Changes in parental feeding practices and preschoolers' food intake following a randomized controlled childhood obesity trial

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Title

Changes in parental feeding practices and preschoolers' food habits following a randomized controlled childhood obesity trial

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Abstract

Childhood obesity treatment involving parents is most effective during the preschool age. However, the mechanisms of change are not known. The present study reports on secondary outcomes (changes in parental feeding practices and child food habits) of early obesity treatment. The More and Less study is a randomized controlled trial conducted in Stockholm County, Sweden. Children with obesity (n=174, mean BMI SDS 3.0, mean age 5 years, 56% girls) and their parents (60% with foreign background, 40% with a university degree) were randomized to: 1) standard treatment focusing on lifestyle recommendations (ST), 2) a parent support program with boosters (PGB), and 3) a parent support program without boosters (PGNB). The Child Feeding Questionnaire (CFQ) was used to measure parental feeding practices. Child food habits were assessed with a Food Frequency Questionnaire (FFQ). We calculated the monthly changes in CFQ practices and FFQ items based on four measurements. We did not find any significant between-group differences in parental feeding practices and child food habits over time. However, general linear models showed that changes in certain feeding practices predicted changes in child food habits. When ST was compared to the parent support groups, some associations moved in opposite directions. For example, increasing maternal restriction predicted increased consumption of cookies/buns in PGNB ($b=2.3$, $p<0.05$) and decreased consumption of cookies/buns in ST ($b=-2.1$, $p<0.05$). This is the first study to examine the effect of parental feeding practices on child food habits and weight status after obesity treatment among preschoolers. We found no evidence that changes in feeding practices or changes in child food habits mediated child weight loss. Future studies should consider other intermediary processes related to general parenting practices and parent-child interactions.

Keywords: Parental feeding practices, Child feeding questionnaire, Randomized controlled trial, Child eating, Family-based treatment

Manuscript

1. Introduction

Successful interventions for early childhood obesity treatment typically involve parents and integrate support in parenting skills with information on a healthy lifestyle (Golan, Kaufman, & Shahar, 2006; Loveman, et al., 2015). These interventions seek to enhance the family environment and thereby support changes in child behaviors indirectly (parent-child interactions) and directly (child food intake and eating routines), with the aim of promoting changes in child weight status. Few studies, however, have examined parental and child behaviors as outcomes (Colquitt, et al., 2016; Duncanson, Shrewsbury, Collins, & Consortium, 2017; Loveman, et al., 2015). In addition, fathers have rarely been included in these studies (Morgan, et al., 2017), despite the increasing involvement of fathers in cooking and feeding (Neuman, Eli, & Nowicka, 2019). Thus, better insight into how family subsystems affect behaviors that drive changes in child weight status may inform more effective and tailored obesity interventions.

In the present paper, we analyze secondary outcomes of the More and Less study (ML study), a randomized controlled trial (RCT) assessing obesity interventions for preschool-age children (Ek, et al., 2015). In the trial, the effect of three treatment conditions was evaluated: standard treatment (ST), a parent support program with booster sessions (PGB), and a parent support program without booster sessions (PGNB). The RCT's primary outcome results showed that PGB was more effective in reducing child weight status over 12 months, compared to the other conditions (Ek, et al., 2019). To understand what factors influenced the results, the present paper evaluates changes in parental feeding practices and child food intake across the treatment groups over 12 months. The parent support program focuses on parenting practices to change child behaviors, therefore associations between changes in parental feeding practices and changes in child food intake are also examined through separate analyses for mother-child and father-child dyads.

1.1 Parental feeding practices and the Child Feeding Questionnaire

Parental feeding practices are the specific strategies parents use during mealtime interactions (Blissett, 2011; Ventura & Birch, 2008), and have consistently been associated with child weight and eating behaviors (Birch, Fisher, & Davison, 2003; E. Jansen, Williams, Mallan, Nicholson, & Daniels, 2018; Rollins, Savage, Fisher, & Birch, 2016). Parental feeding practices are embedded in broader parenting styles that have also been associated with child weight status (Collins, Duncanson, & Burrows, 2014; Hubbs-Tait, Kennedy, Page, Topham, & Harrist, 2008; Niermann, Gerards, & Kremers, 2018; Sleddens, et al., 2014). The development of the Child Feeding Questionnaire (CFQ) (Birch, et al., 2001) has facilitated a systematic examination of controlling parental feeding practices among large samples from diverse contexts (Birch, et al., 2003; Blissett & Bennett, 2013; Derks, et al., 2017; B. Y. Rollins, E. Loken, J. S. Savage, & L. L. Birch, 2014; Wehrly, Bonilla, Perez, & Liew, 2014). In the CFQ, controlling parental feeding practices are divided into three categories: restriction, pressure to eat and monitoring (Birch, et al., 2001; Nowicka, Sorjonen, Pietrobelli, Flodmark, & Faith, 2014). Restriction and pressure to eat represent two coercive forms of parental control during feeding interactions (Vaughn, et al., 2016) which may override a child's innate signals of hunger and/or satiety (DiSantis, Hodges, Johnson, & Fisher, 2011; Rollins, et al., 2016). On the other hand, monitoring is conceptualized as a more favorable form of control whereby parents are aware of child food intake (Birch, et al., 2001; Gubbels, et al., 2011; Vaughn, et al., 2016).

In most studies, restriction and pressure to eat have been associated with higher and lower child weight status, respectively; for monitoring, however, the findings have been less consistent (Shloim, Edelson, Martin, & Hetherington, 2015; Ventura & Birch, 2008). In addition, parental feeding practices have been associated with child behaviors pertaining to food intake. Parental restriction of palatable and energy-dense foods relates to increased liking for and intake of these foods (Brandi Y. Rollins, Eric Loken, Jennifer S. Savage, & Leann L. Birch, 2014), while pressuring a child to eat particular foods relates to decreased liking for and intake of these foods, typically fruits and vegetables which are not readily accepted at younger ages (Galloway, Fiorito, Lee, & Birch, 2005; Galloway, Fiorito, Francis, & Birch, 2006). The majority of studies, however, have been cross-sectional and the direction of the relationships is not clear, although bi-directional relationships seem to be most plausible (Derks, et al., 2017; E. Jansen, et al., 2018; P. W. Jansen, et al., 2017).

Parental feeding practices should also be considered in light of child appetitive traits. From an early age, children with obesity have higher responsiveness to external food cues and lower responsiveness to their internal satiety cues. Therefore, they present distinctive behavioral profiles, which relate to increased food intake (Carnell & Wardle, 2008). Further, parents seem more likely to adjust their feeding practices in response to child behaviors rather than to child weight (e.g. pressure a child to eat if the child engages in picky eating behaviors, regardless of weight) (Ek, et al., 2016; E. Jansen, et al., 2018), which may exacerbate obesity-related child behaviors (Rodgers, et al., 2013). Thus, treatment efforts would benefit from addressing and evaluating the role of parental feeding practices in samples of young children with obesity. In these evaluations, separate analyses for mothers' and fathers' feeding practices are needed since previous research suggests that fathers employ more coercive practices than mothers do (Pratt, Hoffmann, Taylor, & Musher-Eizenman, 2017).

Feeding practices also relate to structural, socio-cultural, socioeconomic and other contextual factors (Blissett & Bennett, 2013; Cardel, et al., 2012; Nowicka, Sorjonen, et al., 2014; C. G. Russell, et al., 2018). In our previous research, mothers born in a country other than Sweden reported higher levels of controlling feeding practices (Nowicka, Sorjonen, et al., 2014; Somaraki, et al., 2016). The present study includes a diverse sample in terms of parental foreign background, to overcome research limitations posed by studying homogeneous samples (Catherine Georgina Russell, et al., 2016).

1.2 Changes in parental feeding practices after obesity treatment

A few studies reporting on childhood obesity interventions have assessed parental feeding practices and found them to be modifiable (Burrows, Warren, & Collins, 2010; Epstein, Paluch, Beecher, & Roemmich, 2008; Holland, et al., 2014; Mazzeo, et al., 2014; Stark, et al., 2014; Steele, Jensen, Gayes, & Leibold, 2014). In particular, family-based treatment demonstrated that modifications in parental feeding practices influence child dietary intake, which in turn affects weight outcomes (Holland, et al., 2014). Previous research, however, has only included families with older children; the one exception was a smaller study with children aged 2-5 years old, which showed no changes in parental feeding practices after treatment (Stark, et al., 2014).

1.3 Child food intake in obesity treatment research

In childhood obesity treatment, the child, the parents, and often all nuclear family members are advised to decrease intake of energy dense foods and opt for healthier options (Altman & Wilfley, 2015). Such changes in eating patterns are associated with reduced child weight status, suggesting that parents play an important role in shaping healthy eating patterns and weight trajectories (Best, et al., 2016; Hayes, et al., 2016; Robson, et al., 2019). Parent-focused interventions specifically seek to enhance evidence-based parenting practices in order to shift feeding dynamics towards healthier food intake. However, child food intake has not been consistently assessed and reported in interventions for younger children (Duncanson, et al., 2017).

1.4 Aim and hypotheses

The present study reports on secondary outcomes of an RCT that evaluated a childhood obesity intervention for families of preschoolers over a 12-month follow-up. Specifically, the study aims to investigate the role of parental feeding practices in child weight status and food intake according to the conceptual model proposed in Fig. 1.

The objectives of this study are:

1. To investigate changes in parental feeding practices and child food intake after early obesity treatment;
2. To examine the association between changes in parental feeding practices and changes in child food intake after early obesity treatment;
3. To examine the moderating effect of parental feeding practices at baseline on changes in child body mass index standard deviation scores (BMI SDS) after early obesity treatment.

Our hypotheses are informed by the results of the ML study (Ek, et al., 2015; Ek, et al., 2019). In ML, children whose parents participated in the PGB significantly decreased their BMI SDS after 12 months by 0.54 (95% CI –0.77 to –0.30) compared to children in the PGNB and in the ST groups (Ek, et al., 2019).

We hypothesize that parents enrolled in the PGB will experience a greater decrease in restriction and pressure to eat, along with a greater increase in monitoring, compared to parents enrolled in the other treatment conditions. Accordingly, we hypothesize that children in the PGB will consume obesogenic foods less often over time and increase their consumption frequency for healthier food options. In addition, we expect that changes in parental feeding practices will be associated with changes in child food intake over the follow-up period, in the PGB compared to the other groups. Moreover, we hypothesize that baseline levels of parental feeding practices will moderate treatment effects on child weight status over the 12-month follow-up, whereby receiving parenting training will most benefit parents with higher baseline levels of restriction/pressure to eat and lower levels of monitoring. Regarding separate analyses for mother-child and father-child dyads, we expect that they will yield similar results according to the hypotheses stated above. In addition, we expect that changes in both mothers' and fathers' feeding practices will be associated with changes in child food intake.

PLEASE INSERT FIGURE 1 HERE

Figure 1. A conceptual illustration of the expected interrelations between parental feeding practices, child food intake and child weight status after early obesity treatment focusing on parenting. Panel A (above). The hypothesized moderation effect of baseline feeding practices on child weight status (primary treatment outcome). Panel B (below). The hypothesized intermediary role of parental feeding practices and child food intake in treatment effectiveness. Dashed arrows leading to the primary outcome of the RCT are not examined in the present paper.

2. Methods

2.1 Study design

The ML is a parallel open label RCT (NCT01792531) designed to evaluate the effects of two approaches (a parent support program with and without booster sessions and standard treatment) to treat obesity in preschoolers. A description of the study procedure and treatment groups has been published elsewhere (Ek, et al., 2015; Ek, et al., 2019), and a brief summary is provided below. The ML study was approved by the ethics committee in Stockholm, Sweden on November 16th 2011 (dnr: 2011/1329-31/4). All participating caregivers provided written informed consent.

2.2 Participant recruitment

Families were eligible to participate based on the following criteria:

The child:

1) was 4 to 6 years old at baseline;

2) was classified as having obesity according to international age- and sex-specific criteria (Cole, Bellizzi, Flegal, & Dietz, 2000; Cole & Lobstein, 2012);

3) did not have any known chronic or developmental conditions that could influence his/her weight and height development;

4) was not already in treatment for obesity.

Additionally, parents' knowledge of Swedish needed to be sufficient to answer questionnaires and participate in treatment.

Families were mainly recruited from 68 child health care centers (primary care). In addition, outpatient pediatric clinics (secondary care) and school health care offices in Stockholm County, Sweden, contributed to recruitment.

After baseline measures, families were assigned (1:1:2) to one of three treatment groups (PGB, PGNB, ST) using an electronic randomization program with permuted blocks. In the parent support program, families and research group members remained blinded to group allocation into booster and non-booster sessions until the ending of the parent group sessions. The study statistician maintained the randomization sequence. Data were collected between May 2012 and October 2017.

2.3 Sample size

Power calculations were based on the primary outcome, child BMI SDS (Kleber, et al., 2009), adjusting for a dropout rate of 21% (Ek, et al., 2015; West, Sanders, Cleghorn, & Davies, 2010). Seventy-five children were estimated to be needed in each of the treatment approaches (parent support program and standard treatment) in order to identify a difference in BMI SDS between the groups at 12 months post-baseline.

2.4 Standard treatment

The ST group received the usual care offered in outpatient pediatric clinics, based on the action plan for childhood obesity in Stockholm County (SLL, 2016). Individual families were offered 5.5 visits on average over one year (Ek, et al., 2019). The treatment sessions focused on lifestyle modifications with respect to eating and activity habits. During the first visit families met with a pediatrician. In follow-up visits, families usually met with a pediatric nurse. If required, some families were also referred to a dietician, psychologist, physiotherapist or occupational therapist.

2.5 Parent support program (with and without booster sessions)

The ML parent support program includes 10 group sessions (1.5 hours/week); each session integrates a parenting component along with a lifestyle component (Ek, et al., 2015). The treatment focuses on strengthening skills that help parents support and sustain a healthy lifestyle and respond to child behaviors in an effective way. The lifestyle content addresses healthy food choices that each family can incorporate into daily practice. Through the program's focus on parenting skills, parents are prompted to implement responsive feeding – characterized by low levels of coercive control and high levels of structure – which has been associated with positive weight outcomes (Rollins, et al., 2016). Either alone or with their partners, mothers were more likely to attend the group sessions than fathers were (58% vs. 42%). All attendees were encouraged to share relevant information with their co-parent or co-caregiver. A participant manual facilitated this process.

Following the parent support program, families randomized to booster sessions received individual support through 30-minute phone calls from the research team every 4 to 6 weeks for up to 12 months post-baseline. The booster sessions revolved around encouraging parents to maintain healthy habits and empowering them to face additional challenges that might have emerged. During these phone calls, booster session facilitators referenced the content of the treatment program and the group sessions.

2.6 Measurements

All measures were administered at baseline, 3, 6 and 12 months post-baseline. Both mothers and fathers reported on their feeding practices, while one parent (mother or father) reported on child food intake. Mothers and fathers were defined as caregivers who identified as the child's biological parent and who reported, through a questionnaire, that they were female or male, respectively. None of the children in the sample were adopted or in the sole care of caregivers other than their biological parents.

2.6.1 Parental feeding practices

We used the CFQ to examine key obesity-related feeding practices employed by parents (mothers and fathers) (Birch, et al., 2001; Nowicka, Sorjonen, et al., 2014). The CFQ consists of 3 subscales - restriction, pressure to eat and monitoring (Shloim, et al., 2015; Ventura & Birch, 2008). Restriction (Cronbach's alpha for mothers 0.7, for fathers 0.8) consists of 6 items (e.g. "I have to be sure that my child does not eat too many high-fat foods"), and pressure to eat (Cronbach's alpha for mothers 0.5; for fathers 0.5) consists of 4 items (e.g. "My child should always eat all of the food on her plate"), with responses ranging from 1 (disagree) to 5 (agree).

Monitoring (Cronbach's alpha for mothers 0.8; for fathers 0.9) consists of 3 items (e.g. "How much do you keep track of the sweets (candy, ice-cream cake, pies, pastries) that your child eats?") with responses ranging from 1 (never) to 5 (always). The "reward items" for restriction were excluded in the Swedish sample after a validation of the questionnaire (Nowicka, Sorjonen, et al., 2014). The total score for each feeding practice is the mean score of its component items. Higher mean scores indicate greater endorsement of the respective practice.

2.6.2 Child food intake

A Food Frequency Questionnaire (FFQ) assessed child food intake relevant to obesity treatment (Ek, et al., 2015). The FFQ was part of a more extensive questionnaire about background characteristics of the child (e.g. child's birth date, siblings) along with current information about the child's health (e.g. health conditions and lifestyle). At each time point, one parent reported on the child's usual food intake. The FFQ assessed the consumption frequency of 10 food items (fresh fruits, vegetables, pizza/hamburger, fish, ice-cream, cookies/buns, soft drinks, juice, sweets & chocolate, chips & snacks), with the response categories ranging from once per month or less to four times per day or more (13 response options in total). Frequency equivalents were calculated for monthly consumption. The food items listed in the FFQ have been used in several international studies (Byrne, et al., 2019; Golley, et al., 2017). In the Swedish context, the items have been included in a national survey administered by the National Food Agency (Livsmedelsverket) to monitor population trends (Enghardt Barbieri, Pearson, & Becker, 2006). In addition, the items have been validated using food diaries in a nation-wide obesity prevention study in young children (Doring, et al., 2014).

2.6.3 Child BMI SDS

Child height and weight were measured by trained health care professionals. Height was measured to the nearest 0.1 cm using a fixed stadiometer and weight was measured to the nearest 0.1 kg in underwear. BMI was calculated based on weight and height. The primary outcome of the RCT, BMI SDS, was computed based on age- and sex-specific reference data (Cole & Lobstein, 2012).

2.7 Statistical analysis

Background characteristics were compared across the three treatment groups (PGB, PGNB, ST) at baseline using one-way ANOVA (for continuous variables) and chi-squared test (for categorical variables). Moreover, baseline characteristics were compared across mothers and fathers using paired samples t-test (for continuous variables) and McNemar's test (for categorical variables). Mean change per month (for maternal/paternal feeding practices - restriction, pressure to eat and monitoring, child food intake and child BMI SDS) was computed for each individual child/parent (Pfister, Schwarz, Carson, & Jancyzk, 2013). In linear regression models, all measurements of each variable (dependent variable) for the individual child/parent were regressed on an independent time variable (0, 3, 6, and 12 months). The extracted mean change per month in each variable was utilized to carry out standard significance tests and statistical procedures. Mean changes were not calculated for individuals who had missing data at two measurement points, and these individuals are not included in the analyses. Moreover, individuals who had invariable measurements at all measurements points were assigned the value zero and were included in the analytical sample.

One-way ANOVAs were used to compare the mean change of maternal and paternal feeding practices across treatment groups (objective 1), and one-sample t-tests were used to compare the mean change within each treatment group against zero change. Moreover, paired samples t-tests were employed to compare the mean change between maternal and paternal feeding practices. General linear models were used to explore the effect of change in parental feeding practices (independent variable) on change in child food intake (dependent variable) (objective 2). The models included a 'treatment group x change in feeding practices' interaction term to evaluate differences between groups. The analyses were separate for mother-child and father-child dyads. When the interaction was found significant, we proceeded to explore the associations of changes in parental feeding practices with changes in child eating patterns in each treatment group separately. If no significant interaction was found, the associations were explored using the total sample.

Moreover, the moderating effect (objective 3) of baseline feeding practices on changes in child BMI SDS was examined using general linear models. Change in BMI SDS was the dependent variable and we added the interaction term 'treatment group x baseline feeding practices'. The analyses were separate for mother-child and father-child dyads.

The significance levels for all analyses were set at 0.05. The software package IBM SPSS Statistics 24 was used for all statistical analyses.

2.7.1 Missing data

We used an intention-to-treat (ITT) approach, as far as missing data allowed, and listwise deletion was applied. Thus, we analyzed the available data without imputing the unknown values.

3. Results

No significant differences in baseline characteristics were found across the treatment conditions (Table 1). On average, children were 5.2 years old and had a BMI SDS of 3.0 at baseline. Their mothers and fathers reported higher restriction (3.8 and 3.5) and monitoring (4.0 and 3.8) compared to pressure to eat (2.1 and 2.3) at baseline, respectively. As compared to mothers, fathers reported lower levels of restriction (3.5 vs. 3.8) and monitoring (3.8 vs. 4.0). However, at baseline neither maternal nor paternal feeding practices differed across treatment groups. Foreign background and education level did not differ between mothers and fathers.

Table 1. Characteristics of the study sample at baseline

	N	Total sample	Parent program		Standard treatment
		N=174	*With* boosters n=44	*Without* boosters n=43	n=87
	N	no.(%) or mean (SD)	no.(%) or mean (SD)		no.(%) or mean (SD)
Child					
Girl	174	98 (56.3)	19 (43.2)	23 (53.5)	56 (64.4)
Living with both parents	143	113 (79)	25 (78.1)	31 (81.6)	57 (78.1)
First born	147	72 (49)	15 (41.7)	21 (51.2)	36 (51.4)
Age at baseline	174	5.2 (0.78)	5.2 (0.83)	5.2 (0.86)	5.3 (0.71)
BMI SDS at baseline	174	2.97 (0.61)	2.99 (0.55)	3.01 (0.69)	2.91 (0.59)
Mother					
Age	139	36.6 (5.5)	38 (5.1)	36 (5.4)	36 (5.7)
BMI	141	28.1 (5.7)	28.2 (6)	29.1 (6.5)	27.6 (5.1)
Foreign background	145	89 (61.4)	21 (63.6)	21 (56.8)	47 (62.7)
University degree	143	58 (40.6)	14 (42.4)	15 (41.7)	29 (39.2)
Father					
Age	124	39.8 (7.1)	43 (7.9)	39 (7.4)	39 (6.3)
BMI	126	29.4 (4.4)	29.1 (4.20)	30.02 (4.59)	29.34 (4.46)
Foreign background	130	75 (57.7)	17 (54.8)	21 (63.6)	37 (56.1)
University degree	128	49 (38.3)	11 (36.7)	12 (37.5)	26 (39.4)

3.1 Changes in parental feeding practices

Table 2 shows the mean changes in mothers' and fathers' feeding practices over time. We found no difference between or within treatment groups. Moreover, no significant differences were found between mothers and fathers in mean change in feeding practices in the total sample.

Table 2. Baseline parental feeding practices and mean monthly changes after a randomized controlled childhood obesity trial

CFQ *Child Feeding Questionnaire*	n	**Parent group with boosters (PGB)** Baseline¥	Mean monthly change ‡	**Parent group without booster (PGNB)** Baseline¥	Mean monthly change ‡	**Standard treatment (ST)** Baseline¥	Mean monthly change ‡	***p-value*** *
				Maternal Feeding Practices [a]				
Restriction	123	3.8 (0.9)	0.02	3.8 (0.8)	0.01	3.8 (0.7)	0.01	*0.69*
Pressure to eat	121	2.2 (0.8)	-0.01	2.0 (0.9)	-0.03	2.0 (0.9)	-0.03	*0.61*
Monitoring	126	4.0 (0.6)	0.02	4.0 (0.8)	0.01	4.1 (0.9)	0.03	*0.77*
				Paternal Feeding Practices [a]				
Restriction	110	3.5 (0.8)	0.01	3.4 (0.8)	-0.003	3.5 (0.9)	0.01	*0.80*
Pressure to eat	113	2.2 (0.8)	0.01	2.4 (0.8)	0.01	2.3 (0.8)	-0.02	*0.53*
Monitoring	112	3.7 (0.6)	0.02	3.5 (1.0)	0.02	3.9 (0.8)	-0.002	*0.14*

‡ Mean monthly changes were computed for each parent in the study based on measurements at all four time points (baseline, 3, 6 and 12 months)
*p-values for comparisons of changes in feeding practices across treatment groups; one-way ANOVA
¥ maternal/paternal feeding practices at baseline did not differ across treatment groups (p>0.05); one-way ANOVA
[a] no significant within-group mean monthly changes (p>0.05); one sample t-test with test value set to zero

3.2 Changes in child eating patterns

Changes in reported intake of food items did not differ between the children in the different treatment conditions (Table 3). Some within-group changes, however, were found to be significant. The average monthly consumption of cookies/buns decreased over time among children in two treatment groups (PGNB: by 0.2, p<0.05, and ST: by 0.2, p<0.05). Moreover, children in ST decreased their reported consumption of sweets and chocolate (by 0.2 per month, p<0.05).

Table 3. Baseline child food intake and monthly changes after a randomized controlled childhood obesity trial

FFQ *Food Frequency Questionnaire (per month)*	n	**Parent group with boosters (PGB)**		**Parent group without booster (PGNB)**		**Standard treatment (ST)**		***p-value ****
		Baseline¥	Mean monthly change ‡	Baseline¥	Mean monthly change ‡	Baseline¥	Mean monthly change ‡	
Fruit	128	45 (34)	-0.5	57 (24)	-1.4	48 (28)	0.004	*0.40*
Vegetables	128	40 (29)	-0.2	49 (26)	-0.3	50 (30)	-0.3	*0.97*
Pizza & hamburgers	128	2.1 (1.6)	0.02	2.4 (1.6)	-0.05	2.1 (1.5)	-0.01	*0.38*
Fish	129	6.2 (4.3)	0.3	8.6 (9.8)	-0.3	7.7 (10)	-0.2	*0.15*
Ice-cream	129	5 (7)	-0.1	3.6 (2.3)	0.1	4.1 (3.9)	-0.1	*0.20*
Cookies/buns	128	4.2 (3.1)	-0.1	5.5 (3.5)	-0.2 [a]	5.1 (5.6)	-0.2 [a]	*0.78*
Soft drinks	127	5.8 (5.1)	-0.2	4.3 (3.5)	-0.03	6.7 (12.5)	-0.5	*0.32*
Juice	126	11.6 (22.3)	-0.3	8.4 (9.9)	-0.2	7.7 (10.7)	-0.2	*0.93*
Sweets & chocolate	128	4.5 (2.5)	-0.05	4.7 (1.8)	-0.01	5.3 (5.2)	-0.2 [a]	*0.10*
Snacks	128	3.5 (2.2)	-0.02	3.6 (3.1)	-0.1	3.4 (4)	-0.1	*0.80*

‡ Mean monthly changes were computed for each parent in the study based on measurements at all four time points (baseline, 3, 6 and 12 months)
**p-values* for between-group comparisons of mean changes in child food intake; one-way ANOVA
¥ child food intake at baseline did not differ across treatment groups (p>0.05); one-way ANOVA
[a] significant within-group mean monthly changes (p<0.05); one sample t-test with test value set to zero

3.3 Associations between changes in parental feeding practices and changes in child eating patterns over 12 months of follow-up

For the total sample, increased monthly consumption of cookies/buns was associated with increasing maternal pressure to eat (b=1.1, $p<0.05$) and decreased monthly consumption of sweets and chocolate was associated with increasing maternal monitoring (b=-1.4, $p<0.05$). The associations between changes in parental feeding practices and changes in the monthly consumption of certain foods diverged between treatment groups (Table 4). In ST, mothers' and fathers' increased restriction was associated with a decrease in child intake of pizza and hamburgers per month (b=-1.4, $p<0.001$ and b=-1.1, $p<0.001$, respectively); the same pattern was shown for mothers' increased monitoring (b=-1.1, $p<0.001$). By contrast, increased levels of mothers' restriction in PGNB were associated with increased monthly intake of pizza and hamburgers (b=0.7, $p<0.05$), and cookies/buns (b=2.3, $p<0.05$). Increased levels of restriction among both mothers and fathers in ST were associated with a decrease in the child's monthly intake of ice-cream (b=-3.6, $p<0.001$ and b=-3.3, $p<0.001$, respectively).

Moreover, increasing maternal pressure to eat was associated with increased ice-cream consumption in PGB (b=1.3, $p<0.05$) and decreased ice-cream consumption in PGNB (b=-3.1, $p<0.001$). Interestingly, increased maternal restriction and pressure to eat were associated with increased monthly consumption of fruits and vegetables in PGNB only.

Table 4. Associations between mean changes in parental feeding practices with mean changes in child food intake

	MOTHERS			FATHERS		
	Restriction ‡	**Pressure to eat ‡**	**Monitoring‡**	**Restriction ‡**	**Pressure to eat ‡**	**Monitoring ‡**
Fruits ‡	× PGNB: b=20.4*	×PGNB: b=25.1*	ns	ns	ns	ns
Vegetables ‡	ns	× PGNB: b=12.1*	ns	ns	ns	ns
Pizza & hamburgers ‡	× PGNB: b=0.7* ST: b=-1.4*	b=0.5*	× ST: b=-1.1*	× PGNB: b=0.6* ST: b=-1.1*	× PGNB: b=-0.4*	ns
Fish ‡	ns	ns	ns	n.s	ns	× PGNB: b=6.7*
Icecream ‡	×ST: b=-3.6*	×PGB: b=1.3* PGNB: b=-3.1*	× ST: b=-1.8*	× ST: b=-3.3*	ns	ns

Cookies/buns ‡	× PGNB: b=2.3* ST: b=-2.1*	b=1.1*	ns	ns	ns	ns
Sweet drink ‡	ns	ns	ns	ns	ns	ns
Juice ‡	ns	ns	ns	ns	ns	ns
Sweets & chocolate ‡	ns	ns	b=-1.4*	ns	ns	ns
Snacks ‡	ns	× PGNB: b=2.1*	ns	ns	ns	ns

PGB: Parent group with boosters; PGNB: Parent group without boosters; ST: Standard treatment
‡ Mean monthly changes were computed based on all four measurements (baseline, 3, 6 and 12 months) for each family in the study
× Food items for which divergent associations were found between treatment groups (significant interaction between treatment group and changes in feeding practices); otherwise associations were examined in the total sample
*p<0.05; ns: not statistically significant, null association
Mean monthly change for individuals with the same measurements over time were assigned the value zero.

3.4 Moderating effects of parental feeding practices on changes in child BMI SDS

Changes in parental feeding practices did not differ across treatment groups. Further, parental feeding practices at baseline did not moderate the treatment effect on changes in child BMI SDS between treatment groups (Table 5).

Table 5. Effects of baseline levels of parental feeding practices on changes in child BMI SDS

	Parental feeding practices at baseline	MOTHERS			FATHERS		
		n	**Child BMI SDS mean monthly change ‡**	**p-value**	**n**	**Child BMI SDS mean monthly change ‡**	**p-value**
PGB	**Restriction**	25	0.013	0.11 [a]	23	0.006	0.50 [a]
	Pressure to eat	24	0.004	0.64 [a]	25	0.009	0.28 [a]
	Monitoring	25	0.020	0.07 [a]	25	0.007	0.53 [a]
PGNB	**Restriction**	31	-0.002 (0.013-0.015) *	0.17 [b]	27	-0.007 (0.006-0.013) *	0.29 [b]
	Pressure to eat	31	0.01 (0.004+0.006) *	0.60 [b]	28	0.003 (0.009-0.006) *	0.62 [b]
	Monitoring	32	0.001 (0.020-0.019) *	0.17 [b]	28	-0.002 (0.007-0.009) *	0.50 [b]
ST	**Restriction**	57	-0.01 (0.013-0.022) *	0.03 [b]	54	0.001 (0.006-0.005) *	0.62 [b]
	Pressure to eat	56	-0.01 (0.004-0.014) *	0.18 [b]	54	-0.001 (0.009-0.010) *	0.33 [b]
	Monitoring	59	0.003 (0.020-0.017) *	0.16 [b]	53	0.005 (0.007-0.003) *	0.84 [b]

‡ Mean monthly changes were computed for each parent in the study based on measurements at all four time points (baseline, 3, 6 and 12 months)
PGB: Parent group with boosters; PGNB: Parent group without boosters; ST: Standard
Reference group: Parent group with boosters (PGB)
[a] significance level for the coefficient in the reference group
* the coefficient in the parent group with boosters and standard treatment as the output of the function in parenthesis
[b] significance level for the difference in coefficients compared to the reference group
Treatment group *interactions* with mothers' feeding practices at baseline: 1) restriction *(p=0.08)*, 2) pressure to eat *(p=0.07)*, 3) monitoring *(p=0. 32)*
Treatment group *interactions* with fathers' feeding practices at baseline: 1) restriction *(p=0.57)*, 2) pressure to eat *(p=0.61)*, 3) monitoring *(p=0.70)*

4. Discussion

This is among the few studies to examine changes in parental feeding practices and changes in child food intake in the context of obesity treatment for preschoolers. We analyzed secondary outcomes from the ML study, in which a parent support program with boosters (PGB) was shown to be more effective than the program without boosters (PGNB) as well as standard treatment (ST) in decreasing child weight status. Contrary to our hypotheses, we found that PGB was no more effective in changing parental feeding practices or child food intake than PGNB or ST. Associations between changes in parental feeding practices and changes in child food intake were identified mainly in PGNB and ST. Moreover, we did not find that different levels of parental feeding practices at baseline moderated treatment effectiveness.

We conducted this study to understand whether the greater decrease in child weight status in the PGB group (Ek, et al., 2019) could be explained by changes in parental feeding practices. To our disappointment, our hypothesis was not confirmed. Previous studies like ours have provided mixed evidence (Okely, et al., 2010; Stark, et al., 2014). A pilot US study comparing family-based behavioral obesity treatment with home visits and pediatrician counseling found greater decrease in child weight after family-based behavioral treatment, although changes in parental feeding practices did not differ between the groups (Stark, et al., 2014). However, in the Australian study HICKUPS, participants in a parent group intervention arm with a focus on diet decreased their restriction more than parents whose intervention did not include the diet component; the former group was also more successful in decreasing child weight status (Burrows, et al., 2010; Okely, et al., 2010). The differences between these groups regarding feeding practices were driven by changes in the two reward items of the CFQ restriction scale (Burrows, et al., 2010). These items describe counterproductive parental behaviors related to offering food in exchange for good behavior (Vaughn, et al., 2016). In Swedish society, using food to reward children is generally considered inappropriate, and in the Swedish validation of the CFQ the reward items had to be excluded due to social desirability issues as seen by high ceiling effect (Nowicka, Sorjonen, et al., 2014). Hence, although the CFQ has been widely used by researchers to measure parental feeding practices in the past two decades (Shloim, et al., 2015; Ventura & Birch, 2008), methodological issues related to the feeding practices the CFQ assesses might explain the lack of group differences in our study. In a recent summary of measurements of parental feeding, Vaughn, et al. (2016) list a wide range of parental feeding strategies involving structure and control. Not all the parental strategies listed are represented in the CFQ, and it is possible that changes in parental feeding practices that we did not measure could explain our results.

The greater reduction in child weight status in PGB was also not explained by changes in reported child food intake. In fact, children within PGNB and ST reportedly reduced their consumption frequency of cookies and buns by half compared to baseline. Although assessment of child food intake has not been prioritized in trials for obesity treatment (Duncanson, et al., 2017), previous research has demonstrated a greater decrease in calorie-dense foods and caloric intake, and a greater increase in dietary quality after intensive family-based treatment, compared to counseling (Robson, et al., 2019). As the authors note, this change in eating patterns also mirrors a greater decrease in child weight status in family-based treatment (Robson, et al., 2019; Stark, et al., 2018), such that a lower energy intake may explain the treatment effect (Kuhl, et al., 2014). In the present study, we found that child food intake relevant to obesity treatment was within recommended levels in all groups already at baseline. Thus, other aspects of food intake, such as portion sizes and energy intake, may have changed during the intervention, which might explain the greater child weight loss in PGB. However, more time-consuming methods, such as 24 h-recalls or food recall diaries, would have been required to extract this information. We chose not to use them, as it would have resulted in greater participant burden. Likewise, we did not measure physical activity using objective measurements such as accelerometers, and therefore could not assess if children's physical activity affected their energy balance.

We found that certain feeding practices were associated with child food intake. Increased parental monitoring and restriction were associated with decreased consumption of energy-dense foods in the total sample and ST. Although a reduction in energy-dense foods can be expected with increased monitoring (Haszard, Skidmore, Williams, & Taylor, 2015; Rollins, et al., 2016), it is a surprising finding considering the coercive nature of restriction, which previous research has suggested might be counterproductive in relation to child eating behaviors (Fisher & Birch, 1999; Rollins, et al., 2016). The similar associations for increased monitoring and restriction may indicate that parents who reported restriction and parents who reported monitoring were referring to similar kinds of control. Recent studies on feeding practices have focused on disentangling the effects of overt control (child can detect parental control, e.g. "How often are you firm about what your child should eat") and covert control (child cannot detect parental control, e.g. "Avoid buying sweets and crisps and bringing them into the house?") (Boots, Tiggemann, & Corsini, 2018; Nowicka, Flodmark, Hales, & Faith, 2014; Ogden, Reynolds, & Smith, 2006). Whereas overt control may lead to unfavorable outcomes over time, covert control is associated with more favorable weight and food intake outcomes (Ogden, et al., 2006; Rodenburg, Kremers, Oenema, & van de Mheen, 2014), such that a more nuanced understanding of parental restriction is needed (Vaughn, et al., 2016). The CFQ items assessing restriction, however, may not make the distinction clear. Of note, a Swedish study of nearly 900 mothers of preschoolers (Nowicka, Sorjonen, et al., 2014) showed that covert control was moderately correlated with restriction (as measured through the CFQ). This shows that, in Sweden, parents may interpret the CFQ restriction items as capturing covert controlling behaviors related to structure and limit setting (Rollins, et al., 2016). Taken together, these findings highlight the challenges for operationalizing relevant constructs in parental feeding research. The field has accumulated a theory-based pool of items that are developmentally appropriate and easy to administer; however, novel ways to analyze existing data that account for certain limitations may be needed. Item Response Theory (IRT) might be one alternative which can facilitate analyses of empirical data while refining our existing conceptualization of feeding practices so that they can be better operationalized (Gordon, 2015).

Despite such challenges, the different patterns of associations across treatment groups provide insights into how parent-reported measures may change through different treatment approaches. This is highlighted by the contrasting patterns of associations of increased restriction in PGNB (increased consumption of pizza and hamburgers) and ST (decreased consumption of pizza and hamburgers). The findings for ST align with a proposed model by which parental restriction and monitoring of obesogenic foods relate to children's decreased consumption of these foods. Because ST was less effective in improving child weight status, such associations may only reflect increased knowledge on matters of nutrition and socially desirable responses, considering the focus of ST on lifestyle modification and the provision of information about *what* would be healthy/unhealthy to consume/not consume.

The associations for PGNB may reflect *how* parent-child dynamics shift after a parenting program not solely focused on food and nutrition. In PGNB, increased restriction and pressure to eat were associated with both increased consumption of healthy foods (fruits and vegetables) and increased consumption of energy-dense foods (pizza and hamburgers and cookies and buns). Parents who attended the program (without receiving booster sessions) may have become more attuned to what their children ate (child food intake), adjusting their feeding practices accordingly. As children grow older they tend to become more food responsive, and thereby increase their obesogenic food intake. At the same time, children appear to become pickier with food, possibly following a normal developmental trajectory. It is possible that in PGNB, parents reporting increasing restriction (or monitoring) along with increasing pressure to eat (which may focus on 'healthier' food items, like vegetables) were responding to developmental changes in children's appetites (Ashcroft, Semmler, Carnell, van Jaarsveld, & Wardle, 2008; Ek, et al., 2016). Data from the ML study indicated that, following the parenting program, children with high levels of picky eating at baseline reduced their weight status over 12 months to a lower degree than non-picky eaters (Sandvik, et al., 2019). Thus, introducing an assessment of child characteristics, such as appetite traits, at baseline, might help to tailor treatment to families' needs. Taken together, the findings suggest that tailored treatment approaches may be more suitable to address high consumption of certain energy-dense foods and/or the low consumption of healthier foods. These findings are unexpected in light of the null associations found in PGB, which is contrary to our hypotheses. Greater child weight loss in this group cannot be explained by the associations between changes in parental feeding practices and changes in child food intake presented in this paper. Such null findings in PGB reflect that parental feeding practices, child weight status, and child food intake were not correlated at the different time points (data not shown). It is possible that general parenting strategies, which reflect the sustained focus on general parenting in PGB, and/or aspects of dietary intake not measured in the study, e.g. portion sizes, may explain the effectiveness of the PGB. Alternatively, parents in PGB who were actively involved for the entire follow-up period became increasingly aware of their parenting practices and their child's behavior, which may have resulted in null associations between those over time.

Regarding the third study objective, our hypothesis was not confirmed and parental feeding practices at baseline did not influence the effect of treatment on child weight status in either mother-child or father-child dyads. In contrast, a study by Epstein, et al. (2008) found that higher restriction at baseline predicted more favorable child weight outcomes for the treatment group that focused on replacing energy-dense foods with healthier alternatives, compared to treatment that only focused on reducing energy-dense foods. This may be because parents who exerted more control over child feeding at baseline continued to apply the same practices during treatment. As a result, they were able to implement positive changes in child food intake, as directed by the intervention, to influence child weight status. While the intervention described by Epstein et al. (2008) exclusively focused on dietary changes without addressing parenting, in the ML study, we have focused on evidence-based parenting practices, such as how to use effective limit setting strategies and how to handle a power struggle with one's child. Since parental feeding practices did not differentially change over time across treatment groups, we could not provide evidence that they mediated treatment effects. However, the children's weight status in the ML study may have been influenced by how general parenting strategies, including parental feeding practices, changed over time (mediating effect) rather than by baseline levels of parental feeding practices (moderating effect).

4.1 Future studies

Although PGB was more successful in decreasing child weight status (Ek, et al., 2019), in the present study we found that changes in feeding practices did not differentially predict changes in child food intake in PGB. Examining potential changes in more general parenting skills may shed light on the greater decreases in child weight in this group. Because feeding practices have considerable stability over time, general parenting might not influence parental feeding practices in a measurable way (Duncanson, Burrows, & Collins, 2016; Powell, Farrow, Meyer, & Haycraft, 2018), and might instead moderate the effects of feeding practices on child eating patterns (Rodenburg, Kremers, Oenema, & van de Mheen, 2012; Sleddens, et al., 2014). Thus, we believe that factors related to co-parenting and the combined effects of maternal and paternal feeding practices (Pratt, et al., 2017; Tan, Domoff, Pesch, Lumeng, & Miller, 2019), as the child perceives them, warrant further investigation. In the ML study, we developed and validated an instrument to assess parenting practices and skills (unpublished data), which has the potential to provide clearer answers on how the intervention worked. Our group will address this in a future analysis.

4.2 Strengths and limitations

The main strength in our study is its diverse sample (Foster, Farragher, Parker, & Sosa, 2015). Sixty percent of mothers and fathers were of non-Swedish background; this allows for higher generalizability of the study across migrant groups, and better reflects demographic changes in Sweden and in Europe more widely. Another strength of the study is the prior validation of the CFQ in Sweden (Nowicka, Sorjonen, et al., 2014). In addition, we included a FFQ to assess child food habits, which are rarely evaluated in obesity interventions (Duncanson, et al., 2017). Placing equal focus on both mothers and fathers is also a strength. Previous research has focused on maternal feeding practices and not much is known about the effect of paternal feeding practices (Khandpur, Blaine, Fisher, & Davison, 2014; Morgan, et al., 2017). In the changing family environment, both parents/caregivers and members of the extended family need to be addressed (Eli, Howell, Fisher, & Nowicka, 2016; Niermann, et al., 2018). Our analysis, which includes mother-child and father-child dyads, is an important step in acknowledging subsystems within the family. Fathers along with mothers were involved in the parenting program, although attendance varied. This may explain why mothers responded to the questionnaires to a greater degree. No data on which caregivers attended ST are available.

The main limitation of the analysis is that power was calculated for the primary outcome of the RCT, change in child BMI SDS, and not for parental feeding practices (Ek, et al., 2015). Another limitation is missing data, which was more pronounced in fathers, for whom 61 and 89 questionnaires (35% and 51% of total sample) were missing at baseline and at 12 months post-baseline, respectively. Consequently, analyses for mother-child dyads are based on a larger sample, which may explain why some associations were found for mothers but not fathers. An alternative explanation is that mothers predominantly filled out the child background questionnaire, which included the FFQ. Mothers also assumed greater responsibility for child eating/drinking. Hence, the observed associations may reflect maternal perceptions of parent-child dynamics in feeding. Moreover, mothers and fathers with a foreign background and no university degree were twice more likely not to respond to the questionnaires. However, the rate of missing data did not differ across treatment groups. We used a listwise approach, which has further reduced statistical power. Moreover, questionnaire data were self-reported and thus social desirability bias cannot be ruled out (Farrow, Blissett, & Haycraft, 2011). Low reliability for maternal/paternal pressure to eat presents additional methodological limitations, which may relate to the non-specificity of food items in the questions about pressure to eat in the CFQ.

4.3 Conclusion

This is among the few studies to examine the effect of parental feeding practices on child food intake and weight status after obesity treatment among preschoolers. Neither changes in feeding practices nor changes in child eating patterns could explain why the parent group with boosters was more effective in reducing children's weight status in the ML study. Because intermediary processes involving parenting practices and parent-child interactions may be important, future studies should examine whether general parenting practices moderate the effect of feeding practices on child weight status. Moreover, from a methodological point of view, our results suggest that instruments that include more nuanced categories for feeding practices should be considered in future research.

Abbreviations

CFQ: Child Feeding Questionnaire; FFQ: Food Frequency Questionnaire; BMI SDS: Body Mass Index; SD: standard deviation; RCT: Randomized Controlled Trial; ML: the More and Less study

Acknowledgements

We want to thank all participating families, child health care and school nurses and all personnel involved in the standard treatment offered in the pediatric outpatient clinics. We also thank Sofia Ljung, Jonna Nyman, Mahnoush Etminan Malek, Karin Nordin, Kathryn Lewis Chamberlain, Jan Ejderhamn, Philip A. Fisher, Patricia Chamberlain and Claude Marcus who were involved in the ML study's design or data collection.

Authors' contributions

PN conceived the study, designed the statistical approach together with MS and supervised the coordination of the study and manuscript process. MS performed the statistical analyses with guidance from KS and drafted the initial manuscript. KS and KE interpreted data and edited the manuscript. AE and PS made a substantial contribution to conception and design, data collection and to interpretation of data. All authors contributed to reviewing and approving the final manuscript.

Declarations of interest

None

Funding

This study was supported by the Swedish Research Council (2014-02404), Karolinska Institutet Doctoral Funds, the Swedish Society of Medicine, VINNOVA (2011-3443), Jerring Foundation, Samariten Foundation, Magnus Bergvall Foundation, Ingrid and Fredrik Thuring Foundation, Helge Ax:son Foundation, Crown Princess Lovisa Foundation, Foundation

Frimurare Barnhuset in Stockholm, Foundation Pediatric Care, Foundation Martin Rind, Jane and Dan Olsson Foundation, Groschinsky Foundation, Sigurd, Elsa Golje Memory Foundation and iShizu Matsumurais Donation and Foundation Tornspiran. The funding sources had no role in the study design, collection, analysis or interpretation of the data, writing the manuscript, or the decision to submit the paper for publication.

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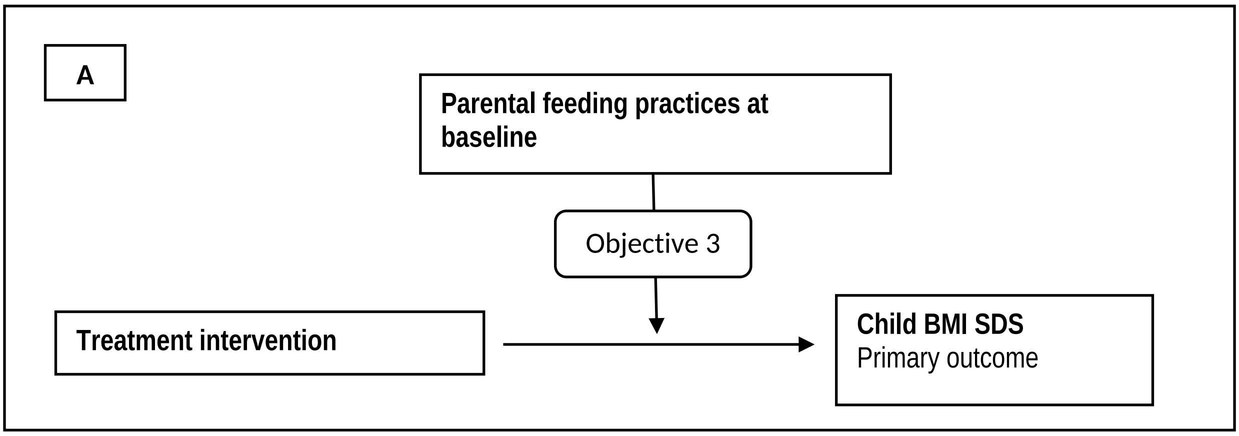
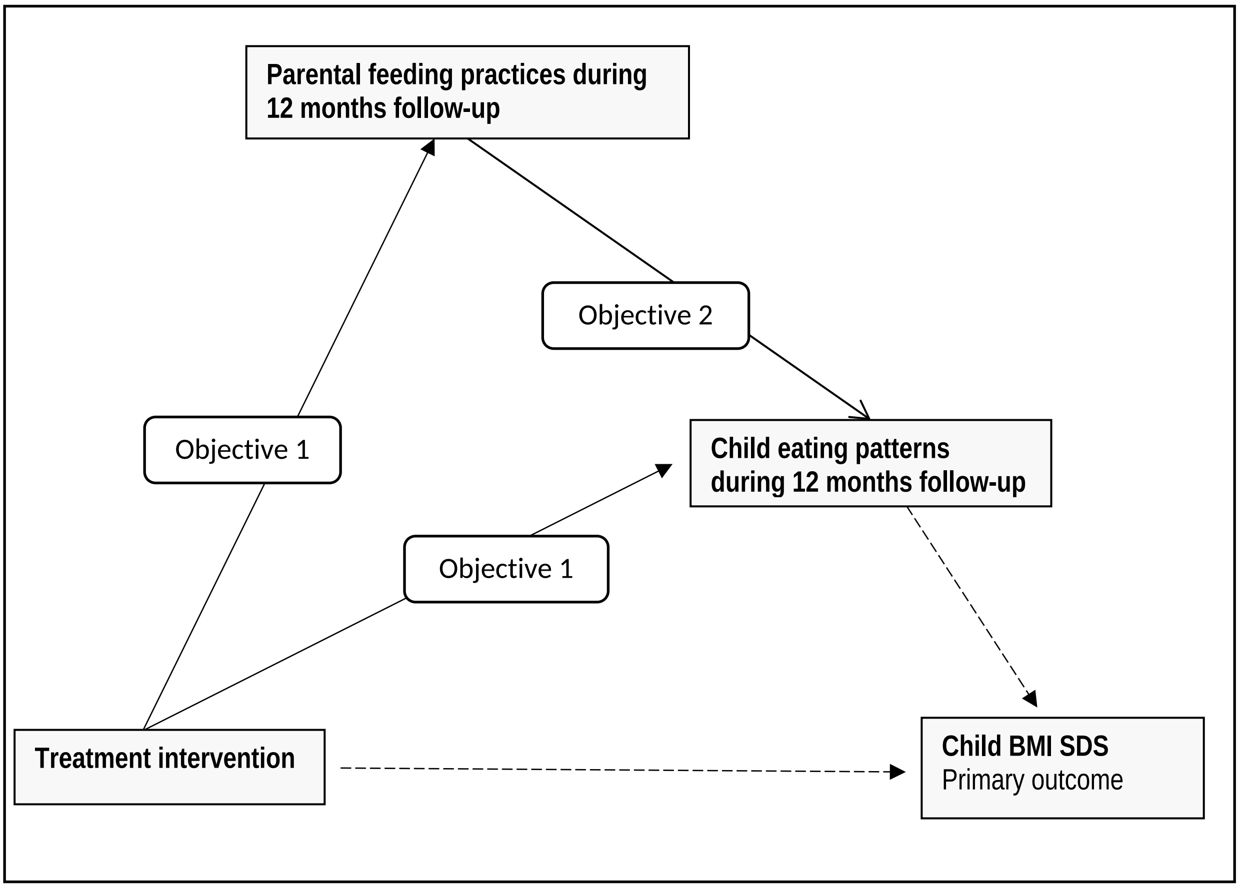

A
Parental feeding practices at baseline
Objective 3
Treatment intervention
Child BMI SDS
Primary outcome


Parental feeding practices during 12 months follow-up
Objective 2
Objective 1
Child eating patterns during 12 months follow-up
Objective 1
Treatment intervention
Child BMI SDS
Primary outcome

Ethical statement

The More and Less study (ML study) described in the attached manuscript was approved by the ethics committee in Stockholm, Sweden on November 16th 2011 (dnr: 2011/1329-31/4). All participating caregivers provided written informed consent on behalf of their children.