Received: 23 June 2019 | Revised: 9 January 2020 | Accepted: 4 February 2020

DOI: 10.1002/osp4.410

ORIGINAL ARTICLE

Obesity Science and Practice Open Access WILEY

Emotion regulation strategies predict weight loss during an inpatient obesity treatment for adolescents

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Funding information
German Pension Insurance South Bavaria (DRV Bayern Süd)

Summary

Objective: Weight loss during an inpatient obesity treatment is an important predictor of subsequent weight maintenance. However, psychological factors influencing weight loss are not well established. Psychological models suggest some importance of executive functioning and emotion regulation strategies. Therefore, this study investigated whether these factors predict weight loss during an inpatient obesity treatment and whether this effect holds after controlling for general personal and treatment characteristics.

Method: A total of 158 adolescents with diagnosed obesity underwent inpatient obesity treatment at a German rehabilitation clinic. Psychological factors (executive functioning and emotion regulation) were measured at admission and used to predict BMI reduction after treatment completion.

Results: More frequent use of reappraisal as an emotion regulation strategy, but not suppression or executive functioning, predicted weight loss at the end of the obesity treatment, even after controlling for age, gender, treatment duration, and BMI at admission.

Conclusion: Functional emotion regulation strategies, like reappraisal, might offer an additional target for obesity treatment programmes, complementary to the more traditional components of psychoeducation, physical activity, and caloric restriction.

KEYWORDS

emotion regulation, inpatient treatment, obesity, weight loss

1 | INTRODUCTION

High prevalence rates of obesity in adolescents[1] are especially relevant to modern Western societies. Adolescents with obesity suffer from more health problems (eg, cardiovascular disease and type 2 diabetes),[2] reduced social functioning (eg, fewer friends, stigmatization, and physical or relational peer victimization),[3] and less academic achievement relative to adolescents with normal weight.[4] Deficits can also be observed more generally in cognitive functions, particularly in inhibitory control,[5,6] which are related to self-regulatory deficits. Self-regulation can be defined as the ability to purposively control one's thoughts, emotions, and behaviour in order to overcome obstacles and pursue one's goals.[7] Deficits in self-regulation have been linked to unhealthy eating and less treatment adherence in children and adolescents with obesity.[8]

Several interventions aim to help adolescents with obesity to lose weight. Interventions have both been established in schools[9] and in outpatient[10,11] and, albeit less frequently, inpatient rehabilitation centres.[12,13] These inpatient clinical treatments last for a minimum of 4 to 6 weeks; however, some programmes continue for up to 1 year.[12,14]

Treatments include a strict diet (eg, allowed energy intake of 1250-1800 kcal per day, depending on height and sex), physical activity (eg, 45-60 min of physical activity per day), and elements of cognitive-behavioural therapy.[14] Such treatments lead to substantial weight reduction during treatment; however, weight loss diminishes and converges towards the baseline over time.[12,13,15] In addition, there is considerable heterogeneity in treatment success between patients and clinics providing treatment[16] leading to questions about for whom treatment works best.[17]

Although weight loss during obesity treatment is one of the strongest predictors of long-term weight maintenance,[18,19] theoretical models addressing psychological influences on weight loss have traditionally focused solely on weight maintenance and did not consider psychological effects on weight loss during treatment. For instance, according to a recent clinical obesity maintenance model,[20] deficits in executive functioning might be central to weight maintenance. Executive functioning includes a wide range of cognitive functions, as, for example, the ability to inhibit inappropriate responses or impulses, to plan and execute behaviour, or to persevere on a task at hand until its completion.[21] Deficits in executive functioning, in particular in inhibition, have frequently been reported in adolescents with obesity, as they are supposedly related to problems suppressing inadequate eating habits, like uncontrolled snacking behaviour, disinhibited eating, or binge eating.[20,22,23]

In addition, executive functioning has been related to emotion regulation, as both executive functioning and emotion regulation continue to develop during adolescence and a frequent suppression of emotions has been related to poor executive functioning.[24] Emotion regulation is composed of a set of strategies to either maintain or change the magnitude or duration of a given affective status.[25] Two emotion regulation strategies have been investigated in more detail: reappraisal and suppression. Reappraisal is a cognitive strategy of rethinking an emotion (eg, a negative emotion) in order to interpret it differently (eg, in a more positive or neutral manner), while suppression characterizes a behavioural strategy of inhibiting ongoing emotion-expressive behaviour. In general, reappraisal is associated with better well-being, less negative affect, and better adaptation than suppression.[25]

Emotion regulation strategies are thought to be especially important in obesity, as they can reduce stress,[26] which is marked by an increased cortisol secretion. As cortisol is appetite-stimulating, greater cortisol secretion increases the likelihood of consuming unhealthy food, which might be buffered by better emotion regulation.[27] In addition, the frequent use of suppression has been associated with consuming more food when feeling emotional, ie, emotional eating.[28] Adolescents with obesity often overeat in negative mood states in order to escape, avoid, or minimize their negative affect. Thereby, emotional eating can occur in the absence of hunger, and eating might go beyond the saturation point, thereby increasing calorie intake and fostering obesity. Maladaptive emotion regulation strategies (eg, suppression) have been associated with more emotional eating, while adaptive strategies (eg, reappraisal) have been associated with less emotional eating in adolescents with obesity.[29] Finally, obesity has been linked to elevated symptoms of depression,[30] which can be reduced by reappraisal.[31]

Hence, while there is a theoretical and empirical basis for psychological factors impacting weight maintenance, less is known regarding factors influencing weight loss during obesity treatment—even though weight loss during obesity treatment is an important predictor of long-term weight maintenance.[18,19] For instance, while depressive symptoms[32] have been associated with withdrawal from treatment programmes, there are no studies on the possible influence of emotion regulation strategies. Instead, most research on psychological predictors of weight loss focused on executive functioning. In particular, impaired inhibitory control in cognitive tasks (eg, Stop-Signal or Go/No-Go tasks) has been related to less BMI reduction during treatments.[10,11,33] However, these studies generally relied on small sample sizes or measured executive functioning with single cognitive tasks, instead of covering a broader range of functions. Measuring executive functioning using a single cognitive task is problematic, as single cognitive tasks are generally considered unreliable.[34] Instead, despite generally low correlations between self-reported data and cognitive tests of executive functioning,[35] questionnaires assessing executive functioning (eg, BRIEF-SR)[36] exhibit greater reliability and examine a broader range of functions.

The present study investigated psychological predictors of adolescents' weight loss during an inpatient obesity treatment. The first aim was to replicate the predictive validity of executive functioning on weight loss during obesity treatment by means of self-report data instead of cognitive tasks. A second analysis tested whether a higher frequency of functional emotion regulation strategy use (eg, reappraisal) predicted more weight loss during an obesity treatment programme than a higher frequency of using dysfunctional strategies (eg, suppression). Finally, adolescents with reduced well-being (eg, more depressive symptoms) were expected to lose less weight during the treatment.

2 | METHOD

2.1 | Participants

A total 174 adolescents with a diagnosed obesity (body mass index [BMI] > 97th percentile according to their age[37]) participated in the study. Participants were between 13 and 18 years old and admitted as inpatients to a Southern-German rehabilitation clinic for the treatment of obesity. Participants applied for obesity treatment after receiving a prescription by their family physician, which was approved by their health insurance company. The treatment lasted for either 4 or 6 weeks, depending on their health insurance company membership, but independent of their medical condition. Participants, who stayed shorter or longer, were excluded, as their treatment would not be comparable with the regular treatment. This exclusion reduced the final sample size to N = 158 (74 male). Participants were on average M_{age} = 14.43 years old (SD = 1.25 y). The mean BMI at admission

amounted to 34.51 kg/m^2 (SD = 5.03 kg/m^2; range, 25.27-52.51 kg/m^2), while the mean BMI at discharge amounted 31.72 kg/m^2 (SD = 4.57 kg/m^2; range, 23.78-49.40 kg/m^2). Ninety-four adolescents (60%) stayed for 4 weeks in the inpatient obesity programme. One parent (35 male) of each participant provided demographic data, indicating a rather low socio-economic status relative to representative data. This was especially evident by both the adolescents and their parents' rate of attending higher secondary school (18.7% and 16.5%, respectively).

2.2 | Procedure

Upon arrival at the rehabilitation clinic, participants and their parents gave written informed consent and parents answered socio-demographic questions and the adolescent's BMI was calculated. During their first week (T_1) and their last week (T_2), adolescents answered several questionnaires on well-being, personality, self-regulation, and emotion-regulation. Before leaving the rehabilitation clinic, the BMI was calculated again. Regarding the psychological measures, only measures from T_1 will be used in this study.

The obesity treatment followed the guidelines for inpatient obesity treatments in rehabilitation clinics for adolescents in Germany.[38] It included elements from four domains: (a) medical care and knowledge about physiological aspects of obesity, (b) psychoeducation and psychological support, (c) dietetics, and (d) physical activity. In the medical care module, a therapy plan was developed according to the patient's goals and motivation. In addition, patients were informed about causes and consequences of obesity, and medical parameters were monitored. In the module on psychoeducation and psychological support, patients took part in one group therapy session of 3 hours to foster long-lasting behavioural changes by supporting self-control, self-awareness, self-efficacy, and problem solving skills. The dieting module consisted of one general information session on healthy eating, one theoretical and one practical session of grocery shopping, and one nutrition counselling and one cooking session per week. During the inpatient obesity treatment, the diet consisted of six meals with a total calorie intake of 1200 to 1400 kcal/d. Finally, regarding physical activity, patients started their day with a short early-morning exercise (15 min; 5 d/wk) and participated in several other physical activities during the week: circuit training (3 × 45 min/wk), self-chosen sport (eg, soccer; 2 × 45 min/wk), evening exercise (1 × 45 min/wk), afternoon exercise (1 × 3 h/wk), swimming with a swimming teacher (1 × 60 min/wk), educational aspects (2 × 45 min/wk), riding on the ergometer (25 min/d), going for a walk (60 min/d), sauna (twice during the treatment), additional sport classes (2 × 45 min per treatment), and physiotherapy on demand.

Participation in the study was voluntarily and independent of participation in the inpatient obesity treatment. The local ethical commission of the Technical University of Munich approved the procedure and materials.

2.3 | Materials

2.3.1 | Executive functioning

Deficits in executive functioning in daily life were assessed via self-report using the German adaptation of the Behavior Rating Inventory of Executive Function Self Report Version (BRIEF-SR).[36] The test consists of 80 items assessing seven subscales on a 3-point scale with higher scores indicating deficits in the specific domain. The seven subscales, which displayed sufficient internal consistencies in the current study, include inhibition (13 items, α = .82), shifting (10 items, α = .70), emotional controlling (10 items, α = .86), revising (five items, α = .75), working memory (12 items, α = .79), planning/structuring (13 items, α = .68), organizing (seven items, α = .65), and fulfilling tasks (10 items, α = .76).

2.3.2 | Emotion regulation

Emotion regulation styles were assessed by self-report through the 10-item German adaptation of the Emotion Regulation Questionnaire (ERQ).[39] The items are measured on a 7-point scale and refer to two regulation styles: suppression (four items, α = .59) and reappraisal (six items, α = .70). Higher sum scores indicate higher manifestations of each style. Internal consistencies for the two subscales in this study were low to moderate.

2.3.3 | Well-being

Well-being was assessed by the WHO-5 Well-being Index via self-report.[40] The scale includes five items on a 6-point scale, with higher values indicating higher well-being. The internal consistency in the present study was high (α = .85).

2.4 | Missing data and data analysis strategy

On an item level, a total of 4% of the data was missing, with 97% of the items and 73% of the participants displaying missing data. Most of the missing values were due to parents not or not fully answering the demographic questionnaire. For instance, family income and parental formal education had the most missing values (24%), while all items answered by adolescents contained at most 7% missing data, mainly due to adolescents skipping single pages of the questionnaire. In addition, Little's MCAR test was not significant, χ^2_{6066} = 6069.96, P = .483, suggesting that the data were observed at random. Hence, to deal with missingness, multiple imputations were performed including all analysis variables under the assumption that missing values were missing at random. The SPSS multiple imputations command generated 100 imputed datasets based on a maximum number of 20 iterations to reach convergence.

In order to analyse psychological factors related to treatment success, correlations between weight loss during the obesity treatment, assessed by the reduction in BMI points, and psychological variables (executive functioning, emotion regulation, and well-being) were

computed. In a second step, a hierarchical linear regression was performed in order to investigate whether psychological factors could predict weight loss during treatment over and above personal or treatment characteristics (eg, age, gender, treatment duration, and BMI at admission).

3 | RESULTS

3.1 | Effects of the inpatient obesity treatment

On average, participants lost 8% of their weight (SD = 3%; range, 3%-17%) during treatment, which equals to 2.80 BMI points and was significantly different from zero, $t_{157} = -31.44$, $P < .001$. Altogether, 85% of the adolescents lost more than 5% of their weight, and 25% of the adolescents lost more than 10% of their weight. Treatment effects were stronger for participants staying for 6 weeks (ΔBMI = −3.21 kg/m^2) than for 4 weeks (ΔBMI = −2.51 kg/m^2), $t_{115.08} = 3.89$, $P < .001$, stronger for males (ΔBMI = −3.22 kg/m^2) than for females (ΔBMI = −2.42 kg/m^2), $t_{157} = -4.79$, $P < .001$, and stronger for adolescents with an higher BMI at admission in the rehabilitation clinic, $r = -.50$, $P < .001$. However, there was no significant association of treatment effects with age, $r = -.14$, $P = .075$.

3.2 | Associations with psychological variables

Bivariate correlations between the subscales of the BRIEF and BMI reduction ranged between $r = -.11$ (planning/structuring) to $r = .06$ (emotional controlling), Ps > .192, indicating no association between any executive function and weight loss. In contrast, regarding emotion regulation, a more frequent use of reappraisal strategies, $r = -.25$, $P = .001$, correlated significantly with BMI reduction, whereas a more frequent use of suppression did not correlate with BMI reduction, $r = -.14$, $P = .072$. Finally, well-being was unrelated to weight loss, $r = -.02$, $P = .851$. Descriptive statistics for the psychological variables are displayed in Table 1.

3.3 | Predicting success of inpatient obesity treatment

To investigate whether emotion regulation strategies predicted weight loss during treatment, even after controlling for personal or treatment characteristics, a hierarchical multiple regression analysis was conducted with change in BMI as the dependent variable. As the first step, BMI at admission, treatment duration, gender, and age were entered as predictors to control for general personal characteristics and characteristics of the treatment. As a second step, both emotion reappraisal and suppression were entered into the equation, as only emotion regulation strategies (ie, reappraisal strategies) displayed bivariate correlations with BMI reduction. Regression statistics are displayed in Table 2.

Hierarchical multiple regression analysis revealed that the general characteristics of the person and the treatment already explained 45.6% of the variance in BMI reduction. Adding emotion regulation strategies in the next step explained a significant additional 2.7% of variance in BMI reduction. This additional explanation in variance was only due to the more frequent use of reappraisal strategies, while suppression exerted no effect.

TABLE 1 Means and standard deviations of executive functioning, emotion regulation, and well-being

	M	SD	Range
Executive functioning			
Inhibition	21.85	4.86	13-39
Shifting	17.26	3.39	10-30
Emotional controlling	17.32	4.84	10-30
Revising	8.57	2.40	5-15
Working memory	20.91	4.59	12-36
Planning/structuring	23.45	4.12	13-39
Organizing	11.87	2.81	7-21
Fulfilling tasks	16.92	3.84	10-30
Emotion regulation			
Reappraisal, T_1	24.66	6.81	6-42
Reappraisal, T_2	25.34	6.49	6-42
Suppression, T_1	16.64	5.32	4-28
Suppression, T_2	16.32	5.18	4-28
Well-being			
WHO-5 sum score, T_1	13.95	9.06	0-30
WHO-5 sum, score, T_2	8.83	5.65	0-30

Note. The range corresponds to the scores that were possible, not to the actual range of empirical values in this sample. T_1 = measured at admission; T_2 = measured at discharge. Executive functioning was only assessed at admission.

4 | DISCUSSION

The present study investigated psychological predictors of weight loss in adolescents with obesity during inpatient obesity treatment. While the inpatient obesity treatment was successful at inducing weight reduction, this change in BMI was best predicted by general characteristics of the person or the programme. These characteristics accounted for approximately half of the variance in BMI reduction. However, albeit important, these factors offer no starting point for intervention, as neither the adolescents' gender nor BMI at admission can be an intervention target, and the duration of a rehabilitation programme cannot easily be changed due to boundary conditions of the health insurance system. Hence, psychological factors for BMI reduction that can be targeted within rehabilitation programmes are important.

In accordance with weight maintenance models,[20,27] we focused on executive functioning, well-being, and emotion regulation strategies as potential psychological factors predicting weight loss. Contrary to previous research,[10,11,33] we did not detect any associations between executive functioning and weight loss during treatment. Yet these studies differ from ours in several ways. Both Pauli-Pott and

TABLE 2 Hierarchical regression of change in BMI on emotion regulation strategies and demographic variables

Predictor Variable	*b*	*SE*	*t*	*P*	R^2	ΔR^2
Step 1					.456	.456
Constant	2.39	0.91	2.62	.009***		
BMI at admission	−0.10	0.01	−7.14	<.001***		
Duration of rehabilitation (4 vs 6 wk)	−0.36	0.07	−5.04	<.001***		
Gender (female)	0.78	0.13	5.84	<.001***		
Age	−0.03	0.06	−0.47	.638***		
Step 2					.483	.027
Constant	3.07	.93	3.30	.001***		
BMI at admission	−0.10	0.01	−7.25	<.001***		
Duration of rehabilitation (4 vs 6 wk)	−0.35	0.07	−4.88	<.001***		
Gender (female)	0.72	0.13	5.38	<.001***		
Age	0.03	0.06	−0.55	.586***		
Reappraisal	−0.03	0.01	2.97	.003***		
Suppression	0.01	0.01	0.54	.592***		

Abbreviation: BMI = body mass index.
**$P < .01$.
***$P < .001$.

colleagues[30] as well as Nederkorn and colleagues[29] relied on outpatient samples of adolescents with obesity, while participants of this study were inpatients in a rehabilitation clinic. Being an outpatient generally means less structure and being confronted with more obesity related situations, like the inhibition of snacking or eating a fatty meal, as well as planning and remembering when to exercise. As a consequence, associations between better executive functioning and more weight loss during treatment might not reflect a direct effect on weight loss, but rather an effect on adhering to a treatment regime in daily life, similar to maintaining weight loss after treatment. For instance, adolescents with obesity lost more weight 1 year after an inpatient obesity treatment when they were less impulsive (eg, exhibited better behavioural inhibition) during treatment onset; however, there were no associations between impulsivity and weight loss during the treatment.[41]

In addition, previous studies on executive functioning and weight loss relied on an assessment through cognitive tasks, like the Stop-Signal task,[10,33] the Go/No-Go task, or interference tasks.[11] However, intercorrelations between these tasks are generally low to modest,[42] as most tasks measuring executive functioning assess several other cognitive processes at the same time as well.[21] In addition, both the Go/No-Go and the interference task used by Pauli-Pott and colleagues[30] measure attentional difficulties rather than behavioural inhibition, as the dependent variable consisted of measures of general response times and valid responses instead of inhibition errors or interference scores.

In contrast, the BRIEF-SR is a reliable measure for assessing deficits in executive functioning in daily life. The reported null results are in line with other findings of no association between impulsivity and weight loss during inpatient obesity treatment,[41] as well as recent findings revealing no association between deficits in behavioural inhibition and weight loss 1 year after treatment completion.[43] Still, better executive functioning remains a plausible psychological mechanism fostering weight maintenance.[44]

Likewise, there were no associations between well-being and weight loss. This is contrary to previous results,[32] but might be due to well-being improving with weight loss rather than predicting weight loss.[45] However, there were no associations between improvements in well-being and weight in the present study, although both improved over time. This missing relationship might be the result of using the WHO-5 questionnaire to quantify well-being. Initially used as a screening instrument for depression, 57% of the adolescents indicated poor well-being on the WHO-5, according to cut-off scores. Yet subsequent diagnostics with a clinical interview revealed that only 14% of the adolescents suffered from an affective disorder (depression or dysthymia). As a screening instrument, the WHO-5 overestimates the severity of symptoms to achieve higher sensitivity.[46] Hence, variance in the WHO-5 might have been too restricted to detect associations with weight loss.

Emotions, nonetheless, are still relevant to weight loss as emotion regulation strategies, in particular reappraisal, were correlated with more weight loss. The marginal significant association of suppression was unexpected, but might reflect a sampling effect, as adolescents with a higher BMI at admission and longer treatment duration most frequently used suppression as a strategy. Indeed, more frequent use of reappraisal was the only psychological predictor of weight loss over and above personal and treatment characteristics.

These results are the first to directly link reappraisal to weight loss in adolescents. Although the effect size was small, it offers a target for interventions and is consistent with the importance of reappraisal as an adaptive emotion regulation strategy for weight maintenance.[20,27] However, the psychological processes underlying

associations between reappraisal and weight loss during an obesity treatment on the one hand and weight maintenance on the other hand might differ. Reappraisal might be related to weight maintenance primarily through a reduction of emotional eating.[28,29] However, with calorie intake strictly controlled in an inpatient setting, this explanation cannot hold for the reported association with weight loss during the inpatient obesity treatment. Instead, this association might reflect a more general treatment readiness, as similar effects have been reported for treatment success in psychopathology through cognitive-behavioural therapy.[47]

Regardless of the psychological processes and mechanisms, the results suggest the inclusion of emotion regulation in therapy programmes for adolescents with obesity. To date, besides physical activity and nutrition, most treatment programmes focus on educating patients in knowledge about obesity and imparting behavioural strategies to improve long-term disease management.[48] However, neglecting any emotional contribution to weight loss and weight maintenance might hamper the success of treatment programmes, especially as emotional eating is an issue in obesity. A small study already generated initial evidence about the effectiveness of including a stress management component, which contained elements of emotion regulation strategies, in the treatment of obesity.[49] In addition, weight loss in an adult outpatient obesity treatment programme was greater when the patients also improved their emotion regulation skills, especially dealing with negative emotions.[50] Similarly, in a recent pilot study, focusing on emotion regulation (eg, identifying negative emotions, preventing of emotional dysregulation) after bariatric surgery in adults resulted in additional weight loss.[51] Taken together, the treatment of obesity in adolescents' might benefit from targeting emotion regulation strategies—both for weight loss during treatment and for long-term weight maintenance.

Accompanying this practical recommendation, future research needs to address several limitations of this study. There is huge heterogeneity between treatment programmes, in the duration, intensity, and content of applied interventions. Future research needs to investigate these factors and possible moderator effects. In addition, it is necessary to determine whether the weight loss achieved during treatment associated with emotion regulation persists over time and whether mechanisms of emotion regulation in weight loss are similar to the mechanisms of emotion regulation associated with weight maintenance. This distinction is crucial for moving beyond the mere prediction of treatment success and turning to explanations and processes that yield additional points for intervention.

ACKNOWLEDGEMENTS

This research was supported by the German Pension Insurance South Bavaria (DRV Bayern Süd). T.R., F.P., F.B., and C.P.B. planned the study. C.P.B. organized the data collection, and T.R. analysed the data. T.R. and F.P. wrote the paper, and authors had final approval of the submitted and published versions. We thank Tessa Hartl, Nicole Katzung, Wiebke Hornig, and Romy Julia Streppel for their help with data collection and data preparation.

CONFLICT OF INTEREST

The authors declared no conflict of interest.

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How to cite this article: Reinelt T, Petermann F, Bauer F, Bauer C-P. Emotion regulation strategies predict weight loss during an inpatient obesity treatment for adolescents. *Obes Sci Pract*. 2020;6:293–299. https://doi.org/10.1002/osp4.410