**Emotion regulation training as an add-on in the treatment of obesity in young adolescents: a randomized controlled superiority trial**

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## Abstract

In an inpatient treatment center for pediatric obesity, the effectiveness of an emotion regulation (ER) training on top of the multidisciplinary obesity treatment (MOT) was tested by means of a RCT. The ER training was evaluated on primary outcomes: ER and emotional eating, and secondary outcomes: well-being and weight loss, taking into account pre, post and follow-up measurements.

From the 115 10-to-14-year old adolescents with obesity (52.2% girls), 65 were allocated to the ER training. Physicians measured their height and weight objectively (4 times). Participants also filled out questionnaires on ER competencies (ER abilities and ER strategies), emotional eating and well-being (3 times).

Significant pre-post interactions were found for 'emotional awareness', 'problem solving' and 'evoking a positive mood'. Moreover, the positive effects of the ER training on emotion regulation strategies were maintained at follow-up. Concerning well-being, no significant pre-post interaction effects were found but a significant interaction effect was found when comparing pre with follow-up. Analyses show a significant main effect of time on weight loss, but this was not qualified by a time x condition interaction effect.

The current RCT study shows limited but promising effects of adding an ER training to the MOT. Further research should investigate whether the positive short-term effects will be maintained.



*Keywords:* Obesity, School-age children, Emotion Regulation, Randomized Controlled Trial


## Introduction

Researching pediatric obesity should be a priority for several reasons. Overweight and obesity show, worldwide, epidemic prevalence rates in children, adolescents and adults (Braet, 2010; Chooi, et al., 2019; WHO, 2016). The predicted further increase of overweight and obesity in the next decades is even more impendent (Chooi et al., 2019; WHO, 2016). Moreover, pediatric obesity often tracks into adulthood and is associated with medical, psychological and social comorbidities, predicting a poor quality of life and high economic repercussions (Apovian, 2013; Dixon, 2010; Nishtar et al., 2016). A final reason for studying pediatric obesity is related with the unsuccessful attempts in realizing long-term treatment effects. The Multidisciplinary Obesity Treatment (MOT; Debeuf et al. (2020)), the golden standard treatment for pediatric obesity, is successful but only in short-term. More specifically, MOT reduces the body mass index

(BMI; -0.5 SD), and improves the physical fitness and the psychosocial well-being (Naets et al., 2017), however, short-term weight-loss seems very hard to maintain, showing the limited long-term effects of MOT (Al-Khudairy et al., 2017; Mead et al., 2017). Therefore, sustained attention in research is imperative to discern the different mechanisms involved in the development and maintenance of pediatric overweight and obesity.

Recently, studies point to "stress" as an important psychological factor in the development and maintenance of pediatric obesity (Aparicio, et al., 2016; O'Connor, et al., 2008). Stress occurs when the available coping resources of a person fail to deal with a situation. Important, the situation needs to be perceived as (goal-related) danger, and is of personal significance for a person (Lazarus and Folkman, 1986). Next to the cognitive and emotional component, stress also contains a physiological component, reflecting the physiological arousal (discussed in Debeuf et al., 2020; Charmandari, et al., 2005; Tomiyama, 2019).

Debeuf et al. (2020) proposes a conceptual framework, in which three well-researched pathways between stress and weight gain/obesity are assumed. First, stress can trigger a chronic increase of the physiological stress tonus (and related affective states), which installs an elevated cortisol production, leading to fat accumulation in the visceral region, directly by a dysregulated lipolysis and a stimulated fat cell growth, and indirectly by an increased appetite and hedonic hunger (Charmandari et al., 2005; Peckett, et al., 2011). Second, stress triggers a low-grade inflammation process, by two trajectories. Indirectly, stress can lead to an unhealthy lifestyle, such as sleeping problems and an unhealthy diet, which subsequently induces inflammation. Directly, stress-induced catecholamines stimulate cytokine production, leading to low-grade inflammation (Hänsel, et al., 2010; Leonard, 2013). Third, stress and negative affective states, such as anger, sadness or irritation often co-occur and are often associated with reports on overeating, specifically high palatable food (Razzoli, et al., 2017). The latter can be seen as emotional or stress eating (EE), a coping strategy defined as "eating in response to stress and emotions" (Aparicio et al., 2016; Evers, et al., 2010). Neutralizing the stress-related arousal by eating highly palatable food, even in the absence of hunger, is known as reinforcing due to the short-term positive effects (Macht, 2008). This way, it is assumed to initiate an automatic learning process (Evers et al., 2010; Macht, 2008; O'Connor et al., 2008), facilitating

EE as the preferred behavior when feeling emotionally distressed. Important, research of Evers et al. (2010) concluded that not the threat itself but especially being unable to adequately regulate the stress and related negative affective states, is associated with more EE. Additionally, the relationship between stress and negative affective states and obesity is not unidirectional but a vicious cycle can be assumed: obesity itself will lead to further emotional imbalance (Âkerstedt, 2006; Pulgaron, 2013).

Consequently, being able to deal with stress and negative affective states is crucial for people with overweight and obesity. Therefore, emotion regulation (ER), defined as the actions by which persons try to influence the emotions they have, when and how they experience and express them, is proposed as the missing link in the stress – obesity relationship (Gross (1998); see also discussed in Debeuf et al. (2020)). Important, ER is trainable in children and adolescents (Volkaert, et al., 2019; Wante, et al., 2018), and studies now show a rapid growing field specifically in the depression domain (see Greimel et al, 2020; Holmqvist Larsson et al, 2019). Although at the beginning of our project in 2017, only a few ER trainings in this age group were evaluated (Schuppert et al., 2012). However, in the context of obesity, this is non-existent, besides the feasibility study of Boelens et al. (2022). Berking and Whitley (2014) combined theoretical insights on ER competencies into a conceptual theory and training model on ER in adults, called the Affect Regulation Training (ART). In this training, first bottom-up ER abilities, such as acceptance and self-support, and second top-down ER strategies, such as problem solving and cognitive reappraisal are learned (discussed in Debeuf et al. (2020)). Moreover, the authors accentuate that the sequence of applying these different ER competencies, by first adopting ER abilities and then selecting ER strategies, is crucial when feeling stressed or having negative affective states, and consequently, both should be part of a comprehensive ER training (McRae et al., 2011). As their ART was shown effective in both clinical and nonclinical adult populations (Berking et al., 2013; Berking and Whitley, 2014), with already limited evidence in people with eating problems, our research group decided to choose for this training program and translated the ART into EuREKA. EuREKA is a child friendly 12-week ER group training for children and adolescents (Verbeken et al., 2019). Evaluations on the feasibility and treatment integrity of the

EuREKA training in a population of children and adolescents with obesity was positive (Boelens et al. 2022), setting the stage for the current study.

**Current study**

The present study examines, in an inpatient treatment center for pediatric obesity, the effectiveness of EuREKA, on top of the MOT by means of a randomized controlled trial (RCT). We hypothesize that the addition of an ER training to the MOT compared with MOT "as usual" will result (on the short-term and at follow-up) for the primary outcomes, in 1) an improvement in ER competencies and 2) less emotional eating. For the secondary outcomes, we expect in the intervention condition 3) improved weight-loss and 4) better psychological well-being. Future studies will evaluate the effects of the EuREKA training on the inflammation grade and physiological parameters (Heart Rate Variability and cortisol).

## Method

**Participants**

Participants were recruited in an inpatient treatment center for obesity in Belgium, between March 2018 and September 2020. During consecutive waves, recruitment took place at intake (T0; 4 months before starting the inpatient treatment). Inclusion criteria of the study were (1) 10–14 years old at the start of the inpatient treatment; (2) primary obesity, with minimum 40% overweight at intake in the treatment center according to the overweight index of Cole et al. (2000); and (3) language proficiency, with mastery of the dominant language of the training protocol. Those with other languages allocated to the intervention condition, were reassigned. In total, 150 adolescents received information on the study and 115 participants (78.66%) gave informed consent for the study [$M_{age}$ = 12.60 ± 1.64; 52.2% girls; $M_{adjusted\ BMI\ at\ recruitment\ (T0)}$ = 194.13 ± 30.76][1]. The recruitment, randomization and allocation process is extensively discussed in Debeuf et al. (2020). Here, Figure 1 gives an overview of the flowchart during the study.

[1] *The typical BMI scores are hard to use in adolescents, as weight and height during adolescence depend on age and gender. Therefore, the adjusted BMI (AdjBMI) attempts to objectify the overweight index of minors, expressed as percentage above the mean, according to age and gender (Braet, 2010). An adjBMI above 120% and 140% reflects overweight and obesity, respectively (Roelants et al., 2009)*

All participants, both in the intervention and control condition, followed an inpatient Multidisciplinary Obesity Treatment (MOT) during 12 months, starting from July. Based on Cohrane guidelines (2009, 2017a, 2017b) the golden standard approach to reduce overweight refers to a Multidisciplinary Obesity Treatment (MOT), in which healthy lifestyle is pursued through the establishment of a healthy diet and daily physical activity, facilitated by cognitive behavioral therapy techniques (CBT). Also the parents are involved in the treatment (e.g. via psycho-educational moments) (see Debeuf et al., 2020). In contrast with outpatient programs, inpatients have more severe overweight, which means that it takes longer to obtain a healthy body weight. In this study, like in boarding school, children attend school, stay in the center during the week, and go home in the weekends, which means that they live in a controlled setting.

**Procedure**

At T0, during their first contact with the residential treatment center approximately four months before admission, the adolescents, meeting the inclusion criteria, and their parents were provided detailed information on the study procedure orally and by letter from the researcher and the psychologists of the inpatient treatment center. After informed consent from the adolescent and at least one parent, participants were randomly assigned (see Randomization section in the protocol paper Debeuf et al. (2020) and the trial registration) to one of the two conditions: the intervention condition or control condition. In the intervention condition, clinical psychologists, who were involved in the development of the ER training, gave the EuREKA training sessions. The EuREKA training consisted of 12 weekly sessions, offered as a group training (14 groups of 4-5 adolescents, divided over 4 consecutive waves). Because of covid-19, about 10% of the 170 sessions were conducted online (partially in Wave 3 and Wave 4). The content and structure of the EuREKA-training was discussed extensively in Debeuf et al. (2020). Both a manual and a workbook are available. The protocol was registered at ISRCTN Registry (December 13, 2017) with study ID: ISRCTN 83822934. The Ethics Committee of the Ghent University Hospital approved the study design, procedure, and data collection. The national laws and the Helsinki Declaration of 1964 were applied in all data collection procedures.

*Insert Figure 1*

## Study Design

The study design concerned a two-arm RCT, evaluating the effects of an ER training intervention versus a care-as-usual control condition (MOT). Assessments in the two conditions were planned at four time points: at intake (T0); when admitted to the center, before the start of the intervention (T1; pre intervention), after the end of the intervention (T2; post intervention), and at 6-months' follow-up (T3). However, the 6-months' follow up 'face-to-face' measurements (T3) for wave 2, 3 and 4 were not conform the COVID-19 measures of the government. During the lockdowns, many youngsters chose to go home and the researcher was not allowed to enter the clinic. Therefore, the face-to-face research was cancelled, although physicians did follow-up on the weight indices. Consequently, we could only collect data of a subgroup: N=43 for questionnaires (or 80% of wave 1 during 2019, when face-to-face research was still allowed); and N=78 for weight indices (68% of the study sample N=115; or 76% of those that completed the study N=103). Primary outcome measures were (1) ER and (2) eating behavior, more specifically EE. As secondary outcome measures, (3) weight change and (4) psychological well-being were taken into account. Before the start of the intervention (T1), at the end of the intervention (T2), and at 6 months' follow-up (T3), participants filled out questionnaires on their ER competencies, eating behavior and psychological well-being. Moreover, at every time-point, physicians in the residential treatment center objectively measured the weight and height of all participants.

## Primary outcome measures

### *Emotion Regulation*

We aim to have a nuanced evaluation of the ER training for several ER competencies by differentiating measures for *ER abilities* (total score as well as for a specific ability: emotional awareness) and ER strategies (total score as well as for specific strategies).

**Difficulties in Emotion Regulation Scale (DERS).** The Difficulties in Emotion Regulation Scale (DERS; Gratz and Roemer (2004)) assesses six possible difficulties in ER. For the current study, only the scale on *emotional awareness* was used with six items to be answered on a five-point Likert scale (from 1

= never to 5 = almost always). High internal consistency, good test-retest reliability, and good validity have been found (Gratz and Roemer, 2004). In the current manuscript, the Cronbach's alpha for emotional awareness is .832. A higher score refers to a better emotional awareness.

**Toronto Alexithymia Scale-II (TAS-20).** The Toronto Alexithymia Scale-II measures alexithymia with 20 items (TAS-20) (Bagby et al., 1994). The items are scored on a three-point Likert scale (from 1 = not correct for me to 3 = correct for me). The questionnaire contains three underlying correlated factors: (1) difficulties in identifying emotions, (2) difficulties in describing emotions to others, and (3) an externally oriented thinking style (Parker et al., 1993). Good internal consistency and validity have been shown in previous research (Bagby et al., 1994). In the current manuscript, a good internal consistency for the total score ($\alpha$ = .804) is found. A higher score refers to more difficulties *on emotional awareness*.

**Emotion Regulation Skill Questionnaire (ERSQ).** The Dutch version of the Emotion Regulation Skill Questionnaire (ERSQ) (Berking, 2017; Berking et al., 2008) consists of 27 items and assesses nine different *ER abilities and strategies*, each operationalized in three items: (1) awareness, (2) (physical) sensations, (3) clarity on which emotions were experienced, (4) understanding of why an emotion occurs, (5) modification/influencing the emotion (= using strategies), (6) acceptance of the emotion, (7) tolerance of the emotion, (8) readiness to confront situations and (9) self-support. Items are answered on a five-point Likert scale (from 0 = not at all to 4 = almost always). Nine subscale scores and one total score for successful ER competencies can be assessed (Grant et al., 2018). In the current study, the total score is taken into account, with a higher score reflecting a more frequent use of effective ER competencies (abilities & strategies), which is seen as a broad measure of emotion regulation competence. Good psychometric qualities are found for the ERSQ, and the questionnaire has been evaluated as reliable and valid (Berking et al., 2008; Grant et al., 2018). In the current study, the Cronbach's alpha for the total score is .950.

**Fragebogen Zur Erhebung der Emotionsregulation Bei Kindern und Jugendlichen (FEEL-KJ).** The Dutch version of the FEEL-KJ (Braet, et al., 2013; Grob and Smolenski, 2005) assesses *ER strategies* in children and adolescents between 8 and 18 years old. The total amount of items is 90, divided in 15 ER strategies, all measured for three emotions: anger, anxiety, and sadness. The 15 ER strategies are

categorized in three subscales: adaptive (e.g., problem solving), maladaptive (e.g., rumination), and external regulation (e.g., social support). Items are answered on a five-point Likert scale (from 0 = not at all to 4 = almost always). For the Dutch and Flemish population, representative norms are available (Braet et al., 2013), and good reliability and validity are found (Cracco et al., 2015). In the current study, only the subscales adaptive and maladaptive emotion regulation are used. A good reliability is found for both adaptive (α = .941) and maladaptive ER (α = .859). Besides these two total scale scores, also all seven adaptive ER strategies are, separately, taken into account: problem solving (α =.678), distraction (α =.888), evoke a positive emotion (α =.885), acceptance (α =.780), forget (α =.750), cognitive problem solving (α =.735) and re-evaluation (α =.707).

***Emotional eating***

We aim to have a nuanced evaluation of the ER training by differentiating the assessment of eating behavior (EE) for *both negative affective states and stress* (*EE when feeling emotional and EE for experiencing stress)*:

**Dutch Eating Behavior Questionnaire (DEBQ).** The Dutch Eating Behavior Questionnaire (DEBQ) (Braet et al., 2008; van Strien et al., 1986) assesses three eating styles: restrained, external, and emotional eating. In this study, only the subscale "emotional eating" is considered, consisting of11 items rated on a five-point Likert scale (from 1 = never to 5 = very often). For both the DEBQ total and the subscale "emotional eating," good reliability and validity have been reported, and the questionnaire is shown to be useful in research with children and adolescents (Braet et al., 2008; Ricciardelli and McCabe, 2001). In the current study, a good reliability is found for the subscale emotional eating (α = .957).

**Salzburg Emotional Eating Scale (SEES) and the Salzburg Stress Eating Scale (SSES).** The Salzburg Emotional Eating Scale (SEES) and the Salzburg Stress Eating Scale (SSES) are developed to measure emotional and stress-related under- and overeating (Meule et al., 2018a, 2018b). The self-report questionnaires contain 20 and 10 items, respectively. The items are formulated as emotional and stressful events of which the participant needs to complement the sentence with one of the five-point Likert scale answer alternatives: 1 = I eat much less, 2 = I eat less, 3 = I eat just as much, 4 = I eat more, and 5 = I eat

much more. The SEES questionnaire contains a four-factor structure with the following four subscales: happiness, sadness, anger, and anxiety. For each subscale a good reliability, internal consistency and validity are found (Meule et al., 2018a). In the current manuscript, all subscales have an acceptable to good internal consistency: happiness: $\alpha = .821$; sadness: $\alpha = .892$; anger: $\alpha = .882$ and anxiety: $\alpha = .723$. The SSES questionnaire has a one-factor structure and is found to have good internal consistency (Meule et al., 2018b). In the current study, the Cronbach's alpha is .898.

**Secondary outcome measures**

***Weight index: Adjusted Body Mass Index (AdjBMI)***

The Adjusted Body Mass Index (AdjBMI) is used to objectify the weight index of the participants. This means that the BMI was calculated and based on normative Flemish data (Roelants et al., 2009), expressed as percentage above the mean, according to age and gender. Cutoff criteria for pediatric overweight and obesity, based on age and gender growth charts, are proposed by the International Obesity Task Force (IOTF) (Cole et al., 2000).

***Psychological well-being: Children's Depression Inventory (CDI)***

The Children's Depression Inventory (CDI) (Kovacs, 1992; Timbremont et al., 2008) contains 27 items and assesses depressive symptoms in children and adolescents (7–17 years old). Participants need to read three sentences and have to choose the sentence that best describes them during the previous 2 weeks. Scores assigned to the sentences are 0, 1, or 2, with higher scores indicating more depressive symptoms. Much empirical research has strongly confirmed the good reliability and validity of the questionnaire (Kovacs, 1992). In the current study, a good reliability is found ($\alpha = .850$).

**Data-analytical plan**

After randomization, differences between the control and intervention condition on age, socio-economic status, ER competencies (*ER abilities, ER strategies*), eating behavior (*EE when feeling emotional and EE for experiencing stress)* and well-being were analyzed by means of independent sample *t*-tests. For gender, *a chi-square* test was performed. If meaningful differences were found, we controlled for these variables.

To evaluate the EuREKA training on top of MOT, linear mixed model analyses with random intercept were conducted by testing within-person changes. Herein, the interaction effect 'time x condition' was tested on (1) primary outcomes: ER and EE and (2) secondary outcomes: weight change and psychosocial well-being. The analyses were conducted from T1 (pre intervention) to T2 (post intervention). Afterwards, same analyses were also conducted for the 6 months' follow-up (T3; N=43 questionnaires; N=78 weight indices) measurement point.

*Treating missing values:* The effects of EuREKA on primary and secondary outcome measures were tested using the intention-to-treat (ITT) analysis (*N*=115; in line with the Consolidated Standards of Reporting Trials; CONSORT; Moher et al. (2012)). ITT analysis allows for the most stringent test of the effects of EuREKA, handling missing data with the Last-Observation-Carried-Forward (LOFC) method (in line with previous RCT studies, e.g. Hoorelbeke et al. (2015); Hoorelbeke and Koster (2017)). In addition, as sensitivity analyses, (1) we also estimated the data by Expectation Maximization in SPSS (Schafer, 1997), further labeled as the Estimated (ES) dataset (*N*=115), and (2) completers-only analyses were also performed, further labeled as the Completers only (CO) dataset (*N*=103). Expectation Maximization was allowed since the Missing Completely At Random test (MCAR; Little (1988)) was nonsignificant ($\chi^2$ (656) = 65.74, p=1.00), indicating that the assumption of randomly missing data was confirmed (Bollen, 1989).

Further, recent studies conclude that ER is highly affected by one specific ER competency: the ER emotional awareness (Boden and Thompson, 2015; Van Beveren et al., 2019). Therefore, linear mixed model analyses were re-conducted with emotional awareness (measured with the subscale of the DERS) added as covariate. Moreover, looking on the secondary outcome weight, also the adjBMI at T0 will be included as a covariate in the analyses, as we expect that adolescents with more severe obesity will lose weight more rapidly than the adolescents with less severe obesity.

## Results

### Descriptive analyses

Means and standard deviations of demographic variables and questionnaires at T1, T2 and T3 are presented in Table 1 and 2, for the total group, the intervention and control condition. The conditions did

not differ significantly on EE behavior, adjBMI and depressive symptoms at T1. However, adolescents in the control condition, unexpectedly, scored significantly higher on some adaptive ER scales (FEEL-KJ), and on the emotional awareness scale (DERS) (Table 1). By using mixed model analyses, within-person changes have been modeled and these baseline differences have been accounted for.

*Insert Table 1* / *Insert Table 2*

**Evaluation of the EuREKA training.**

Since the results with or without emotional awareness as covariate resulted in the same conclusions, we have only shown the set without the covariate. All results comparing data ***pre-post*** can be found in Table 3. The pre-post-FU results including the 6 month follow-up data (T3 with smaller sample size) are additionally described underneath.

***Primary outcome: ER Abilities***

**Comparing data pre-post.** Emotional awareness (DERS instrument) was significantly influenced by the intervention, while alexithymia and the overall ER abilities were not. Analyses on the estimated data (ES) show a significant interaction effect (*coefficient β=0.11*) for emotional awareness. The more stringent ITT analyses or CO analyses show the same effect size but findings were no longer significant on $p<.05$ level ($p=0.050$, $p=0.057$). More specific, the ER ability emotional awareness improved in the intervention condition and deteriorated in the control condition (Table 1 and 2).

**Comparing data pre-post-FU.** When also integrating the 6 months' follow-up measures, significant interaction effects were not anymore found for emotional awareness.

***Primary outcome: ER Strategies***

**Comparing data pre-post.** All analyses (CO, ITT, ES) revealed a significant interaction effect for the ER strategies 'problem solving' and 'evoke a positive mood' (Table 3). The ER strategies 'problem solving' and 'evoke a positive mood' improved in the intervention condition ($p<.05$), while the strategies deteriorated in the control condition (Table 1 and Table 2). Figure 2 shows the %change from T1 to T2 for every ER strategy, measured by the FEEL-KJ. The %change was calculated as a relative difference score from T1 to T2, controlling for the baseline differences at T1.

**Comparing data pre-post-FU.** When also integrating the 6 months' follow-up measures, all analyses (CO, ITT, ES) revealed that the ER strategies 'problem solving' (p=.012, p=.012, p=.005) and 'evoke a positive mood' (p=.012, p=.014, p=.024) again show a significant -even stronger- interaction effect. Interesting, effects for two other ER strategies now also become significant, although the findings depend on the method used (for 'forget', findings are significant with ITT and ES analyses; for 'acceptance', findings are significant for ES analyses).

*Insert Figure 2*

***Primary outcome: Emotional eating***

**Comparing data pre-post.** No significant interaction effects were found.

**Comparing data pre-post-FU.** After adding T3, no significant interaction effects occurred.

***Secondary outcome: Weight***

**Comparing data pre-post.** No significant interaction effect was found for AdjBMI (Table 3). Important, as the RCT ran in an inpatient treatment center for obesity, we also explored the time-effects on weight loss in detail. Significant adjBMI decreases occurred in the ITT, CO and ES dataset.

**Comparing data pre-post–FU.** After adding T3, no significant interaction effects were revealed.

***Secondary outcome: Well-being***

**Comparing data pre-post.** No interaction effects were found (Table 3).

**Comparing data pre-post–FU.** No interaction effects were found. Of note, when further exploring the data, (not depicted in the tables) comparing T1 with T3, a significant interaction effect was revealed, on the ITT and CO analyses for well-being. *Without covariate*, the interaction effect is *Bèta=-0.17 with p=.039*. *With emotional awareness as covariate*, the interaction effect is *Bèta= -0.17 with p=.040*. From T1 to T3, the depressive symptoms remained stable in the intervention condition, while in the control condition an increase in depressive symptoms was observed (Table 1 and Table 2).

*Insert Table 3*

## Discussion

The current RCT study aimed to investigate an ER group training, EuREKA, on top of MOT, in adolescents (10-14 years) with obesity. This first evaluation focused specifically on the experiences of the participants as reported on the psychological questionnaires on both primary outcomes: ER abilities, ER strategies and emotional eating, and on two secondary outcomes: well-being, and weight loss.

First, we found limited but promising treatment effects of the EuREKA training *on the primary outcomes*. When looking at the changes in the ER abilities and ER strategies, three important significant effects were found, showing a higher improvement in the intervention condition compared to the control condition. More specifically, adolescents in the intervention condition reported a higher score on emotional awareness (relying on ES analyses), and on the ER strategies 'problem solving' and 'evoke a positive mood' compared to the adolescents receiving only the MOT. These results are in line with our hypotheses, and with previous research showing that ER is trainable (Volkaert et al., 2019; Wante et al., 2018). Moreover, these results are also in line with Berking et al. (2013) (adults) and are congruent with Holmqvist Larsson, et al. (2019) and Schuppert et al. (2012) (adolescents).

Interesting, after including follow-up measures (6 month follow up)~~,~~ in the analyses, the ER strategies 'problem solving 'and 'evoke a positive emotion', remain significant, suggesting the stability of positive gains of longer periods post treatment. Moreover, also a significant effect was found for the ER 'forget' and 'acceptance', with higher scores in the intervention than the control condition, although here the findings should be handled carefully, as the significance was not observable in all three analyses conducted.

Specifically the enhanced scores for 'Problem solving' are promising as this is an important ER strategy and a key-component in many interventions, as it is the basis of good emotional self-regulation (Berking and Whitley, 2014). Next, also the findings for 'evoke a positive emotion' can be seen as a very helpful self-supporting ER strategy, also part of self-compassion, which is found to be effective in reducing EE and stress and negative affective states (Debeuf et al., 2022; Ehret et al., 2018).

Still, we have to acknowledge that the results in the current RCT study are limited on realizing outcomes on ER strategies, as not all findings were significant. However, concerning Gupta (2011), the credibility of the results increases as the ITT analyses and the CO analyses reveal the same effects, which is fulfilled in

the current study for important ER strategies, even at FU. Next, we neither could find a significant effect of the training on the total ERSQ. On this scale, however, we observe significant time effects: all adolescents reported better ER abilities at the end of therapy, suggesting that MOT is helpful to a certain extent and this could have led to floor effects.

For one of the most important emotion regulation abilities, emotional awareness, we did find interaction effects (***pre-post***) when measured with the DERS. This is interesting. Growing evidence suggests that next to adopting emotion regulation strategies, also other skills are crucial in regulating emotions (Berking and Whitley, 2014). Therefore, in addition to studying specific emotion regulation strategies to up- or downregulate emotions, the current research includes emotion regulation as a broad set of skills based on the Adaptive Coping with Emotions Model (ACE). Within this approach, next to the modification of emotions (i.e., using strategies) also tolerance and acceptance of emotions is important. One crucial facilitator to effectively modify or tolerate emotions is the ability emotional awareness (Berking and Whitley, 2014; Gratz and Roemer, 2004), a central preceding skill in which noticing, identifying, labeling and understanding emotions is essential, which is seen as a very promising outcome.

The research of Evers et al. (2010), concludes that inadequate ER, rather than the stress and negative affective state itself, relates with emotional eating. More recent research also found a negative association between emotion regulation and emotional eating, with the latter positively associated with adiposity (Shriver et al., 2019). Based on this study, it should be concluded that, next to focusing on emotion regulation, also adding specific interventions on emotional eating could be necessary to both prevent and treat obesity. Remarkable concerning the EE measurements, on the SSES and SEES questionnaires, adolescents in both conditions report a decrease in stress- and emotional eating, while an increase in emotional eating is reported in the DEBQ (Braet et al., 2008; van Strien et al., 1986). A possible explanation can be found in the construction of the questionnaires. The SSES and SEES, respectively measuring stress- and emotional eating, differentiate between stress, positive and negative emotions, and question both eating less and eating more in response to stress and negative affect. This explanation is in line with recent research (Verbiest et al., 2022) showing, in both a community and obesity sample that the SEES measures something

else than the emotional eating subscale of the DEBQ. The authors suggest that the SEES might thus be of added value next to using the DEBQ. Furthermore, a meta-analysis on the effect of emotions on eating behavior in experimental settings (Evers et al., 2018) revealed that scores on emotional eating scales do not translate to increased eating when being emotional. However, these self-reports do have a value, as they are the reflection of one's internal states and so they have the ability to guide future emotions and behavior as well. One strategy that is recommend is to enrich this assessment always with other modalities (multi-method-multi-informant assessment).

Finally, for weight, no significant interaction effect was found, neither on well-being as secondary outcome measures, although one important interaction effect was found, emphasizing the promising effects of EuREKA, but also showing the limits. Here, we have to acknowledge that, when analyzing ***pre-post*** measurements, we did not find any significant interaction effects on well-being. However, when looking into the comparison of the pretest with FOLLOW-UP measures, a significant interaction effect occurred. Carefully interpreted, the ER training was more successful in maintaining treatment effects on well-being, operationalized as depressed symptoms, compared to the MOT alone. This finding is congruent with previous research, concluding that integrating ER in the treatment for depression significantly improves the efficacy of cognitive behavior therapy (Berking et al., 2013). Moreover, a prospective study in adults (Berking, Wirtz, Svaldi, & Hofmann, 2014) showed that deficits in ER predict symptoms of depression five years later, and concluded that ER interventions systematically prevent the (re)lapse of depressive symptoms. Similar findings were recently shown in a prevention program (Volkaert et al., 2022) and also shown by Holmqvist Larsson, et al. (2019) for emotion regulation, measured by the Difficulties in Emotion Regulation Scale, showing significant improvement after treatment for both adolescents and parents. For adolescents, also measures of alexithymia were significantly reduced while emotional awareness was significantly increased. Also here, findings did not generalize to measures of more distal outcomes.

We acknowledge the importance for youth with obesity, the significant time-effects with weight as outcome measure, which can also result in potential floor effects, when looking for effects of the condition ER training on top of MOT. These time-effects confirm the positive and good short-term effects of previous

studies on MOT (Naets et al., 2017). The study relies on Debeuf et al. (2020) conceptual framework, in which three well-researched pathways between stress and weight gain are assumed, all suggesting that dealing with stress and negative affective states is crucial for people with overweight. We must acknowledge that the connection between stress and obesity is even more elaborated by Tomiyama (2019) who articulates a compressive framework which includes direct and indirect (circular) paths between stress and obesity thereby recognizing the impact of stress on cognitive processes (e.g. executive function, self-regulation) as well as on behavior (eating, activity and sleep) and both interact also with physiological changes (e.g secretion of glucocorticoids and insulin) (Tomiyama, 2019; Reichenberger et al., 2016). However, **why stress induces these processes is still unclear**. Here, our study put forward the interesting hypothesis based on Evers et al. (2010), that stress is only harmful when not successfully managed. It is assumed that today, many people experience high levels of stress leading to different negative emotions (Roos and Witkiewitz, 2017). Only when stress (and its related negative emotions) is not well-regulated, stress will be associated with less sleep-quality, more unhealthy eating behavior and less physical activity, whereby after iterative interactions with one's cognitive processes and physiological reactions, leading to a higher vulnerability for weight change. Evidence for this pathway is recently shown in a longitudinal study by Shriver et al. (2019) whereby emotion regulation was negatively associated with emotional eating, emotional eating was positively associated with adiposity and, most of interest here, emotional eating at age 16 serves as a mechanism that helps explain the associations between emotion regulation and adiposity four years later. Although our findings on training emotion regulation did not result in similar positive evidence for the assumed associations, the effect sizes on some outcome measures were positive and rather small but nevertheless indicating to keep the framework in future research on emotion regulation as a mediating mechanism in the stress and obesity relation

**Limitations and strengths**

Due to the covid-19 pandemic, the current RCT study failed to organize the complete, extensive 6 months' follow up assessments. This is a limitation since MOT has already good short-term effects, but especially the long-term effects are problematic (Al-Khudairy et al., 2017; Mead et al., 2017). Therefore,

future research should definitely include follow-up measurements, when participants returned to their home environment (Sigrúnarson et al., 2013). Adding an ER training, on top of MOT, is an added value on the assumption that it promotes long-term therapy effects. More specifically, by deploying the learned ER competencies in response to psychosocial stress in the own living environment, the adolescent may be more able to not grab to EE and to resist the tempting food environment. This hypothesis is in line with a recent study on the associations between ER and EE, showing that ER strategy suppression is associated with a greater intake of energy-dense food, mediated by emotional eating; and in contrast, that ER strategy cognitive reappraisal is associated with less energy-dense food intake (Lu, Tao, Hou, Zhang, & Ren, 2016). Moreover, also Gianini et al. (2013) found that ER deficits play a role in the maintenance of EE in persons with obesity. Consequently, in order to maintain weight-loss after resignation out of the inpatient treatment center, ER is of crucial interest in the transition to home. Still, we think that it is justified to learn first these new ER competencies in a safe environment. In adding the ER training to the MOT, the exercises should be continued in a later stadium of the inpatient treatment as well by organizing booster sessions, and further supported in a blended care format after participants returned to home. In that way, the adolescents will have more possibilities to exercise the ER competencies. Although it should be noted that, since comorbidity is highly prevalent in individuals with obesity (e.g. eating pathology, internalizing and externalizing problems), it remains difficult to determine whether the emotion regulation difficulties are attributable to obesity itself or to the comorbid problems.

Another limitation of the present study concerns the "passive" control group, making it impossible to control for several aspects, such as extra attention, rewards, and homework. Next, using a double-blind paradigm was not possible in the residential treatment setting. Consequently, the instruction by the researchers to the participants of the intervention condition could be contaminated, trying to better the performance (Hawthorne effect) (Hutchison and Styles, 2010). However, this lack is common in educational research trials (Hutchison and Styles, 2010). Moreover, we only used trait questionnaires to research the effects of the ER training. However, in order to capture more state changes in ER and EE, using daily

measurements should add to the study (Slovak et al., 2021), and fits with our suggestion for a multi-method multi-informant assessment procedure.

Third, we should acknowledge the multiple testing due to the many tested concepts in the current manuscript: ER, EE, weight and well-being. Many expected effects were however not significant or significant with rather small effect size, which could suggest a lack of statistical power. Indeed, a priori power analyses for power 80% suggested N=63 participants per group (see Debeuf et al., 2020), which is now not reached due to drop-out. However, we still conducted many interaction effects on secondary outcomes as the evaluation of the ER training on these several concepts is seen as an added value. Adding alternative analyses on an individual level, e.g. reliable change indexes, could be interesting next to the group level analyses in the current study.

The current study was conducted in children who stayed in a boarding school during their inpatient obesity treatment and leave the clinic in the weekends. This could raise some questions regarding the generalization of the findings. However, our studies in outpatient groups with similar emotional problems show similar findings. Actually, in contrast with outpatient programs, inpatients have more severe overweight, which means that it takes longer to obtain a healthy body weight but, the way the children are treated relies on the same protocol. We see only one limitation that in inpatient care it is more easy to organize group sessions as they are less practical organizational problems combined with outpatient treatment. Based on the ART for adults (Berking and Whitley, 2014) and research evaluating the effects of the separate ER strategies included in the ACE model in children and adolescents (Boelens et al., 2022; Volkaert et al., 2020; Wante et al., 2018), the Emotion Regulation Training for Children and Adolescents (EuREKA) could be seen as a transdiagnostic protocol also applicable in outpatient centers for children with different problems and even as prevention program. Currently, the EuREKA prevention protocol has already been evaluated outpatient for community youth between 12 and 13 years old in a randomized controlled trial (RCT) (Volkaert, et al., 2018; Volkaert, et al., 2022). The school-based training was evaluated as feasible and showed significant improvements on depressive symptoms, self-esteem and indirect on bullying immediately post intervention.

Otherwise, the current study has some notable strengths. A first strength of the study is the use of a rigorous design, including a care-as-usual control group (MOT) and randomization of the participants in an inpatient treatment for obesity (Freedland et al., 2011). Second, the study design included, however limited due to covid-19, 6 month's follow-up measurements to evaluate the effect of the EuREKA training. A third strength is the well-evaluated ART model and training, which has been the basis for the development of the EuREKA training (Berking and Whitley, 2014). Fourth, although we have to acknowledge that the results in the current RCT study are limited on realizing effective changes in ER, EE, weight and well-being, the credibility of the results is high as the ITT analyses and the CO analyses reveal the same effects for important ER strategies both at posttest and at follow-up (Gupta, 2011).

**Conclusion**

The current RCT study shows limited but promising effects of adding an ER training to the MOT, in order to maintain the positive short-term effects of MOT. The current study contributes to the literature in the field of ER and obesity. More specifically, the study showed, experimentally, by manipulating ER competencies in an inpatient obesity treatment for adolescents, that ER training is associated with small but important changes in ER competences, and well-being. Moreover, the training focusses on strengthening both ER abilities and ER strategies proves to work in an ecological valid setting, based on a strong model ART (Berking & Whitley, 2014). In this way, the study results thus go beyond previous research from observational and laboratory studies (Debeuf et al., 2022), and outcome studies, only evaluating ER strategies (Volkaert et al., 2018). This study is also congruent with the study of Berking et al. (2019), in adults with depression and with the randomized controlled school-based trial of Volkaert (see Volkaert et al., 2018; Volkaert, et al., 2022), suggesting the generalization potential of this ER training. However, further research is necessary, also focusing on follow-up measurements (Sigrunarson et al., 2013). Due to covid-19, the 6-month's follow-up measures were limited in sample size numbers. Further research should investigate the hypothesis that adolescents in the intervention condition, especially, will be able to better maintain the positive short-term effects of MOT, by using the learned ER competencies in the ER training.

**Reference list**

Åkerstedt, T. J. S. j. o. w., environment. (2006). Psychosocial stress and impaired sleep. *J Scandinavian journal of work, environment health Psychology, 32*(6), 493-501.

Al-Khudairy, L., Loveman, E., Colquitt, J. L., Mead, E., Johnson, R. E., Fraser, H., . . . O'Malley, C. (2017). Diet, physical activity and behavioural interventions for the treatment of overweight or obese adolescents aged 12 to 17 years. *J Cochrane database of systematic reviews*(6). Doi: 10.1002/14651858.CD012691.

Aparicio, E., Canals, J., Arija, V., De Henauw, S., & Michels, N. (2016). The role of emotion regulation in childhood obesity: implications for prevention and treatment. *J Nutrition research reviews, 29*(1), 17-29. Doi: 10.1017/S0954422415000153

Apovian, C. M. (2013). The clinical and economic consequences of obesity. *J Am J Manag Care, 19*(11 Suppl), s219-228.

Bagby, R., Taylor, G., & Parker, J. (1994). The twenty-item Toronto Alexithymia Scale—II. Convergent, discriminant, and concurrent validity. *Journal of psychosomatic research, 38*(1), 33-40.

Berking, M. (2017). *Emotieregulatie. Training voor psychotherapeuten, klinisch psychologen en psychiaters*. Houten: Bohn Stafleu Van Loghum.

Berking, M., Ebert, D., Cuijpers, P., & Hofmann, S. G. (2013). Emotion regulation skills training enhances the efficacy of inpatient cognitive behavioral therapy for major depressive disorder: a randomized controlled trial. *Psychotherapy and psychosomatics, 82*(4), 234-245. Doi: https://doi.org/10.1159/000348448

Berking, M., Poppe, C., Luhmann, M., Wuppermann, P., Jaggi, V., & Seifritz, E. (2012). Emotion-regulation skills and psychopathology: is the ability to modify one's negative emotions the ultimate pathway by which all other skills affect symptoms of mental disorders. *Journal of Behavior Therapy and Experimental Psychiatry, 43*, 931-937. Doi: https://doi.org/10.1016/j.jbtep.2011.09.009

Berking, M., & Schwarz, J. (2014). Affect regulation training. Handbook of emotion regulation. In: Berlin, Germany: Springer.

Berking, M., & Whitley, B. (2014). Affect regulation training. *Handbook of emotion regulation, 2*, 529-547.

Berking, M., Wirtz, C. M., Svaldi, J., & Hofmann, S. G. (2014). Emotion regulation predicts symptoms of depression over five years. *Behaviour research and therapy, 57*, 13-20. Doi: https://doi.org/10.1016/j.brat.2014.03.003

Berking, M., Wupperman, P., Reichardt, A., Pejic, T., Dippel, A., & Znoj, H. (2008). Emotion-regulation skills as a treatment target in psychotherapy. *Behaviour research and therapy, 46*(11), 1230-1237. Doi: https://doi.org/10.1016/j.brat.2008.08.005

Boden, M. T., & Thompson, R. J. (2015). Facets of emotional awareness and associations with emotion regulation and depression. *Emotion, 15*(3), 399. Doi: http://dx.doi.org/10.1037/emo0000057

Boelens, E., Braet, C., Debeuf, T., Wante, L., Volkaert, B., & Verbeken, S (2022). A Brief Emotion Regulation Training in Children and Adolescents with Obesity: A Feasibility Study. *Obesity Research & Clinical Practice?* Doi: https://doi.org/10.1016/j.orcp.2022.07.006

Bollen, K. A. (1989). A new incremental fit index for general structural equation models. *Sociological methods & research, 17*(3), 303-316. Doi: https://doi.org/10.1177/0049124189017003004

Braet, C. (2010). Kinderen met overgewicht. *Amsterdam: Hogrefe*.

Braet, C., Claus, L., Goossens, L., Moens, E., Van Vlierberghe, L., & Soetens, B. (2008). Differences in Eating Style between Overweight and Normal-Weight Youngsters. *Journal of Health Psychology, 13*(6), 733-743. Doi:10.1177/1359105308093850

Braet, C., Cracco, E., & Theuwis, L. (2013). *FEEL-KJ: vragenlijst voor emotieregulatie bij kinderen en jongeren*. Amsterdam: Hogrefe

Braet, C., & Van Winckel, M. (2000). Long-term follow-up of a cognitive behavioral treatment program for obese children. *Behavior Therapy, 31*(1), 55-74. Doi: https://doi.org/10.1016/S0005-7894(00)80004-0

Charmandari, E., Tsigos, C., & Chrousos, G. (2005). Endocrinology of the stress response. *Annual review of physiology, 67*, 259-284. Doi:10.1146/annurev.physiol.67.040403.120816

Chooi, Y. C., Ding, C., & Magkos, F. (2019). The epidemiology of obesity. *Metabolism, 92*, 6-10. Doi: https://doi.org/10.1016/j.metabol.2018.09.005

Cole, T., Bellizzi, M., Flegal, K., & Dietz, W. (2000). Establishing standard definition for child overweight and obesity worldwide: International survey. *BMJ (Clinical research ed.), 320*, 1240-1243. Doi: https://doi.org/10.1136/bmj.320.7244.1240

Cracco, E., van Durme, K., & Braet, C. (2015). Validation of the FEEL-KJ: an instrument to measure emotion regulation strategies in children and adolescents. *PloS one, 10*(9). Doi: https://doi.org/10/1371/journal.pone.0137080

Debeuf, T., Verbeken, S., Boelens, E., Volkaert, B., Van Malderen, E., Michels, N., & Braet, C. (2020). Emotion regulation training in the treatment of obesity in young adolescents: protocol for a randomized controlled trial. *Trials, 21*(1), 153. Doi: https://doi.org/10.1186/s13063-019-4020-1

Debeuf, T., Verbeken, S., Volkaert, B., Michels, N., Blechert, J., & Braet, C. (2022). Emotional Eating After Manipulating Emotion Regulation: A Laboratory Study in Adolescents. *Behaviour Change*, *39*(2), 65-87. Doi: https://doi.org/10.1017/bec.2021.20

Dixon, J. B. (2010). The effect of obesity on health outcomes. *Modular and Cellular Endocrinology, 316*(2), 104-108. Doi: https://doi.org/10.1016/j.mce.2009.07.008

Ehret, A. M., Joormann, J., & Berking, M. (2018). Self-compassion is more effective than acceptance and reappraisal in decreasing depressed mood in currently and formerly depressed individuals. Journal of Affective Disorders, 226, 220-226. Doi: https://doi.org/10.1016/j.jad.2017.10.006

Evers, C., Stok, M., & de Ridder, D. T. (2010). Feeding your feelings: Emotion regulation strategies and emotional eating. Personality & Social Psychology Bulletin, 36(6), 792-804. Doi: 10.1177/0146167210371383

Evers, C., Dingemans, A., Junghans, A. F., & Boevé, A. (2018). Feeling bad or feeling good, does emotion affect your consumption of food? A meta-analysis of the experimental evidence. Neuroscience & Biobehavioral Reviews, 92, 195-208. Doi: https://doi.org/10.1016/j.neubiorev.2018.05.028

Freedland, K. E., Mohr, D. C., Davidson, K. W., & Schwartz, J. E. (2011). Usual and unusual care: existing practice control groups in randomized controlled trials of behavioral interventions. J Psychosomatic medicine, 73(4), 323. Doi: 10.1097/PSY.0b013e318218e1fb

Gianini, L. M., White, M. A., & Masheb, R. M. (2013). Eating pathology, emotion regulation, and emotional overeating in obese adults with binge eating disorder. Eating behaviors, 14(3), 309-313. Doi: https://doi.org/10.1016/j.eatbeh.2013.05.008

Grant, M., Salsman, N., & Berking, M. (2018). The assessment of successful emotion regulation skills use: Development and validation of an English version of the Emotion Regulation Skills Questionnaire. PloS one, 13(10). Doi: https://doi.org/10.1371/journal.pone.0205095

Gratz, K. L., & Roemer, L. (2004). Multidimensional assessment of emotion regulation and dysregulation: Development, factor structure, and initial validation of the difficulties in emotion regulation scale. Journal of psychopathology, 26(1), 41-54. Doi: 0882-2689/04/0300-0041/0

Greimel, E., Feldmann, L., Piechaczek, C., Oort, F., Bartling, J., Schulte-Rüther, M., & Schulte-Körne, G. (2020). Study protocol for a randomised-controlled study on emotion regulation training for adolescents with major depression: the KONNI study. BMJ open, 10(9). Doi: http://dx.doi. org/10.1136/bmjopen-2019- 036093.

Grob, A., & Smolenski, C. (2005). FEEL-KJ. Fragebogen zur Erhebung der Emotionsregulation bei Kindern und Jugendlichen. Bern: Huber.

Gross, J. (1998). The emerging field of emotion regulation: An integrative review. Review of general psychology, 2(3), 271-299.

Gupta, S. K. (2011). Intention-to-treat concept: a review. Perspectives in clinical research, 2(3), 109. doi: 10.4103/2229-3485.83221

Hänsel, A., Hong, S., Camara, R. J., & Von Kaenel, R. (2010). Inflammation as a psychophysiological biomarker in chronic psychosocial stress. Neuroscience & Biobehavioral Reviews, 35(1), 115-121. Doi: https://doi.org/10.1016/j.neubiorev.2009.12.012

Hollingshead, A. B. (1975). Four factor index of social status.

Holmqvist Larsson, K., Andersson, G., Stern, H., & Zetterqvist, M. (2020). Emotion regulation group skills training for adolescents and parents: A pilot study of an add-on treatment in a clinical setting. Clinical child psychology and psychiatry, 25(1), 141-155. DOI: 10.1177/1359104519869782

Hoorelbeke, K., Faelens, L., Behiels, J., & Koster, E. H. (2015). Internet-delivered cognitive control training as a preventive intervention for remitted depressed patients: Protocol for a randomized controlled trial. Bmc Psychiatry, 15(1), 1-9. DOI 10.1186/s12888-015-0511-0

Hoorelbeke, K., & Koster, E. H. (2017). Internet-delivered cognitive control training as a preventive intervention for remitted depressed patients: Evidence from a double-blind randomized controlled trial study. Journal of consulting and clinical psychology, 85(2), 135. doi:10.1037/ccp0000128

Hutchison, D., & Styles, B. (2010). A guide to running randomised controlled trials for educational researchers: NFER Slough.

Kovacs, M. (1992). CDI. Children's Depression Inventory. Multi-Health Systems, New York.

Lazarus, R., & Folkman, S. (1986). Cognitive theories of stress and the issue of circularity Plenum, New York.

Leonard, B. (2013). Inflammation as the Cause of the Metabolic Syndrome in Depression. Modern trends in pharmacopsychiatry, 28, 117-126. doi:10.1159/000343974

Little, R. J. (1988). A test of missing completely at random for multivariate data with missing values. Journal of the American statistical Association, 83(404), 1198-1202.

Lu, Q., Tao, F., Hou, F., Zhang, Z., & Ren, L.-l. (2016). Emotion regulation, emotional eating and the energy-rich dietary pattern. A population-based study in Chinese adolescents. Appetite, 99, 149-156. Doi: https://doi.org/10.1016/j.appet.2016.01.011

Macht, M. (2008). How emotions affect eating: A five-way model. Appetite, 50, 1-11. doi:10.1016/j.appet.2007.07.002

McRae, K., Misra, S., Prasad, A. K., Pereira, S. C., & Gross, J. (2011). Bottom-up and top-down emotion generation: implications for emotion regulation. Social cognitive and affective neuroscience, 7(3), 253-262. doi:10.1093/scan/nsq103

Mead, E., Brown, T., Rees, K., Azevedo, L. B., Whittaker, V., Jones, D., . . . Ells, L. J. (2017). Diet, physical activity and behavioural interventions for the treatment of overweight or obese children from the age of 6 to 11 years. Cochrane Database of Systematic Reviews(6). doi:10.1002/14651858.Cd012651

Meule, A., Reichenberger, J., & Blechert, J. (2018a). Development and Preliminary Validation of the Salzburg Emotional Eating Scale. Frontiers in Psychology, 9. doi:10.3389/fpsyg.2018.00088

Meule, A., Reichenberger, J., & Blechert, J. (2018b). Development and preliminary validation of the Salzburg Stress Eating Scale. Appetite, 120, 442-448. Doi: https://doi.org/10.1016/j.appet.2017.10.003

Moher, D., Hopewell, S., Schulz, K. F., Montori, V., Gøtzsche, P. C., Devereaux, P., . . . Altman, D. G. (2012). CONSORT 2010 explanation and elaboration: updated guidelines for reporting parallel group randomised trials. International journal of surgery, 10(1), 28-55.

Naets, T., Peene, S., Van De Steene, S., Verdonck, L., De Geeter, S., & Braet, C. (2017). Eight years “Maatjes in Balans”: an evaluation of an evidence-based outpatient group prgram in the treatment of middle school children with obesity. Tijdschrift voor Geneeskunde, 74(2), 106-115.

Nishtar, S., Gluckman, P., & Armstrong, T. (2016). Ending childhood obesity: a time for action. The Lancet, 387(10021), 825-827. Doi: http://dx.doi.org/10.1016/ S0140-6736(16)00140-9

O'Connor, D. B., Jones, F., Conner, M., McMillan, B., & Ferguson, E. (2008). Effects of daily hassles and eating style on eating behavior. Health Psychology, 27(1), S20-S31. doi:10.1037/0278-6133.27.1(Suppl.).S20

Parker, J., Bagby, R., Taylor, G., Endler, N., & Schmitz, P. J. E. J. o. p. (1993). Factorial validity of the 20-item Toronto Alexithymia Scale. J European Journal of personality, 7(4), 221-232.

Peckett, A., Wright, D., & Riddell, M. (2011). The effects of glucocorticoids on adipose tissue lipid metabolism. Metabolism: clinical and experimental, 60, 1500-1510. doi:10.1016/j.metabol.2011.06.012

Pulgaron, E. R. (2013). Childhood Obesity: A Review of Increased Risk for Physical and Psychological Comorbidities. Clinical Therapeutics, 35(1), A18-A32. doi:10.1016/j.clinthera.2012.12.014

Razzoli, M., Pearson, C., Crow, S., & Bartolomucci, A. (2017). Stress, overeating, and obesity: Insights from human studies and preclinical models. Neuroscience & Biobehavioral Reviews, 76, 154-162. Doi: https://doi.org/10.1016/j.neubiorev.2017.01.026

Reichenberger, J., Kuppens, P., Liedlgruber, M.,Wilhelm, F. H., Tiefengrabner, M., Ginzinger, S., et al. (2016). No haste, more taste: an EMA-study on the effects of stress, negative and positive emotions on eating behavior. Biol. Psychol. 131, 54–62. doi: 10.1016/j.biopsycho.2016.09.002

Reilly, J. J., & Kelly, J. (2011). Long-term impact of overweight and obesity in childhood and adolescence on morbidity and premature mortality in adulthood: systematic review. International Journal of Obesity, 35(7), 891-898. doi:10.1038/ijo.2010.222

Ricciardelli, L. A., & McCabe, M. P. (2001). Children's body image concerns and eating disturbance: A review of the literature. Clinical Psychology Review, 21(3), 325-344. Doi: https://doi.org/10.1016/S0272-7358(99)00051-3

Roelants, M., Hauspie, R., & Hoppenbrouwers, K. (2009). References for growth and pubertal development from birth to 21 years in Flanders, Belgium. Annals of human biology, 36(6), 680- 694. doi:10.3109/03014460903049074

Roos, C. R., & Witkiewitz, K. (2017). A contextual model of self-regulation change mechanisms among individuals with addictive disorders. Clinical psychology review, 57, 117-128. Doi: https://doi.org/10.1016/j.cpr.2017.08.008

Schafer, J. L. (1997). Analysis of incomplete multivariate data: CRC press.

Schuppert, H. M., Timmerman, M. E., Bloo, J., van Gemert, T. G., Wiersema, H. M., Minderaa, R. B., . . . Nauta, M. H. (2012). Emotion regulation training for adolescents with borderline personality disorder traits: a randomized controlled trial. Journal of the American Academy of Child & Adolescent Psychiatry, 51(12), 1314-1323. Doi: e1312.

Shriver, L. H., Dollar, J. M., Lawless, M., Calkins, S. D., Keane, S. P., Shanahan, L., & Wideman, L. (2019). Longitudinal associations between emotion regulation and adiposity in late adolescence: indirect effects through eating behaviors. Nutrients, 11(3), 517. Doi: 10.3390/nu11030517

Sigrúnarson, V., Gråwe, R. W., & Morken, G. (2013). Integrated treatment vs. treatment-as-usual for recent onset schizophrenia; 12 year follow-up on a RCT. Bmc Psychiatry, 13(1), 1-8.

Slovak, P., Ford, B., Widen, S., Roquet, C. D., Theofanopoulou, N., Gross, J. J., . . . Klasnja, P. (2021). An In-situ, Child-led Intervention To Promote Emotion Regulation Competence in Middle Childhood: Protocol For an Exploratory Randomised Control Trial. JMIR research protocols. Doi: doi:10.2196/28914

Timbremont, B., Braet, C., & Roelofs, J. (2008). Children's Depression Inventory. Handleiding (herziene uitgave).

Tomiyama, A. J. (2019b). Stress and obesity. Annual review of psychology, 70, 703-718. Doi: https://doi.org/10.1146/annurev-psych-010418- 102936

Van Beveren, M.-L., Goossens, L., Volkaert, B., Grassmann, C., Wante, L., Vandeweghe, L., . . . Braet, C. (2019). How do I feel right now? Emotional awareness, emotion regulation, and depressive symptoms in youth. European child & adolescent psychiatry, 28(3), 389-398. Doi: https://doi.org/10.1007/s00787-018-1203-3

van Strien, T., Frijters, J. E. R., Bergers, G. P. A., & Defares, P. B. (1986). The Dutch Eating Behavior Questionnaire (Debq) for Assessment of Restrained, Emotional, and External Eating Behavior. Int. J. Eating Disorders, 5, 295-315. doi:10.1002/1098-108X(198602)5:23.0.CO;2-T

Verbeken, S., Boelens, E., Debeuf, T., Volkaert, B., Van Malderen, E., Wante, L., & Braet, C. (2019). EuREKA: een transdiagnostisch emotieregulatietrainingsprotocol voor kinderen en adolescenten met psychische klachten. In Emotieregulatietraining bij kinderen en adolescenten (pp. 139-247): Springer.

Verbiest, I., Blechert, J., Verbeken, S., Debeuf, T., & Braet, C. (2022). Eating as Emotion Regulation in Youth: A closer look with the Salzburg Emotional Eating Scale [Manuscript submitted for publication]. Department of Developmental, Personality and Social Psychology, Ghent University

Volkaert, B., Wante, L., Vervoort, L., & Braet, C. (2018). 'Boost Camp', a universal school-based transdiagnostic prevention program targeting adolescent emotion regulation; evaluating the effectiveness by a clustered RCT: a protocol paper. BMC Public health, 18(1), 1-14. Doi: https://doi.org/10.1007/s00787-018-1203-3

Volkaert, B., Wante, L., Van Beveren, M.-L., Vervoort, L., & Braet, C. (2019). Training Adaptive Emotion Regulation Skills in Early Adolescents: The Effects of Distraction, Acceptance, Cognitive

Reappraisal, and Problem Solving. Cognitive Therapy and Research, 1-19. Doi: https://doi.org/10.1007/s10608-019-10073-4

Volkaert, B., Wante, L., Loeys, T., Boelens, E., & Braet, C. (2022). The evaluation of boost camp: A universal school-based prevention program targeting adolescent emotion regulation skills. School mental health, 1-14. Doi: https://doi.org/10.1007/s12310-021-09478-y

Wante, L., Van Beveren, M.-L., Theuwis, L., & Braet, C. (2018). The effects of emotion regulation strategies on positive and negative affect in early adolescents. Cognition and emotion, 32(5), 988-1002. Doi: https://doi.org/10.1080/02699931.2017.1374242

WHO. (2016). Consideration of the evidence on childhood obesity for the Commission on Ending Childhood Obesity: report of the ad hoc working group on science and evidence for ending childhood obesity, Geneva, Switzerland.

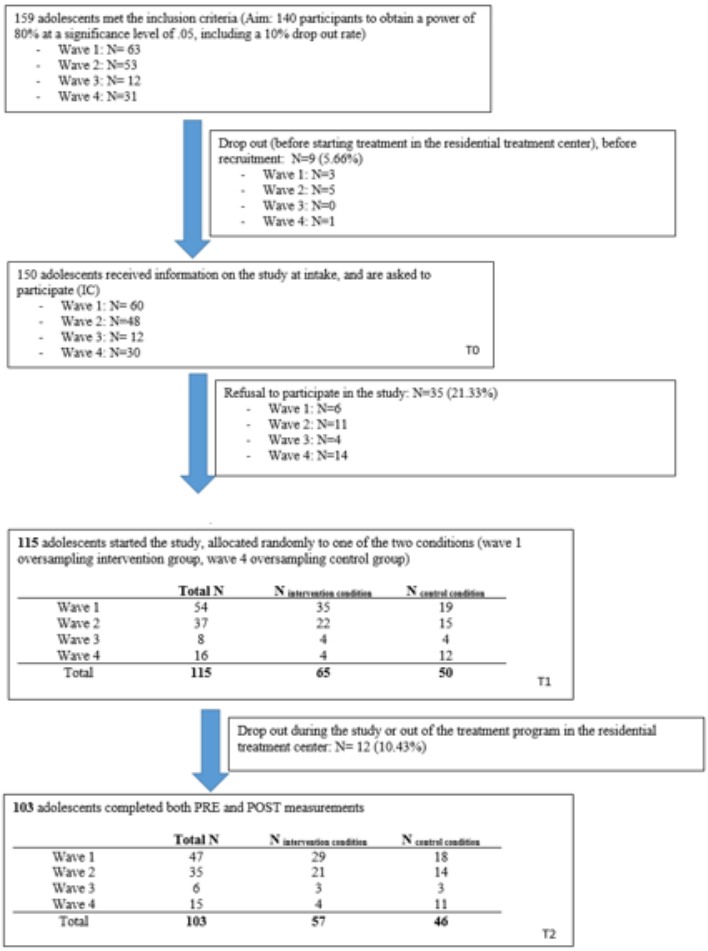


Figure 1: Process of recruitment, randomization and allocation

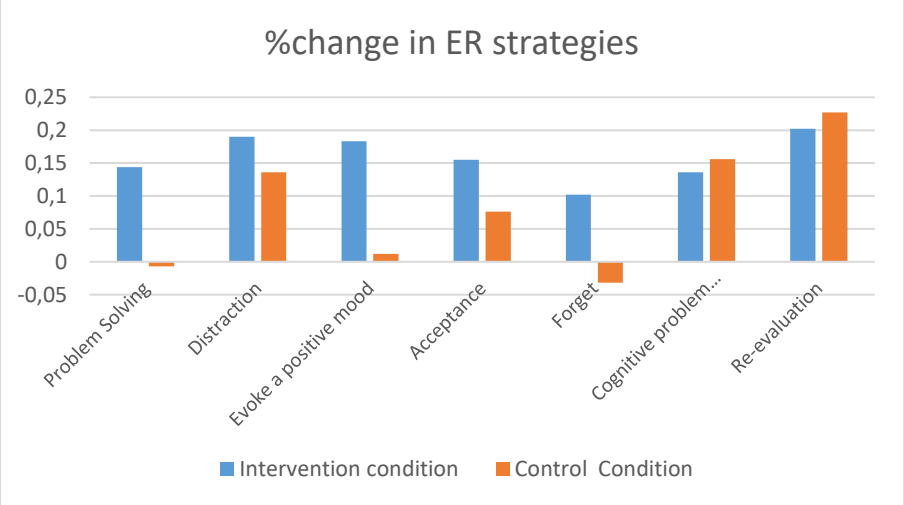


Figure 2: Histogram on the % change from PRE to POST intervention (ITT)
*Note*: %change was calculated as: (raw score $_{T2}$ – raw score $_{T1}$) / raw score $_{T1}$

*Note:* *: %change was significantly different between intervention and control condition ($p<.05$)

**Table 1**
**Characteristics of participants in intervention and control condition at T1**

| ***Demographic variables*** | | | | |
|---|---|---|---|---|
| | **Total (n=115) M (SD)** | **Intervention condition (n=65) M (SD)** | **Control condition (n=50) M (SD)** | ***t*-test** |
| Age | 12.60 (1.64) | 12.45 (1.63) | 12.80 (1.64) | $t(113)=1.15$; $p=.252$ |
| Socio Economic status | 23.65 (8.59) | 23.55 (9.30) | 23.82 (7.36) | $t(82)=.14$; $p=.888$ |
| | **$N_{girls}$ ($N_{boys}$)** | **$N_{girls}$ ($N_{boys}$)** | **$N_{girls}$ ($N_{boys}$)** | **$Chi^2$ test** |
| Gender | 60 (55) | 36 (29) | 24 (26) | $X^2(1)=.62$; $p=.432$ |
| | **Total M (SD)** | **Intervention condition M (SD)** | **Control condition M(SD)** | ***t*-test** |
| ***Emotion regulation abilities*** | | | | |
| Emotional awareness (DERS) | 14.72 (5.44) | 13.54 (4.72) | 16.26 (5.95) | t(113)=2.736; p=.007 |
| ERSQ_ total score (ERSQ) | 47.54 (20.73) | 46.62 (19.20) | 48.74 (22.71) | t(113)=.543; p=.588 |
| Alexithymia (TAS-20) | 18.70 (6.91) | 18.26 (6.75) | 19.26 (7.15) | t(113)=.766; p=.445 |
| ***Emotion regulation strategies (FEEL-KJ)*** | | | | |
| Adaptive ER | 121.84 (28.49) | 116.24 (25.04) | 129.19 (31.24) | $t(109)=2.424$; $p=.017$ |
| Problem solving | 17.63 (4.60) | 16.52 (4.14) | 19.08 (4.81) | t(109)=3.008; p=.003 |
| Distraction | 17.96 (6.31) | 17.13 (5.90) | 19.06 (6.72) | t(109)=1.613; p=.110 |
| Evoke a positive mood | 17.99 (6.37) | 16.59 (5.51) | 19.83 (6.99) | t(109)=2.737; p=.007 |
| Acceptance | 17.31 (4.99) | 16.30 (4.47) | 18.63 (5.36) | t(109)=2.488; p=.014 |
| Forget | 18.60 (5.00) | 17.65 (4.81) | 19.85 (5.01) | t(109)=2.347; p=.021 |
| Cognitive problem solving | 17.20 (4.84) | 17.06 (4.50) | 17.38 (5.30) | t(109)=.334; p=.739 |
| Re-evaluation | 15.14 (4.62) | 14.98 (4.30) | 15.35 (5.05) | t(109)=.417; p=.678 |
| Maladaptive ER | 82.76 (17.83) | 84.48 (16.85) | 80.50 (19.00) | t(109)=-1.166; p=.246 |
| ***Emotional eating*** | | | | |
| Emotional eating (DEBQ) | 29.61 (14.07) | 30.34 (14.10) | 28.67 (14.12) | t(107)=-.616; p=.539 |
| Stress eating (SSES) | 27.57 (7.90) | 26.92 (8.24) | 28.40 (7.44) | t(113)=.993; p=.323 |
| Happiness (SEES) | 13.47 (3.14) | 13.06 (3.07) | 14.00 (3.19) | t(113)=1.599; p=.113 |
| Sadness (SEES) | 14.90 (5.19) | 14.69 (5.26) | 15.18 (5.14) | t(113)=.498; p=.620 |
| Anger (SEES) | 13.65 (4.30) | 13.38 (4.50) | 14.00 (4.04) | t(113)=.759; p=.449 |
| Anxiety (SEES) | 13.45 (3.22) | 13.08 (3.24) | 13.94 (3.16) | t(113)=1.431; p=.155 |
| ***Weight indices*** | | | | |
| Adjusted BMI T0 | 194.13 (30.76) | 192.85 (30.75) | 196.19 (31.08) | $t(97)=.523$; $p=.602$ |
| Adjusted BMI T1 | 175.93 (27.41) | 174.69 (27.46) | 177.91 (27.57) | $t(97)=.567$; $p=.572$ |
| ***Well-being (CDI)*** | | | | |
| Depressive symptoms | 13.64 (7.24) | 13.55 (7.07) | 13.76 (7.54) | t(111)=.148; p=.883 |

*Note:* Socio Economic Status was measured by the hollingshead index (Hollingshead, 1975); BMI = Body Mass Index; ER = emotion regulation ; FEEL-KJ = Fragebogen Zur Erhebung der Emotionsregulation Bei Kindern und Jugendlichen; ERSQ = Emotion Regulation Skills Questionnaire; TAS-20 = Toronto Alexithymia Questionnaire; DERS = Difficulties in Emotion Regulation Scale; DEBQ = Dutch Eating Behavior Questionnaire; SSES = Salzburger's Stress Eating Scale; SEES = Salzburger's Emotional Eating Scale; CDI = Children's Depression Inventory

**Table 2**
**Characteristics of participants in intervention and control condition at T2 and T3**

| | Post (T2) | | | Follow-up (T3) | | |
|---|---|---|---|---|---|---|
| | **Total** *M (SD)* | **Intervention condition** *M (SD)* | **Control condition** *M (SD)* | **Total** *M (SD)* | **Intervention condition** *M (SD)* | **Control condition** *M (SD)* |
| ***Emotion regulation abilities*** | | | | | | |
| Emotional awareness (DERS) | 14.76 (5.32) | 14.58 (4.59) | 14.98 (6.16) | 19.79 (4.06) | 18.89 (3.85) | 21.31 (4.14) |
| ERSQ_total score (ERSQ) | 55.54 (21.21) | 55.86 (21.93) | 55.15 (20.52) | 51.30 (21.04) | 53.04 (22.46) | 48.38 (18.73) |
| Alexithymia (TAS-20) | 20.21 (9.62) | 19.98 (9.48) | 20.61 (9.89) | 38.26 (8.66) | 37.41 (8.72) | 39.69 (8.64) |
| ***Emotion regulation strategies (FEEL-KJ)*** | | | | | | |
| Adaptive ER | 126.72 (34.76) | 125.12 (35.74) | 128.70 (33.79) | 123.05 (29.94) | 122.92 (32.10) | 123.25 (26.89) |
| Problem solving | 18.07 (5.46) | 18.00 (5.30) | 18.15 (5.71) | 17.23 (5.05) | 17.59 (5.08) | 16.63 (5.11) |
| Distraction | 18.91 (6.34) | 18.58 (6.19) | 19.32 (6.57) | 17.81 (5.07) | 17.48 (5.12) | 18.38 (5.10) |
| Evoke a positive mood | 18.42 (6.32) | 18.47 (5.96) | 18.35 (6.82) | 17.81 (5.40) | 17.89 (5.26) | 17.69 (5.80) |
| Acceptance | 17.90 (5.24) | 17.30 (5.11) | 18.65 (5.36) | 17.77 (4.44) | 17.93 (4.81) | 17.50 (3.86) |
| Forget | 18.35 (5.62) | 18.00 (5.63) | 18.78 (5.64) | 17.53 (4.85) | 17.56 (4.76) | 17.50 (5.15) |
| Cognitive problem solving | 18.14 (5.19) | 17.84 (5.46) | 18.50 (4.86) | 17.79 (4.29) | 17.59 (4.75) | 18.12 (3.50) |
| Re-evaluation | 16.93 (4.76) | 16.93 (5.12) | 16.93 (4.33) | 17.09 (4.21) | 16.89 (4.44) | 17.44 (3.92) |
| Maladaptive ER | 83.77 (20.96) | 84.11 (19.98) | 83.85 (22.33) | 80.49 (15.76) | 79.29 (16.21) | 82.50 (15.26) |
| ***Emotional eating*** | | | | | | |
| Emotional eating (DEBQ) | 32.17 (12.42) | 32.30 (11.75) | 32.02 (13.33) | 33.53 (11.18) | 35.19 (11.91) | 30.75 (9.54) |
| Stress eating (SSES) | 21.91 (6.71) | 21.14 (5.86) | 22.87 (7.59) | 29.40 (8.44) | 27.52 (8.63) | 32.56 (7.30) |
| Hapiness (SEES) | 11.77 (3.54) | 10.74 (2.74) | 13.04 (4.02) | 14.12 (3.75) | 13.26 (3.36) | 15.56 (4.03) |
| Sadness (SEES) | 11.72 (3.73) | 10.82 (3.05) | 12.83 (4.21) | 14.26 (4.19) | 13.74 (3.93) | 15.13 (4.59) |
| Anger (SEES) | 10.91 (3.59) | 10.30 (3.05) | 11.67 (4.07) | 14.47 (3.88) | 13.74 (3.54) | 15.69 (4.24) |
| Anxiety (SEES) | 11.24 (3.23) | 10.77 (2.80) | 11.83 (3.65) | 14.21 (3.91) | 13.37 (3.58) | 15.63 (4.16) |
| ***Weight indices*** | | | | | | |
| Adjusted BMI | 154.88 (23.29) | 153.89 (24.04) | 156.12 (22.54) | 134.80 (25.25) | 131.07 (26.94) | 140.15 (21.92) |
| ***Well-being (CDI)*** | | | | | | |
| Depressive symptoms | 13.26 (8.95) | 12.75 (8.88) | 13.92 (9.11) | 19.02 (9.52) | 16.81 (9.92) | 22.75 (7.70) |

Note: BMI = Body Mass Index; ER = emotion regulation ; FEEL-KJ = Fragebogen Zur Erhebung der Emotionsregulation Bei Kindern und Jugendlichen; ERSQ = Emotion Regulation Skills Questionnaire; TAS-20 = Toronto Alexithymia Questionnaire; DERS = Difficulties in Emotion Regulation Scale; DEBQ = Dutch Eating Behavior Questionnaire; SSES = Salzburger's Stress Eating Scale; SEES = Salzburger's Emotional Eating Scale; CDI = Children's Depression Inventory

**Table 3: Pre-post intervention effects on primary and secondary outcome variables: time effects and time x condition interaction.**

| | | *Main effect of time* | | | *Time x Condition interaction* | | | |
|---|---|---|---|---|---|---|---|---|
| | | ***B*** | ***SE*** | ***p*** | ***B*** | ***SE*** | ***p*** | ***Bèta*** |
| **Emotion regulation competencies** | | | | | | | | |
| Emotional awareness | Completers only | -3.57 | 1.91 | .064 | 2.32 | 1.17 | .050 | 0.11 |
| | Intention to treat | -4.79 | 1.83 | **.010** | 2.07 | 1.08 | .057 | 0.10 |
| | Estimated data | -3.66 | 1.80 | **.007** | 2.36 | 1.09 | **.033** | 0.11 |
| TAS-20 | Completers only | 1.08 | 2.89 | .710 | 0.24 | 1.77 | .890 | 0.01 |
| | Intention to treat | 1.06 | 2.62 | .686 | 0.14 | 1.60 | .931 | 0.01 |
| | Estimated data | 0.96 | 2.70 | .722 | .355 | 1.64 | .829 | 0.01 |
| ERSQ_total | Completers only | 3.47 | 8.21 | .674 | 2.93 | 5.02 | .561 | 0.03 |
| | Intention to treat | 3.29 | 7.61 | .666 | 2.54 | 4.64 | .584 | 0.03 |
| | Estimated data | 3.68 | 7.79 | .638 | 2.86 | 4.75 | .562 | 0.03 |
| Adaptive ER_short | Completers only | 1.50 | 4.78 | .754 | 1.53 | 2.93 | .602 | 0.03 |
| | Intention to treat | 1.50 | 4.78 | .754 | 1.53 | 2.93 | .602 | 0.03 |
| | Estimated data | 0.67 | 4.63 | .866 | 1.68 | 2.82 | .554 | 0.03 |
| Problem Solving | Completers only | -3.36 | 1.93 | .084 | 2.42 | 1.18 | **.043** | 0.11 |
| | Intention to treat | -3.10 | 1.81 | .090 | 2.18 | 1.10 | **.049** | 0.11 |
| | Estimated data | -3.49 | 1.79 | .055 | 2.46 | 1.09 | **.027** | 0.12 |
| Distraction | Completers only | -0.93 | 2.09 | .658 | 1.26 | 1.29 | .331 | 0.05 |
| | Intention to treat | -0.67 | 1.96 | .731 | 1.05 | 1.19 | .380 | 0.04 |
| | Estimated data | -1.34 | 2.06 | .517 | 1.36 | 1.26 | .280 | 0.05 |
| Evoke a positive mood | Completers only | -4.61 | 1.99 | **.023** | 3.25 | 1.22 | **.009** | 0.13 |
| | Intention to treat | -3.97 | 1.86 | **.035** | 2.78 | 1.13 | **.015** | 0.11 |
| | Estimated data | -5.13 | 1.91 | **.009** | 3.48 | 1.16 | **.003** | 0.14 |
| Acceptance | Completers only | -1.07 | 1.89 | .571 | 1.09 | 1.16 | .348 | 0.05 |
| | Intention to treat | -1.08 | 1.77 | .542 | 1.08 | 1.07 | .316 | 0.05 |
| | Estimated data | -1.72 | 1.84 | .352 | 1.36 | 1.12 | .228 | 0.07 |
| Forget | Completers only | -2.81 | 1.84 | .130 | 1.66 | 1.13 | .144 | 0.08 |
| | Intention to treat | -2.95 | 1.72 | .092 | 1.74 | 1.05 | .100 | 0.08 |
| | Estimated data | -2.86 | 1.73 | .101 | 1.64 | 1.05 | .122 | 0.08 |
| Cognitive problem solving | Completers only | 1.30 | 1.90 | .495 | -0.21 | 1.17 | .855 | -0.01 |
| | Intention to treat | 1.10 | 1.79 | .541 | -0.12 | 1.09 | .913 | -0.01 |
| | Estimated data | 1.28 | 1.79 | .477 | 0.27 | 1.09 | .808 | -0.01 |
| Re-evaluation | Completers only | 1.17 | 1.69 | .488 | 0.45 | 1.03 | .663 | 0.02 |
| | Intention to treat | 1.32 | 1.57 | .402 | 0.30 | 0.95 | .751 | 0.01 |
| | Estimated data | 0.72 | 1.66 | .663 | 0.58 | 1.01 | .568 | 0.03 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Maladaptive ER | Completers only | 4.80 | 6.67 | .480 | -2.03 | 4.15 | .626 | -0.02 |
| | Intention to treat | 3.75 | 6.31 | .554 | -1.16 | 3.83 | .762 | -0.02 |
| | Estimated data | 5.54 | 6.40 | .388 | -2.96 | 3.90 | .450 | -0.04 |
| **Eating behavior** | | | | | | | | |
| DEBQ | Completers only | 4.97 | 4.95 | .319 | -1.52 | 3.04 | .619 | -0.03 |
| | Intention to treat | 5.64 | 4.64 | .226 | -2.11 | 2.83 | .459 | -0.04 |
| | Estimated data | 4.12 | 4.71 | .384 | -1.11 | 2.87 | .701 | -0.02 |
| SEES_happiness | Completers only | 0.42 | 1.38 | .763 | -1.37 | 0.85 | .108 | -0.10 |
| | Intention to treat | 0.34 | 1.30 | .793 | -1.20 | 0.79 | .131 | -0.09 |
| | Estimated data | 0.08 | 1.32 | .951 | -1.14 | 0.80 | .159 | -0.08 |
| SEES_sadness | Completers only | -0.76 | 1.73 | .661 | -1.55 | 1.06 | .146 | -0.08 |
| | Intention to treat | -0.54 | 1.63 | .740 | -1.44 | 0.99 | .152 | -0.07 |
| | Estimated data | -1.13 | 1.71 | .511 | -1.32 | 1.04 | .209 | -0.07 |
| SEES_anger | Completers only | -1.54 | 1.54 | .320 | -0.78 | 0.94 | .410 | -0.05 |
| | Intention to treat | -1.44 | 1.42 | .314 | -0.64 | 0.86 | .459 | -0.04 |
| | Estimated data | -1.76 | 1.50 | .242 | -0.62 | 0.91 | .496 | -0.04 |
| SEES_anxiety | Completers only | -1.81 | 1.28 | .161 | -0.25 | 0.78 | .746 | -0.02 |
| | Intention to treat | -1.39 | 1.17 | .241 | -0.35 | 0.71 | .624 | -0.03 |
| | Estimated data | -2.07 | 1.24 | .098 | -0.09 | 0.76 | .909 | -0.01 |
| SSES | Completers only | -5.33 | 2.71 | .051 | -0.21 | 1.65 | .901 | -0.01 |
| | Intention to treat | -5.29 | 2.53 | **.039** | 0.16 | 1.54 | .914 | 0.01 |
| | Estimated data | -5.53 | 2.64 | **.038** | -0.08 | 1.61 | .960 | -0.01 |
| **Wellbeing** | | | | | | | | |
| CDI | Completers only | 1.48 | 2.34 | .528 | -1.13 | 1.42 | .428 | -0.03 |
| | Intention to treat | 1.34 | 2.06 | .515 | -1.01 | 1.25 | .420 | -0.03 |
| | Estimated data | 1.98 | 2.35 | .401 | -1.34 | 1.43 | .351 | -0.04 |
| **Weight indices** | | | | | | | | |
| AdjBMI | Completers only | -16.09 | 2.10 | **<.001** | -2.07 | 1.73 | .234 | -0.02 |
| | Intention to treat | -15.03 | 3.45 | **<.001** | -1.08 | 2.05 | .599 | -0.01 |
| | Estimated data | -24.30 | 5.10 | **<.001** | 2.07 | 3.10 | .506 | -0.02 |
| | Completers only[1] | -15.74 | 2.92 | **<.001** | -2.21 | 1.74 | .208 | -0.02 |
| | Intention to treat[1] | -14.94 | 3.45 | **<.001** | -1.12 | 2.05 | .584 | -0.01 |
| | Estimated data[1] | -24.30 | 5.10 | **<.001** | 2.07 | 3.10 | .506 | 0.02 |

*Note*: [1] AdjBMI was used as covariate. Main effect AdjBMI T0 p<0.001 ; *Note:* FEEL-KJ = Fragebogen Zur Erhebung der Emotionsregulation Bei Kindern und Jugendlichen; ERSQ = Emotion Regulation Skills Questionnaire; TAS-20 = Toronto Alexithymia Questionnaire; DEBQ = Dutch Eating Behavior Questionnaire; SSES = Salzburger's Stress Eating Scale; SEES = Salzburger's Emotional Eating Scale; CDI = Children's Depression Inventory; AdjBMI = BMI adjusted for sex and age
*Note:* Adaptive ER_short = sum of three adaptive subscales of the FEEL-KJ = Distraction + Cognitive reappraisal + Re-evaluation