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Subjective evaluation of psychosocial well-being in children and youths with overweight or obesity: the impact of multidisciplinary obesity treatment

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Abstract

Purpose To investigate the effects of a multidisciplinary childhood obesity treatment programme on subjective evaluations of psychosocial well-being and quality of life.

Methods This longitudinal observational study included 1291 children, adolescents and young adults, 6–22 years of age, with overweight or obesity. At entry and after 2–82 months of obesity treatment, the patients evaluated the following domains of psychosocial well-being on a visual analogue scale: quality of life, mood, appetite, bullying, motivation for weight loss and body image satisfaction. The degree of overweight was calculated using a body mass index (BMI) standard deviation score (SDS) at each visit.

Results At entry, the mean BMI SDS was 2.81 (range: 1.35–6.65, 95% confidence interval (95% CI): 2.44–3.18). After a median of 14 months of treatment, the median reduction in BMI SDS was 0.29 (95% CI: 0.26–0.31, $p < 0.0001$). Improvements were observed in the domains

of quality of life, mood, appetite, bullying and body image satisfaction ($p < 0.0001$). Larger reductions in BMI SDS were associated with greater improvements in the domains of quality of life ($p = 0.001$), mood ($p = 0.04$) and body image satisfaction ($p < 0.0001$), independent of BMI SDS at entry. However, improvements in psychosocial well-being were also observed in those increasing their BMI SDS ($n = 315$).

Conclusions In a large group of children and youths, psychosocial well-being improved during a multidisciplinary childhood obesity treatment programme, irrespective of the degree of obesity at treatment entry. Greater reductions in BMI SDS were associated with greater improvements in psychosocial well-being, but even in the group increasing their BMI SDS improvements were observed.

Abbreviations

BMI	Body mass index
HRQoL	Health-related quality of life
QoL	Quality of life
SDS	Standard deviation score
TCOCT	The children's obesity clinic treatment
VAS	Visual analogue scale

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Introduction

The development of paediatric obesity is influenced by a wide range of factors including genetic predisposition [1], sedentary behaviour [2], unfavourable diet [3], socioeconomic status [4, 5] and health-related quality of life

(HRQoL) [6]. In children and adolescents, the degree of obesity is inversely correlated with HRQoL [6–8]. Furthermore, depressed mood and depression, especially among adolescents, is associated with paediatric obesity [8–11].

Children and adolescents with obesity are subjected to stigmatization and discrimination, and are more exposed to bullying than their normal-weight peers [12, 13]. Children, who are teased or bullied, are more likely to engage in unhealthy behaviours [14]. The motivation for weight loss has been suggested to impact the results of obesity treatment [15]. Furthermore, lack of patient motivation is commonly perceived as a barrier for paediatric nurses and paediatricians treating childhood obesity [15].

Body image dissatisfaction is associated with adolescent obesity and increases the risk of depressed mood and low self-esteem among adolescents [16, 17]. In addition, body image dissatisfaction has been implicated in induction of binge eating disorders in girls [18]. A cross-sectional study in 100 children and adolescents (10–18 years of age) suggested that food addiction and increased appetite play a role in childhood obesity [19]. A study in 314 children with normal weight and overweight, aged 6–14 years, found a positive association between a higher body mass index (BMI) and the desire to lose weight [20]. Measuring subjective phenomena, including psychosocial well-being, is a challenge to which the visual analogue scale (VAS) provides a valid and reliable approach [21, 22].

To summarize, psychosocial burdens are associated with childhood onset overweight and obesity. Therefore, it is imperative that treatment programmes targeting childhood obesity also focus on the improvement of psychosocial well-being. However, little is known about effects of obesity treatment and reductions in the degree of obesity on the psychosocial well-being in children and youths. In the present paper, the term 'youths' is covering adolescents (13–18 years of age) and young adults (19–24 years of age).

The present study aimed to evaluate the effect of multidisciplinary childhood obesity treatment on the self-reported degree of (1) quality of life (QoL), (2) mood, (3) appetite, (4) bullying (being subjected to bullying), (5) motivation for weight loss and (6) body image satisfaction (BIS), evaluated using a six-item VAS score developed as a clinical tool to elucidate the child's or youth's self-image.

Methods

Study population

From January 2008 to June 2015, 1574 patients, aged 4–22 years, with overweight or obesity were enrolled in a longitudinal observational study of a multidisciplinary,

outpatient treatment programme following The Children's Obesity Clinic treatment (TCOCT) protocol [23]. The patients were assessed at least twice with a six-item assessment of psychosocial well-being. The patients were included from The Children's Obesity Clinic, Department of Paediatrics, Copenhagen University Hospital Holbæk in Denmark and from eight Danish community-based healthcare centres providing childhood obesity treatment according to the TCOCT protocol. The Children's Obesity Clinic is accredited a European Paediatric Centre of Obesity Management by the European Association for the Study of Obesity (EASO).

The inclusion criteria were (1) enrolment into treatment according to the TCOCT protocol, (2) at least two assessments of psychosocial well-being during treatment, (3) age 6–22 years and (4) a BMI standard deviation score (SDS) ≥1.28 (corresponding to the 90th percentile). The exclusion criteria for this study were (1) missing assessment of the six-item VAS scores at entry into treatment and (2) the diagnosis of disordered psychological development. Information on BMI SDS and VAS scores was obtained at entry and at follow-up.

The obesity treatment

The childhood obesity treatment provided was an outpatient, family-based, multidisciplinary childhood obesity treatment programme. At entry, a paediatrician or a paediatric nurse conducted a 1-h consultation with the family, during which a thorough physical examination was performed and a medical history was obtained. Extensive information regarding the child's intake of fat, sugar and other sources of nutrition, physical activity and inactivity patterns, psychosocial capabilities, disturbed eating behaviours, sleep, hygiene, allowances and others was obtained [23]. Subsequently, a tailor-made treatment plan was produced and introduced to the patient and family to enable the most optimal treatment course. The treatment encompassed behaviour-modifying techniques and a range of lifestyle and nutritional advices [23–25]. The patient and family were scheduled to a consultation with a paediatrician or a paediatric nurse annually, as well as in-between consultations with a dietician and/or a paediatric nurse every 6–8 weeks throughout the programme. The patient was seen at individual intervals, depending on the severity of the disease and comorbidities, the degree of treatment success and practical requirements. Consultations with a psychologist and/or a social worker within the treatment team were offered if significant socio-psychological problems were noted. Referrals to a psychologist and/or a social worker were performed in the context of psychosocial need or problems. The treatment protocol encompasses a structured pedagogical approach that urges all relevant lifestyle

changes to be initiated at the first consultation, to optimize diagnosis, evaluation, follow-up and treatment effect in every patient and to teach the patients and their families how to control their environment. This approach enables the establishment of a long-term trusting relationship between the healthcare staff and the patient and family.

Applying the TCOCT protocol costs an average of 5 h of health professional time per patient per year [23]. The TCOCT protocol has been described in detail by Holm et al. [23].

Assessment of psychosocial well-being

Psychosocial well-being was evaluated using a six-item subjective assessment of the domains: (1) QoL, (2) mood, (3) appetite, (4) bullying, (5) motivation for weight loss and (6) BIS based on the patient's general everyday life (Table 1). This evaluation was assessed via a VAS score that was not previously validated. The assessment tool was developed for daily clinical practice, comprising a single simple question addressing each of these six important psychosocial qualities in a time-efficient and understandable manner [24, 26, 27]. At the consultation, the patients were asked about the six domains. Based on his/her perception of his/her everyday life, the patient was asked to rate the questions on a VAS ranging from 0 to 10 by marking a blank line with a cross. The scale was unnumbered, except for the two anchor points 0 and 10, and the clinician measured the exact answer with one decimal precision after the consultation. All questions were read aloud by a paediatrician or nurse (Table 1). This was performed at the very first consultation and again at follow-up.

Anthropometry

At all consultations, weight was measured to the nearest 0.1 kg on a Tanita digital scale (WB-100 MA; Tanita Corp., Tokyo, Japan). Height was measured to the nearest 0.1 mm by a stadiometer. The measurements were conducted with the child wearing light indoor clothing and no shoes. BMI was calculated as weight divided by height squared (kg/m^2). The BMI SDS was calculated by the LMS method by converting BMI into a normal distribution by sex and age using the median coefficient of variation and a measure of the skewness [28] and the Box-Cox power plot based on sex- and age-specific Danish BMI references [29].

Socioeconomic status

The socioeconomic status was assessed at entry into treatment and categorized into five groups in accordance with the modified National Statistics Socioeconomic Classification based on the occupation of the parent with the highest income [30].

Statistics

Nonparametric testing was performed on the variables of the six-item assessment of psychosocial well-being, age, height, weight and BMI SDS: The Wilcoxon rank-sum test was used to analyse differences between boys and girls, between the study group and the group lost to follow-up and between the groups stratified by the length of the follow-up period. The paired Wilcoxon signed-rank test was used to analyse differences between baseline and follow-up values, including the estimations of differences from

Table 1 Subjective visual analogue scale (VAS) score assessment

	Definition	Question
Quality of life	The general perception of life and its contents	*Do you have the best life (pointing at 10), the worst life (pointing at 0) or somewhere in between?*
Mood	The experience of being happy or sad most of the time	*Are you very happy (pointing at 10), very sad (pointing at 0) or somewhere in between?*
Appetite	The degree of feeling hungry	*Are you very hungry (pointing at 10), not hungry (pointing at 0) or somewhere in between?*
Bullying	Being socially excluded, teased, beaten or bothered in a repulsive manner	*Are you bullied a lot (pointing at 10), never bullied (pointing at 0) or somewhere in between?*
Motivation	Motivation for weight loss	*Do you want to lose weight (pointing at 10), do you not care to lose weight (pointing at 0) or somewhere in between?*
BIS	The perception of own body image and contentment of own physical appearance	*Are you happy with your body (pointing at 10), are you dissatisfied with your body (pointing at 0) or somewhere in between?*

An overview of the six-item subjective assessment of psychosocial well-being

BIS body image satisfaction

baseline to follow-up, and the corresponding nonparametric confidence intervals (CI). Differences in socioeconomic status were analysed using the Chi-squared test. Associations at baseline between each of the individual VAS scores and the BMI SDS were investigated using linear regression models (one model for each of the six domains of psychosocial well-being). These linear regression models were adjusted for the independent variables age, sex, socioeconomic status and baseline BMI SDS. Associations at follow-up between the changes in the VAS scores and the change in BMI SDS were investigated using linear regression models (one model for each of the six domains of psychosocial well-being), adjusted for the independent variables age, sex, socioeconomic status, baseline BMI SDS and the treatment duration. Linear regression analyses involving the change in BMI SDS were based on the logarithmically transformed baseline and follow-up values of BMI SDS. The level of significance was set at $p < 0.05$. Statistical analyses were performed using "R" statistical software version 3.2.3 [31].

Ethical approval

The study was approved by the Danish Data Protection Agency (REG-06-2014) and The Ethics Committee of Region Zealand, Denmark (SJ-104), and is registered at ClinicalTrials.gov (Registration No.: NCT00928473).

Results

Of 1574 enrolled patients, 34 were not included in this study due to an age younger than 6 years and 16 due to a baseline BMI SDS <1.28. A total of 228 were excluded due to missing VAS score data at entry into treatment and five were excluded due to disorders of psychological development (autism, anxiety disorder, Tourette's disorder, Asperger's disorder and mental retardation). At entry into treatment, the median age of the remaining 1291 eligible patients (709 girls) was 11.2 years (range: 6.1–20.6) and the mean BMI SDS was 2.81 (range: 1.35–6.65, 95% CI: 2.44–3.18) (Table 2). The 228 patients who were excluded due to missing VAS score data at entry did not differ from the 1291 eligible patients in regards to age ($p = 0.99$), sex ($p = 1.00$), socioeconomic status ($p = 0.24$) or BMI SDS at entry ($p = 0.10$).

At treatment entry, girls exhibited a lower BMI SDS ($p < 0.0001$) and lower VAS scores in the domains of QoL ($p = 0.02$), mood ($p < 0.0001$), appetite ($p = 0.007$) and BIS ($p < 0.0001$) compared to boys (Table 2).

In the adjusted linear regression models with the baseline VAS score as the dependent variable, baseline BMI SDS was inversely associated with QoL ($p = 0.009$), BIS ($p = 0.0009$) and positively with bullying ($p < 0.0001$), but

was not associated with mood ($p = 0.12$), appetite ($p = 0.97$) or motivation ($p = 0.24$) (Table 3).

Upon entry, 25% of the boys (as illustrated by the interquartile ranges in Fig. 1) had VAS scores in the domains QoL below 6.0, mood below 5.6, appetite above 9.0, bullying above 3.4, motivation below 8.5 and BIS below 2.7, while 25% of the girls had VAS scores in the domains QoL below 5.5, mood below 6.5, appetite above 8.0, bullying above 4.5, motivation below 9.3 and BIS below 1.2 (Fig. 1).

In post hoc analyses, the patients were stratified by age (two groups divided at the median age): a younger group (age at treatment entry of 11.2 years or younger, $n = 654$) and an older group (age at treatment entry older than 11.2 years, $n = 637$). The younger group did not differ from the older group in regards to sex ($p = 1.00$), socioeconomic status ($p = 0.24$) or BMI SDS at entry ($p = 0.71$), but the younger group was treated a median of 2 months longer than the older group (13 vs. 15 months, $p = 0.002$).

At entry, the younger group, compared with the older, reported a higher QoL (median VAS score 9.1 vs. 7.7, $p < 0.0001$), were bullied more (median VAS score 0.8 vs. 0.0, $p < 0.0001$), exhibited a lower motivation for weight loss (median VAS score 10.0 vs. 10.0, $p = 0.008$) and reported a higher BIS (median VAS score 5.4 vs. 3.4, $p < 0.0001$).

Follow-up

After a median of 14 months (range: 2–82) of obesity treatment, BMI SDS decreased by a median of 0.29 (95% CI: 0.26–0.31, $p < 0.0001$), VAS scores in QoL, mood and BIS increased (all $p < 0.0001$) and VAS scores in appetite, bullying and motivation decreased (all $p < 0.0001$) (Table 4 and Fig. 1). Both boys and girls had a median of three assessments (range 2–10 for both sexes, $p = 0.40$ for difference between the sexes) of psychosocial well-being performed during the treatment period.

Since the range of treatment duration varied, the 1291 patients were stratified by the length of their follow-up period, which provides insight to the changes in VAS scores over the time course of the treatment, as well as the number of children with VAS scores within each time period (Additional table 1). The majority of patients were followed for up to 12–24 months. This time period also represented the largest improvement in VAS scores, except for the VAS scores for bullying and appetite, which continued to decline beyond this point (Additional table 1).

Of the 1291 patients, 75.6% ($n = 976$) reduced their BMI SDS during treatment and exhibited concomitant improvements in all six domains of subjectively expressed psychosocial well-being (*all $p < 0.0001$*). In the 24.4% ($n = 315$) who increased their BMI SDS, VAS scores

Table 2 Baseline characteristics of the 1291 patients

	Boys	Girls	p
N	582 (45.1%)	709 (54.9%)	
Socioeconomic status*			0.97
1	50 (9.5%)	56 (8.7%)	
2	128 (24.4%)	162 (25.2%)	
3	175 (33.3%)	206 (32.1%)	
4	123 (23.4%)	154 (24.0%)	
5	49 (9.3%)	64 (10.0%)	
Age, *years*	11.2 (6.1–18.7)	11.2 (6.2–20.6)	0.87
Height, *m*	150.6 (116.3–193.0)	151.0 (113.3–181.2)	0.20
Weight, *kg*	57.9 (28.5–156.2)	56.6 (27.1–185.0)	0.28
BMI SDS	3.0 (1.3–6.6)	2.6 (1.4–4.6)	<0.0001
Quality of life	8.5 (0–10)	8.0 (0–10)	0.02
Mood	8.0 (0–10)	7.5 (0–10)	<0.0001
Appetite	6.0 (0–10)	5.5 (0–10)	0.007
Bullying	0.2 (0–10)	0.4 (0–10)	0.38
Motivation	10.0 (0–10)	10.0 (0–10)	0.05
BIS	5.0 (0–10)	4.5 (0–10)	<0.0001

Values are given as medians with ranges. The difference in the composition of the socioeconomic status groups was tested by the Chi-square test. *Data on socioeconomic status were available in 1167 patients (642 girls)

BMI body mass index, *SDS* standard deviation score, *BIS* body image satisfaction

Table 3 Baseline associations between the VAS scores and the BMI SDS adjusted for age, sex and socioeconomic status

	Baseline BMI SDS		
Dependent variable	β (95% CI)	R^2	p
Baseline VAS, quality of life	−0.28 (−0.49 to −0.07)	0.04	**0.009**
Baseline VAS, mood	−0.16 (−0.37 to 0.04)	0.02	0.12
Baseline VAS, appetite	0.00 (−0.22 to 0.23)	0.01	0.97
Baseline VAS, bullying	0.52 (0.26–0.78)	0.07	**<0.0001**
Baseline VAS, motivation	0.11 (−0.07 to 0.29)	0.03	0.24
Baseline VAS, body image satisfaction	−0.46 (−0.73 to −0.19)	0.24	**0.0009**

Estimates (β), 95% confidence intervals (95% CI) and correlation coefficients (R^2) of the relationship between the baseline VAS score (as the dependent variable) and the baseline BMI SDS, adjusted for age, sex and socioeconomic status

Bold values indicate significant *p*-values

increased in the domains of mood ($p = 0.04$) and BIS ($p = 0.004$), while reductions were observed in appetite ($p < 0.0001$), bullying ($p < 0.0001$) and motivation ($p = 0.0002$). No change was observed in the QoL score ($p = 0.60$).

In the adjusted linear regression models, with the change in VAS score as the dependent variable, the change in BMI SDS was inversely associated with changes in QoL ($p = 0.001$), mood ($p = 0.04$) and BIS ($p < 0.0001$) scores, and was positively associated with changes in the motivation score ($p = 0.005$). The change in BMI SDS was not associated with the changes in appetite ($p = 0.65$) or bullying ($p = 0.51$) scores (Table 5).

Further adjustment for the number of psychosocial well-being assessments did not change the overall results (data not shown). The positive association between the change in BMI SDS and the change in the motivation score was only present in the older group ($p = 0.003$), and not the younger ($p = 0.52$).

In the older group, the appetite score at entry was positively associated with changes in BMI SDS ($p = 0.04$). In the total cohort, none of the baseline VAS scores were associated with the change in BMI SDS (all $p > 0.05$, with or without further adjustment for the number of psychosocial well-being assessments). The full dataset underlying the study is available in the additional material (Additional file 1).

Fig. 1 Subjective psychosocial well-being at baseline and follow-up of childhood obesity treatment. Values are presented as medians with interquartile ranges (*arrows*). *$p < 0.01$, **$p < 0.0001$. The *p* values indicate the difference between baseline and follow-up values. *VAS* visual analogue scale, *QoL* quality of life, *Body Satisfaction* body image satisfaction
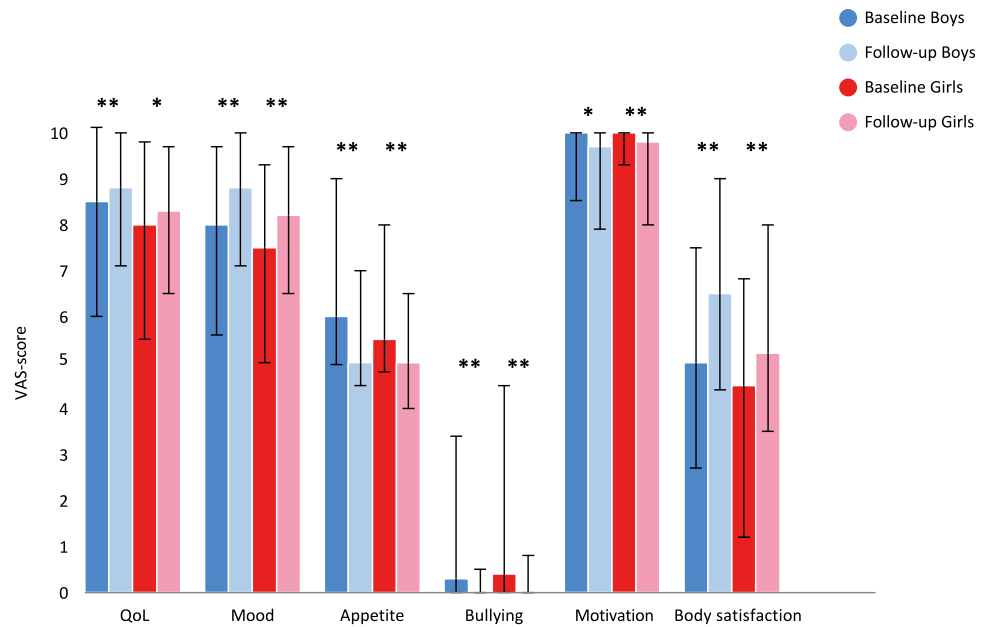

Table 4 Follow-up characteristics of the 1291 patients

	Boys	Girls	*p*
N (%)	582 (45.1%)	709 (54.9%)	
Age at visit, years	12.9 (6.4–23.7)	12.8 (6.8–23.2)	0.92
Height, m	162.2 (126.4–198.0)	159.6 (123.0–181.5)	<0.0001
Weight, kg	66.9 (30.3–175.8)	65.4 (28.2–171.0)	0.05
BMI SDS	2.6 (0.5–6.2)	2.4 (-0.4–4.5)	<0.0001
Quality of life	8.8 (0–10)	8.3 (0–10)	<0.0001
Mood	8.8 (0–10)	8.2 (0–10)	<0.0001
Appetite	5.0 (0–10)	5.0 (0–10)	0.005
Bullying	0.0 (0–10)	0.0 (0–10)	0.23
Motivation	9.7 (0–10)	9.8 (0–10)	0.55
BIS	6.4 (0–10)	5.2 (0–10)	<0.0001

Values are given as medians with ranges

BMI body mass index, *SDS* standard deviation score, *BIS* body image satisfaction

Table 5 Adjusted associations between the changes in the VAS scores and the change in BMI SDS during treatment

	Δ BMI SDS		
Dependent variable	β (95%CI)	R^2	*p*
Δ VAS, quality of life	−0.58 (−0.92 to −0.23)	0.02	**0.001**
Δ VAS, mood	−0.35 (−0.69 to −0.01)	0.02	**0.04**
Δ VAS, appetite	0.09 (−0.31 to 0.50)	0.01	0.65
Δ VAS, bullying	0.14 (−0.27 to 0.54)	0.04	0.51
Δ VAS, motivation	0.48 (0.14–0.83)	0.04	**0.005**
Δ VAS, body image satisfaction	−1.39 (−1.84 to −0.94)	0.09	**<0.0001**

Estimates (β), 95% confidence intervals (95%CI) and correlation coefficients (R^2) of the relationship between the change (Δ) in VAS scores (as the dependent variable) and the change in BMI SDS adjusted for treatment duration age, sex and socioeconomic status

Bold values indicate significant *p*-values

Discussion

During a multidisciplinary treatment of childhood obesity according to the TCOCT protocol, the majority of patients (75.6%) reduced their degree of obesity and improved their psychosocial well-being. Even the patients who increased their BMI SDS improved their psychosocial well-being. In a 1-year intervention study, Fenner et al. reported similar results in 56 adolescents, who improved their psychosocial well-being independent of the degree of weight loss [32]. In the present study, the observed degree of weight loss was associated with the changes in QoL, mood and BIS.

In line with the present study, two other longitudinal observational studies of 4 months of multidisciplinary obesity intervention in 75 children (3–5 years of age) [33] and a 4-week obesity treatment programme in 133 adolescents [34] have reported inverse associations between changes in BMI and changes in HRQoL, suggesting a robust relationship.

In accordance with the results reported in the present study, a number of cross-sectional studies have reported positive associations between overweight and a low HRQoL in children and adolescents [35–40].

We found no direct comparative studies investigating changes in mood and appetite scores during childhood obesity treatment. Nevertheless, paediatric cross-sectional studies have reported that a higher degree of obesity is associated with depressed mood (as a marker for deteriorated mood) [8, 9, 36, 41] and increased appetite [42, 43]. Further, emotional status has been associated with eating without hunger [44]. This seems in contrast to the present study, where no associations were observed between the degree of obesity and the mood and appetite scores at baseline. The differences in regards to appetite may be due to differences in the data collection method and cohort. The present study reported the patient's own assessment and included only children with overweight or obesity. In contrast, Carnell et al. and Croker et al. investigated parent-reported assessments, including children with both obesity and normal weight [42, 43].

In a number of smaller longitudinal studies ($n < 150$) of children and youths undergoing obesity treatment, significant increases in HRQoL [45, 46] and self-esteem [46, 47] have been reported. This seems in line with the improved QoL, mood and BIS observed in the present study. In a longitudinal study by Holsen et al., a decrease in the degree of obesity was associated with an increase in BIS in 1242 adolescents and young adults [48]. Although Holsen et al. studied an older cohort, which limits the comparability, the findings are consistent with the findings of the present study. Additionally, supporting the present results, Herget et al. found an increased BIS in 154 children and youths

after a 1-year telephone-based obesity treatment programme. However, in contrast to the findings in the present study, the increase in BIS was not associated with changes in BMI SDS [49].

In the present study, girls exhibited a lower BMI SDS and lower VAS scores for QoL, mood, appetite and BIS than boys at entry. Consistently, Holsen et al. and Herget et al. reported lower BIS scores in girls than in boys regardless of weight status [48, 49].

We found a reduction in bullying independent of the change in BMI SDS, which is in line with the results from a study reporting reductions in bullying, independent of weight loss, during a 16-week behavioural weight control intervention in 118 adolescents with obesity [42]. In the present study, a high BMI SDS at baseline was associated with a higher degree of bullying, which is in accordance with other studies in children [50–52] and in youths [12, 53–56].

Lack of patient motivation has been suggested as a barrier of weight loss [15]. In contrast, we observed a high motivation score at entry, and no association between a low motivation at entry and the following weight loss ($p = 0.28$). The decline in motivation score, observed during the course of treatment, may be explained by the consistent degree of weight loss observed during treatment, leading to a decline in motivation due to the fact that patients reduced their degree of obesity during treatment. Further, as the majority of patients scored the highest possible score in the motivation domain at entry, the decline may also be partly explained by a 'regression towards the mean' effect.

In the present study, 25% of the boys and girls expressed relatively high degrees of appetite (VAS scores above 9.0 and 8.0) and body image dissatisfaction (VAS scores below 2.7 and 1.2), emphasizing that a rather large part of the patients experienced a compromised psychosocial well-being. Consistently, Strauss et al. reported that 34% of 13- to 14-year-old white girls with obesity (defined as BMI > 95th percentile) had low self-esteem (<10th percentile) compared with 8% of white girls without obesity [57].

The strengths of the present study are the large number of children and youths included in the study and the long follow-up period. Furthermore, height and weight were measured in the clinic and thus were not self-reported. A limitation is that only 1291 of the 1574 included patients were eligible at follow-up. A total of 228 patients were excluded due to not completing the VAS score assessment at entry (but completed it later), which most probably was due to the fact that the health care professionals were busy in clinical practice and then failed to make the patient complete the VAS score assessment at entry. However, those who did not complete the VAS score sheet at entry

did not differ from those eligible in regards to age, sex, socioeconomic status or degree of obesity at treatment entry. Another limitation is that the VAS score assessment, in its specific form in the present study, is not validated. Nevertheless, the use of VAS scores as a tool for measuring subjective psychosocial well-being has previously been evaluated as valid, reliable and reproducible [21, 22]. Furthermore, we measured potential changes in the VAS score during treatment, where each individual served as his or her own control. The lack of a control group is an obvious limitation, as we do not know whether similar changes would occur in children not undergoing childhood obesity treatment. Hence, we cannot distinguish changes that were caused by intervention from changes that were due to a 'regression towards the mean' effect [58]. However, as greater reductions of BMI SDS were associated with greater improvements of psychosocial well-being, it is less likely that the changes were exclusively caused by a 'regression towards the mean' effect. The treatment duration did vary between individuals and we tried to overcome this limitation by grouping the patients according to the treatment duration. However, using a linear mixed model might have strengthened the results. The presence of the parent or legal guardian during the VAS assessment may have influenced the answers of all six domains. Although this bias possibility was present in all assessments, a great variation across the participating children and youths would be expected. This limitation should be seen in the context that the children and youths served as their own controls in the follow-up analyses. Lastly, we did not have information on family events such as divorce, domestic violence, drug abuse, psychiatric disease in the family or loss of close family members, factors which might impact the child's psychosocial well-being, thus possibly affecting the results of the study.

Future studies should aim at validating the VAS score assessment in each of the six domains in children and youths with as well as without obesity. Whether realistic or not to conduct, a randomized controlled trial, investigating the TCOCT protocol versus standard care, would be preferred to investigate the specific impact of the treatment protocol upon each of the six domains of psychosocial well-being.

In conclusion, the present multidisciplinary childhood obesity treatment protocol was associated with improved psychosocial well-being in proportion with the degree of weight loss, in a large cohort of unselected children and youths.

Improvements in psychosocial well-being were independent of the degree of obesity at treatment entry and improved even in the children and youths increasing their BMI SDS.

Authors' contribution CF and JH designed the study. HG and JH developed the method of assessing the psychosocial well-being. JH developed the TCOCT protocol and is the founder of The Danish Childhood Obesity Biobank. CF, TN, PM and JH collected the data. CF, SH and JH analysed and interpreted the data. CF and SH drafted the initial manuscript. TN, MJ, HG and PM participated in the interpretation of the data and in writing the manuscript. All authors critically revised the manuscript and approved the final version. All authors can account for all aspects of the study.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Informed consent All participants gave informed assent. Parents or participants of 18 years of age or older signed an informed written consent prior to enrolment into treatment.

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