The Egyptian Journal of Medical Human Genetics 18 (2017) 257–260

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Contents lists available at ScienceDirect

The Egyptian Journal of Medical Human Genetics

journal homepage: www.sciencedirect.com

Original article

Prevalence of food addiction and its relationship to body mass index

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ARTICLE INFO

Article history:
Received 3 October 2016
Accepted 23 October 2016
Available online 24 December 2016

Keywords:
Food addiction
Body mass index
Adolescents
Egypt

ABSTRACT

Background: Food addiction (FA) is a new terminology that simulates craving for food to drug addiction. It is recently measured by the Yale Food Addiction Scale (YFAS). It was speculated that FA is incriminated in the current obesity epidemic. Egypt is one of the highest African countries in the prevalence of obesity.
Aim: Estimation of the prevalence of FA in Egyptian adolescents and exploration of its relationship to the body mass index (BMI). Subjects and methods This study included 801 adolescents aged 11–18 years recruited by a multistage cluster sampling technique from preparatory and secondary school students distributed in Cairo. All the included subjects had their weight and height measured followed by calculation of the BMI then they were interviewed by the YFAS. The diagnosis of FA was made if there were ⩾3 symptoms with clinically significant impairment.
Results: FA prevalence was 15.7% in the studied sample. The most prevalent FA symptom was tolerance which was present in 52.1% of the sample. FA diagnosis didn't differ across the different BMI categories; however, all of the FA symptoms showed significant differences in relation to the BMI when classified as normal, overweight and obese except for the symptom of tolerance.
Conclusion: FA exists in one sixth of Egyptian adolescents. FA symptoms rather than FA diagnosis differed in the different BMI categories.

1. Introduction

The rising obesity rates in recent years [1] raised public concerns to explore the eating habits contributing to obesity. The first description of the addictive properties to sugar [2] put the basis to further exploration of this new idea and culminated in the development of the Yale Food Addiction Scale (YFAS) by Gearhardt et al. in 2009 to measure the symptomatology of food addiction (FA) [3]. Evidence exists that the biological reaction to food involves activation of opioid and dopamine pathways which are also activated by drugs of abuse. Consequently, the strong desire to obtain palatable foods was similar to the craving of addicts to get their addictive substances [3,4], despite being different in the role of abstinence [5]. FA is subject to many influences including genetic, environmental, social and neurobiological [6]. Excess consumption of unhealthy food contributes to the highly rising obesity prevalence [7]. FA represents a form of uncontrollable eating causing impaired function regarding social, occupational or recreational activities. This form of eating to get the psychological rewarding effect of palatable food is genetically controlled by altered dopamine signals [8].

FA has been accepted recently as a valid phenotype of obesity [9]. Egypt is an African country with the highest obesity rate in adolescents among 7 recently surveyed countries [10]. Therefore the primary aim of this study was to measure FA prevalence in Egyptian adolescents and the secondary aim was to explore the relationship of the various FA symptomatology and relate them together with the diagnosis of FA to the body mass index (BMI) in a community-based sample.

2. Subjects and methods

This was a cross sectional study that included 801 Egyptian adolescents recruited randomly from public and private schools in Cairo over 6 months from December 2014 to May 2015. Their ages ranged from 11 to 18 years. Their mean age was 14.4 ± 1.7 years.

2.1. Sampling technique

We had a multistage cluster sample to get a representative sample of students in the 4 zones of Cairo; eastern, western, northern

Peer review under responsibility of Ain Shams University.
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http://dx.doi.org/10.1016/j.ejmhg.2016.10.002
1110-8630/

and southern Cairo. In the first stage, we stratified the sample according to school types (governmental and private) then schools were selected randomly from the list of schools that were obtained from the Ministry of Education. In the second stage, inside each school, school grades were stratified into (1st, 2nd and 3rd) then classes were randomly selected from each grade and all students in selected classes were eligible to participate.

2.2. Sample size justification

It was calculated as a cluster sample using the following formula:

Sample size for a cluster sample = simple random sample size × design effect.

Where the design effect = $(1 + (m - 1)p)$, m = size of the cluster and p = intra-cluster correlation coefficient (ICC). Assumed that the proportion to be evaluated = 0.21 and a confidence interval of width = 0.2, at 95% confidence interval. The sample size for a simple random sample = 72. For correction for design (the cluster design) we had to estimate the ICC = 0.01 and the average cluster size (average number of respondents of each type in every cluster (type of school)). The average cluster size was 40 and ICC was 0.01, we had a design effect of 1.39. So, the sample size of each group after correction was approximately 100 individuals. By multiplication of 100 by 2 types of schools in 4 districts, the whole sample was calculated as 800 students. All adolescents in the defined age range were eligible for inclusion according to randomization unless they were receiving any medications, having neurologic, neurodevelopmental, or psychiatric problems, declaring or showing signs of substances dependence or medical disease.

2.2.1. Clinical assessment

We measured the weight of all participants in kilograms with a digital scale with minimal clothing. Height was measured to the nearest 0.1 cm on a portable stadiometer (Seca stadiometer 213). The BMI was calculated as weight (kg)/height $(m)^2$ and standard deviation scores were calculated according to the norms [11]. All measurements were done between 9 am and 12 pm. All subjects had been interviewed to assess food addiction by the YFAS [12]. This scale is composed of 7 questions. These questions inquired about tolerance which is the intake of large amount of food to achieve the desired rewarding effect or the reduction of the pleasurable sensory input related to food with consumption of the same amount of food each time without increasing it, withdrawal symptoms when not obtaining the desired food which was similar to withdrawal manifestations in substance abuser or the intake of food to avoid the negative impact of food absence, continuing to take food for a longer time than expected, unsuccessful attempts to cut down food intake, large amount of time spent to get food or recover from its effects and continuing to eat too much inspite of knowledge of the side effects of taking too much food. Presence of $\geqslant 3$ of the symptoms together with the presence of significant functional impairment in the social, occupational and recreational aspects of one's life were required to make the diagnosis of FA.

Translation of the YFAS into Arabic was done by an accredited translation office then checked by the researchers and reviewed by three experts to be sure of its validity. The diagnosis of food addiction was made if there were $\geqslant 3$ symptoms with clinically significant impairment or distress [13].

Weight for height and height for age were considered normal (average) if they fell within +2 to −2 standard deviations (SDS). Below average was considered for those < −2 SDS and above average was defined as > +2 SDS for each of them. Overweight was defined as BMI > +1 SDS and obesity was defined as BMI > +2 SDS above the mean. Those with BMI < −2 SDS below the mean were classified as being thin [14].

2.2.2. Ethical considerations

The work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments on humans. The study was approved by the local ethics committee of Ain Shams University and the Egyptian Ministry of Education as well as the administrative departments of the involved schools. Verbal assent was obtained from the adolescents participating in the study on the day of the interview.

2.2.3. Statistical analyses

All analyses were performed with Portable PASW statistics 18 statistical package. Mean ± standard deviation (SD) used for quantitative variables and frequency percentage for qualitative variables. Comparison was done using the chi-squared test for qualitative variables and student t test for quantitative variables. A value of $p < 0.05$ was considered statistically significant.

3. Results

This study included 801 adolescents in preparatory and secondary schools in Cairo. Their ages ranged from 11 to 18 years distributed nearly equally between public and private schools. The demographic and anthropometric criteria of the studied subjects are listed in Table 1. The prevalence of FA in the studied adolescents was 15.7%. The various FA symptoms are listed in Table 2. This study showed that the most prevalent FA symptom was tolerance (52.1%). The relationship of the diagnosis of FA to age, gender and BMI is shown in Table 3. It shows that the diagnosis of FA showed significant differences in relation to age; the mean age of adolescents without FA was 14.36 ± 1.7 years while those with FA had a mean age of 14.86 ± 1.76 years. Thus adolescents with FA were clustered in the age range of more than 14.5 years. The relationships of the different symptomatology of food addiction and the diagnosis of FA according to the YFAS to the different BMI categories; normal, overweight and obese are shown in Table 4. It shows that all symptoms differed significantly in the different BMI categories except tolerance.

4. Discussion

The prevalence of FA in Egyptian adolescents was 15.7% in consistence with the results of a systematic review which showed a prevalence of 19.9% in the general population [13]. Studies evaluating FA in obese subjects showed a higher prevalence; 38% [15], 40% [16] and up to 71% [17] in some studies. The most prevalent

Table 1
Descriptive characteristics of the studied participants.

Age in years	(Mean ± SD)
	14.4 ± 1.7
Age groups	Number (%)
11 – <14	280 (35)
14 – < 17	410 (51.2)
⩾17–18	111(13.9)
Type of School	Number (%)
Public	424 (52.9)
Private	377 (47.1)
Height SDS	Number (%)
< −2 SDS	26 (3.2)
+2 to −2SDS	753 (94)
>+2SDS	22 (2.7)
Weight SDS	Number (%)
< −2 SDS	12 (1.5)
+2 to −2SDS	571 (71.3)
> +2SDS	218 (27.2)

Table 2
Prevalence of food addiction and its symptoms among study subjects.

Food addiction symptoms	N (%)
Tolerance	417 (52.1)
Withdrawal	387 (48.3)
Important activities given up or reduced	371 (46.3)
Tried unsuccessfully to quit	336 (41.9)
Loss of control	267 (33.3)
Large amount of time spent to obtain food	205 (25.6)
Continued use despite adverse consequences	173 (21.6)
Clinically significant impairment	171 (21.3)
Food addiction diagnosis	126 (15.7)
Total	801 (100)

symptom in our study was tolerance which is getting larger amount of food progressively to feel its psychologically rewarding effect. The next most common symptom was feeling of withdrawal symptoms when not getting the desired food. Each of tolerance and withdrawal symptoms was present in nearly half of the study subjects. This contrasts what was found in middle aged and older women who showed that persistent desire and unsuccessful efforts to cut down or control eating to be the most prevalent symptoms [18]. Our study showed a significant difference in relation to age in contrast to what was reported in low-income reproductive women [19] but there were no differences related to gender or BMI categories. The relationship of FA to the different BMI categories was different in different studies; some reported similar findings to our results [19] and others showed that there is only a weak positive relationship in the middle zone of the BMI that is represented by the overweight and obese subjects. However, this relationship was not evident neither in those with normal BMI nor in those with severe obesity [20]. Thus, our data and others [20] showed that FA does occur in obese, overweight, normal and underweight individuals. Finding no significant differences in the different BMI categories in those with and without FA in our study may argue for the presence of other controllers of the BMI other than the mere excess of caloric intake or may be explained by the fact that the BMI is not a true reflection of the body fat [21] and that other measures of fat accumulation should be put in consideration when seeking relationships with FA.

Data on gender differences regarding FA diagnosis were scarce [22]. However, our results and others [22] showed no gender differences in FA diagnosis. This study adds to the knowledge about gender and racial variations in the prevalence of FA diagnosis as well as its various symptomatology as data in this regard are still evolving particularly in community samples. The various symptoms of FA differed significantly in the different BMI categories except for the symptom of tolerance.

Longitudinal studies are needed to assess whether or not lean individuals with FA will develop obesity and study the factors aiding or combating this evolution so as to direct proper interventional strategies and to answer the question of whether the presence of addictive behaviour to food will result in escalation of food intake to achieve satiety due to the development of

Table 3
Relationships of food addiction to age, gender and body mass index (BMI) category.

Variable	Food addiction		*p*	Total
	Yes	No		
Age (years)				
(Mean±SD)	14.86 ± 1.76		0.003*	433 (54.1)
		14.36 ± 1.7		368 (45.9)
Gender	Number (%)	Number (%)		
Males	60(47.9)	312(46.2)	0.7	372 (46.4)
Females	66(52.4)	363(53.8)		429 (53.6)
BMI (kg/m^2)				
Normal (−2 to 1 SDS)	41 (32.5)	260 (38.5)	0.1	301 (37.6)
Overweight (BMI > 1 SDS)	30 (23.8)	187 (27.7)		217 (27.1)
Obese (BMI > 2 SDS)	55 (43.7)	228 (33.8)		283 (35.3)
Total	126(15.7)	675(84.3)		801 (100)

Table 4
Relationships of food addiction (FA) symptoms to body mass index (BMI) category.

FA symptoms		Normal BMI (BMI −2 to 1 SDS) Number (%)†	Overweight (BMI > 1 SDS) Number (%)†	Obese (BMI > 2 SDS) Number (%)†	*p*
Tolerance	No	159 (41.4)	98 (25.5)	127 (33.1)	0.1
	Yes	142(34.1)	119(28.5)	156(37.4)	
Withdrawal	No	173 (41.8)	124 (30)	117 (28.3)	0.000*
	Yes	128 (33.1)	93 (24)	166(42.9)	
Important activities given up or reduced	No	190 (44.2)	120 (27.9)	120 (27.9)	0.000*
	Yes	111 (29.9)	97 (26.1)	163 (43.9)	
Tried unsuccessfully to quit	No	216 (46.5)	120 (25.8)	129 (27.7)	0.000*
	Yes	85 (25.3)	97 (28.9)	154 (45.8)	
Loss of control	No	221 (41.4)	150 (28.1)	163 (30.5)	0.000*
	Yes	80 (30)	67 (25.1)	120 (44.9)	
Large amount of time spent to obtain food	No	237 (39.8)	170 (28.5)	189 (31.7)	0.000*
	Yes	64 (31.2)	47 (22.9)	94 (45.9)	
Continued use despite adverse consequences	No	259 (41.2)	183 (29.1)	186 (29.6)	0.000*
	Yes	42 (24.3)	34 (19.7)	97 (56.1)	
Clinically significant impairment	No	245 (40.3)	183 (29.1)	193 (30.6)	0.000*
	Yes	47 (27.5)	34 (19.9)	90 (52.6)	
Total		301 (37.6)	217 (27.1)	283 (35.3)	

† The percentage is expressed within each symptom.

tolerance in non-obese subjects and the effect of this behaviour on their weight gain. Surprisingly, tolerance was the only symptom that didn't differ among the different BMI categories, so could lean individuals with FA be immune to tolerance to food so that their intake of food is not subject to progressive increase? These mechanistic insights need further exploration. Longitudinal studies are needed to study the contribution of FA symptomatology to evolution of the obese phenotype.

5. Limitations of the study

The community based nature of the study and the large number of study participants didn't allow the authors to use accurate determination of body fat indices and relate them to the diagnosis of FA as these indices need to be operated in clinical settings.

6. Conclusion

This study confirmed the presence of FA in adolescents 11–18 years of different BMI categories not only in obese subjects. FA symptomatology rather than FA diagnosis differed significantly in the different weight categories.

Compliance with Ethical Standards

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

The work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments on humans. The study was approved by the local Ethics Committee of Ain Shams University.

This manuscript has not been published previously (partly or in full) and is not currently under consideration by any other journal.

All authors have read and approved the final article.

Conflict of interest

No conflicts of interest and no funding sources regarding any of the authors.

Acknowledgement

The authors would like to acknowledge Dr Ashley Gearhardt, Assistant Professor of Psychology, University of Michigan for her kind permission to use the YFAS as well as her generous help in providing the corresponding author with papers and the necessary package for scoring the answers of the studied participants.

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