A new insight into food addiction in childhood obesity

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Uncontrolled eating behaviour in obese subjects is very similar to behaviour 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). Cut-off value for food addiction was defined as having 3 and more symptoms. Participants were between the age of 10-18 years and 63% were girls. Of the participants 71% had food addiction. The most addictive foods were chocolate, ice cream, carbonated beverage, fries, white bread, rice, candy, chips and pasta, in the decreasing order of frequency. Frequent feeling of hunger led to 2.2 fold increase in food addiction risk, while consumption of french fries ≥1-2 times per week increased 2.3 fold (p<0.05). The high Yale Food Addiction Scales 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 bring a new perspective for prevention and treatment of obesity.

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

Childhood obesity is a multifactorial process that one of these factors is genetics. Besides genetic factors consumption of high-carbohydrate foods contributes to this process. Recently, it is focused on mechanism of ‘food addiction’ which may play a role in over-consumption of some kind of foods such as high-carbohydrated nutrients¹. Food addiction is defined as a recurrent course which is resulted from hedonic factors prompting to desire the foods. Consumption of high carbohydrates foods to deal with an affective disorder developing after reduction of serotonin level is an example of this process².

Food addiction may be responsible from binge-eating causing obesity. Neurobiologic researchs have shown the similarities between food addiction and reward-pathway in drug addiction³-⁶. Food addiction may be resulted from impulsive and compulsive behaviors and finally loss of control².

It was ascertained that all foods do not cause addiction-like behaviors but ingredient containing, salty, fatty and sweet foods are more likely addictive⁷.

Despite the similarity between binge-eating and drug addiction, clinicians did not consider food addiction in developing new strategies for treatment of obesity. Since there are no diagnostic criteria and accurate definition of food addiction this is not an unexpected condition¹. This study was designed to analyse the relationship between obesity and food addiction and detect the frequency of food addiction in obese children and adolescents.
Material and Methods

Study group

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

Study protocol

The participants were enrolled by a pediatric endocrinologist, dietician and psychologist. The data was collected from the participants’ self reports. TANITA TBF-300 was used for measurement of body fat percent (%), fat weight (kg), fat-free mass (kg) and basal metabolic rate was calculated. Following the anthropometric measurements the questionnaire was replied by participants. Yale Food Addiction Scale (YFAS) was used for determination of food addiction (8,9). Food frequency questionnaire (FFQ) was administered to participants to evaluate the nutritional status. FFQ is based on daily, weekly and monthly consumption of food groups (10). All participants underwent a standard 2-hour OGTT.

Anthropometric measurements

Height was measured to the nearest 0.1cm, and weight to nearest 0.5 kg in light clothing and without shoes. BMI was calculated as weight (kg)/height (m^2). All measurements were taken by trained dieticians. BMI was evaluated according to national standards and BMI-SDS between 1 and 2 SDS was defined as overweight, ≥ 2 SDS <3 SDS was defined obese and ≥+3 SDS was defined as morbidly obese, respectively. Waist circumference was measured with a non-elastic tape at a point midway between the lower border of the rib cage and the iliac crest at the end of normal expiration. Waist circumferences of participants were evaluated regarding to Turkish children and adolescents waist circumference percentiles.

Body fat percentage was measured with TANITA TBF-300 Body Composition Analyser. Weight measurements of participants were made while wearing light clothes and standing straight with bare feet. The percentage of body fat was evaluated according to Turkish children and adolescence body fat reference. Body fat percentage above 85th percentile and 95th percentile was considered as excess fat and obese, respectively.

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 above >3.16 was accepted as a marker of insulin resistance.

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 in relation to eating behavior (including symptoms such as tolerance and withdrawal symptoms, vulnerability in social activities, difficulties cutting down or controlling substance use, etc.) by applying the DSM-IV TR. Turkish validity and reliability study of the scale was performed and Cronbach [ ] value was calculated as 0.93. The scale uses a combination of Likert scale and dichotomous scoring options. The Likert Scoring was used for symptom scoring of food addiction (e.g. tolerance and withdrawal) ranging from 0 to 7. The criteria for ‘food addiction’ are 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. Chi-square test was used in the analysis of categorical data and Mann-Whitney U test was used for comparison between two groups.
Binary logistic regression test was used to determine the variables of food addiction. P<0.05 was considered statistically significant18.

**Results**

Of 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 and 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, 59% were girls  (p<0.05). Of the food-addicted participants, 57 (80.3%) had a BMI-SDS value >+2SDS, 64 (90.1%) had a body fat percentage ≥95 percentile. Insulin resistance frequency was 77.5% among the food-addicted participants, as it was 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) while the mean body fat percentage 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 SDS (range:1.0-4.1, median:2.5) and non-addicted participants was 2.6±1.18 SDS (range:0.6-6.6, median:2.6), respectively. There was no statistically significant difference (p>0.05). Meanwhile the mean HOMA-IR levels of the food-addicted and non-addicted participants were 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 chocolate (70%), ice cream (58%), carbonated beverage (59%), fries (57%), white bread (55%), rice (53%), candy (50%), chips (48%) and pasta(43%), in the decreasing order of frequency. Chocolate addiction was present in 79.4% of food-addicted girls and 54.1% of food-addicted boys, and the difference was statistically significant (p<0.05). Of the food-addicted participants, 32.4% reported consumption of chocolate, 36.6% carbonated beverage, 46.8% fries, 95.8% white bread, 46.5% rice-pasta, 43.7% candy, 38.2% chips everyday and 47.4% reported consumption of ice-cream 3-5 times a week.

When we analysed the eating habits of the participants we detected that frequent feeling of hunger was more common among the food-addicted participants comparing to non-addicted participants (60.6% vs 37.9%)

<table>
<thead>
<tr>
<th>Food addiction</th>
<th>Total</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food-addicted (n:71)</td>
<td>Non-addicted (n:29)</td>
<td>n (100)</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>29</td>
<td>41.0</td>
</tr>
<tr>
<td>Female</td>
<td>42</td>
<td>59.0</td>
</tr>
<tr>
<td>BMI-SDS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-2 SDS</td>
<td>14</td>
<td>19.7</td>
</tr>
<tr>
<td>≥2-3 SDS</td>
<td>35</td>
<td>49.3</td>
</tr>
<tr>
<td>≥3SDS</td>
<td>22</td>
<td>31.0</td>
</tr>
<tr>
<td>Body fat (%) 85-94 p</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥95 p</td>
<td>9</td>
<td>12.7</td>
</tr>
<tr>
<td>Waist circumference (cm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥90-&lt;97 p</td>
<td>62</td>
<td>87.3</td>
</tr>
<tr>
<td>≥97 p</td>
<td>HOMA-IR</td>
<td></td>
</tr>
<tr>
<td>&lt;3.16</td>
<td>16</td>
<td>22.5</td>
</tr>
<tr>
<td>≥3.16</td>
<td>55</td>
<td>77.5</td>
</tr>
<tr>
<td>NS p&gt;0.05</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Table I. Comparison of the Food-addicted and Non-addited Participants Regarding to Anthropometric Measurements and HOMA-IR Levels.*
However there was no significant difference between food-addicted and non-addicted participants regarding to frequency of feeling extremely hungry, eating fast, eating with big bites, eating outside main meals, consumption of junk food, adding extra salt to meals (p>0.05) (Table II).

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

### Discussion

Food addiction has become a hot-topic recent years, however the diagnostic criteria of food addiction are not defined accurately, yet\(^{19,20}\). Some authors suggest food addiction should take a place among DSM-V classification as a substance related disorder\(^{21,22}\).

Recently, YFAS was constituted as a means to determine food addiction\(^8\). YFAS was developed on the evidence of the similarity between binge-eating disorder and substance abuse\(^{23}\). YFAS criteria was used to determine the prevalence of food addiction among the patients with eating disorder\(^{24}\), obese individuals\(^{25}\) and college students\(^{26}\). The prevalence of food addiction in our study group was detected to be 71% by using YFAS (Table I). Davis et al\(^{25}\) found the prevalence of food addiction among obese adults as 25%. Another research showed that the prevalence of food addiction was 37.5% in obese adults, 14% in over-weight adults and 6% in normal individuals, respectively\(^{27}\). Pedram et al\(^{28}\) determined the prevalence of food addiction in adults to be 5.4%, however they found that it was higher in obese individuals comparing to control group.

In a recent study a significant correlation (r=0.54, p<0.001) between BMI and food addiction symptoms was found among the children aged between 8 and 19 years \(^1\). However, Meule and Kübler\(^{26}\) did not find any correlation between BMI and existence of food addiction in a study group consisted of college students whose mean age was 24.5±4.0 year. Similarly we did not detect a significant correlation between food addiction and BMI, waist circumference, body fat percentage in our study (Table I). We consider that may be resulted from consisting of only overweight and obese children and adolescents and also not using control groups in the research.

Some kind of foods are more likely to be associated with food addiction. Increment of body fat percentage and insulin resistance may enhance food addiction and create a vicious

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

\(* p<0.05 \ NS p>0.05\)
It is known that neuronal insulin signaling is exquisitely sensitive to dietary macronutrient intake. Dawe 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 the non-addicted participants may explain the statistical insignificance.

The most addictive foods in order of frequency were chocolate (70%), ice cream (58%), carbonated beverage (59%), fries (57%), white bread (55%). Fat and carbohydrate content of all these foods are high. Gearhardt and colleagues indicated that sugary and salty foods are more palatable therefore they are more addictive than traditional foods such as fruit, vegetables and legume. Similarly, Avena and Gold emphasized the high addictive potential of sugary, salty and fatty foods. Clinical researches showed that fatty and sugary foods have reward effect on obese individuals thus they are consumed more frequently. In our study we observed that participants were consuming the foods which they were addicted to, 3-5 times in a week. We determined that consumption of fries with a high fat content, more than 1-2 times a week increased the risk of food-addiction 2.3 folds (p<0.05) (Table III). Although concept of food addiction is still theoretical, it is thought that there are many factors involved in its etiology. Indeed, the mechanisms (genetic, environmental impacts, social learning and neurobiological factors) that contribute to the development of food addiction are reported to be same with the etiologic factors of substance abuse. The increasing availability of high-fat, high-calorie foods, sweetened foods in schools, super markets and fast food restaurants, and widespread advertisements of these foods which are very attractive for children affects the nutritional choices of children and facilitates development of obesity among children and adolescents. Of the food-addicted participants in this study, 96% reported consumption of junk food, 70% reported once a week, 39% reported three or more times a week (Table II).

We found that the food-addicted participants had more frequent feeling of hunger than non-addicted participants (p<0.05) (Table II) and frequent feeling of hunger led to 2.2 fold increase in food addiction risk (p<0.05) (Table III). However, frequency of the other symptoms reflecting eating pattern like feeling extremely hungry, eating fast, eating with big bites was similar in all participants regardless of food-addiction (Table II). This result suggests that the term of ‘food-addiction’ is not adequate to explain all eating habits among obese individuals.

In conclusion, this study shows that frequency of food-addiction is high among obese children and adolescents. However, controlled, large scaled researches are needed to conclude food-addiction as one of the most important cause of obesity. We consider that further studies about food-addiction will illuminate pathogenesis of obesity and imply new perspectives about its treatment.

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

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

*p<0.05
REFERENCES


