiety, depression, and stress scores than those without food addiction[24]. Berenson et al. also reported a significant association between depression levels and food addiction[27]. Similarly, Nicolau et al. demonstrated that individuals with food addiction exhibited significantly higher depressive symptom scores[3].

In our study, the mean 'MMAS-8' score of the patients was 6.19±1.89, with adherence distribution among patients as follows: 35.4% high adherence, 32% moderate adherence, and 32.6% low adherence. In a study conducted in Turkey by Kara et al., comparing medication adherence of 286 type 2 diabetes patients using 'OAD+insulin' and 246 patients using 'OAD only', the mean 'MMAS-8' score was calculated as 6.1±1.7 for those using OAD only, and 5.6±1.9 for those using OAD combined with insulin.[33] In another study involving 405 type 2 diabetes patients, it was found that 57.3% of the patients were adherent to medication (with 'MMAS-8' scores of 6 or above), whereas 42.7% were non-adherent (with 'MMAS-8' scores below 6)[34]. In a validity and reliability study of the Morisky scale conducted in Korea, the frequencies of low, moderate, and high adherence were calculated as 41.6%, 27.4% and 30.9%, respectively, with a mean 'MMAS-8' score of 6.7[35]. These results indicate that there are significant treatment adherence issues among patients with type 2 diabetes.

No significant relationship was found between disease duration and 'MMAS-8' scores in our study. Sayıner's study reported a statistically significant decrease in treatment adherence as disease duration increased, attributing this to patient fatigue from prolonged treatment and doctor-patient relationship factors[16]. Similarly, a study conducted in Nigeria with 360 type 2 diabetes patients found no statistically significant relationship between disease duration and treatment adherence, consistent with our findings[36]. Conversely, another study with type 2 diabetes patients reported that the likelihood of adherence to prescribed medication regimens increased as disease duration lengthened[37]. In our study, no statistically significant relationship was found between the number of medications and 'MMAS-8' scores. However, a study with 600 type 2 diabetes patients demonstrated a statistically significant decrease in adherence levels as the number and dosage of medications increased[38]. Sayıner et al.'s study, similar to our results, found no significant relationship between the number of diabetes medications, the number of daily insulin doses administered, and Morisky treatment adherence levels[16].

In our study, 50.6% of patients reported adhering to their diet and 44.9% reported engaging in regular physical activity. Patients who adhered to their diet and those who exercised regularly had significantly higher MMAS-8 scores than those who did not. These findings highlight the importance of diet and regular physical activity in supporting treatment adherence. Sharma et al. reported dietary adherence in 23.3% of patients and exercise adherence in 31.7% of individuals with type 2 diabetes[38]. In another study involving 565 patients, exercise adherence was reported in 62.1% and dietary adherence in 86.4%. Similar to our findings, patients who exercised regularly had significantly higher MMAS-8 scores, although no significant difference in MMAS-8 scores was found between those with good and poor dietary adherence [39].

A weak positive correlation was found between 'MMAS-8' scores and age in our study, indicating that as age increased, 'MMAS-8' scores also increased. A diabetes study involving 192 participants diagnosed with type 2 diabetes reported that older patients (>65 years) were more likely to adhere to prescribed medication regimens[37]. In contrast, Sayıner's study and a study conducted in Nigeria found no relationship between age and treatment adherence[16,36].

No statistically significant difference was observed between educational status and 'MMAS-8' medication adherence scores in our study. Studies by Kirkman et al. and Curkendall et al. identified demographic factors such as younger age, lower education level, and low income as being associated with poor adherence among patients with type 2 diabetes[40,41]. Similarly, Sayıner's study found no association between educational status and 'MMAS-8' scores, consistent with our findings[16].

No significant relationship was found between the presence of psychiatric illness and 'MMAS-8' scores in our study. Similarly, Kreyenbuhl et al. reported no significant difference in treatment adherence rates between individuals with and without psychiatric disorders, supporting our findings[42]. On the other hand, some studies have demonstrated that depression is associated with decreased treatment adherence in diabetic patients[36,43].

In our study, a very weak, statistically significant negative correlation was found between 'MMAS-8' scores and BMI. As BMI increased, 'MMAS-8' scores decreased. The 'MMAS-8' scores of individuals with normal BMI were significantly higher than those of obese individuals. In the SHIELD study, which included 742 patients with type 2 diabetes, the relationship between weight loss and treatment adherence was investigated, and patients who lost weight within one year showed significantly higher treatment adherence[44]. Similarly, Sayıner's study demonstrated a low-level negative correlation between BMI and 'MMAS-8' scores consistent with our results[16].

In the present study, no statistically significant relationship was found between food addiction and treatment adherence in individuals with type 2 diabetes. Although this finding may initially appear unexpected, it can be explained by several methodological and sample-related factors. First, the homogeneity of the sample (consisting solely of individuals diagnosed with type 2 diabetes, n = 176) may have resulted in limited variability in both food addiction and treatment adherence scores. Restricted variance is known to reduce the likelihood of detecting statistically significant associations, even when a relationship may exist in the broader population. In addition, the prevalence of food addiction in this sample was lower than that reported in previous studies conducted with individuals with type 2 diabetes. The relatively low level of food addiction symptoms in the present sample may have weakened the potential impact of this variable on treatment adherence behaviors. Furthermore, both food addiction and treatment adherence were assessed using self-report measures. This approach may have introduced social desirability bias, particularly in relation to treatment adherence, as participants might have tended to overestimate their level of compliance with medical recommendations. Such bias could have obscured a potential association between the variables. Conceptually, food addiction is more closely related to impulsivity and emotional dysregulation, whereas treatment adherence is primarily influenced by cognitive and motivational factors such as self-efficacy and health beliefs. Since impulsivity was not assessed in this study, potential indirect or mediating links between food addiction and treatment adherence may not have been captured. Finally, the cross-sectional design of the study limits the ability to draw conclusions regarding the temporal or causal relationship between food addiction and treatment adherence. It is possible that the impact of maladaptive eating behaviors on adherence emerges over time, which cannot be detected within a single time-point assessment.

A key limitation of this study is that several main variables including dietary adherence, physical activity level, psychiatric history, and medication adherence were assessed using self-report instruments. Such self-reported data are inherently susceptible to recall bias and social desirability bias, as participants may unintentionally misreport or consciously overestimate positive health behaviors while underreporting unfavorable ones. Consequently, these biases may have led to an underestimation or overestimation of the true prevalence of food addiction and the level of treatment adherence.

In conclusion, the findings of this study suggest that food addiction may not have a significant direct impact on medication adherence among patients with type 2 diabetes. However, better adherence to dietary recommendations and regular physical activity were associated with significantly higher levels of treatment adherence. These results highlight the importance of a multidisciplinary approach in diabetes management, emphasizing lifestyle modification alongside medical treatment. In addition to evaluating therapeutic efficacy, clinicians should routinely assess adherence behaviors. For individuals exhibiting low adherence, incorporating a brief psychiatric evaluation or a screening tool for food addiction into diabetes education programs may offer additional benefits.

Future studies are recommended to adopt longitudinal research designs to better clarify the causal relationships among the variables. In addition, incorporating psychological and behavioral variables such as impulsivity and self-control skills into the model may contribute to a more comprehensive understanding of the examined relationship. To enhance the validity and reliability of the findings, it is important to complement self-report measures with structured clinical interviews, accelerometer-based physical activity assessments, dietary logs, and biochemical indicators such as HbA1c.

Author Contributions: Concept/Design : AB, IG, NGB; Data acquisition: AB; Data analysis and interpretation: AB, IG, NGB; Drafting manuscript: AB, IG; Critical revision of manuscript: AB, IG, NGB; Final approval and accountability: AB, IG, NGB; Technical or material support: AB; Supervision: AB, IG, NGB; Securing funding (if available): n/a.
Ethical Approval: Ethical approval was obtained from the Haydarpaşa Numune Training and Research Hospital Clinical Research Ethics Committee with decision number HNEAH-KAEK 2021/217 dated 02.08.2021.
Peer-review: Externally peer-reviewed.
Conflict of Interest: Authors declared no conflict of interest.
Financial Disclosure: No financial sources have been used for this article.

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