



ORIGINAL ARTICLE

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

Mette Fogh ^{1,2} Morten AV Lund ^{1,2} Pernille M Mollerup,¹ Mia Ø Johansen,¹ Rikke H Melskens,¹ Cæcilie Trier,^{1,3} Julie T Kloppenborg,³ Torben Hansen ^{4,5} and Jens-Christian Holm ^{1,4,6}

¹The Children's Obesity Clinic, Department of Paediatrics, Copenhagen University Hospital Holbæk, Holbæk, ²Department of Biomedical Sciences, ⁴The Novo Nordisk Foundation Center for Basic Metabolic Research, Section of Metabolic Genetics, ⁶Faculty of Health and Medical Sciences, University of Copenhagen, Copenhagen, ³Department of Paediatrics, Copenhagen University Hospital Hvidovre, Hvidovre and ⁵Faculty of Health Sciences, University of Southern Denmark, Odense, Denmark

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: A total of 3621 patients aged 3–18 years enrolled in a multidisciplinary obesity treatment programme were studied. Follow-up data after a median of 12.4 months were available for 2055 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 than patients without these disturbed eating behaviours ($P < 0.02$). After 1 year of treatment, BMI SDS was reduced in 75.7% of patients, and the median reduction was 0.24 (95% confidence interval: 0.22–0.27). Overeating was associated with a higher degree of weight loss, while meal skipping, emotional eating and rapid eating did not associate with the degree of weight loss at follow-up.

Conclusions: Disturbed eating behaviours were highly prevalent in children and adolescents with overweight or obesity, and varied with age and sex. After 1 year of treatment, the degree of obesity improved, regardless of the presence of disturbed eating behaviours at treatment initiation.

Key words: child nutrition disorder; eating behaviour; food habit; paediatric obesity; weight loss.

What is already known on this topic

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

What this paper adds

- 1 Upon enrolment into obesity treatment, children and adolescents who report overeating or rapid eating have a higher body mass index standard deviation score than children and adolescents without these eating behaviours.
- 2 The prevalence of meal skipping, emotional eating and rapid eating increases with age in children and adolescents with overweight or obesity.
- 3 In this intervention programme, the degree of obesity improved in 75.7% of patients after 1 year of treatment. The presence of disturbed eating behaviours at treatment initiation did not reduce treatment effect.

Childhood obesity is highly prevalent¹ and impairs physical and psychosocial health.^{2–4} Disturbed eating behaviours have been

associated with overweight or obesity^{5,6} and with increased risk of future weight gain in children and adolescents.^{7,8} Further, studies of obesity treatment effects in children and adolescents with disturbed eating behaviours have shown inconsistent results.^{9–11}

Disturbed eating behaviours are traditionally categorised into three domains: cognitive restraint, emotional eating and uncontrolled eating.^{12–14} In children and adolescents, these domains have been defined as follows: cognitive restraint as a conscious restriction of food intake to avoid gaining weight¹⁵; emotional eating as the tendency to eat in response to emotions^{16,17}; and lastly, uncontrolled

Correspondence: Dr Morten AV Lund, The Children's Obesity Clinic, Department of Paediatrics, Copenhagen University Hospital Holbæk, Smedelundsgade 60, Holbæk DK-4300, Denmark; email: mtlu@regionsjaelland.dk

M Fogh and MAV Lund shared first authorship.

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eating as a tendency to eat more than usual and a concurrent feeling of loss of control.¹⁸ While this definition of uncontrolled eating resembles the diagnosis of binge eating disorder, clinical diagnoses of eating disorders are rarely made before adolescence.^{19,20}

Disturbed eating behaviours are more common in children and adolescents with overweight or obesity compared with their normal weight peers.^{5,8,21–23} Eating behaviour changes during childhood and adolescence, with for example food fussiness and aversion affecting young children especially,²⁴ making it difficult to compare the prevalence of disturbed eating behaviours across paediatric 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.^{5,9,21,25–28}

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,^{9,10} and one RCT that found reduction in the degree of obesity and binge eating symptoms.¹¹ 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.^{9–11}

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.

Methods

Study population

This study included children and adolescents ($n = 3697$) enrolled into the Danish Childhood Obesity Biobank from January 2009 to June 2018, who participated in a multidisciplinary obesity treatment programme. Overweight was defined as a BMI above the 90th percentile in accordance with Danish age- and sex-specific references.²⁹ Exclusion criteria were: (i) age younger than 3.0 or older than 18.9 years; (ii) missing disturbed eating behaviour information at baseline; and (iii) 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

Table 1 Structured interview questions for assessment of eating behaviours

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

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.²⁰

Intervention

The intervention consisted of an evidence-based treatment protocol developed at the Children's Obesity Clinic, Copenhagen University Hospital Holbaek.^{30,31} The protocol is family-centred, multidisciplinary and comprises a range of behavioural life-style recommendations based upon Expert Committee guidelines from 2007.³² 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 life-style changes should be integrated in the entire family. At the initial 1-hour consultation, a paediatrician or paediatric nurse obtains a detailed medical history and conducts a questionnaire-based interview aimed at identifying all the life-style changes necessary to reduce the degree of overweight or obesity in the child or adolescent. These life-style recommendations are incorporated into an individualised treatment plan containing 15–20 items of advice regarding the implementation of the life-style 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 6 weeks after the initial consultation, the patient and family consult a dietitian for 1 h. 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 5 h 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.*³⁰

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, R Foundation for Statistical Computing, Vienna). To investigate the 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 Q–Q plots. Differences between sexes and age groups were examined using Wilcoxon rank-sum test, Kruskal-Wallis test or χ^2 test, where appropriate. A multivariate linear regression model, adjusted for age, sex, ethnicity and socio-economic status was used to evaluate the association between the presence of disturbed eating behaviour and: (i) BMI SDS at enrolment; and (ii) change in BMI SDS at follow-up. The 95% confidence intervals (CIs) 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, 3697 (2017 girls) children and adolescents with overweight or obesity were enrolled. A total of 51 patients were excluded due to age, 32 due to missing disturbed eating behaviour information at baseline and 23 due to syndromal obesity, leaving 3621 (1967 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: the 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); the prevalence of emotional eating increased with age from the youngest to oldest in girls (52 vs. 61%, $P = 0.005$); and the 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 socio-economic 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, $P = 0.015$).

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

| | All | Girls | Boys | P value |
|---|------------------|------------------|------------------|---------|
| Patients, <i>n</i> | 3621 | 1967 | 1654 | |
| Age, years, median (IQR) | 11.4 (9.0–13.6) | 11.3 (8.7–13.9) | 11.5 (9.4–13.3) | 0.131 |
| Height, cm, median (IQR) | 152 (140–164) | 151 (138–163) | 153 (142–165) | <0.001* |
| Weight, kg, median (IQR) | 60.0 (45.8–78.8) | 59.1 (43.7–79.2) | 61.0 (47.8–78.0) | 0.001* |
| BMI SDS, median (IQR) | 2.87 (2.43–3.36) | 2.72 (2.34–3.11) | 3.15 (2.63–3.64) | <0.001* |
| Prevalence of disturbed eating behaviours, % | 82.2 | 81.5 | 83.0 | 0.269 |
| Number of disturbed eating behaviours, % | | | | 0.016* |
| 0 | 17.8 | 18.5 | 17.0 | |
| 1 | 14.0 | 15.3 | 12.5 | |
| 2–4 | 68.2 | 66.3 | 70.5 | |
| Prevalence of individual disturbed eating behaviours, % | | | | |
| Meal skipping | 52.9 | 51.2 | 55.0 | 0.028* |
| Emotional eating | 54.3 | 56.9 | 51.3 | 0.001* |
| Overeating | 58.0 | 56.7 | 59.6 | 0.081 |
| Rapid eating | 48.0 | 42.8 | 54.1 | <0.001* |

* $P < 0.05$. *P* values are calculated for differences between girls and boys by Wilcoxon rank-sum test or χ^2 test. BMI SDS, body mass index standard deviation score; IQR, interquartile range.

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

| | Age, years | | | P value |
|---|------------------|------------------|------------------|---------------------------------|
| | 3.0–9.9 | 10.0–14.9 | 15.0–18.9 | |
| Patients, <i>n</i> | | | | |
| Female | 741 | 923 | 303 | |
| Male | 518 | 935 | 201 | |
| Age, years, median (IQR) | | | | |
| Female | 8.0 (6.7–9.0) | 12.4 (11.2–13.6) | 16.1 (15.5–17.0) | |
| Male | 8.3 (7.1–9.3) | 12.2 (11.2–13.2) | 16.0 (15.5–16.8) | |
| BMI SDS, median (IQR) | | | | |
| Female | 2.74 (2.32–3.15) | 2.67 (2.32–3.01) | 2.85 (2.45–3.27) | <0.001* |
| Male | 3.45 (2.84–4.06) | 2.95 (2.52–3.41) | 3.38 (2.94–3.79) | <0.001* |
| Prevalence of disturbed eating behaviours, % | | | | |
| Female | 79.2 | 83.0 | 82.8 | 0.117 |
| Male | 82.4 | 82.4 | 87.6 | 0.186 |
| Number of disturbed eating behaviours, % | | | | 0.023 (female)* 0.101 (male) |
| 0 | | | | |
| Female | 20.8 | 17.0 | 17.2 | |
| Male | 17.6 | 17.6 | 12.4 | |
| 1 | | | | |
| Female | 17.4 | 14.4 | 12.5 | |
| Male | 14.3 | 12.2 | 9.5 | |
| 2–4 | | | | |
| Female | 61.8 | 68.6 | 70.3 | |
| Male | 68.1 | 70.2 | 78.1 | |
| Prevalence of individual disturbed eating behaviours, % | | | | |
| Meal skipping | | | | |
| Female | 40.2 | 55.8 | 64.4 | <0.001* |
| Male | 40.0 | 59.4 | 73.1 | <0.001* |
| Emotional eating | | | | |
| Female | 52.2 | 59.4 | 60.7 | 0.005* |
| Male | 49.8 | 51.7 | 53.7 | 0.611 |
| Overeating | | | | |
| Female | 55.3 | 57.6 | 57.1 | 0.633 |
| Male | 61.6 | 57.6 | 63.7 | 0.156 |
| Rapid eating | | | | |
| Female | 41.4 | 42.8 | 46.2 | 0.367 |
| Male | 51.9 | 52.6 | 66.7 | 0.001* |

* $P < 0.05$. P values are calculated for differences across age groups for each sex by Kruskal-Wallis test or χ^2 test. BMI SDS, body mass index standard deviation score; IQR, interquartile range.

Table 4 Follow-up characteristics

| | All | Girls | Boys | P value |
|---|----------------------|----------------------|----------------------|---------|
| Patients, <i>n</i> | 2055 | 1136 | 919 | |
| Baseline age, years, median (IQR) | 11.1 (8.6–13.2) | 10.9 (8.3–13.3) | 11.3 (9.1–13.0) | 0.063 |
| Baseline BMI SDS, median (IQR) | 2.83 (2.41–3.31) | 2.71 (2.32–3.09) | 3.07 (2.58–3.59) | <0.001* |
| Duration of follow-up, months, median (IQR) | 12.4 (11.7–13.6) | 12.5 (11.8–13.7) | 12.4 (11.7–13.5) | 0.211 |
| Change in BMI SDS at follow-up, median (95% CI) | −0.24 (−0.27, −0.22) | −0.19 (−0.22, −0.16) | −0.34 (−0.36, −0.29) | <0.001* |

* $P < 0.05$. The 95% CI 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. BMI SDS, body mass index standard deviation score; CI, confidence interval; IQR, interquartile range.

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

| | Estimate† | 95% CI | P value |
|------------------|-----------|-------------|---------|
| Meal skipping | 0.01 | −0.04, 0.05 | 0.742 |
| Emotional eating | 0.01 | −0.03, 0.06 | 0.564 |
| Overeating | −0.04 | −0.09, 0.00 | 0.046* |
| Rapid eating | −0.02 | −0.06, 0.02 | 0.390 |

* $P < 0.05$. †Estimates and 95% CIs derived by a linear regression model, adjusted for age, sex, ethnicity and socio-economic 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. CI, confidence interval.

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 ($P = \text{NS}$, data not shown).

Disturbed eating behaviour and weight loss at follow-up

Follow-up BMI SDS data was available for 2055 (1136 girls) children and adolescents (Table 4). At enrolment, this subgroup was younger (median age 11.1 (interquartile range: 8.6–13.2) vs. 11.4 (interquartile range: 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, socio-economic status and sex distribution was 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 (1555 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 socio-economic 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 1 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.^{13,14,33–35} The several studies that have reported the prevalence of disturbed eating behaviours in children and adolescents with overweight or obesity^{5,9,21,25–28} 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 and 56%,^{5,9,21,25–28} while a recent meta-analysis estimated an overall prevalence of binge eating and loss of control eating of 26%.³⁶ 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).²⁸ 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.^{9,37,38} A population-based study of 3275 children found that a larger part of children aged 5 and 6 years ate breakfast compared with children aged 11–14 years.³⁷ This is in line with a smaller study³⁸ and with our results that the prevalence of meal skipping increased with age in both sexes.

We further found that the 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 eating³⁹ as well as disturbed eating⁵ increased with age in girls, and no age-related differences in the prevalence of overeating.²² 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 paediatric 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,^{5,37,39} and in a meta-analysis including only children and adolescents with overweight or obesity.³⁶ 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.²⁶

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.³⁶ 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.^{13,14,33–35} We observed associations between overeating and rapid eating (uncontrolled eating) and the degree of obesity at enrolment, while meal skipping and emotional eating was not associated with the 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,¹⁸ 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.¹⁶ 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 1 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 6 and 12 months of obesity treatment between participants with or without disturbed eating behaviour.¹¹ However, two other RCTs of 12 months of obesity treatment including 192 children⁹ and 111 adolescents¹⁰ 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-centred, 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 were only available in 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 1 year of treatment, regardless of the presence of disturbed eating behaviours at treatment initiation. This indicates that a family-centred, multidisciplinary obesity treatment programme is effective for paediatric patients, and does not need to place a specific focus on the child's eating behaviours.

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References

- Skinner AC, Ravanbakht SN, Skelton JA, Perrin EM, Armstrong SC. Prevalence of obesity and severe obesity in US children, 1999–2016. *Pediatrics* 2018; **141**: e20173459.
- 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.
- Oude Luttikhuis H, Baur L, Jansen H et al. Interventions for treating obesity in children. *Cochrane Database Syst. Rev.* 2009; **1**: CD001872.
- Sahoo K, Sahoo B, Choudhury AK, Sofi NY, Kumar R, Bhadoria AS. Childhood obesity: Causes and consequences. *J. Family Med. Prim. Care* 2015; **4**: 187–92.
- Neumark-Sztainer D, Hannan PJ. Weight-related behaviors among adolescent girls and boys: Results from a national survey. *Arch. Pediatr. Adolesc. Med.* 2000; **154**: 569–77.
- Oda-Montecinos C, Saldaña C, Andrés A. Eating behaviors are risk factors for the development of overweight. *Nutr. Res.* 2013; **33**: 796–802.
- 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**: 559–68.
- Herpertz-Dahlmann B, Dempfle A, Konrad K, Klasen F, Ravens-Sieberer U; BELLA Study Group. 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**: 675–84.
- 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.* 2010; **34**: 1143–8.
- 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.
- Bishop-Gilyard CT, Berkowitz RI, Wadden TA, Gehrman CA, Cronquist JL, Moore RH. Weight reduction in obese adolescents with and without binge eating. *Obesity* 2011; **19**: 982–7.
- 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. *J. Nutr.* 2004; **134**: 2372–80.
- 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**: 1279.
- 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. *Br. J. Nutr.* 2010; **104**: 1074–9.
- 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.
- Gross AC, Fox CK, Rudser KD, Foy AMH, Kelly AS. Eating behaviours are different in youth with obesity and severe obesity. *Clin. Obes.* 2016; **6**: 68–72.
- van Strien T, Oosterveld P. The children's DEBQ for assessment of restrained, emotional, and external eating in 7- to 12-year-old children. *Int. J. Eat. Disord.* 2008; **41**: 72–81.
- Morgan CM, Yanovski SZ, Nguyen TT et al. Loss of control over eating, adiposity, and psychopathology in overweight children. *Int. J. Eat. Disord.* 2002; **31**: 430–41.
- American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders: DSM-5™*, 5th ed. Arlington, VA: American Psychiatric Publishing; 2013.
- 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**: 360–5.
- Slyper AH, Kopfer K, Huang W-M, Re'em Y. Increased hunger and speed of eating in obese children and adolescents. *J. Pediatr. Endocrinol. Metab.* 2014; **27**: 413–7.
- 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**: 67–74.
- 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**: 53–61.
- Webber L, Hill C, Saxton J, Van Jaarsveld CH, Wardle J. Eating behaviour and weight in children. *Int. J. Obes.* 2009; **33**: 21–8.
- Decaluwé V, Braet C, Fairburn CG. Binge eating in obese children and adolescents. *Int. J. Eat. Disord.* 2003; **33**: 78–84.
- Lourenco BH, Arthur T, Rodrigues MD et al. Binge eating symptoms, diet composition and metabolic characteristics of obese children and adolescents. *Appetite* 2008; **50**: 223–30.
- Isnard P, Michel G, Frelut M-L et al. Binge eating and psychopathology in severely obese adolescents. *Int. J. Eat. Disord.* 2003; **34**: 235–43.
- Herpertz-Dahlmann B, Wille N, Hölling H, Vloet TD, Ravens-Sieberer U; BELLA Study Group. 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.
- 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**: 177–84.
- 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**: 188–96.
- 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**: e0173033.
- 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.
- Nogay NH. The role of psychological eating styles in obesity among Turkish adolescents: A cross-sectional study. *J. Pak. Med. Assoc.* 2017; **67**: 573–6.

- 34 Megalaki O, Mouveaux M, Hubin-Gayte M, Wypych L. Body image and cognitive restraint are risk factors for obesity in French adolescents. *Eat. Weight Disord.* 2013; **18**: 289–95.
- 35 Martin-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.
- 36 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. *Int. J. Eat. Disord.* 2017; **50**: 91–103.
- 37 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**: 570–6.
- 38 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**: e0166996.
- 39 Snoek HM, van Strien T, Janssens JMAM, Engels RCME. Emotional, external, restrained eating and overweight in Dutch adolescents. *Scand. J. Psychol.* 2007; **48**: 23–32.



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