Food addiction: A key factor contributing to obesity?

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Background: People may develop addiction to hyperpalatable foods, which may be a cause of obesity. This study aimed to determine the prevalence of obesity among adolescents and the effect of food addiction on obesity. **Materials and Methods:** In this cross-sectional study, food addiction and obesity status of high school students were investigated. Among 17,000 10th and 11th grade students, assuming the design effect as 2.0, with obesity prevalence of 10%, with 3% error, and 95% confidence interval, at least 752 participants were included. Obesity was the dependent variable, whereas sociodemographic characteristics, body image, eating habits, and food addiction were the independent variables. Food addiction was assessed using the Yale Food Addiction Scale. Obesity was determined by age- and sex-specific body mass index (BMI) percentiles for adolescents < 18 years of age and BMI ≥ 30.0 for those aged ≥ 18. Data were collected through face-to-face interviews. Statistical analyses were performed using SPSS 25.0. After adjustment for age, sex, and other variables, the effect of food addiction on obesity was determined through logistic regression. $P < 0.05$ was deemed statistically significant. **Results:** Among adolescents ($n = 874$), 18.9% were food addict, 25.1% were overweight, and 12.1% were obese. After adjusted for age, sex, and other variables, food addiction significantly increased the risk of obesity (odds ratio: 1.9; 95% confidence interval: 1.167–3.335). Having a fragmented family, working mother, overweight father, and participants not knowing their weight correctly significantly increased obesity. **Conclusion:** While quarter of the adolescents had weight problems, one-fifth suffered from food addiction. After adjusting for confounders, food addiction significantly increased obesity. Identifying individuals with food addiction, providing treatment to overcome that, paying special attention to adolescents with obese parents or living in fragmented families, and providing support to both parents and adolescents could be useful in tackling obesity.

Key words: Adolescents, food addiction, obesity, student

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INTRODUCTION

Obesity is a growing health problem, affecting all age groups in the world.[1] The prevalence of obesity is also increasing among adolescents, which is stated by the World Health Organization as one of the most important public health problems of the 21st century.[2] In a great number of countries, the prevalence of obesity in children and adolescents has doubled since the 1980s.[3,4] Latest Organisation for Economic Co-operation and Development (OECD) report says that the prevalence of overweight (including obesity) was 15.5% in the OECD countries, with the highest rate in the USA (31%) and the lowest in Denmark (9.5%).[5] The Turkish Nutrition and Health Survey (2010) revealed that the prevalence of obesity among adolescents aged 15–18 years was 8.3%, and that one out of every five (21.6%) adolescents had a weight problem.[6] Several studies have demonstrated that given the complex interaction between genetic and environmental influences, overweight or obesity in adolescence may be explained by hereditary factors.[7] Although 18 genes have been identified likely to lead to excessive fat accumulation, it is extremely difficult to reveal the genetic basis of obesity because families share not only genetic material, but also environmental factors and eating habits.[8]

The American Psychiatric Association defines addiction as a chronic disorder whose development and maintenance are affected by biological, psychological,

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social, and environmental factors.[9] In the Diagnostic and Statistical Manual of Mental Disorders-V, addiction is given under the heading "substance-related and addictive disorders," and is defined as inappropriate substance use which leads to clinical disorder manifesting itself as having at least 2 of the 11 criteria within the last 12 months, which is detailed elsewhere.[10,11] Instinctive behaviors such as eating that give people happiness and are necessary for the survival of life are called "natural rewards."[12] Gearhardt *et al*. listed the common characteristics of addictive substances and hyperpalatable foods as follows: they increase dopamine and opioid neural system activity, trigger artificially high levels of reward, enter the bloodstream rapidly, stimulate the neurobiological systems, lead to the continued consumption despite negative consequences, and are difficult to quit although the person is willing to quit.[13] Studies suggest that foods containing excess fat/sugar overstimulate reward pathways, and increase dopamine release, which leads to compulsive food consumption, i.e. to food addiction.[9,14,15]

The present study aimed to determine the prevalence of obesity among adolescents in different high schools in an urban area and the effect of food addiction on obesity.

MATERIALS AND METHODS

This cross-sectional study was conducted with 10th and 11th grade students of different socioeconomic levels going to three high schools in an urban district in İzmir, a province in western part of Turkey. There are 26 state high schools in this district. In these high schools, the number of 10th and 11th grade students is approximately 17,000. The minimum number of students to be included in the study was calculated as 376, assuming the prevalence of obesity in adolescents to be 10% with a margin of error of 3% and 95% confidence interval. Assuming the design effect as 2.0, the minimum number of students to be included in the sample was 752. However, it was decided to include at least 10% more students (n = 825) considering the possibility of withdrawals or losses during the study. The schools in the district were divided into three categories according to the socioeconomic level of their location by the Ministry of Education (MoE) Provincial Directory and using the list of schools given by MoE, one school from each category was randomly determined. Because the total number of students going to the designated schools was higher than the sample size, these three schools were considered sufficient.

While the main dependent variable of the study was obesity (body mass index [BMI] ≥95 percentiles for those aged <18 years[16,17] and BMI ≥30.0 for those aged ≥18), overweight (BMI ≥ 85 percentiles for those aged <18 years[16,17] and BMI ≥25.0 for those aged ≥18)

was also evaluated. Independent variables were sociodemographic characteristics, eating habits, body image, knowing his/her own weight correctly, and food addiction. While the variables such as age, sex, family type, the number of siblings, and socioeconomic level of the school's location were considered as sociodemographic variables, the variables such as how the student perceived his/her body image (underweight, normal, overweight, or obese), having breakfast, adding salt to the food without tasting it, consumption of vegetables and fruits daily, and having junk food at home were addressed as eating habits. Before students' weights were measured, they were asked about their weights, and if the weight they stated was within ± 5% of the measured weight, it was considered that they knew their weight correctly. Food addiction was determined using the Yale Food Addiction Scale developed by Gearhardt *et al*. in 2009.[18] The scale consists of 27 items and 8 subscales. Scoring of the scale was given elsewhere in detail.[18] The Turkish validity and reliability study of the Yale Food Addiction Scale was conducted by Bayraktar *et al*. in 2012.[19]

The data were collected in schools through face-to-face interviews. The participants wore light clothes and did not take off shoes when their measurements were conducted because they were reluctant to do so. However, because the data were collected during the warm months, shoes they wore were light sports shoes or flat shoes, therefore, 1 kg for weight measurement and 2 cm for height measurement were subtracted from the actual measurement values. Height measurements were performed via a portable stadiometer as the participant was in the standing position with the head in the Frankfort horizontal plane, eyes looking straight ahead, and legs straight and together. Weight measurements were performed with a 100-gr precision digital scale.

Statistical analyses were performed using SPSS 25.0 (IBM SPSS Statistics, version 25; IBM, New York, NY, USA). Continuous variable was presented with mean ± standard deviation, and classified data were presented with numbers and percentages. The relationship between continuous independent variables and obesity was determined with independent samples t-test, and the relationship between the classified data and obesity was determined by Yates corrected Chi-square test. After adjusting for other confounders which are the variables found to have significant association in univariate analysis, the effect of food addiction on the prevalence of overweight or obesity was determined by logistic regression models. Three different models were constituted for both obesity and overweight. In the first model, the effect of food addiction on obesity or overweight was determined after adjusted for age and sex. The second model was adjusted for age

and sex and sociodemographic factors such as number of siblings, family type, employment status, smoking status, and physical appearance were included in the model. The third model was adjusted for the variables present in the second model and for not knowing his/her weight correctly and presence of junk food at home. $P < 0.05$ was considered statistically significant.

Ethical approval to conduct the study was obtained from Ege University Medical Research Ethics Committee (19-2T/25). To use the Yale Food Addiction Scale, permission from the researchers who conducted the Turkish validity and reliability study of the scale was obtained. The permissions to perform the study in schools were obtained from İzmir Governorship and Buca Provincial Directorate of National Education (No. 12018877-604.01.02-E.8308125). The participating students were informed before data collection, and their written informed consent was obtained.

RESULTS

Of the participants ($n = 874$), 54.2% were boys, 84.1% were 15–17 years old, 25.1% ($n = 106$) were overweight, and 12.1% ($n = 219$) were obese. The prevalence of food addiction was 18.9% ($n = 165$). Table 1 shows the association of sociodemographic characteristics of the participants and obesity and overweight.

As shown in Table 1, the increase in the prevalence of overweight and obesity was significantly high in the participants as their age and number of siblings decreased and high in the participants who had a fragmented family, smoking mothers, and working mothers. The greater the prevalence of overweight and obesity in the participants was, the more overweight and obese their fathers were. The effect of nutritional habits of adolescents on the prevalence of obesity and overweight is given in Table 2.

The incidence of obesity and overweight decreased in those as the prevalence of having junk food at home increased. On the other hand, the prevalence of overweight and obesity was significantly higher among the participants who had overweight appearance, who were food addicts, and who did not know their weight correctly. The prevalence of food addiction was 25.6% in the overweight participants and 29.2% in the obese participants.

The time spent watching TV on the weekend was more than was that spent on weekdays. However, the average time spent watching TV on the weekend or on weekdays did not significantly affect the prevalence of overweight or obesity ($P > 0.05$). After adjustments for confounders, the effect of food addiction on the prevalence of overweight is summarized in Table 3.

Table 1: The association of sociodemographic characteristics of the participants and obesity and overweight

	Obesity		Overweight	
	n (%)	*P*	*n* (%)	*P*
Sex				
Boys	60 (12.7)	0.676	127 (26.8)	0.226
Girls	46 (11.5)		92 (23.0)	
Age (years)				
15-16	52 (14.1)	0.013*	108 (29.3)	0.011*
17	47 (12.8)		84 (23.0)	
18-19	7 (5.0)		27 (19.4)	
SES of the school's location				
Low	42 (15.6)	0.077*	79 (29.3)	0.188*
Middle	33 (10.6)		69 (22.1)	
High	31 (10.6)		71 (24.3)	
Family type				
Nuclear-extended	89 (11.0)	<0.001	194 (24.1)	0.007
Fragmented	17 (30.4)		23 (41.4)	
Number of siblings				
Single child	21 (22.3)	0.024*	33 (35.1)	0.005*
2-3 siblings	66 (11.0)		150 (25.1)	
≥4 siblings	19 (10.8)		34 (19.3)	
Mother's characteristics				
Education				
Nongraduate	13 (9.7)	0.082*	32 (23.9)	0.404*
Elementary-junior high school	51 (11.1)		111 (24.1)	
Senior high school-higher	40 (15.0)		72 (27.1)	
Employment				
Employed	50 (18.0)	<0.001	93 (33.5)	<0.001
Unemployed	53 (9.1)		121 (20.8)	
Smoking				
Smoker	48 (17.0)	0.003	88 (31.3)	0.004
Nonsmoker	56 (9.7)		126 (21.9)	
Physical appearance				
Underweight-normal	68 (12.0)	0.429	135 (23.8)	0.198
Overweight	27 (10.6)		68 (26.8)	
Obese	10 (20.4)		15 (30.6)	
Father's characteristics				
Education				
Elementary-junior high school	61 (12.2)	1.000	120 (24.0)	0.299
Senior high school-higher	44 (12.4)		97 (27.3)	
Employment				
Employed	91 (12.0)	0.777	194 (25.6)	0.825
Unemployed	10 (13.9)		17 (23.6)	
Smoking				
Smoker	64 (14.1)	0.066	128 (28.3)	0.024
Nonsmoker	38 (9.7)		83 (21.3)	
Physical appearance				
Underweight-normal	56 (10.7)	0.013*	117 (22.4)	0.001*
Overweight	31 (11.7)		66 (24.8)	
Obese	16 (24.2)		30 (45.5)	

Bold fonts indicate significant difference. χ^2 Yates; *χ^2 for trend. SES=Socioeconomic status

In all the models, the presence of food addiction increased the prevalence of overweight 1.8 times significantly when

all the confounders were considered (95% confidence interval [CI]: 1.234–2.822). In addition to food addiction, living in a fragmented family (odds ratio [OR]: 2.0, 95%

CI: 1.059–3.788), mothers working at a paid job (OR: 1.6, 95% CI: 1.128–2.243), fathers overweight appearance (OR: 2.1, 95% CI: 1.179–3.835), and the participants not knowing his/her own weight correctly (OR: 1.9, 95% CI: 1.365–2.719) significantly increased the prevalence of overweight in adolescents. The prevalence of overweight increased significantly in those as the prevalence of having junk food at home decreased significantly. The effect of food addiction on the prevalence of obesity after adjustments were made for other factors is summarized in Table 4.

The analysis of the effect of food addiction on the prevalence of obesity demonstrated that food addiction increased the prevalence of obesity by 2.0 times (95% CI: 1.263–3.183) after the adjustments for age and sex and increased the prevalence 1.9 times (95% CI: 1.159–3.312) when all the confounders were taken into account. Other factors increasing the prevalence of obesity were as follows: having a fragmented family, mothers working at a paid job, fathers obese appearance, not knowing his/her own weight correctly, and having junk food at home occasionally or never.

DISCUSSION

According to the Turkish Nutrition and Health Survey (TNHS) (2010), while the prevalence of overweight (including obesity) among adolescents aged 15–18 years was 21.6%, the prevalence of obesity alone was 8.2%.[6] In their meta-analysis conducted to investigate obesity tendencies in children and adolescents aged 5–19 years, Alper *et al.* determined that the prevalence of obesity was 7.3% between 2011 and 2015, which was 11.6 times higher than was that between 1990 and 1995.[2] The literature review performed by Erem demonstrated that

Table 2: The effect of nutritional habits of adolescents on the prevalence of obesity and overweight

	Obesity		Overweight	
	n (%)	*P*	*n* (%)	*P*
Presence of junk food at home				
Always	14 (7.0)	**0.001***	36 (17.9)	**0.004***
Occasionally	83 (13.1)		169 (26.7)	
Never	9 (24.3)		13 (35.1)	
Eating fresh vegetables and fruits every day				
Yes	87 (12.2)	1.000	183 (25.7)	0.243
No	13 (11.8)		22 (20.0)	
Adding salt to the food without tasting it				
Yes	20 (10.2)	0.417	39 (19.9)	0.072
No	85 (12.7)		178 (26.6)	
Having breakfast every day				
Yes	94 (12.2)	1.000	190 (24.7)	0.424
No	12 (12.0)		29 (29.0)	
Physical appearance				
Underweight-normal	12 (1.8)	**<0.001***	64 (9.8)	**<0.001***
Overweight	58 (34.1)		110 (64.7)	
Obese	35 (76.1)		41 (89.1)	
Knowing his/her own weight correctly				
Yes	41 (9.3)	**0.011**	88 (19.9)	**<0.001**
No	65 (15.1)		131 (30.4)	
Food addiction				
Yes	31 (18)	**0.005**	56 (33.9)	**0.005**
No	75 (10.6)		163 (23.0)	

Bold fonts indicate significant difference. χ^2 Yates; *χ^2 for trend

Table 3: The effect of food addiction on the prevalence of overweight after adjustments for confounders

	Model 1		Model 2		Model 3	
	OR	95% CI (*P*)	OR	95% CI (*P*)	OR	95% CI (*P*)
Food addiction (yes)	**1.765**	**1.220-2.552 (0.003)**	1.778	1.188-2.661 (0.005)	1.897	1.256-2.864 (0.002)
The number of siblings (≥4)			1.00		1.00	
2-3			1.590	0.838-3.016 (0.156)	1.610	0.835-3.106 (0.155)
Single child			1.330	0.839-2.107 (0.225)	1.462	0.913-2.342 (0.114)
Family type (fragmented)			**1.956**	**1.046-3.660 (0.036)**	**2.003**	**1.059-3.788 (0.033)**
Is the mother employed? (yes)			**1.642**	**1.155-2.336 (0.006)**	**1.663**	**1.162-2.379 (0.005)**
Does the mother smoke (yes)			0.767	0.533-1.105 (0.155)	0.748	0.514-1.089 (0.129)
Does the father smoke (yes)			0.792	0.558-1.123 (0.190)	0.772	0.539-1.104 (0.156)
The father's physical appearance (underweight-normal)			1.00		1.00	
Overweight			1.080	0.748-1.561 (0.681)	1.057	0.726-1.538 (0.772)
Obese			**2.159**	**1.216-3.831 (0.009)**	**2.295**	**1.276-4.127 (0.006)**
Knowing his/her own weight correctly (no)					**1.861**	**1.322-2.618 (<0.001)**
Presence of junk food at home (always)					1.00	
Occasionally					**2.011**	**1.281-3.156 (0.002)**
Never					**3.449**	**1.442-8.249 (0.005)**

All models were adjusted for age and sex. Bold fonts indicate significant difference. Model 1=Presence of food addiction after adjustment for age and sex, Model 2=Model 1 + sociodemographic characteristics, Model 3=Model 2 + knowing his/her own weight correctly and eating habits. CI=Confidence interval, OR=Odds ratio

Table 4: The effect of food addiction on the prevalence of obesity after adjustments are made for other factors

	Model 1		Model 2		Model 3	
	OR	95% CI (*P*)	OR	95% CI (*P*)	OR	95% CI (*P*)
Food addiction (yes)	**2.005**	**1.263-3.183 (0.003)**	**1.825**	**1.094-3.047 (0.021)**	**1.973**	**1.167-3.335 (0.011)**
The number of siblings (≥4)			1.00		1.00	
2-3			1.467	0.663-3.245 (0.344)	1.433	0.633-3.245 (0.388)
Single child			0.978	0.531-1.803 (0.943)	1.109	0.595-2.066 (0.745)
Family type (fragmented)			**2.778**	**1.377-5.603 (0.004)**	**2.851**	**1.391-5.843 (0.004)**
Is the mother employed? (yes)			**1.833**	**1.151-2.919 (0.011)**	**1.840**	**1.149-2.947 (0.011)**
Does the mother smoke (yes)			0.701	0.435-1.129 (0.144)	0.654	0.401-1.067 (0.089)
Does the father smoke (yes)			0.797	0.495-1.282 (0.350)	0.752	0.463-1.221 (0.249)
The father's physical appearance (underweight-normal)			1.00		1.00	
Overweight			1.072	0.647-1.774 (0.788)	1.042	0.624-1.740 (0.876)
Obese			**2.550**	**1.294-5.028 (0.007)**	**2.740**	**1.362-5.512 (0.005)**
Knowing his/her own weight correctly (no)					1.972	1.242-3.130 (0.004)
Presence of junk food at home (always)					1.00	
Occasionally					2.576	1.319-5.033 (0.006)
Never					6.128	2.109-17.800 (0.001)

All models were adjusted for age and sex. Bold fonts indicate significant difference. Model 1=Presence of food addiction after adjustment for age and sex, Model 2=Model 1 + sociodemographic characteristics, Model 3=Model 2 + knowing his/her own weight correctly and eating habits. CI=Confidence interval, OR=Odds ratio

the prevalence of overweight and obesity ranged between 8.3% and 22.4% and between 1.6% and 10.6%, respectively, in regional studies conducted from 2001 to 2011. The differences between the results of these studies may have stemmed from the fact that the studies were conducted in different places with participants of different age groups.[20] In the present study, the prevalence of overweight, although slightly higher, is consistent with that given in the TNHS, but the prevalence of obesity was higher than was that given in the TNHS. This difference may be due to the fact that the present study was conducted in an urban area, and that prevalence of obesity was a bit more common in urban areas than in rural areas,[6] or that the prevalence of obesity actually increased during the 9-year period from 2010 when TNHS was performed until now.

In large-scale studies conducted on adolescents, the prevalence of food addiction has been found to range between 2% and 16%.[21] In a study which included 600 high school students from three randomly selected high schools, the prevalence of food addiction was 12.4%,[22] which was somewhat lower than that (18.9%) determined in the present study. This difference might be due to the higher prevalence of obesity in the participants in the present study.

Studies conducted on the issue demonstrated that there was a correlation between food addiction and the prevalence of obesity.[23-25] In studies carried out in Russia and Germany, the prevalence of food addiction was higher in obese and overweight adolescents.[23,25] According to the results of Rodrigue *et al.*'s study, the prevalence of food addiction in overweight or obese adolescents varied between 10% and 38%.[21] These results are consistent with the results of the present study, which indicated that the prevalence of food addiction was higher among the obese participants (29%).

Studies have shown that both genetic and environmental factors are associated with obesity.[7] According to Erem, low physical activity, high income, parents' education level, living in a city, and having obese parents are some of the factors affecting obesity in Turkish children and adolescents.[20] In the present study, the parents' obesity status was evaluated based on the perception of the participating adolescents. The risk of being overweight and obese was significantly high in the participants whose fathers were overweight and obese. In a study conducted with approximately 23,000 children/adolescents (6–18 years old) in Iran, those who had overweight or obese parents were about twice as likely to be overweight or obese.[7] Parents' feeding practices and life habits may have influenced children's eating habits at an early age because children imitate to learn. Practices such as family food culture, preparing meals at home, eating out, and skipping meals may have caused both the father and adolescent to become overweight/obese.

Women's participation in working life and their receiving inadequate support from other members of the family may have caused them to devote less time preparing food at home or to cook foods that are practical, ready to eat, and energy intensive or to eat out more frequently. A study indicated that in Bulgaria whose economic conditions were like those of Turkey, mothers working status was a risk factor for obesity in children, but that in Sweden, which has advanced economy, mothers working status at a paid job had an opposite effect.[26]

In the present study, the prevalence of obesity was significantly higher in children having fragmented families. The separation/divorce process can cause stress not only on parents but also on children; cause them to

experience economic difficulties; change the family's daily routine (e.g., meal times and types of foods) for the worse, which damages child–parent relationships; and the child will have to live in a new social environment if the family has to move somewhere else, all of which will affect the child's eating habits adversely,[27] and it is argued that all these changes will cause the child to develop unhealthy eating habits, which can be linked with divorce.[28] In a study, it was found that routine behaviors in the family affected nutritional habits positively and protected family members against obesity, and that in families with divorced parents, stress levels were higher, nutritional habits were negative, and obesity was more prevalent.[28] In the UK, a cohort study found that children whose parents were separated or divorced were more at risk for obesity not at the beginning but at the later part of the separation/divorce.[27] The fact that the participants having a fragmented families were at risk for obesity, even after adjustments made for age, sex, and other variables, is the strength of the present study, although it is cross-sectional in nature.

The frequency of having junk food at home (always, sometimes, and never) was inversely related to obesity. The prevalence of obesity was almost twice higher in the participants who occasionally had junk food at home and five times higher in the participants who never had junk food at home. Contrary to expectations, this result may be due to the cross-sectional nature of the study and therefore the direction of causality was not determined. The families may have refrained from having junk food at home because there was an adolescent with a weight problem at home.

This study has several limitations. The fact that the parents' weight and height were not measured instead the adolescents' perceptions of their parents appearance were taken into account may have not reflected the actual weight status of the parents. The reason that the mother's appearance did not have a significant effect on the obesity of the adolescent may be due to the fact it was a perception-based reporting. The cross-sectional nature of the study may have led to the inability to evaluate the direction of causality, which may cause doubts whether the negative eating habits are the cause or the result of obesity.

CONCLUSION

One-quarter (25.1%) of the participants had weight problems and the prevalence of food addiction was 18.9%, reaching nearly one out of three in obese adolescents. After adjustments were made for age, sex, and other confounders, the presence of food addiction significantly increased the prevalence of both overweight and obesity. Recognition and appropriate treatment of food addiction

to prevent obesity or to ensure weight loss, paying special attention to adolescents whose parents are obese or who have fragmented families, and providing support both to adolescents and to their parents if necessary may help the fight against obesity.

Conflicts of interest
There are no conflicts of interest.

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