A new insight into food addiction in childhood obesity

Alev Keser[1], Ayşegül Yüksel[2], Gül Yeşiltepe-Mutlu[3], Asuman Bayhan[2], Elif Özsu[4], Şükrü Hatun[2]

[1]Department of Nutrition and Dietetics, Faculty of Health Sciences, Ankara University, Ankara, [2]Division of Pediatric Endocrinology and Diabetes, Department of Pediatrics, Kocaeli University, Faculty of Medicine, Kocaeli, [3] Division of Pediatric Endocrinology and Diabetes, Department of Pediatrics, Zeynep Kamil Gynecologic and Pediatric Training and Research Hospital, İstanbul, [4]Division of Pediatric Endocrinology and Diabetes, Department of Pediatrics, Samsun Gynecologic and Pediatric Training and Research Hospital, Samsun, Turkey
E-mail: alevkeser@gmail.com
Received: 29 August 2014, Accepted: 22 December 2014

SUMMARY: Keser A, Yüksel A, Yeşiltepe-Mutlu G, Bayhan A, Özsu E, Hatun Ş. A new insight into food addiction in childhood obesity. Turk J Pediatr 2015; 57: 219-224.

Uncontrolled eating behavior in obese subjects is very similar to behavior in food addiction, suggesting a relationship. This study was designed to evaluate the relationship between childhood obesity and food addiction and to determine the frequency of food addiction among obese children and adolescents. The study included 100 overweight and obese children. Food addiction was evaluated by the Yale Food Addiction Scale (YFAS). The cutoff value for food addiction was defined as the presence of 3 or more symptoms. Participants were between 10 and 18 years of age; 63% were girls. Of the participants, 71% had food addiction. The most addictive foods were chocolate, ice cream, carbonated beverages, French fries, white bread, rice, candy, chips and pasta, in decreasing order of frequency. Experiencing a frequent feeling of hunger was associated with a 2.2-fold increase in food addiction risk, while consumption of French fries ≥1-2 times per week was associated with a 2.3-fold increase in risk ($p<0.05$). The high YFAS scores in obese and overweight adolescents suggest that food addiction plays an important role in childhood obesity. Evaluation of food addiction in more detail may open a new perspective on the prevention and treatment of obesity.

Key words: Food addiction, overeating, obesity, children, adolescent.

Childhood obesity is a multifactorial process, with one of the factors being genetics. Consumption of high-carbohydrate foods also contributes to this process. Recently, there has been a focus on the mechanism of "food addiction," which may play a role in the overconsumption of some kind of foods, such as those with high levels of carbohydrates[1]. Food addiction is defined as a recurrent course resulting from hedonic factors that prompt the desire for food. Consumption of high-carbohydrate foods to deal with an affective disorder that develops after reduction of the serotonin level is an example of this process[2].

Food addiction may be responsible for binge eating, in turn causing obesity. Neurobiologic research has shown similarities between food addiction and the reward pathway in drug addiction[3-6]. Food addiction may result from impulsive and compulsive behaviors and, finally, loss of control[2].

It has been ascertained that all foods do not cause addiction-like behavior; salty, fatty and sweet foods are more likely to be addictive[7].

Despite the similarity between binge eating and drug addiction, clinicians have not considered food addiction when developing new strategies for the treatment of obesity. Since there are no diagnostic crtieria nor is there an accurate definition of food addiction, this is not surprising[1]. The present study was designed to analyze the relationship between obesity and food addiction and to detect the frequency of food addiction in obese children and adolescents.

Material and Methods

Study group

The study group consisted of 100 children and adolescents aged 10-18 years who were admitted or referred to our outpatient clinic between June and December 2012. Patients with hypothyroidism, growth hormone deficiency and Cushing syndrome were excluded. Before collecting the patient data, the necessary permission from the Kocaeli University IRB Office was obtained by completing the informed consent and protocol submission forms, having the study reviewed and receiving final approval from the IRB Review Board. The IRB protocol number is KOÜ KAEK 2012/138.

Study protocol

The participants were enrolled by a pediatric endocrinologist, a dietician and a psychologist. The data was collected from the participants' self-reports. The TANITA TBF-300 body composition analyzer was used for measurement of body fat percentage (%), fat weight (kg) and fat-free mass (kg); basal metabolic rate was calculated. After the anthropometric measurements were taken, the participants completed the questionnaire. The Yale Food Addiction Scale (YFAS) was used to determine whether signs of food addiction were present[8,9]. A food frequency questionnaire (FFQ) was administered to participants to evaluate their nutritional status. The FFQ was based on daily, weekly and monthly consumption of food from the various food groups[10]. All participants underwent a standard 2-hour oral glucose tolerance test (OGTT).

Anthropometric measurements

Height was measured to the nearest 0.1 cm, and weight to the nearest 0.5 kg. BMI was calculated as weight (kg)/height (m^2)[11]. All measurements were taken by trained dietitians. BMI was evaluated according to national standards[12], and a BMI-SDS between 1 and 2 SD was defined as overweight, ≥2 SD and <3 SD as obese, and ≥3 SD as morbidly obese[13]. Waist circumference was measured with a nonelastic tape at a point midway between the lower border of the rib cage and the iliac crest at the end of normal expiration. The waist circumferences of the participants were evaluated according to waist circumference percentiles for Turkish children and adolescents[14]. Body fat percentage was measured with the TANITA TBF-300 body composition analyzer. Participants had their weight measurements taken while wearing light clothing and no shoes, and standing straight. The percentage of body fat was evaluated according to body fat reference curves for Turkish children and adolescents. Body fat percentages above 85th percentile and the 95th percentile were categorized as excess fat and obese, respectively[15].

Insulin resistance

The participants underwent a standard 2-hour OGTT, receiving an oral glucose load of 1.75 g/kg (maximum 75 g) after a 10-12-hour overnight fast. Blood samples were obtained at 0, 30, 60, 90, and 120 min for determination of glucose and insulin levels. Homeostasis model assessment of insulin resistance (HOMA-IR) was calculated with the formula [(FG (nmol/l) x fasting insulin (mIU/ml)/22.5]. A level >3.16 was considered to be a marker of insulin resistance[16].

Food addiction

The diagnosis of "food addiction" was based on the Yale Food Addiction Scale (YFAS)[8,9]. This questionnaire consists of 27 items that assess eating patterns over the past 12 months. The YFAS translates the Diagnostic and Statistical Manual IV TR (DSM-IV TR) substance dependence criteria to the setting of eating behavior (including symptoms such as tolerance and withdrawal symptoms, vulnerability in social activities, difficulties cutting down or controlling substance use, etc.). A Turkish validity and reliability study of the scale was performed, and Cronbach's α value was calculated to be 0.93[17].

The scale uses a combination of Likert scale and dichotomous scoring options. The Likert scale was used for scoring the symptoms of food addiction (e.g., tolerance and withdrawal), with a range of 0 to 7. The criterion for "food addiction" is met when three or more symptoms are present within the past 12 months and clinically significant impairment or distress is present[8,9].

Statistical analysis

SPSS 20 was used for statistical analysis. A chi-square test was used in the analysis of categorical data, and the Mann-Whitney U test was used for comparison between two

groups. Binary logistic regression was used to determine the variables of food addiction. A *p*-value <0.05 was considered statistically significant[18].

Results

Among the participants in the study group, 63% (n: 63) were girls; 71% of the participants were food-addicted. The mean age of the food-addicted participants was 14.6±2.07 (range: 10-18, median: 14.6) years; that of the non-addicted participants was 13.9±1.96 (range: 10-18, median: 14) years (p>0.05). Forty-one percent of the food-addicted participants were boys, and 59% were girls (p<0.05). Of the food-addicted participants, 57 (80.3%) had a BMI-SDS value >+2SD; 64 (90.1%) had a body fat percentage ≥95th percentile. Insulin resistance frequency was 77.5% among the food-addicted participants, and 69% among the non-addicted participants (p>0.05) (Table I).

The mean body fat percentage of the food-addicted participants was 37.7±7.9% (range: 20.8-58.2, median: 37.2); that of non-addicted participants was 37.6±7.5 (range: 23.1-48.7, median: 37.6). The mean BMI-SDS value of the food-addicted participants was 2.6±0.65 SD (range: 1.0-4.1, median: 2.5); that of non-addicted participants was 2.6±1.18 SD (range: 0.6-6.6, median: 2.6). There was no statistically significant difference (p>0.05). The mean HOMA-IR levels of the food-addicted and non-addicted participants were also similar [5.1±2.77 (1.5-20.4) vs. 5.2±2.82 (0.7-12.5)] (p>0.05) (Table I).

The most addictive foods were found to be chocolate (70%), ice cream (58%), carbonated beverages (59%), French fries (57%), white bread (55%), rice (53%), candy (50%), chips (48%) and pasta (43%), in decreasing order of frequency. Chocolate addiction was present in 79.4% of food-addicted girls, but only 54.1% of food-addicted boys; the difference was statistically significant (p<0.05). Of the food-addicted participants, 32.4% reported daily consumption of chocolate; 36.6%, daily consumption of carbonated beverages; 46.8%, daily consumption of French fries; 95.8%, daily consumption of white bread; 46.5%, daily consumption of rice/pasta; 43.7%, daily consumption of candy; 38.2%, daily consumption of chips; and 47.4%, consumption of ice cream 3-5 times a week.

When we analyzed the eating habits of the participants, we found that experiencing frequent feelings of hunger was more common among the food-addicted participants than the non-addicted participants (60.6% vs. 37.9%)

Table I. Comparison of Anthropometric Measurements and HOMA-IR Levels of Food-Addicted and Non-Addicted Participants

	Food addiction				Total		p
	Food-addicted (n: 71)		Non-addicted (n: 29)		n (100)		
	Number	%	Number	%	Number	%	
Gender							
Male	29	41.0	8	27.5	37	37.0	
Female	42	59.0	21	72.5	63	63.0	NS
BMI-SDS							
1-2 SD	14	19.7	6	20.7	20	20.0	
≥2-3 SD	35	49.3	14	48.3	49	49.0	NS
≥3 SD	22	31.0	9	31.0	31	31.0	
Body fat (%) 85-94 p							
≥95 p	9	12.7	5	17.2	14	14.0	NS
Waist circumference (cm)	62	87.3	24	82.8	86	86.0	
≥90-<97 p	4	5.6	1	3.4	5	5.0	NS
≥97 p	67	94.4	28	96.6	95	95.0	
HOMA-IR							
<3.16	16	22.5	9	31.0	25	25.0	NS
≥3.16	55	77.5	20	69.0	75	75.0	

*NS p>0.05

Table II. Comparison of Eating Habits in Food-Addicted and Non-Addicted Participants

	Food addiction				Total (n: 100)		p
	Food-addicted (n: 71)		Non-addicted (n: 29)				
	Number	%	Number	%	Number	%	
Frequent feeling of hunger	43	60.6	11	37.9	54	54.0	p= 0.03*
Extreme feeling of hunger	34	47.9	11	37.9	45	45.0	NS
Eating fast	51	71.8	16	55.2	67	67.0	NS
Eating big bites	42	59.1	17	58.6	59	59.0	NS
Eating outside main meals	68	95.8	26	89.6	94	94.0	NS
Consumption of junk food	68	95.8	26	89.6	94	94.0	NS
Eating at a fast food restaurant every week	49	69.0	18	62.1	67	67.0	NS
Eating at a fast food restaurant ≥3 per week	28	39.4	8	27.6	36	36.0	NS
Adding extra salt to meals	42	59.2	18	62.1	60.	60.0	NS

* p<0.05 NS p>0.05

(p<0.05). However, there was no significant difference between food-addicted and non-addicted participants regarding frequency of feeling extremely hungry, eating fast, eating large bites, eating outside main meals, consumption of junk food and adding extra salt to meals (p>0.05) (Table II).

According to the logistic regression analyses, experiencing a frequent feeling of hunger was associated with a 2.2-fold increase in food addiction risk, and consumption of French fries ≥1-2 times per week with a 2.3-fold increase (p<0.05) (Table III).

Discussion

Although food addiction has become a hot topic in recent years, the diagnostic criteria for food addiction have yet to be precisely defined[19,20]. Some authors suggest food addiction should have a place in the DSM-V classification as a substance-related disorder[21,22].

In recent years, the YFAS was developed as a means to detect food addiction[8]. It was based on the evidence of the similarity between binge-eating disorder and substance abuse[23]. YFAS criteria were used to determine the prevalance of food addiction among patients with eating disorders[24], obese individuals[25] and college students[26]. Using the YFAS, the prevalance of food addiction in our study group was determined to be 71% (Table I). Davis et al.[25] found the prevalance of food addiction among obese adults to be 25%. Another study showed the prevalance of food addiction to be 37.5% in obese adults, 14% in overweight adults and 6% in normal individuals[27]. Pedram et al.[28] determined that the prevalance of food addiction in adults was 5.4%; however, they found it to be higher in obese individuals than in the control group.

Table III. Factors Associated with Food Addiction (logistic regression analysis)

Variable	B (coefficient)	Standard error	Wald	p	OR	95% CI
Frequent feeling of hunger	0.767	0.488	2.467	0.039*	2.153	0.827-5.608
Eating fast	0.150	0.536	0.079	0.108	1.162	0.406-3.324
Consumption of French fries ≥1-2 times a week	0.828	0.532	2.423	0.007*	2.289	0.807-6.496
Consumption of hamburger ≥1-2 times a week	0.423	0.517	0.671	0.106	1.527	0.555-4.206

*p<0.05

In a recent study, a significant correlation ($r=0.54$, $p<0.001$) between BMI and food addiction symptoms was found among children aged 8-19 years[1]. However, Meule and Kübler[26] did not find any correlation between BMI and the existence of food addiction in a study group of college students whose mean age was 24.5±4.0 years. Similarly, we did not detect a significant correlation between food addiction and BMI, waist circumference and body fat percentage in our study (Table I). We believe that may have resulted from the fact that our participants consisted solely of overweight and obese children and adolescents, and from the absence of a control group in the study.

Some types of foods are more likely to be associated with food addiction. Incremental increases in body fat percentage and insulin resistance may enhance food addiction and create a vicious cycle[29-31]. It is known that neuronal insulin signaling is exquisitely sensitive to dietary macronutrient intake[32]. Daws[32] suggested a link between dysregulated brain insulin signaling and altered monoamine-related behaviors, including food intake. In this model, food-induced disruption of brain insulin action (insulin resistance) may confer risk for and/or underlie "food-use" by altering dopamine reward pathways, since these pathways are insulin-sensitive. However, we did not find a significant difference between the HOMA-IR levels of the food-addicted and non-addicted participants in this study (Table I). The small number of non-addicted participants may explain this.

The most addictive foods in order of frequency were: chocalate (70%), ice cream (58%), carbonated beverages (59%), French fries (57%) and white bread (55%). The fat and/or carbohydrate contents of all these foods are high. Gearhardt and colleagues[33] indicated that sugary and salty foods are more palatable and therefore more addictive than foods such as fruit, vegetables and legumes. Similarly, Avena and Gold[7] emphasized the high addictive potential of sugary, salty and fatty foods. Clinical investigations have shown that fatty and sugary foods have a "reward effect" on obese individuals and thus are consumed more frequently[34-36]. In our study, we observed that participants were consuming the foods they were addicted to 3-5 times a week. We determined that consumption of French fries, with their high fat content, more than 1-2 times a week increased the risk of food addiction 2.3 fold ($p<0.05$) (Table III).

Although the concept of food addiction is still theoretical, it is thought that there are many factors involved in its etiology. Indeed, the mechanisms (genetic and environmental impact, social learning and neurobiological factors) that contribute to the development of food addiction are reported to be same as the etiologic factors seen in substance abuse[1]. The increasing availability of high-fat, high-calorie foods and sweetened foods in schools, supermarkets and fast food restaurants, and the widespread advertisements for these foods, which are very attractive to children, affect children's nutritional choices and facilitate the development of obesity in children and adolescents[1,37]. Of the food-addicted participants in this study, 96% reported consumption of junk food; 70% reported its consumption once a week, and 39%, three or more times a week (Table II).

We found that the food-addicted participants had more frequent feelings of hunger than non-addicted participants ($p<0.05$) (Table II), and this hunger was associated with a 2.2-fold increase in the risk for food addiction ($p<0.05$) (Table III). However, the presence of other symptoms reflecting eating patterns, such as feeling extremely hungry, eating fast and eating large bites, was similar in all participants, regardless of the presence of food addiction (Table II). This result suggests that the term "food addiction" is not adequate to explain all eating habits among obese individuals.

In conclusion, this study shows that the rate of food addiction among obese children and adolescents is high. However, controlled, large-scale studies are needed before it can be definitively concluded that food addiction is one of the most important causes of obesity. We suggest that further studies of food addiction will illuminate the pathogenesis of obesity and offer new perspectives regarding its treatment.

REFERENCES

1. Merlo LJ, Klingman C, Malasanos TH, Silverstein JH. Exploration of food addiction in pediatric patients: a preliminary investigation. J Addict Med 2009; 3: 26–32.

2. Liu Y, von Deneen KM, Kobeissy FH, Gold MS. Food addiction and obesity: evidence from bench to bedside. J Psychoactive Drugs 2010; 42: 133–145.
3. Wilson GT. Eating disorders, obesity and addiction. Eur Eat Disord Rev 2010; 18: 341–351.
4. Avena NM, Rada P, Hoebel BG. Evidence for sugar addiction: behavioral and neurochemical effects of intermittent, excessive sugar intake. Neurosci Biobehav Rev 2008; 32: 20–39.
5. Hoebel BG, Avena NM, Bocarsly ME, Rada P. Natural addiction: a behavioral and circuit model based on sugar addiction in rats. J Addict Med 2009; 3: 33–41.
6. Pandit R, de Jong JW, Vanderschuren LJ, Adan RA. Neurobiology of overeating and obesity: the role of melanocortins and beyond. Eur J Pharmacol 2011; 660: 28–42.
7. Avena NM, Gold MS. Food and addiction—sugars, fats and hedonic overeating. Addiction 2011; 106: 1214–1215.
8. Gearhardt AN, Corbin WR, Brownell KD. Preliminary validation of the Yale Food Addiction Scale. Appetite 2009; 52: 430–436.
9. Gearhardt AN, Roberto CA, Seamans MJ, Corbin WR, Brownell KD. Preliminary validation of the Yale Food Addiction Scale for children. Eat Behav 2013; 14: 508–512.
10. Pekcan G. Hastanın beslenme durumunun saptanması. In: Baysal A, Bozkurt N, Pekcan G, et al. (eds). Diyet El Kitabı. Hatiboğlu Yayınevi: Ankara; 1999: 61–106.
11. Lee RD, Nieman DC. Anthropometry. In: Lee RD, Nieman DC (eds). Nutritional Assessment (3rd ed). New York: McGraw-Hill; 2003: 164–169.
12. Neyzi O, Günöz H, Furman A, et al. Türk çocuklarında vücut ağırlığı, boy uzunluğu, baş çevresi ve vücut kitle indeksi referans değerleri. Çocuk Sağlığı ve Hastalıkları Dergisi 2008; 51: 1–14.
13. de Onis M, Onyango AW, Borghi E, Siyam A, Nishida C, Siekmann J. Development of a WHO growth reference for school-aged children and adolescents. Bull World Health Organ 2007; 85: 660–667.
14. Hatipoglu N, Ozturk A, Mazicioglu MM, Kurtoglu S, Seyhan S, Lokoglu F. Waist circumference percentiles for 7- to 17-year-old Turkish children and adolescents. Eur J Pediatr 2008; 167: 383–389.
15. Kurtoglu S, Mazicioglu MM, Ozturk A, Hatipoğlu N, Cicek B, Ustunbas HB. Body fat reference curves for healthy Turkish children and adolescents. Eur J Pediatr 2010; 169: 1329–1335.
16. Keskin M, Kurtoglu S, Kendirci M, Atabek ME, Yazici C. Homeostasis model assessment is more reliable than the fasting glucose/insulin ratio and quantitative insulin sensitivity check index for assessing insulin resistance among obese children and adolescents. Pediatrics 2005; 115: e500–e503.
17. Bayraktar F, Erkman F, Kurtuluş E. Adaptation study of Yale Food Addiction Scale. Klinik Psikofarmakoloji Bülteni 2012; 22: S38.
18. Sümbüloğlu K, Sümbüloğlu V. Biyoistatistik (4th ed). Özdemir Yayıncılık: Ankara, 1993.
19. Ziauddeen H, Fletcher PC. Is food addiction a valid and useful concept? Obes Rev 2013; 14: 19–28.
20. Corsica JA, Pelchat ML. Food addiction: true or false? Curr Opin Gastroenterol 2010; 26: 165–169.
21. Volkow ND, O'Brien CP. Issues for DSM-V: should obesity be included as a brain disorder? Am J Psychiatry 2007; 164: 708–710.
22. Taylor VH, Curtis CM, Davis C. The obesity epidemic: the role of addiction. CMAJ 2010; 182: 327–328.
23. Davis C, Carter JC. Compulsive overeating as an addiction disorder. A review of theory and evidence. Appetite 2009; 53: 1–8.
24. Gearhardt AN, White MA, Masheb RM, Morgan PT, Crosby RD, Grilo CM. An examination of the food addiction construct in obese patients with binge eating disorder. Int J Eat Disord 2011; 45: 657–663.
25. Davis C, Curtis C, Levitan RD, Carter JC, Kaplan AS, Kennedy JL. Evidence that 'food addiction' is a valid phenotype of obesity. Appetite 2011; 57: 711–717.
26. Meule A, Kubler A. Food cravings in food addiction: the distinct role of positive reinforcement. Eat Behav 2012; 13: 252–255.
27. Meule A, Vögele C, Kübler A. German translation and validation of the Yale Food Addiction Scale. Diagnostica 2012; 58: 115–126.
28. Pedram P, Wadden D, Amini P, et al. Food addiction: its prevalence and significant association with obesity in the general population. PloS One 2013; 8: e74832.
29. Volkow ND, Wang GJ, Tomasi D, Baler RD. Obesity and addiction: neurobiological overlaps. Obes Rev 2013; 14: 2–8.
30. Kenny PJ. Common cellular and molecular mechanisms in obesity and drug addiction. Nat Rev Neurosci 2011; 12: 638–651.
31. Ifland JR, Preuss HG, Marcus MT, et al. Refined food addiction: a classic substance use disorder. Med Hypotheses 2009; 72: 518–526.
32. Daws LC, Avison MJ, Robertson SD, Niswender KD, Galli A, Saunders C. Insulin signaling and addiction. Neuropharmacology 2011; 61: 1123–1128.
33. Gearhardt AN, Grilo CM, DiLeone RL, Brownell KD, Potenza MN. Can food be addictive? Public health and policy implications. Addiction 2011; 106: 1208–1212.
34. Stice E, Spoor S, Bohon C, Small DM. Relation between obesity and blunted striatal response to food is moderated by TaqlA1 allele. Science 2008; 322: 449–452.
35. Karhunen LJ, Lappalainen RI, Vanninen EJ, Kuikka JT, Uusitupa MI. Regional cerebral blood flow during food exposure in obese and normal-weight women. Brain 1997; 120: 1675–1684.
36. Stice E, Spoor S, Ng J, Zald DH. Relation of obesity to consummatory and anticipatory food reward. Physiol Behav 2009; 97: 551–560.
37. Campbell KJ, Crawford DA, Salmon J, Carver A, Garnett SP, Baur LA. Associations between the home food environment and obesity-promoting eating behaviors in adolescence. Obesity (Silver Spring) 2007; 15: 719–730.