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# Study of disturbed eating behaviors in children with attention deficit hyperactivity disorder

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## Abstract

**Background:** There is emergent evidence that disturbed eating behaviors, including emotional eating and obesity, co-occur with attention deficit hyperactivity disorder (ADHD) in children. The hypothesis that disturbed eating behaviors in ADHD children are related to ADHD symptom severity, so we aimed to examine the link between ADHD symptoms and eating behaviors.

**Results:** Fifty ADHD children were included, and they completed the Emotional Eating scale adapted for children (ESS-C) to evaluate eating in response to emotions. Parents completed the Children's Eating Behavior Questionnaire (CEBQ) to assess children's eating behavior. Multivariable regression analysis was used to detect the most independent factor for higher body mass index (BMI) risk. Higher rates of overweight/obesity were detected among ADHD children than among the normal population. Also, higher Conners global index was associated with higher BMI z scores. Both inattentive and combined types were linked to higher BMI, while hyperactive type with lower BMI. Regarding eating behaviors, a positive association between food approach and BMI, and a negative association between food avoidant and BMI z-scores was found. Similarly, there was a noteworthy positive relation between emotional overeating and BMI. Sixty-eight of ADHD children were high emotional eaters, mainly inattentive and combined types. Others, mainly hyperactive type, were low emotional eaters. Only ESS-C total score was confirmed as an independent factor for higher BMI risk.

**Conclusion:** Our findings provide evidence that emotional overeating and food approach eating behaviors are common among ADHD children with higher BMI associated with them. Future studies for a better understanding of this overlap will enhance potential interventions.

**Keywords:** Emotional eating, eating behaviors, Overweight/obesity, Attention-deficit hyperactivity disorder, children

## Background

Attention-deficit/hyperactivity disorder (ADHD) is a disorder of inattention, hyperactivity, or combined that affects 5 to 8% of children worldwide [1]. ADHD children's neurobehavioral data have shown a relation between inattention/impulsivity and childhood obesity [2]. The association between ADHD and obesity could be explained by disinhibited eating behavior, such as binge eating, which has been found to partially mediate the link between ADHD and obesity among adults [3, 4]. Recent data from adult and youth studies in both clinical and population-

based settings suggest that individuals with ADHD have an elevated risk for obesity [4, 5]. Meanwhile, in younger children, the comorbidity between ADHD and overweight has not been examined sufficiently, especially with less available data based on population. A study based on a small clinical sample of boys had confirmed that ADHD can elevate the hazard of obesity in male children [6]. Emotional eating is defined as eating in response to a wide range of negative emotions including anxiety, depression, loneliness, and boredom to overcome stressful negative affect [7, 8]. Emotional eating is greatly associated with eating disorders, like binge eating disorder and bulimia nervosa as they are closely related to maladaptive coping strategies, emotion-focused coping, and a strong aversion to negative feelings and stimuli [9, 10]. Moreover, the

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potential role of disturbed eating behaviors like emotional overeating, binge eating, loss of control (LOC) overeating and bulimic behaviors to the prevalence of obesity among ADHD patients was highlighted in some studies [11, 12].

Although it may be difficult to fully decipher the direction of the association between ADHD, eating patterns and obesity; in-depth understanding of this association can not only help preventative efforts for weight gain and obesity, but can also support our understanding of the risk mechanisms. We hypothesized that disturbed eating behaviors in children diagnosed with ADHD are related to ADHD symptom profile and severity. This study aimed to distinguish different eating behaviors and abnormal emotional eating in children with ADHD and detect the link between ADHD symptoms profile and disturbed eating behaviors in children. Also, we aimed to assess the relation between ADHD and overweight/obesity.

## Methods

### Study population

This is a cross-sectional observational study, which was conducted on 50 Egyptian children, with a clinical diagnosis of ADHD according to DSM-V criteria [13]. The sample size was assessed by a professor of medical statistics at the Community Department, Faculty of Medicine, Ain Shams University. They were randomly recruited from Mataria Teaching Hospital Psychiatry outpatient clinic between May 2018 and April 2019. During this period, 134 ADHD children were seen; we include 50 patients who met inclusion criteria, and other 84 patients were excluded according to the following criteria.

We included patients aged between 6 and 12 years, from both sexes, with average IQ assessed by the Wechsler-Bellevue Intelligence Scale for Children (WISC) Arabic version [14]. BMI was calculated by measuring body weight in kilograms divided by the square of the person's height in meters ( $\text{kg}/\text{m}^2$ ), and then was classified according to standard WHO BMI-z percentile for age and sex. We excluded patients with any medical or psychiatric comorbidities other than ADHD using the mini international neuropsychiatric interview for children and adolescents (MINI KID) Arabic version [15]. Any patients on medications for ADHD were excluded, as these medications could affect their body weight. Also, history of family eating disorders was excluded. Family dynamics were assessed using pre-prepared questioner assessing the flowing items (age, level of education, occupation, BMI, parenting style, and reaction to eating behaviors of parents, also housing, and family eating habits).

### ADHD test

We used The Conners' Parent Rating Scale Revised-Long version Arabic version [16]. It is an 80-item questionnaire to be completed by parents for the rating of

ADHD symptoms in children. In our study, the Conners scale was used to assess patients' symptoms severity and categorize them into mild, moderate or severe ADHD. Also, cases were sub-grouped according to ADHD types into predominantly hyperactive ADHD, predominantly inattentive and combined type of ADHD.

### Emotional eating

We used The Emotional Eating Scale adapted for Children and Adolescents (EES-C) [9]. It was adapted from the EES for adults to assess the children. The EES is a 25-item self-report measure used to evaluate the impulse to cope with negative affect by eating. The EES-C produces four subscales reflecting a desire to eat in response to different emotions: (1) anger, anxiety, and frustration (EESC-AAF), (2) depressive symptoms (EESC-D), (3) feeling unsettled (EESC-U), and (4) happiness (EESC-H). During this study, we needed to categorize EES-C into low and high emotional eating, so we used a median split as done previously in the construct validity of the scale [17]. We found that 22.6 is the median split in this study, according to it, we categorized scores below it as low emotional eaters and scores above as high emotional eaters.

### Eating behavior

We used Children's Eating Behavior Questionnaire (CEBQ), designed for the use with children [18]. It is a 35-items parent-report (mothers in our study) tool for assessment of eight dimensions of eating style in children. They included food approaching behaviors (responsiveness to food, enjoyment of food, emotional overeating, and desire for drinks) and food avoiding behaviors (slowness in eating, food fussiness, emotional undereating, and satiety responsiveness). During this study, we used the results of this score to categorize our subjects into food approaching or food avoidant as done during the validation of the score [19].

In both EES-C and CEBQ, subjects responded to each item of the scale on a 5-point Likert scale from 1 to 5 (1 = never, 2 = rarely, 3 = sometimes, 4 = often, 5 = always).

### Study proper

Face to face clinical interview was conducted with each child and parent to build up a rapport and to ensure inclusion criteria for the patient.

Each participant of the study was subjected to the following tools: (a) WISC to test IQ, (b) MINI-KID for diagnosis of ADHD, (c) Conners scale for rating of symptoms of ADHD, (d) CEBQ for assessment of eating behaviors, (e) EES-C for assessment of emotional eating, and (f) measurement of body weight, height, and body mass index (BMI) calculation.

**Statistical analyses**

The data were summarized using mean and standard deviation (SD) for quantitative data with parametric distribution and number with percentages for qualitative data. When comparing two groups with quantitative data and parametric distribution, independent *t* test is used. While comparing between more than two groups, one-way analysis of variance (one-way ANOVA) was used. The chi-square test was used to compare groups according to qualitative data. Logistic regression analysis was used to assess independent risk factors for higher BMI z-scores in ADHD children. The confidence interval (CI) was set to 95% and the margin of error accepted was set to 5%, and a *P* < 0.05 was considered statistically significant. All calculations were performed using SPSS 20.0 ([www.SPSS.com](http://www.SPSS.com)).

**Results**

A description of the participants' demographics data showed that age, sex, and BMI z-scores is presented in Table 1. By categorizing our participants into subgroups according to BMI percentiles; 52% had abnormal weight, (10% underweight, 30% overweight, and 12% obese), while 48% had average weight. Also, the results of ADHD test, as global index, severity, and ADHD type are shown in Table 1. The description of

multiple family dynamics to analyze their effect on our participants' BMI z-scores is summarized in Table 2.

**Assessment of both emotional eating and eating behaviors**

Assessment of both emotional eating and eating behaviors showed EES-C total scores of our participants ranged 54–94 (mean SD 76.24 ± 15.34). To categorize our participants into high and low emotional eaters, we used the median split

**Table 1** A description of the participant demographic, BMI z-scores, and ADHD characteristics

	Participant No. = 50
Age	
Mean ± SD	8.92 ± 1.94
Range	6–12
Sex	
Female	20 (40.0%)
Male	30 (60.0%)
BMI z-scores for age	
Mean ± SD	60.92 ± 36.23
Range	3–96
Conners global index total	
Mean ± SD	77.68 ± 5.37
Range	68–86
Severity of Conners index	
Marked	36 (72.0%)
Moderate	14 (28.0%)
ADHD type	
Hyperactive	8 (16.0%)
Inattentive	16 (32.0%)
Combined	26 (52.0%)

SD standard deviation, BMI body mass index

**Table 2** A description of the participants' families dynamics

	Participant No. = 50
Family meal	
Not present	14 (28.0%)
Irregular	16 (32.0%)
Regular	20 (40.0%)
Number/week	
Mean ± SD	10.50 ± 4.25
Range	4–15
Environment	
Quarrelsome	32 (64.0%)
Harmonious	18 (36.0%)
Reaction to eating behavior	
Appropriate	12 (24.0%)
Criticism	16 (32.0%)
Restriction	16 (32.0%)
Pressure to eat	6 (12.0%)
Housing	
Extended	20 (40.0%)
Separate	30 (60.0%)
Maternal education	
Low	12 (24.0%)
Middle	14 (28.0%)
High	24 (48.0%)
Paternal education	
Low	14 (28.0%)
Middle	13 (26.0%)
High	23 (46.0%)
Maternal occupation	
House wife	22 (44.0%)
Working	28 (56.0%)
Paternal occupation	
Professional	21 (42.0%)
Laborer	29 (58.0%)

SD standard deviation

(22.66 in the current study), and we found that 68% of the participant were high emotional eaters, while 32% were low emotional eaters as shown in Table 3. Assessing children eating behaviors by the CEBQ showed that Food approach behaviors scores ranged 29–81 (mean SD 53.44 ± 14.33), while food avoidant behaviors scores ranged 34–85 (mean SD 58.04 ± 17.62) as shown in Table 3.

**Correlation of BMI with both age and sex**

We found that BMI percentiles increased with patient age, with high statistical significance (*P* value < 0.01), but not with their sex (*P* value > 0.05).

**Correlation of BMI with family dynamics**

First, the presence of either overweight or obese family members was associated with higher BMI z-scores with

high statistical significance (*P* value < 0.01) as shown in Table 4. Family meals significantly affected child BMI z scores. The absence of regular family meals was found to correlate with higher BMI z-scores. Meanwhile, subjects having regular family meals had much lower BMI z-scores with a highly statistically significant difference (*P* value < 0.001) as shown in Table 4. Also, the reaction of family members to child eating behaviors showed a

**Table 3** Emotional Eating as assessed by EEC-S and Child Eating Behavior assessed by CEBQ

	Participant
	No. = 50
Emotional Eating as assessed by Emotional Eating Scale for Children	
EESC-AAF	
Mean ± SD	31.08 ± 3.29
Range	25–39
EESC-D	
Mean ± SD	27.16 ± 9.87
Range	11–37
EESC-U	
Mean ± SD	13.60 ± 5.61
Range	4–20
EESC-H	
Mean ± SD	4.40 ± 0.70
Range	3–5
EESC group	
Low EE	16 (32.0%)
High EE	34 (68.0%)
Total	
Mean ± SD	76.24 ± 15.34
Range	54–94
Child Eating Behavior assessed by Child Eating Behavior questionnaire	
CEBQ-approach	
Mean ± SD	53.44 ± 14.33
Range	29–81
CEBQ-avoid	
Mean ± SD	58.04 ± 17.62
Range	34–85

EESC Emotional Eating Scale for Children, EESC-AAF EESC Anger, Anxiety, and Frustration, EESC-D EESC Depression, EESC-U EESC Unsettled, EESC-H EESC Happiness, CEBQ Child Eating Behavior Questionnaire

**Table 4** Relation of family dynamics with BMI z-scores

	% BMI for age		Test value	P value	Sig.
	Mean ± SD	Range			
Family obesity					
Average	30.71 ± 30.87	3–84	11.124 <sup>b</sup>	< 0.01	HS
Overweight	67.08 ± 35.07	5–96			
Obese	87.2 ± 7.61	75–95			
Family meal					
Not present	92.29 ± 2.81	89–96	24.674 <sup>b</sup>	< 0.001	HS
Irregular	70.63 ± 29.4	3–94			
Regular	31.2 ± 31.04	3–85			
Reaction to EB					
Appropriate	22.5 ± 16.72	10–55	159.757 <sup>b</sup>	< 0.001	HS
Criticism	91.88 ± 3.84	84–96			
Restriction	80.25 ± 12.47	50–89			
Pressure to eat	3.67 ± 1.03	3–5			
Environment					
Quarrelsome	79.62 ± 23.96	3–96	6.703	< 0.01	HS
Harmonious	27.67 ± 30.13	3–86			
Housing					
Extended	79.1 ± 22.42	25–96	3.15 <sup>a</sup>	< 0.01	HS
Separate	48.8 ± 38.84	3–95			
Maternal education					
Low	91.5 ± 4.03	85–96	18.621 <sup>b</sup>	< 0.001	HS
Middle	26.43 ± 18.34	10–55			
High	65.75 ± 36.91	3–95			
Paternal education					
Low	76.12 ± 26.19	10–92	2.047 <sup>b</sup>	0.078	NS
Middle	44.3 ± 30.78	25–80			
High	67.51 ± 37.81	3–96			
Maternal occupation					
House wife	51.73 ± 36.36	5–95	1.616 <sup>a</sup>	0.113	NS
Working	68.14 ± 35.09	3–96			
Paternal occupation					
Professional	56.32 ± 38.86	10–94	1.439 <sup>a</sup>	0.285	NS
Laborer	63.25 ± 21.9	3–95			

SD standard deviation, BMI body mass index, Sig. significance, HS highly significance, NS non-significance

<sup>a</sup>Independent t test

<sup>b</sup>One-way ANOVA test

highly statistically significant correlation with BMI z-scores ( $P$  value  $< 0.001$ ). Children who reported exposure to negative reactions to their eating behaviors like criticism had the highest BMI z-scores (mean SD  $91.88 \pm 3.84$ ). Also, food restriction led to higher BMI z-scores (mean SD  $80.25 \pm 12.47$ ). While appropriate reactions to child eating behaviors were associated with average BMI z-scores (mean SD  $22.5 \pm 16.72$ ). The pressure to eat was associated with the lowest BMI z-scores (mean SD  $3.67 \pm 1.03$ ) as shown in Table 4. Each of home environment and family housing showed high statistical significance ( $P$  value  $< 0.01$ ) in their relation with BMI z-scores, quarrelsome environment (mean SD  $79.62 \pm 23.96$ ) and was associated with higher BMI z-scores more than harmonious (mean SD  $27.67 \pm 30.13$ ), also extended housing (mean SD  $79.1 \pm 22.42$ ) was associated with higher BMI z-scores more than separate housing (mean SD  $48.8 \pm 38.84$ ) as shown in Table 4. Regarding mother education, low maternal educational level (mean SD  $91.5 \pm 4.03$ ) were associated with higher BMI z-scores, while high education (mean SD  $65.75 \pm 36.91$ ) was associated with both extremities of BMI z-scores and middle level (mean SD  $26.43 \pm 18.34$ ) was associated more with average BMI with high statistical significance ( $P$  value  $< 0.01$ ) as shown in Table 4. While, maternal working status, either being housewife (mean SD  $51.73 \pm 36.36$ ) or working (mean SD  $68.14 \pm 35.09$ ) did not show statistical significance ( $P$  value  $> 0.05$ ) in relation to BMI z-scores, as shown in Table 4. On the other hand, neither paternal occupation nor paternal education was statistically significant in relation to child BMI ( $P$  value  $> 0.05$ ).

**Correlation between ADHD severity, types, and BMI**

We found that severity of ADHD as assessed by Conners scale was significantly related to BMI z-scores. ADHD Connors' Global index score showed a highly statistically significant correlation with BMI z-score ( $P$  value  $< 0.001$ )

as shown in Table 5. When classifying patients according to Conners scale into severe and moderate in correlation with BMI z-scores, there was high statistical significance ( $P$  value  $< 0.01$ ) with severe type (mean SD  $74.61 \pm 31.84$ ) and moderate type (mean SD  $25.71 \pm 19.10$ ) as shown in Table 5. About ADHD type, it was found to be significantly correlated with BMI ( $P$  value  $< 0.05$ ). Inattentive ADHD children had higher BMI z score (mean SD  $91.38 \pm 4.13$ ) than those with the combined type (mean SD  $59.31 \pm 31.18$ ), while hyperactive type (mean SD  $5.25 \pm 3.06$ ) had a negative correlation with BMI z-scores as shown in Table 5 and Fig. 1.

**Correlation between children eating behaviors using CEBQ with BMI**

Correlation between children eating behaviors using CEBQ with BMI showed that higher CEBQ food-approach score were associated with higher BMI z-scores, while higher CEBQ food-avoiding were associated with lower BMI z-scores. There was a highly significant positive association between CEBQ Food approach subscales scores and BMI z-scores ( $P$  value  $< 0.01$ ) as shown in Fig. 2. While there was a highly significant negative association between CEBQ food-avoiding subscales scores and BMI z-scores ( $P$  value  $< 0.01$ ) as shown in Fig. 3.

**Correlation between children emotional eating using EES-C and BMI**

Higher total emotional eating score was associated with higher BMI z-scores in ADHD children with high statistical significance ( $P$  value  $< 0.001$ ) as shown in Table 6. Highly statistically significant ( $P$  value  $< 0.01$ ) positive correlation was found between high emotional eaters and BMI z-scores, while low emotional eaters had a negative correlation with BMI z-scores as shown in Table 6 and

**Table 5** Relation between ADHD severity, types, and BMI z-scores

	% BMI for age		Test value	P value	Sig.
	Mean $\pm$ SD	Range			
Severity of Conners global index					
Marked	74.61 $\pm$ 31.84	3.00–96.00	5.363 <sup>a</sup>	< 0.01	HS
Moderate	25.71 $\pm$ 19.10	5.00–55.00			
ADHD type					
Hyperactive	5.25 $\pm$ 3.06	3.00–10.00	37.891 <sup>b</sup>	< 0.05	S
Inattentive	91.38 $\pm$ 4.13	85.00–96.00			
Combined	59.31 $\pm$ 31.18	10.00–91.00			
Conners global index: total			0.619 <sup>**</sup>	< 0.001	HS

SD standard deviation, BMI body mass index, Sig. significance, HS highly significance, NS non-significance, S significance

\*\*Chi-square test

<sup>a</sup>Independent t test

<sup>b</sup>One-way ANOVA test

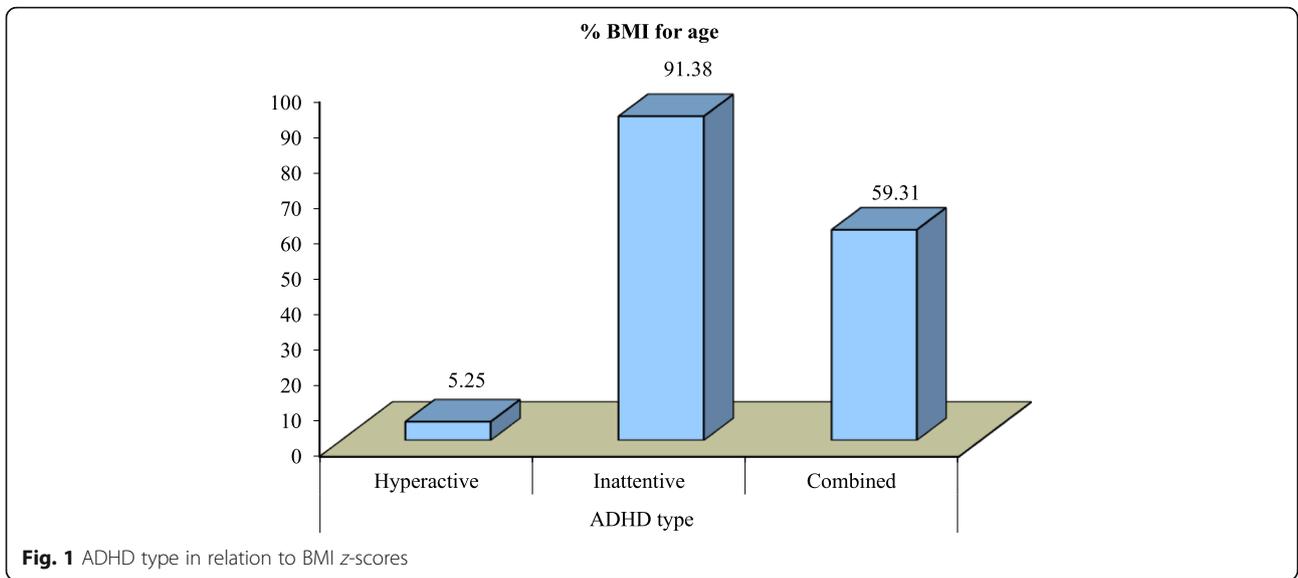
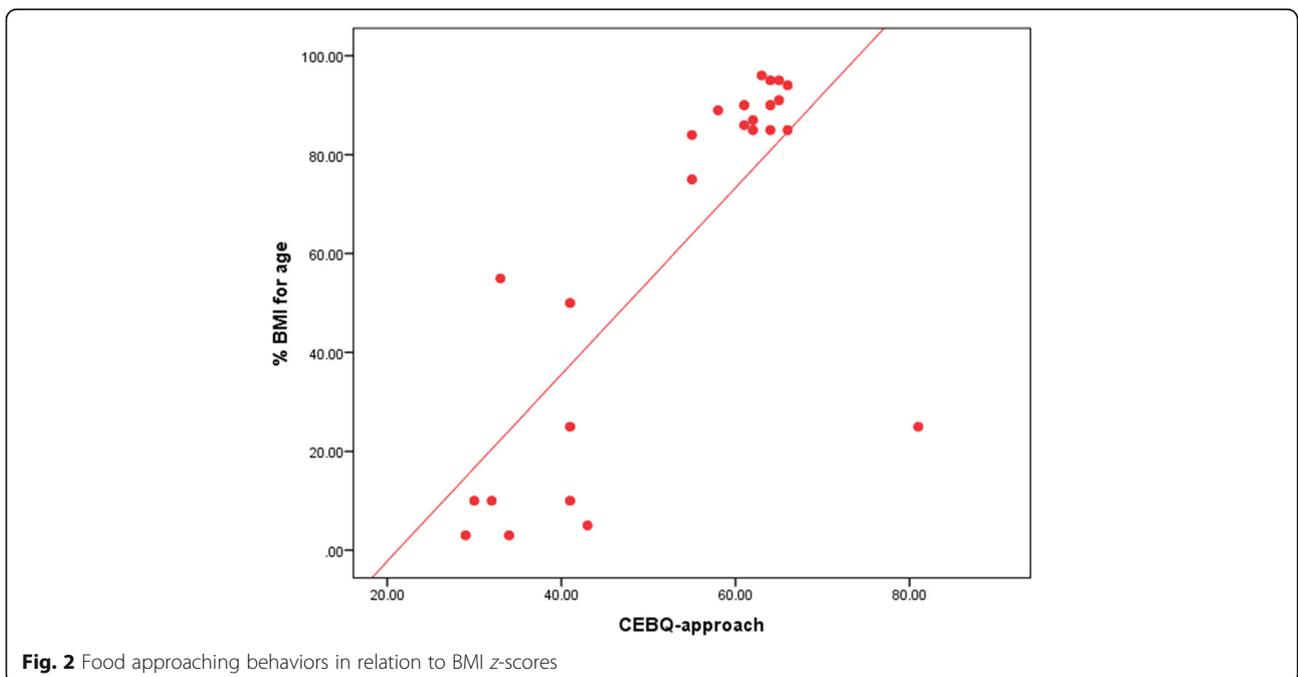
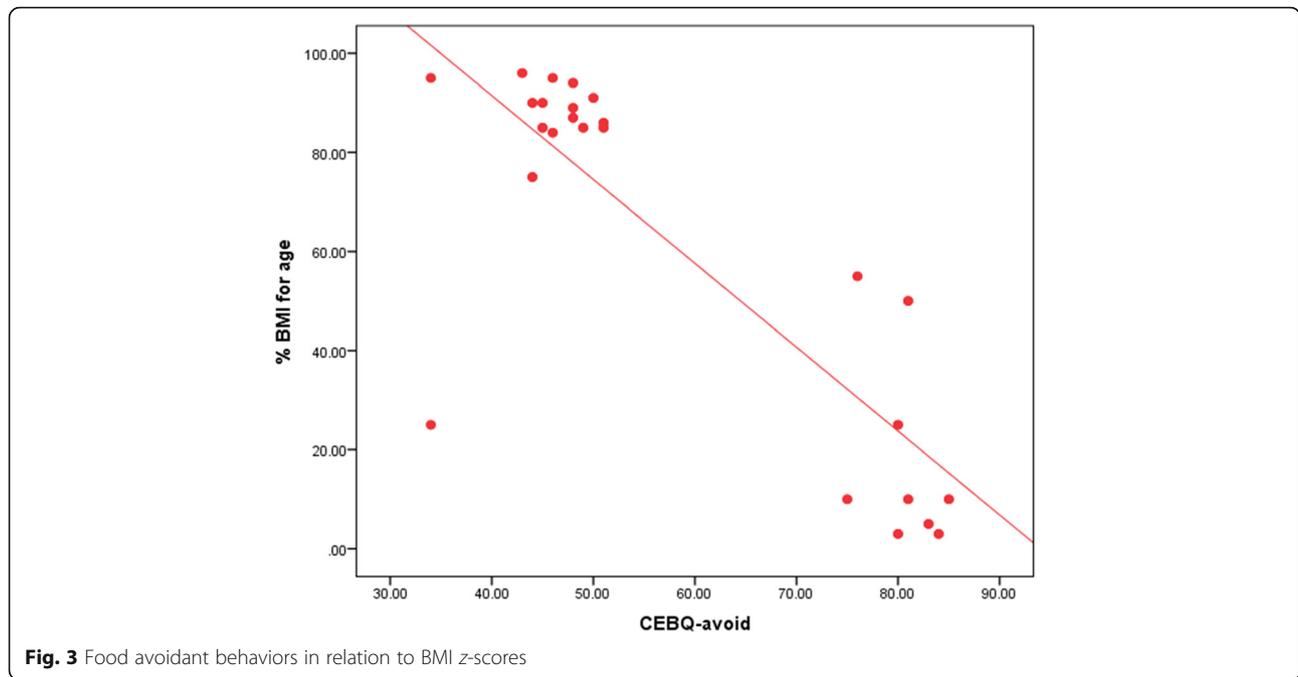


Fig. 4. Also, we found that higher scores in subscales for unsettlement (EESC-U) and for depression (EESC-D) were associated with higher BMI z-scores with high statistical significance ( $P$  value  $< 0.01$ ), also subscales for happiness (EESC-H) higher scores were associated with higher BMI z-scores with statistical significance ( $P$  value  $< 0.05$ ) as shown in Table 6. Contrarily, EES-C Subscale for anger/anxiety/frustration (EESC-AAF) was associated with lower BMI z-scores, but without statistical significance ( $P$  value  $> 0.05$ ) as shown in Table 6.

**Correlation of ESS-C total score and subscales scores with ADHD subtypes**

Higher EES-C total scores were found to correlate with each ADHD types with high statistical significance ( $P$  value  $< 0.001$ ). Inattentive type scores ranged 84–94 (mean SD  $88.50 \pm 3.14$ ), combined type ranged 54–91 (mean SD  $75.31 \pm 14.50$ ), while hyperactive type ranged only 54–56 (mean SD  $54.75 \pm 0.89$ ) as shown in Table 7 and Fig. 5. Also, correlation with high EE, low EE scores with ADHD types showed statistical significance ( $P$  value  $< 0.05$ ), with





**Fig. 3** Food avoidant behaviors in relation to BMI z-scores

higher high EE in inattentive type (87.5%), then combined (65.4%) and the least was hyperactive (37.5%), while higher low EE was in hyperactive (62.5%), then combined (34.6%) and the least was inattentive (12.5%). Correlation of ADHD type to EES-C subscales showed that in EESC-AAF subscale scores combined type scores the highest, then inattentive type and the lowest was hyperactive type as shown in Table 7. EESC-D subscale scores were highest in inattentive type and then combined type, while the hyperactive type was the lowest as shown in Table 7. EESC-U subscale scores were found to be the highest in inattentive type, then combined type, and lowest in hyperactive type the lowest as shown in Table 7. EESC-H subscale scores were the highest in inattentive type, than

combined type, while hyperactive type had the lowest scores as shown in Table 7.

**Correlation of CEBQ-approach, CEBQ-avoid, and ADHD subtypes**

Higher CEBQ-approach scores were found to correlate with each ADHD types with high statistical significance ( $P$  value < 0.01). Inattentive type scores ranged 61–66 (mean SD  $63.50 \pm 1.71$ ), combined type ranged 32–81 (mean SD  $53.23 \pm 14.32$ ), while hyperactive type ranged only 29–43 (mean SD  $34.00 \pm 5.90$ ) as shown in Table 7 and Fig. 6. Also, higher CEBQ-avoid scores were found to correlate with each ADHD types with high statistical significance ( $P$  value < 0.001). However, hyperactive type scores ranged 75–84 (mean SD  $80.50 \pm 3.74$ ), combined type ranged 34–85 (mean SD  $59.15 \pm 17.83$ ), while inattentive type ranged only 43–51 (mean SD  $45.00 \pm 5.01$ ) as shown in Table 7 and Fig. 6.

**Table 6** EES-C scores relation with BMI z-scores

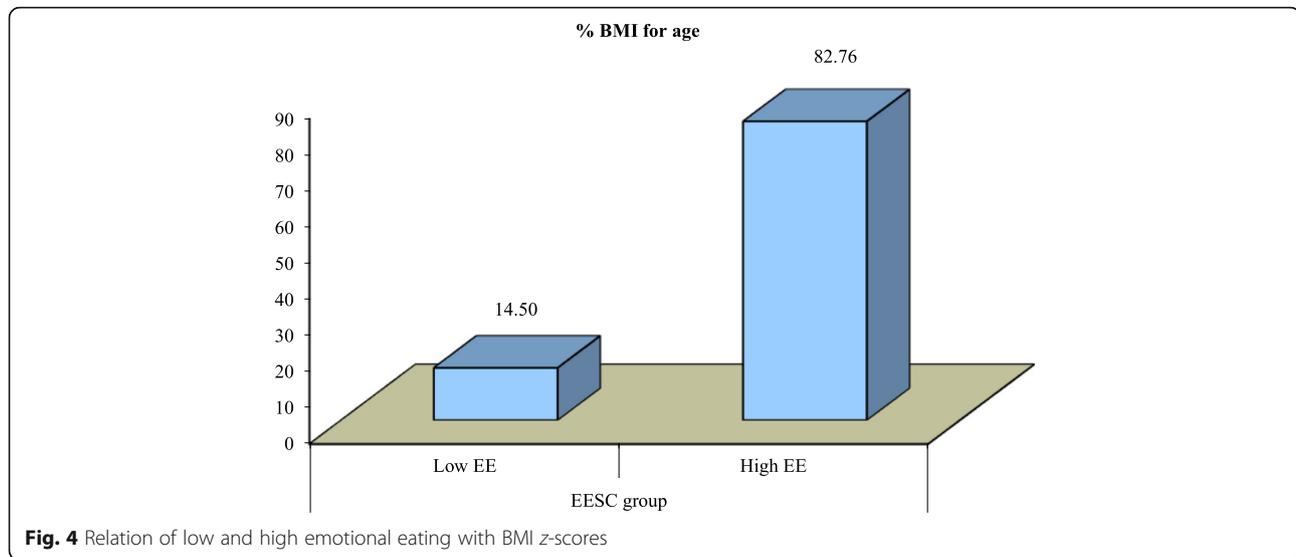
	% BMI for age		Sig.
	<i>R</i>	<i>P</i> value	
EESC-AAF	- 0.056	0.702	NS
EESC-D	0.781**	< 0.01	HS
EESC-U	0.874**	< 0.01	HS
EESC-H	0.628**	< 0.05	S
Low EE	- 13.366 <sup>a</sup>	< 0.001	HS
High EE			
Total EES-C	0.804**	< 0.001	HS

EESC Emotional Eating Scale for Children, EESC-AAF EESC Anger, Anxiety, and Frustration, EESC-D EESC Depression, EESC-U EESC Unsettled, EESC-H EESC Happiness, Low EE low emotional eating, High EE high emotional eating, Sig. significance, HS highly significance, NS non-significance, S significance

<sup>a</sup>Chi-square test  
<sup>a</sup>Independent t test

**Independent risk for increase BMI in patients with ADHD**

By using multivariate linear regression analysis, different items assessed in this study were examined to detect independent risk for increase BMI. These items included emotional eating assessed by Emotional Eating Scale for Children (EES-S) total score and each subscale scores (EESC-D, EESC-U, and EESC-AAF), eating behavior assessed by Child Eating Behavior Questionnaire (CEBQ) two subscales (food approach and food avoidant) and ADHD severity assessed by Conners global index score. This analysis revealed that only higher emotional eating detected by higher total EES-C, not its subscales, could



be used to predict higher BMI z-scores in ADHD children with high statistical significance ( $P$  value  $< 0.01$ ), while eating behavior and ADHD severity were not found significant.

## Discussion

To the best of our knowledge, the present study is the first to specifically investigate the relationship between eating behaviors and ADHD symptoms in a sample of ADHD Egyptian children. Even though eating disorders have been demonstrated to be a significant mediating factor in the relation between ADHD and overweight/obesity in adults and adolescents, very limited evidence is available when it comes to children.

Our findings are consistent with the previous studies which have related ADHD symptoms to food approach behaviors in adults. Current literature supports that adults with ADHD show a higher prevalence of abnormal eating behaviors such as binge eating in [20–22]. Also, our findings are consistent with few population-based studies which support the presence of an association between disturbed eating patterns and ADHD symptoms in children [23–26].

In this study, there is a higher percentage of abnormal BMI z-scores in ADHD children more than population studies, which was also reported in other previous cross-sectional studies in children [23] and in another two cohort studies [24, 26]. However, another cross-sectional study done on non-clinical samples had found no association between ADHD and BMI in children [25]. Contrarily, two studies found that patients with ADHD who were medicated, especially methylphenidate, had lower odds of obesity compared to patients without ADHD [26, 27]. This finding was confirmed by a meta-analysis, which showed that individuals medicated for ADHD

were not at higher risk of obesity, signifying that ADHD pharmacological treatment might exert a protective action on the risk of obesity development [28].

To our knowledge, only three previous studies had investigated the association between ADHD and emotional eating in children [24–26]. We found that ADHD positively contributed to emotional eating. ADHD children were more high emotional eaters using EES score. These results concord with results from the cross-sectional study by Tong and colleagues and the cohort study by Leventakou and colleagues [24], who concluded that there was a noteworthy positive link between emotional overeating and ADHD symptoms.

Analysis of our data showed that higher Conners global index was associated with higher BMI z-score in ADHD children. These results concord with the results from two different studies conducted on preschool children and school-aged children [29, 30]. On the other hand, another recent population-based study found no significant relation between ADHD severity and BMI z-score although it concluded that ADHD upsurge the hazard of abnormal eating in children [25]. Regarding ADHD subtypes and symptom severity and their relation to BMI, we found a positive association of severity of inattentive and, to a lesser extent, combined type with higher BMI z-scores, whereas there was a negative relation with hyperactive scores. These results agreed with results from other previous studies [30, 31], whereas other studies found no correlation between BMI z-scores and inattention or hyperactivity/impulsivity symptoms [32, 33].

The current study revealed that there was a highly significant positive association between CEBQ-food approach scores and BMI z-scores, while CEBQ-food avoiding scores were associated negatively with BMI z-

**Table 7** Relation between emotional eating and child eating behavior and types of ADHD

	Hyperactive No. = 8	Inattentive No. = 16	Combined No. = 26	Test value	P value	Sig.
Relation between Emotional Eating assessed by EES-C and types of ADHD						
EESC-AAF						
Mean ± SD	28.00 ± 2.00	30.00 ± 3.10	32.69 ± 2.81	10.311 <sup>b</sup>	< 0.05	S
Range	25–30	25–33	27–39			
EESC-D						
Mean ± SD	16.25 ± 1.75	35.63 ± 0.89	25.31 ± 10.11	19.877 <sup>b</sup>	< 0.01	HS
Range	15–19	35–37	11–36			
EESC-U						
Mean ± SD	6.50 ± 1.60	18.13 ± 1.41	13.00 ± 5.48	21.752 <sup>b</sup>	< 0.01	HS
Range	4–8	15–20	6–19			
EESC-H						
Mean ± SD	4.00 ± 0.00	4.75 ± 0.68	4.31 ± 0.74	3.961 <sup>b</sup>	> 0.05	NS
Range	4–4	3–5	3–5			
Total						
Mean ± SD	54.75 ± 0.89	88.50 ± 3.14	75.31 ± 14.50	26.588 <sup>b</sup>	< 0.001	HS
Range	54–56	84–94	54–91			
EESC group						
Low EE	5 (62.5%)	2 (12.5%)	9 (34.6%)	6.298 <sup>a</sup>	< 0.05	S
High EE	3 (37.5%)	14 (87.5%)	17 (65.4%)			
Relation between Eating Behaviors assessed by CEBQ and types of ADHD						
CEBQ-approach						
Mean ± SD	34.00 ± 5.90	63.50 ± 1.71	53.23 ± 14.32	20.147	< 0.01	HS
Range	29–43	61–66	32–81			
CEBQ-avoid						
Mean ± SD	80.50 ± 3.74	45.00 ± 5.01	59.15 ± 17.83	18.935	< 0.001	HS
Range	75–84	34–51	34–85			

EESC Emotional Eating Scale for Children, EESC-AAF EESC Anger, Anxiety and Frustration, EESC-D EESC Depression, EESC-U EESC Unsettled, EESC-H EESC Happiness, CEBQ Child Eating Behavior Questionnaire, Sig. significance, HS highly significance, NS non-significance, S significance

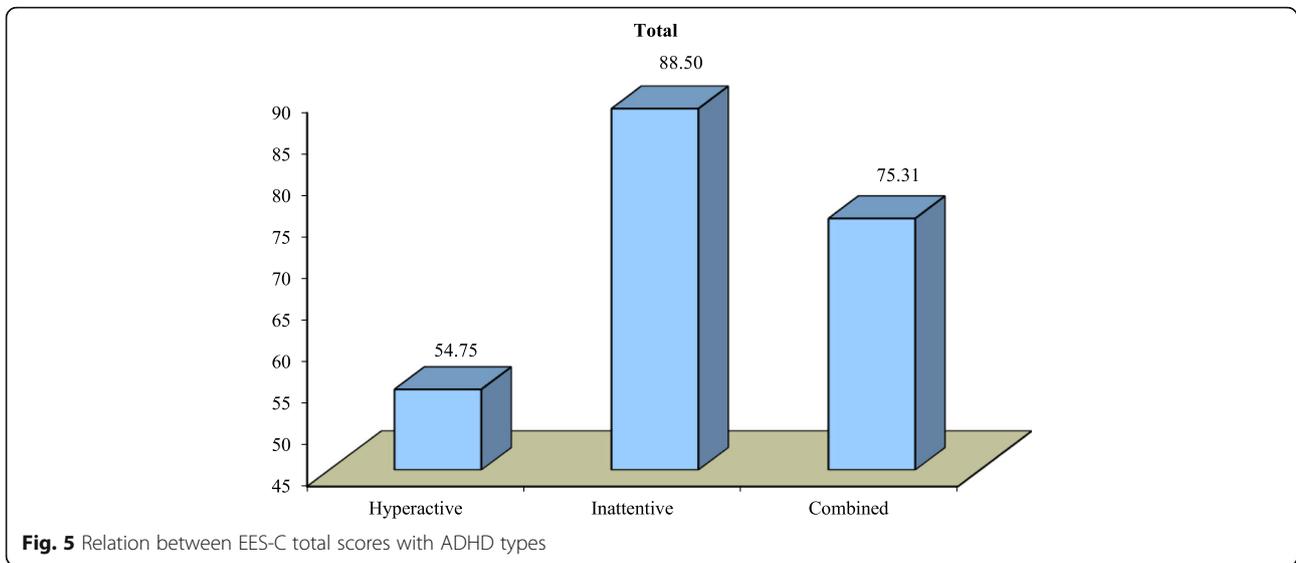
<sup>a</sup>Chi-square test

<sup>b</sup>One-way ANOVA test

scores in ADHD children. This agreed with results from most of the literature [24, 34, 35]. Moreover, a recent systematic review, conducted by Kaisari and his colleagues, concluded the same results across the life span in ADHD patients [36]. Our findings indicated that higher total Emotional Eating score was associated with higher BMI *z*-scores in ADHD children; moreover, high emotional eaters had a positive correlation with BMI *z*-scores, while low emotional eaters had a negative correlation with BMI *z*-scores. This agreed with the only two studies examined the relationship between emotional eating and BMI *z*-scores in ADHD children [24, 25]. Correlation between EES-C subscales and BMI *z*-scores showed that higher subscale for depression (EESC-D) and unsettlement (EESC-U) were associated with higher BMI *z*-scores. Contrarily, the EES-C subscale for anger/

anxiety/frustration (EESC-AAF) was associated with lower BMI *z*-scores. This agreed with results from Tong and his colleagues who found that ADHD significantly contributed to depression, and depression directly predicted emotional overeating [25].

We used multivariate linear regression analysis for the detection of higher BMI *z*-scores in ADHD children. Different items assessed in this study, as emotional eating assessed by Emotional Eating Scale for Children (EES-S) total score and each subscale scores (EESC-D, EESC-U, and EESC-AAF), eating behavior assessed by Child Eating Behavior Questionnaire (CEBQ) two subscales (Food approach and food avoidant) and ADHD severity assessed by Conners global index score were analyzed. This analysis revealed that only higher emotional eating detected by higher total EES-C, not its subscales could be used to predict higher BMI *z*-scores in



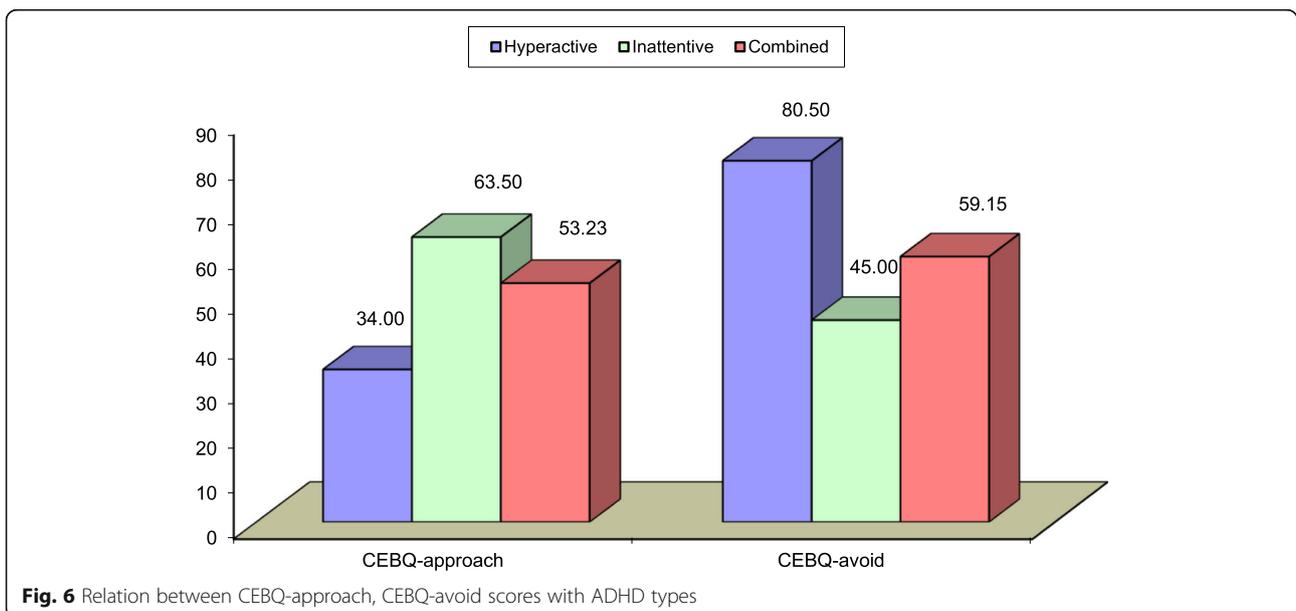
ADHD children while eating behavior and ADHD severity were not found significant in this study.

We found that ADHD children with abnormal weight (either overweight or underweight) were more than the average population of the same age. Since the risk of obesity increases in people with ADHD from childhood to adulthood, a recently published review study tried to explain their comorbidity. It found that both disorders share familial risk factors as family environment and pleiotropic genes. Besides, genes that contribute to the comorbidity of ADHD and obesity may cause deficits in executive functions, which may act as a common neuropsychological pathway of both disorders. Also, prenatal environmental factors could play a key role in the

development of neuropsychological characteristics associated with ADHD, and of subsequent obesity [37].

Adjustment for other risk factors suggests that ADHD is a specific risk factor for eating pathology. Searching for the mechanism for that, a systematic review analysis found that dysfunctions in the dopamine pathways of the brain have been found among both individuals who are obese and individuals with ADHD. Besides that, individuals who have ADHD symptoms and carry genetic profiles associated with greater dopamine activation in brain reward areas are more likely to engage in overeating behaviors, such as binge and emotional eating [36].

ADHD severity was associated with higher BMI z-scores, mostly in inattentive type and to a lesser extent



with combined type, while hyperactive type was associated with less BMI *z*-scores. Deficient inhibitory control could reinforce abnormal eating behaviors that, in turn, would increase the likelihood of obesity. Inattention and poor planning might cause difficulties in adhering to regular eating patterns and dietary regimens; additionally, a lack of attention may be associated with a lack of awareness of food intake [38]. Another important factor is the hyperactive physical component of ADHD, as motor overactivity, that would intuitively be considered to decrease, rather than increase, the risk of obesity; assuming that it increases energy expenditure and weight loss. A previous study had showed that ADHD (predominantly inattentive type) children were 57% less likely to meet recommended levels of physical activity than controls [39].

ADHD children showed a positive association between CEBQ food-approach behaviors and BMI *z*-score, while CEBQ food-avoidant behaviors were associated negatively. Also, correlation of EES-C score and BMI *z*-scores in ADHD children revealed that there was a positive correlation between BMI *z* and EES-C total scores, as most of ADHD children with high EES have higher BMI-*z*, and vice versa.

Regarding ADHD types and their relation with EES-C, there were higher EES-C scores among both inattentive and combined types, but not among the hyperactive type. A speculated mechanism to explain this association is that children with ADHD may face more stress and negative emotions which increase the risk of emotional eating behaviors as a maladaptive coping mechanism as individuals involve in emotional eating mostly when they are experiencing difficulty in coping with negative emotions. Emotional eating is associated with a range of psychological problems, such as low self-esteem and feelings of inadequacy, social anxiety, and mood disorders. Children with ADHD often suffer from low social recognition, problematic peer relationship, poor academic achievement, and high concurrence with mood disorders, which may contribute to emotional eating [25]. There are many limitations to our study, as it was limited by the sample size; thus, caution should be exercised in the generalization of the results of this study, and more research should be carried out on larger samples to replicate these results. Another limitation of our study was that it was cross-sectional in nature, and although it helped identify associations, it was difficult to infer causality in relationships. A longitudinal study would help answer many questions in this area.

## Conclusion

This study is to evidence that there is a relation between ADHD severity and type and disturbed eating behaviors.

Disturbed eating is one of the problems associated with ADHD and can cause more comorbidities in ADHD children compared to their peers like overweight and obesity. ADHD type and severity are positively related to BMI and hence overweight/obesity as revealed in our study. Moreover, food approach eating behaviors such as food responsiveness and emotional overeating are associated with an increase of abnormal weight status in ADHD children. The early recognition of abnormal emotional eating and eating behaviors can provide an avenue for intervention and thus lead to the more effective management of ADHD symptoms in early childhood and can help in the prevention of other adverse outcomes that may occur, such as obesity. Moreover, our findings add to the existing literature on the overlap between eating behaviors and ADHD, and future studies should aim to understand the biological basis of this overlap.

## Abbreviations

ADHD: Attention-deficit hyperactivity disorder; BMI: Body mass index; CEBQ: Children's Eating Behavior Questionnaire; DSM-V: Diagnostic and Statistical Manual of Mental Disorders 5th edition; EES-C: Emotional Eating scale adapted for children

## Acknowledgements

The authors thank all parents and patients as well as colleagues involved in the medical care of our patients.

## Authors' contributions

HE conceived and designed the study. AZ collected, analyzed, and interpreted the data. MK wrote the first draft of the manuscript, and AA revised wrote the final manuscript. All authors agreed with the results and conclusions of this article. All authors read and approved the final manuscript.

## Funding

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

## Availability of data and materials

All data and materials are available.

## Ethics approval and consent to participate

The study was approved by the Ethics Committee of the Institute of Psychiatry, Ain Shams University. Unfortunately, due to technical issues in our institutional IT system, our ethical committee reference number cannot be retrieved at the moment. However, we would be happy to supply a signed letter from our head of institution explaining that this research has been previously approved.

The child and the parent agreed to participate in the research, after receiving detailed information about the research. Written informed consent for participation in the study was obtained from parents.

## Consent for publication

All authors have approved the manuscript for publication.

## Competing interests

The authors declare that they have no competing interests.

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Received: 12 August 2019 Accepted: 14 January 2020

Published online: 24 March 2020

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