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## **Disturbed eating behaviours do not impact treatment response in a paediatric obesity chronic care treatment programme**

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## **Title page**

**Title:** Disturbed Eating Behaviours Do Not Impact Treatment Response in a  
Paediatric Obesity Chronic Care Treatment Programme

**Running title:** Eating Behaviours: Effect on Weight Loss

## **Original Article**

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MAVL analysed the data, and wrote the paper draft; All authors contributed with  
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**Conflicts of interest:**

The authors declare that they have no conflicts of interest.

**What is already known on this topic:**

- The prevalence of disturbed eating behaviours in children and adolescents with overweight or obesity varies from 12% to 56%.
- The effects of obesity treatment in children and adolescents who exhibit disturbed eating behaviours are unclear.

**What this paper adds:**

- Upon enrolment into obesity treatment, children and adolescents who report overeating or rapid eating have a higher BMI SDS than children and adolescents without these eating behaviours.
- The prevalence of meal skipping, emotional eating and rapid eating increases with age in children and adolescents with overweight or obesity.
- In this intervention programme, the degree of obesity improved in 75.6% of patients after one year of treatment. The presence of disturbed eating behaviours at treatment initiation did not reduce treatment effect.

**Abstract:**

**Aim:** This study investigates the prevalence of disturbed eating behaviours in children and adolescents initiating obesity treatment, and how the prevalence varies with age, sex and body mass index (BMI) standard deviation score (SDS). Secondly, it examines whether the presence of disturbed eating behaviours at enrolment is associated with the degree of weight loss after 12 months of treatment.

**Methods:** 3,621 patients aged 3–18 years enrolled in a multidisciplinary obesity treatment programme were studied. Follow-up data after a median of 12.4 months was available for 2,055 patients. Upon entry, patients were assessed for the following disturbed eating behaviours: meal skipping, emotional eating, overeating, and rapid eating. Height and weight were measured at baseline and follow-up.

**Results:** At enrolment median age was 11.4 years, median BMI SDS was 2.87, and 82.2% of patients exhibited one or more disturbed eating behaviours. The prevalence of meal skipping, emotional eating and rapid eating increased with age ( $p<0.01$ ). Patients who reported overeating or rapid eating exhibited a 0.06–0.11 higher BMI SDS at enrolment ( $p<0.02$ ). After one year of treatment, BMI SDS was reduced in 75.6% of patients, and the median reduction was 0.24 (95% CI: 0.22-0.27).

Overeating was associated with a higher degree of weight loss.

**Conclusions:** Disturbed eating behaviours were highly prevalent in children and adolescents with overweight or obesity, and varied with age and sex. After one year of treatment the degree of obesity improved, regardless of the presence of disturbed eating behaviours at treatment initiation.

**Keywords:** Child Nutrition Disorders, Eating Behavior, Food Habits, Pediatric Obesity, Weight Loss.

## **Introduction**

Childhood obesity is highly prevalent<sup>1</sup> and impairs physical and psychosocial health.<sup>2-</sup>

<sup>4</sup> Disturbed eating behaviours have been associated with overweight or obesity<sup>5,6</sup> and with increased risk of future weight gain in children and adolescents.<sup>7,8</sup> Further, studies of obesity treatment effects in children and adolescents with disturbed eating behaviours have shown inconsistent results.<sup>9-11</sup>

Disturbed eating behaviours are traditionally categorised into three domains: cognitive restraint, emotional eating, and uncontrolled eating.<sup>12-14</sup> In children and adolescents these domains have been defined as follows: cognitive restraint as a conscious restriction of food intake to avoid gaining weight;<sup>15</sup> emotional eating as the tendency to eat in response to emotions;<sup>16,17</sup> and lastly, uncontrolled eating as a tendency to eat more than usual and a concurrent feeling of loss of control.<sup>18</sup> While this definition of uncontrolled eating resembles the diagnosis of binge eating disorder, clinical diagnoses of eating disorders are rarely made before adolescence.<sup>19,20</sup>

Disturbed eating behaviours are more common in children and adolescents with overweight or obesity compared with their normal weight peers.<sup>5,8,21-23</sup> Eating behaviour changes during childhood and adolescence, with e.g. food fussiness and aversion affecting young children especially,<sup>24</sup> making it difficult to compare prevalence of disturbed eating behaviours across pediatric age groups. As such the

reported prevalence of disturbed eating behaviours in children and adolescents with overweight or obesity varies widely from 12% to 56%, and in addition to age, sex and degree of obesity, differences in methods used for assessment of disturbed eating behaviours also contribute to these discrepancies between studies.<sup>5,9,21,25-28</sup>

Effects of weight loss treatment in children and adolescents with disturbed eating behaviours have been studied in two randomised controlled trials (RCTs) that found weight regain in children and adolescents with disturbed eating behaviours,<sup>9,10</sup> and one RCT that found reduction in the degree of obesity and binge eating symptoms.<sup>11</sup> The lack of consistency may be due to a limited number of studies, small sample sizes, different age ranges, and the different methods used for assessment of disturbed eating behaviours.<sup>9-11</sup>

Consequently, this study aimed to investigate the prevalence of disturbed eating behaviours in a large cohort of Danish children and adolescents initiating obesity treatment, and how this prevalence varied with age, sex and body mass index (BMI) standard deviation score (SDS). Secondly, it aimed to examine whether the presence of disturbed eating behaviours at enrolment was associated with the degree of weight loss (change in BMI SDS) after 12 months of treatment.

## **Materials and methods**

### *Study population*

This study included children and adolescents (N=3,697) enrolled into the Danish Childhood Obesity Biobank from January 2009 to June 2018, who participated in a

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multipdisciplinary obesity treatment programme. Overweight was defined as a BMI above the 90<sup>th</sup> percentile in accordance with Danish age- and sex-specific references.<sup>29</sup> Exclusion criteria were: 1) age younger than 3.0 or older than 18.9 years; 2) missing disturbed eating behaviour information at baseline; and 3) syndromal obesity including melanocortin 4 receptor- and leptin receptor mutations.

#### *Anthropometrics*

Height was measured on a stadiometer to the nearest 0.1 cm and weight was measured to the nearest 0.1 kg on a Tanita digital scale (WB-110 MA; Tanita Corp., Tokyo, Japan). All measurements were conducted with the child or adolescent wearing light indoor clothes and without shoes.

#### *Assessment of disturbed eating behaviours*

At the first visit to the clinic, the three domains of disturbed eating behaviours were assessed by asking the child or adolescent and their parents four questions regarding the patient's eating behaviour. The four yes/no questions are shown in Table 1, along with four optional questions used if further explanation was necessary. Note that uncontrolled eating was assessed by two questions, asking about overeating and rapid eating separately, as previous studies have shown that uncontrolled eating is difficult to understand and recognise in children.<sup>20</sup>

#### *Intervention*

The intervention consisted of an evidence-based treatment protocol developed at the Children's Obesity Clinic, Copenhagen University Hospital Holbaek.<sup>30,31</sup> The protocol is family-centered, multidisciplinary and comprises a range of behavioural lifestyle recommendations based upon Expert Committee guidelines from 2007.<sup>32</sup> The treatment is delivered by a team of paediatricians, paediatric nurses, dietitians, a psychologist and a social worker. Parents are encouraged to attend all consultations and the recommended lifestyle changes should be integrated in the entire family. At the initial one-hour consultation, a paediatrician or paediatric nurse obtains a detailed medical history and conducts a questionnaire-based interview aimed at identifying all the lifestyle changes necessary to reduce the degree of overweight or obesity in the child or adolescent. These lifestyle recommendations are incorporated into an individualised treatment plan containing 15–20 items of advice regarding the implementation of the lifestyle changes into the daily lives of the families. Examples include changes in dietary habits, means of transportation, physical activity, sedentary behaviours, screen time, sleep duration, snacking, social activities and intake of sweets in all forms. The individualised treatment plan contains several strategies, including a meal eating exercise to be used at dinner.

Approximately six weeks after the initial consultation, the patient and family consult a dietitian for one hour. At this consultation and at all subsequent consultations, the treatment plan is evaluated and adjusted to accommodate the challenges and needs of the patient and family. The frequency of consultations is individual, but an average of

five hours of health professional time is invested in the treatment of each patient per year. Details of the treatment protocol have been reported in Holm *et al.*<sup>30</sup>

### *Ethics*

Informed written and oral consents were obtained from all parents or legal guardians and from adolescents aged 18 years. The study was part of the Danish Childhood Obesity Biobank, registered at clinicaltrials.gov (ID. No NCT00928473), and was approved by the Ethics Committee of Region Zealand, Denmark, (protocol no. SJ-104) and by the Danish Data Protection Agency.

### *Statistics*

Statistical analyses were performed in R statistical software (v.3.5.1).<sup>33</sup> To investigate effects of age, the participants of each sex were allocated into three groups: 3.0–9.9, 10.0–14.9, and 15.0–18.9 years of age. Normality of data was evaluated for the sexes combined and separately using histograms and qq plots. Differences between sexes and age groups were examined using Wilcoxon rank-sum test, Kruskal-Wallis test, or Chi-squared test, where appropriate. A multivariate linear regression model, adjusted for age, sex, ethnicity and socioeconomic status was used to evaluate the association between the presence of disturbed eating behaviour and 1) BMI SDS at enrolment, and 2) change in BMI SDS at follow-up. 95% confidence intervals for median change in BMI SDS at follow-up were calculated by bootstrapping. A  $P < 0.05$  was considered statistically significant.

## Results

### *Baseline characteristics*

During the study period, 3,697 (2,017 girls) children and adolescents with overweight or obesity were enrolled. 51 patients were excluded due to age, 32 due to missing baseline disturbed eating behaviour data, and 23 due to syndromal obesity, leaving 3,621 (1,967 girls) patients for further analysis. The median age at enrolment was 11.3 years in girls and 11.5 years in boys and the median BMI SDS was 2.72 in girls and 3.15 in boys (table 2).

### *Prevalence of disturbed eating behaviours*

At baseline, 82.2% of the children and adolescents exhibited one or more of the studied disturbed eating behaviours. More boys than girls reported meal skipping and rapid eating (55% vs. 51%,  $p=0.028$ ; and 54% vs 43%,  $p<0.001$ ; table 2), while the prevalence of emotional eating was higher in girls (57%) compared with boys (51%,  $p=0.001$ ; table 2). The prevalence of overeating showed no sex differences.

### *Disturbed eating behaviour and age*

Table 3 shows the patients divided into three age groups. While the prevalence of exhibiting one or more of the studied disturbed eating behaviours were similar across age groups, age related differences were present for the individual disturbed eating behaviours: prevalence of meal skipping increased in both sexes from 40% in the

youngest age group (3.0–9.9 years) to 64–73% in the oldest age group (15.0–18.9 years) ( $p<0.001$ , table 3); prevalence of emotional eating increased with age from the youngest to oldest in girls (52% vs. 61%,  $p=0.005$ ); and prevalence of rapid eating increased in boys from the youngest to oldest (52% vs. 67%,  $p=0.001$ ).

#### *Disturbed eating behaviour and degree of obesity at enrolment*

After adjusting for age, sex, ethnicity, and socioeconomic status, patients exhibiting overeating had a 0.11 higher BMI SDS at enrolment (95% CI: 0.06–0.16,  $p<0.001$ ) compared with those not exhibiting overeating. A similar association was found for patients exhibiting rapid eating ( $\beta=0.06$ , 95% CI: 0.01–0.10,  $p=0.015$ ). BMI SDS at enrolment was not associated with meal skipping ( $\beta=-0.01$ , 95% CI: -0.05–0.04,  $p=0.81$ ) or emotional eating ( $\beta=0.04$ , 95% CI: 0.00–0.09,  $p=0.062$ ). Likewise, there were no differences in BMI SDS at enrolment between patients exhibiting 0, 1, or 2–4 disturbed eating behaviours ( $p=ns$ , data not shown).

#### *Disturbed eating behaviour and weight loss at follow-up*

Follow-up BMI SDS data was available for 2,055 (1,136 girls) children and adolescents (table 4). At enrolment, this subgroup was younger (median age 11.1 [IQR: 8.6; 13.2] vs. 11.4 [IQR: 9.0; 13.6],  $p<0.001$ ) and had a lower prevalence of meal skipping (47% vs. 53%,  $p<0.001$ ) and emotional eating (50% vs. 54%,  $p=0.003$ ). Prevalence of overeating and rapid eating, BMI SDS, ethnicity,

socioeconomic status and sex distribution were unchanged from the baseline population.

Following a median treatment duration of 12.4 months (range 11–24), BMI-SDS was reduced in 75.7% of patients (1,555 individuals). In the group as a whole, the median change in BMI SDS was -0.24 (95% CI: -0.27– -0.22,  $p < 0.001$ ). After adjusting for age, sex, ethnicity, and socioeconomic status there were no associations between the prevalence of meal skipping, emotional eating or rapid eating at enrolment and the degree of weight loss at follow-up, while exhibiting overeating at enrolment was associated with a slightly higher degree of weight loss at follow-up ( $\beta = -0.04$ , 95% CI: -0.09–0.00,  $p = 0.046$ , table 5).

## **Discussion**

We examined a large cohort of children and adolescents enrolled in a multidisciplinary obesity treatment programme, and found a high prevalence of disturbed eating behaviours. The prevalence of meal skipping, emotional eating and rapid eating all increased with age. Importantly, in this intervention programme BMI SDS improved after one year of treatment in three out of four patients, regardless of the presence of disturbed eating behaviours at enrolment.

### *Prevalence of disturbed eating behaviour*

Previous studies that have examined the three domains of disturbed eating behaviour: cognitive restraint, emotional eating, and uncontrolled eating, have focused more on

the association between disturbed eating behaviour and body weight than on absolute prevalence.<sup>13,14,34-36</sup> The several studies that have reported prevalence of disturbed eating behaviours in children and adolescents with overweight or obesity<sup>5,9,21,25-28</sup> have often concentrated on the domain of uncontrolled eating.

Individual studies report prevalences of overeating and/or rapid eating in children and adolescents with overweight or obesity between 12-56%,<sup>5,9,21,25-28</sup> while a recent meta-analysis estimated an overall prevalence of binge eating and loss of control eating of 26%.<sup>37</sup> These large inconsistencies may reflect the considerable variation in age, sex, degree of obesity, ethnicity and geography across studies, and particularly the number and types of disturbed eating behaviours assessed and the methods used to assess them.

As such, a larger study of German adolescents, that examined multiple domains of disturbed eating behaviours, reported that among the subgroup with overweight or obesity, the prevalence of disturbed eating behaviours were 36% (overweight) and 54% (obesity).<sup>28</sup> These results are in line with our findings in Danish adolescents with obesity.

#### *Relation to age*

Few studies have compared the prevalence of disturbed eating behaviours between different age groups.<sup>9,38,39</sup> A population-based study of 3,275 children found that a larger part of children aged five and six years ate breakfast compared with children

aged 11 to 14 years.<sup>38</sup> This is in line with a smaller study<sup>39</sup> and with our results that the prevalence of meal skipping increased with age in both sexes.

We further found that prevalence of emotional eating increased with age in girls and rapid eating increased with age in boys, while overeating did not change with age.

These observations are similar to those from previous population-based studies of adolescents, which found that emotional eating and restrained eating<sup>40</sup> and disturbed eating<sup>5</sup> increased with age in girls, and no age-related differences in prevalence of overeating.<sup>22</sup> It should be noted that the majority of these studies were population-

based and included adolescents, and as such are not suitable to compare disturbed eating behaviours across the full pediatric age range as is done in the present paper.

Taken together these results indicate that several disturbed eating behaviours increase in prevalence through childhood and adolescence in both population-based cohorts and in cohorts with obesity, and that knowledge of and focus on the patients' disturbed eating behaviours is important, especially as the child enters adolescence and becomes more independent.

### *Sex differences*

We found that more girls than boys reported emotional eating and that more boys than girls reported meal skipping and rapid eating. Previous studies have generally found a higher prevalence of the different disturbed eating behaviours including meal skipping in girls than boys. This is reported in population-based studies of children and/or adolescents,<sup>5,38,40</sup> and in a meta-analysis including only children and

adolescents with overweight or obesity.<sup>37</sup> It should be noted, that the absolute prevalence of the individual disturbed eating behaviours was high in both sexes and for all but rapid eating in girls exceeded 50%, and that the sex differences increased with age, as can be appreciated in table 3. This might explain why previous smaller studies including mostly children have found no sex differences.<sup>26</sup>

As these studies show, eating behaviour varies with sex especially in adolescence, which is evident in larger studies. However, our study suggests that boys tend to exhibit more disturbed eating behaviours than girls, and is inconsistent with other large studies including a meta-analysis including only children and adolescents with overweight or obesity.<sup>37</sup> In our study, boys did have a higher degree of obesity at enrolment than girls (median BMI SDS 3.15 vs. 2.72), which may have contributed to the observed sex difference, but the full implications of these correlations remain unclear.

#### *Degree of obesity at enrolment*

Previous studies have reported associations between different disturbed eating behaviours and obesity or risk of obesity.<sup>13,14,34-36</sup> We observed associations between overeating and rapid eating (uncontrolled eating) and degree of obesity at enrolment, while meal skipping and emotional eating was not associated with degree of obesity in this study. This is in line with a small study of 112 children with obesity that found a higher degree of obesity among those exhibiting uncontrolled eating,<sup>18</sup> and partly with another small study of children with obesity, where the presence of emotional

eating and uncontrolled eating increased with increasing degree of obesity in girls.<sup>16</sup> That we did not find this association between emotional eating and degree of obesity may be due to the larger number of children and adolescents in our study. Overall, the association between uncontrolled eating and degree of obesity seems to be robust and reproducible across studies, while the associations between emotional eating and degree of obesity is less well studied.

#### *Disturbed eating behaviours and response to weight loss treatment*

We found that three out of four patients reduced their degree of obesity, assessed by BMI SDS, after one year of treatment, regardless of the presence of disturbed eating behaviours at baseline. This important finding is in line with results from a small RCT of 82 adolescents that found no difference in the degree of weight reduction after six and 12 months of obesity treatment between participants with or without disturbed eating behaviour.<sup>11</sup> However, two other RCTs of 12 months obesity treatment including 192 children<sup>9</sup> and 111 adolescents<sup>10</sup> observed that the participants with disturbed eating behaviours reduced their degree of obesity less than those without. Further, participants with one or more disturbed eating behaviours had significant weight regain after 12, 18, and 24 months of follow-up in both of the intervention groups. Both of these studies thus conclude that disturbed eating behaviours and binge eating in particular should be considered in obesity treatment. Our findings contrarily suggest that a family-centered, multidisciplinary intervention programme, personalised to each family's needs and challenges without focusing specifically on

the child's eating behaviour, is effective for patients both with and without disturbed eating behaviour at treatment initiation. In addition to differences in obesity treatment programme, the discrepancies on the influence of disturbed eating behaviours on treatment effect might be explained by differences in degree of obesity of participants across studies.

### *Strengths and limitations*

Strengths of the study are the large number of children and adolescents included and the relatively long treatment period (11–24 months). Furthermore, great effort was invested in ensuring a uniform assessment of all patients through thorough training and regular supervision of the paediatricians and paediatric nurses conducting the questionnaire-based interviews. A limitation is that follow-up data was only available on a subgroup of the children and adolescents. However, most of the demographic characteristics of this subgroup were similar to those of the baseline population. Additionally, boys were heavier than girls at baseline and while this gives a valid reflection of the Danish paediatric population referred to obesity treatment, it may have influenced our results. Moreover, the three domains of disturbed eating behaviour were evaluated using non-validated questions. The questions do not cover all aspects of the three domains, nor do they provide a clinical diagnosis of a disordered eating syndrome. The questions were developed as a clinical tool aimed to provide the paediatrician or paediatric nurse with an overview of each patient's eating

behaviour, which can be included directly to produce specific and individually tailored items of advice for the patient and family during obesity treatment.

Lastly, this study did not evaluate the changes in disturbed eating behaviour during the treatment period and thus, we cannot know whether the treatment had an impact on the prevalence of disturbed eating behaviours. In this respect, further research is essential to elucidate disturbed eating behaviour at follow-up visits.

### *Conclusions*

Disturbed eating behaviours were highly prevalent in children and adolescents with overweight or obesity, and increased with age. The prevalence of both overeating and rapid eating was positively associated with the degree of obesity at enrolment.

Importantly, the degree of obesity was reduced after one year of treatment, regardless of the presence of disturbed eating behaviours at treatment initiation. This indicates that a family-centered, multidisciplinary obesity treatment programme is effective for paediatric patients, and does not need to place specific focus on the child's eating behaviours.

## References:

1. Skinner AC, Ravanbakht SN, Skelton JA, Perrin EM, Armstrong SC. Prevalence of Obesity and Severe Obesity in US Children, 1999-2016. *Pediatrics* 2018.
2. DeSmet A, Deforche B, Hublet A, Tanghe A, Stremersch E, De Bourdeaudhuij I. Traditional and cyberbullying victimization as correlates of psychosocial distress and barriers to a healthy lifestyle among severely obese adolescents--a matched case-control study on prevalence and results from a cross-sectional study. *BMC Public Health* 2014; **14**: 224.
3. Oude Luttikhuis H, Baur L, Jansen H, et al. Interventions for treating obesity in children. *The Cochrane Database of Systematic Reviews* 2009; (1): CD001872.
4. Sahoo K, Sahoo B, Choudhury AK, Sofi NY, Kumar R, Bhadoria AS. Childhood obesity: causes and consequences. *Journal of Family Medicine and Primary Care* 2015; **4**(2): 187-92.
5. Neumark-Sztainer D, Hannan PJ. Weight-related behaviors among adolescent girls and boys: results from a national survey. *Arch Pediatr Adolesc Med* 2000; **154**(6): 569-77.
6. Oda-Montecinos C, Saldaña C, Andrés A. Eating behaviors are risk factors for the development of overweight. *Nutrition Research (New York, NY)* 2013; **33**(10): 796-802.
7. Neumark-Sztainer D, Wall M, Guo J, Story M, Haines J, Eisenberg M. Obesity, disordered eating, and eating disorders in a longitudinal study of adolescents: how do dieters fare 5 years later? *J Am Diet Assoc* 2006; **106**(4): 559-68.
8. Herpertz-Dahlmann B, Dempfle A, Konrad K, Klasen F, Ravens-Sieberer U, group Bs. Eating disorder symptoms do not just disappear: the implications of adolescent eating-disordered behaviour for body weight and mental health in young adulthood. *Eur Child Adolesc Psychiatry* 2015; **24**(6): 675-84.
9. Wildes JE, Marcus MD, Kalarchian MA, Levine MD, Houck PR, Cheng Y. Self-reported binge eating in severe pediatric obesity: impact on weight change in a randomized controlled trial of family-based treatment. *Int J Obes (Lond)* 2010; **34**(7): 1143-8.
10. Gow ML, Baur LA, Ho M, et al. Can early weight loss, eating behaviors and socioeconomic factors predict successful weight loss at 12- and 24-months in adolescents with obesity and insulin resistance participating in a randomised controlled trial? *Int J Behav Nutr Phys Act* 2016; **13**: 43.
11. Bishop-Gilyard CT, Berkowitz RI, Wadden TA, Gehrman CA, Cronquist JL, Moore RH. Weight reduction in obese adolescents with and without binge eating. *Obesity (Silver Spring, Md)* 2011; **19**(5): 982-7.

12. de Lauzon B, Romon M, Deschamps V, et al. The Three-Factor Eating Questionnaire-R18 is able to distinguish among different eating patterns in a general population. *The Journal of Nutrition* 2004; **134**(9): 2372-80.
13. Banna JC, Panizza CE, Boushey CJ, Delp EJ, Lim E. Association between Cognitive Restraint, Uncontrolled Eating, Emotional Eating and BMI and the Amount of Food Wasted in Early Adolescent Girls. *Nutrients* 2018; **10**(9).
14. Gallant AR, Tremblay A, Pérusse L, Bouchard C, Després JP, Drapeau V. The Three-Factor Eating Questionnaire and BMI in adolescents: results from the Québec family study. *The British Journal of Nutrition* 2010; **104**(7): 1074-9.
15. Halberstadt J, van Strien T, de Vet E, Eekhout I, Braet C, Seidell JC. The association of eating styles with weight change after an intensive combined lifestyle intervention for children and adolescents with severe obesity. *Appetite* 2016; **99**: 82-90.
16. Gross AC, Fox CK, Rudser KD, Foy AMH, Kelly AS. Eating behaviours are different in youth with obesity and severe obesity. *Clinical Obesity* 2016; **6**(1): 68-72.
17. van Strien T, Oosterveld P. The children's DEBQ for assessment of restrained, emotional, and external eating in 7- to 12-year-old children. *The International Journal of Eating Disorders* 2008; **41**(1): 72-81.
18. Morgan CM, Yanovski SZ, Nguyen TT, et al. Loss of control over eating, adiposity, and psychopathology in overweight children. *The International Journal of Eating Disorders* 2002; **31**(4): 430-41.
19. American Psychiatric Association e. Diagnostic and Statistical Manual of Mental Disorders L DSM-5. Washington, DC: American Psychiatric Association.
20. Tanofsky-Kraff M, Marcus MD, Yanovski SZ, Yanovski JA. Loss of control eating disorder in children age 12 years and younger: proposed research criteria. *Eat Behav* 2008; **9**(3): 360-5.
21. Slyper AH, Kopfer K, Huang W-M, Re'em Y. Increased hunger and speed of eating in obese children and adolescents. *Journal of pediatric endocrinology & metabolism: JPEM* 2014; **27**(5-6): 413-7.
22. Ackard DM, Neumark-Sztainer D, Story M, Perry C. Overeating among adolescents: prevalence and associations with weight-related characteristics and psychological health. *Pediatrics* 2003; **111**(1): 67-74.
23. Tanofsky-Kraff M, Yanovski SZ, Wilfley DE, Marmarosh C, Morgan CM, Yanovski JA. Eating-disordered behaviors, body fat, and psychopathology in overweight and normal-weight children. *J Consult Clin Psychol* 2004; **72**(1): 53-61.
24. Webber L, Hill C, Saxton J, Van Jaarsveld CH, Wardle J. Eating behaviour and weight in children. *Int J Obes (Lond)* 2009; **33**(1): 21-8.
25. Decaluwé V, Braet C, Fairburn CG. Binge eating in obese children and adolescents. *The International Journal of Eating Disorders* 2003; **33**(1): 78-84.

26. Lourenco BH, Arthur T, Rodrigues MD, et al. Binge eating symptoms, diet composition and metabolic characteristics of obese children and adolescents. *Appetite* 2008; **50**(2-3): 223-30.
27. Isnard P, Michel G, Frelut M-L, et al. Binge eating and psychopathology in severely obese adolescents. *The International Journal of Eating Disorders* 2003; **34**(2): 235-43.
28. Herpertz-Dahlmann B, Wille N, Hölling H, Vloet TD, Ravens-Sieberer U, group Bs. Disordered eating behaviour and attitudes, associated psychopathology and health-related quality of life: results of the BELLA study. *Eur Child Adolesc Psychiatry* 2008; **17 Suppl 1**: 82-91.
29. Nysom K, Molgaard C, Hutchings B, Michaelsen KF. Body mass index of 0 to 45-y-old Danes: reference values and comparison with published European reference values. *Int J Obes Relat Metab Disord* 2001; **25**(2): 177-84.
30. Holm JC, Gamborg M, Bille DS, Gr Nb KH, Ward LC, Faerk J. Chronic care treatment of obese children and adolescents. *Int J Pediatr Obes* 2011; **6**(3-4): 188-96.
31. Mollerup PM, Gamborg M, Trier C, et al. A hospital-based child and adolescent overweight and obesity treatment protocol transferred into a community healthcare setting. *PLoS One* 2017; **12**(3): e0173033.
32. Barlow SE, Expert C. Expert committee recommendations regarding the prevention, assessment, and treatment of child and adolescent overweight and obesity: summary report. *Pediatrics* 2007; **120 Suppl 4**: S164-92.
33. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria).
34. Nogay NH. The role of psychological eating styles in obesity among Turkish adolescents: A cross-sectional study. *JPMA The Journal of the Pakistan Medical Association* 2017; **67**(4): 573-6.
35. Megalakaki O, Mouveau M, Hubin-Gayte M, Wypych L. Body image and cognitive restraint are risk factors for obesity in French adolescents. *Eating and weight disorders: EWD* 2013; **18**(3): 289-95.
36. Martín-García M, Vila-Maldonado S, Rodríguez-Gómez I, et al. The Spanish version of the Three Factor Eating Questionnaire-R21 for children and adolescents (TFEQ-R21C): Psychometric analysis and relationships with body composition and fitness variables. *Physiol Behav* 2016; **165**: 350-7.
37. He J, Cai Z, Fan X. Prevalence of binge and loss of control eating among children and adolescents with overweight and obesity: An exploratory meta-analysis. *The International Journal of Eating Disorders* 2017; **50**(2): 91-103.
38. Utter J, Scragg R, Mhurchu CN, Schaaf D. At-home breakfast consumption among New Zealand children: associations with body mass index and related nutrition behaviors. *J Am Diet Assoc* 2007; **107**(4): 570-6.
39. Anderson YC, Wynter LE, Butler MS, et al. Dietary Intake and Eating Behaviours of Obese New Zealand Children and Adolescents Enrolled in a Community-Based Intervention Programme. *PLoS One* 2016; **11**(11): e0166996.

40. Snoek HM, van Strien T, Janssens JMAM, Engels RCME. Emotional, external, restrained eating and overweight in Dutch adolescents. *Scand J Psychol* 2007; **48**(1): 23-32.

**Tables:****Table 1:** Structured interview questions for assessment of eating behaviors

<b>Domain</b>	<b>yes/no questions</b>	<b>+/- optional question</b>
<b>Cognitive restraint</b>	<i>“Do you skip meals?”</i>	<i>“Do you eat breakfast, lunch, and dinner every day?”</i>
<b>Emotional eating</b>	<i>“Do you comfort eat?”</i>	<i>“Do you eat in relation to emotions, for example when feeling bored, sad, happy, or distressed, instead of eating because of feeling hungry?”</i>
<b>Uncontrolled eating</b>	<i>“Do you overeat?”</i> <i>“Do you eat fast?”</i>	<i>“Do you continue eating even after feeling full”</i> <i>“Do you finish your meals long before your siblings, parents, or peers?”</i>

**Table 2: Baseline characteristics and prevalence of disturbed eating behaviours in the study population**

	<b>All</b>		<b>Girls</b>		<b>Boys</b>		<b>P</b>
<b>Patients (n)</b>	3,621		1,967		1,654		
<b>Age (years)</b>	11.4	[9.0; 13.6]	11.3	[8.7; 13.9]	11.5	[9.4; 13.3]	0.131
<b>Height (cm)</b>	152	[140; 164]	151.8	[138; 163]	153	[142; 165]	<.001
<b>Weight (kg)</b>	60.0	[45.8; 78.8]	59.1	[43.7; 79.2]	61.0	[47.8; 78.0]	<b>0.001</b>
<b>BMI SDS</b>	2.87	[2.43; 3.36]	2.72	[2.34; 3.11]	3.15	[2.63; 3.64]	<.001
<b>Prevalence of disturbed eating behaviours (%)</b>	82.2		81.5		83.0		0.269
<b>Number of disturbed eating behaviours (%)</b>							<b>0.016</b>
<b>0</b>	17.8		18.5		17.0		
<b>1</b>	14.0		15.3		12.5		
<b>2-4</b>	68.2		66.3		70.5		
<b>Prevalence of individual disturbed eating behaviours (%)</b>							
<b>Meal skipping</b>	52.9		51.2		55.0		<b>0.028</b>
<b>Emotional eating</b>	54.3		56.9		51.3		<b>0.001</b>
<b>Overeating</b>	58.0		56.7		59.6		0.081

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<b>Rapid eating</b>	48.0	42.8	54.1	<b>&lt;.001</b>
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Data are medians and [IQR] or prevalence in percent, as stated. BMI SDS = Body mass index Standard Deviation Score.

**Table 3: Baseline characteristics and prevalence of disturbed eating behaviours by age and sex.**

P values are calculated for differences between girls and boys by Wilcoxon rank-sum test or Chi-squared test.

		3.0-9.9		10.0-14.9		15.0-18.9		P
<b>Patients (n)</b>	f	741		923		303		
	m	518		935		201		
<b>Age (years)</b>	f	8.0	[6.7; 9.0]	12.4	[11.2; 13.6]	16.1	[15.5; 17.0]	
	m	8.3	[7.1; 9.3]	12.2	[11.2; 13.2]	16.0	[15.5; 16.8]	
<b>BMI SDS</b>	f	2.74	[2.32; 3.15]	2.67	[2.32; 3.01]	2.85	[2.45; 3.27]	<.001
	m	3.45	[2.84; 4.06]	2.95	[2.52; 3.41]	3.38	[2.94; 3.79]	<.001
<b>Prevalence of disturbed eating behaviours (%)</b>	f	79.2		83.0		82.8		0.117
	m	82.4		82.4		87.6		0.186
<b>Number of disturbed eating behaviours (%)</b>							f	<b>0.023</b>
							m	0.101
<b>0</b>	f	20.8		17.0		17.2		
	m	17.6		17.6		12.4		
<b>1</b>	f	17.4		14.4		12.5		
	m	14.3		12.2		9.5		

<b>2-4</b>	f	61.8	68.6	70.3	
	m	68.1	70.2	78.1	
<b>Prevalence of individual disturbed eating behaviours (%)</b>					
<b>Meal skipping</b>	f	40.2	55.8	64.4	<b>&lt;.001</b>
	m	40.0	59.4	73.1	<b>&lt;.001</b>
<b>Emotional eating</b>	f	52.2	59.4	60.7	<b>0.005</b>
	m	49.8	51.7	53.7	0.611
<b>Overeating</b>	f	55.3	57.6	57.1	0.633
	m	61.6	57.6	63.7	0.156
<b>Rapid eating</b>	f	41.4	42.8	46.2	0.367
	m	51.9	52.6	66.7	<b>0.001</b>

Data are medians and [IQR] or prevalence in percent, as stated. BMI SDS = Body mass index Standard Deviation

Score.

P values are calculated for differences across age groups for each sex by Kruskal-Wallis test or Chi-squared test.

**Table 4: Follow-up characteristics.**

	All		Girls		Boys		<i>P</i>
<b>Patients (n)</b>	2.055		1,136		919		
<b>Baseline age (years)</b>	11.1	[8.6; 13.2]	10.9	[8.3; 13.3]	11.3	[9.1; 13.0]	0.063
<b>Baseline BMI SDS</b>	2.83	[2.41; 3.31]	2.71	[2.32; 3.09]	3.07	[2.58; 3.59]	<.001
<b>Duration of follow-up (months)</b>	12.4	[11.7; 13.6]	12.5	[11.8; 13.7]	12.4	[11.7; 13.5]	0.211
<b>Change in BMI SDS at follow-up median (95% CI)</b>	-0.24	(-0.27; -0.22)	-0.19	(-0.22; -0.16)	-0.34	(-0.36; -0.29)	<.001

Data are medians and [IQR]. BMI SDS = Body mass index Standard Deviation Score. 95% confidence intervals for median change in BMI SDS at follow-up were calculated by bootstrapping. P values are calculated for differences between girls and boys by Wilcoxon rank-sum test.

**Table 5: Disturbed eating behaviours and change in degree of obesity at follow-up.**

	<b>Estimate<sup>†</sup></b>	<b>95% CI<sup>‡</sup></b>	<b><i>P</i></b>
<b>Meal skipping</b>	0.01	−0.04; 0.05	0.742
<b>Emotional eating</b>	0.01	−0.03; 0.06	0.564
<b>Overeating</b>	−0.04	−0.09; 0.00	<b>0.046</b>
<b>Rapid eating</b>	−0.02	−0.06; 0.02	0.390

<sup>†</sup>Estimates and 95% confidence intervals derived by a generalized linear model, adjusted for age, sex, ethnicity and socioeconomic status. A negative estimate indicates that the presence of a disturbed eating behaviour is associated with a higher degree of weight loss at follow-up. <sup>‡</sup>CI = confidence interval

## **Title page**

**Title:** Disturbed Eating Behaviours Do Not Impact Treatment Response in a Paediatric Obesity Chronic Care Treatment Programme

**Running title:** Eating Behaviours: Effect on Weight Loss

## **Original Article**

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### **Conflicts of interest:**

The authors declare that they have no conflicts of interest.