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Associations between child weight and maternal feeding styles are mediated by maternal perceptions and concerns

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Abstract

Objective—To determine whether controlling parental feeding practices are associated with children's adiposity and test the hypothesis that any associations are mediated by maternal perception of their child's weight.

Method—Children aged 7-9 yrs (n=405) were weighed and measured at school as part of the Physical Exercise and Appetite in CHildren Study (PEACHES). Adiposity was indexed with BMI SD-scores. The Child Feeding Questionnaire (CFQ) was completed by 53% of mothers of participating children (n=213). Mothers reported whether they thought their child was overweight, normal weight or underweight, and rated their concern about future overweight on a 5-point scale.

Results—Higher child adiposity was associated with lower 'pressure to eat' and higher 'restriction' scores. Restriction increased linearly with maternal concern about overweight, and maternal concern about overweight fully mediated the association between child adiposity and restriction. Use of pressure increased as mothers perceived their child to be thinner, but perceived weight did not mediate the association between child weight status and maternal pressure to eat. Monitoring was not associated with child adiposity, maternal perception of weight or concern about overweight.

Conclusion—Restriction appears to be a consequence of mothers' concern about their child becoming overweight rather than a cause of children's weight gain. Pressure may be a more complex response that is influenced by the desire to encourage consumption of healthy foods as well as ensure adequate energy intake and appropriate weight gain.

Keywords

BMI; feeding; concern; adiposity; parents

Controlling feeding practices have been hypothesised to have negative consequences for children's weight trajectories by disrupting self-regulation of food intake (Birch et al., 2003; Birch and Fisher, 1998; Costanzo and Woody, 1985; Farrow and Blissett, 2008; Johnson and Birch, 1994; Orrell-Valente et al., 2007). The feeding practices that have received particular attention are 'pressure to eat' (either towards overall consumption or just 'healthy' foods), and 'restriction' which is generally directed towards limiting the child's intake of unhealthy (or snack) foods (Birch et al., 2001; Faith et al., 2004).

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Pressure to eat is hypothesised to promote eating beyond satiety, which may teach children to ignore internal satiety signals and could ultimately result in positive energy balance and weight gain (Johnson and Birch, 1994). Observational studies have shown that pressuring strategies are associated with higher energy intake at a meal (Campbell et al., 2006; Fisher et al., 2002) and faster eating (Iannotti et al., 1994), although the effect was reversed in one study that adjusted for duration of eating (Drucker et al., 1999). However, pressuring feeding strategies are typically associated with *lower* not higher adiposity in children (Carnell and Wardle, 2007; Keller et al., 2006; Matheson et al., 2006; Spruijt-Metz, 2002). Rather than assume that pressuring results in lower weight, one explanation may be that mothers exert pressure when they perceive their child to be underweight or to have a small appetite.

Restrictive feeding practices have also been hypothesised to play a role in weight gain during childhood. Experimental studies that manipulate access to snack foods have shown that children consume more of a previously restricted snack food than an unrestricted snack food when both are made freely available (e.g. Fisher and Birch, 1999a; Fisher and Birch, 1999b). In observational studies, a positive association between maternal restriction and child weight has been reported in some samples (Fisher and Birch, 1999b; Francis et al., 2001; Keller et al., 2006; Lee et al., 2001; Moens and Braet, 2007), but where participants were from socio-economically and ethnically diverse populations, no association was found (e.g. Carnell and Wardle, 2007; Montgomery et al., 2006; Powers et al., 2006). Cultural variation in attitudes to weight might explain these discrepancies; for example, lower adherence to western cultural ideals of thinness may minimize the use of restriction.

Despite inconsistencies in the evidence, the causal pathway is often regarded as running from parent to child, with parental feeding practices assumed to affect the child's weight status (Birch et al., 2001; Clark et al., 2007). However, it is equally likely that children's characteristics – or parents' perceptions of those characteristics - influence the way the parent feeds their child as part of their effort to maximize the child's health and wellbeing. In this case, maternal perception of the child's weight could be predicted to mediate the association between feeding practices and children's weights because parents could be trying to increase food intake in children perceived to be underweight and restrict intake in children perceived to be overweight. In a recent UK study of 6-11yr olds, parents increased their use of restrictive feeding practices after receiving feedback of their child's overweight status (Grimmett et al., 2008), suggesting that perception of the child's (over)weight status can elicit practices aimed at reducing the child's intake of unhealthy foods.

Weight perception alone might not alter parental feeding styles if parents are not concerned about weight. Parents of overweight and obese children typically report relatively low levels of concern about their child's current weight (e.g. Etelson et al., 2003; Gray et al., 2007; May et al., 2007), although they are more concerned about their child becoming overweight in the future (Campbell et al., 2006; Carnell et al., 2005; Francis et al., 2001). These observations suggest that maternal concerns about overweight (either in the present or the future) might be another mechanism linking child weight to maternal feeding practices.

The aim of this study was therefore to test the hypothesis that the association between child weight and controlling parental feeding practices is mediated by parents' perceptions of weight or concern for child overweight.

Methods

Participants

Following ethical approval from the University College London Ethics of Non-National Health Service Human Research Committee, 531 families with children aged 7-9 years from five London schools were invited to take part in the Physical Exercise and Appetite in CHildren Study (PEACHES). This is a longitudinal study of the associations between eating behaviours, physical activity and adiposity during childhood. Analyses for the present study are based on data collected at baseline. Parental consent for anthropometric measurements was given for 405 (79%) children. Parents were sent a questionnaire that included measures of attitudes to their child's weight and their feeding practices. There was a 60% return rate (n=244), with the majority of respondents being mothers (n=213). Because mothers have been reported to feed differently to fathers (Blissett et al., 2006), analyses were restricted to mothers for homogeneity of the sample.

Measures

Maternal socio-demographic information—Parents' were asked to indicate their highest level of education (in the UK system) using seven response options ('no qualifications', 'O-level/GCSE/equivalent', 'vocational', A-level/equivalent', 'bachelor degree/equivalent', 'higher degree' and 'other, please state'). These were combined as 'GCSEs and below' and 'A-levels/vocational and above' for analysis. Ethnicity was reported using 11 response options based on 1991 UK census (1991 Census, Crown Copyright, ESRC purchase), but because of the diversity of the non-white groups, subdividing the sample into different ethnic sub-groups produced very small samples, and so ethnicity was dichotomised into 'white' and 'non-white' for these analyses.

Maternal feeding practices—Maternal feeding practices were assessed with the Child Feeding Questionnaire (CFQ; Birch et al., 2001), which has three subscales assessing 'pressure' (e.g. 'If my child says "I'm not hungry" I try to get him/her to eat anyway'), 'restriction' (e.g. 'I have to be sure that my child does not eat too many high fat foods'), and 'monitoring' (e.g. 'How much do you keep track of the snack food (e.g. crisps, cheesy crackers) that your child eats?'). Response options were 'never,' 'rarely', 'sometimes', 'often', and always' for the pressure to eat and monitoring scales, and 'disagree', 'slightly disagree', 'neutral', 'slightly agree', and 'agree' for the restriction scale. Mean scale scores were computed if at least 70% of the items were completed (Tabachnick and Fidell, 1996).

Maternal perception of weight and concern about overweight—Each mother's perception of her child's weight was assessed using one item: 'How would you describe your child's weight at the moment', with response options of: 'very underweight,' 'underweight', 'normal', 'overweight' and 'very overweight'. Concern about overweight was assessed using the item: 'How concerned are you about your child becoming or remaining overweight in the future', with response options on a 5-point scale: 'unconcerned', 'a little concerned', 'concerned', 'fairly concerned,' 'very concerned'. Both items have been used with parents of children of a similar age (Grimmett et al., 2008; Carnell et al., 2005).

Children's anthropometry—Children were weighed and measured in a private space at school by trained researchers using standardised procedures. Height was measured to the nearest millimetre using a freestanding stadiometer (Leicester height measure, SECA, Birmingham, UK), and weight (kg) to the nearest 0.01 kilogramme using the Tanita TBF-300MA Body Composition Analyser (Tanita corporation, Japan). Inter-rater reliability

in a sub-sample of 30 children was high for weight (r=1.0) and height (r=0.99). Information on age and sex was obtained from the school.

Data treatment and statistical analysis

Body Mass Index (BMI: kg/m^2) was calculated and converted into age- and sex-adjusted standard deviation scores (BMI SD-score) according to 1990 British reference data (Cole et al., 1995) using the Imsgrowth macro (http://homepage.mac.com/tjcole). BMI SD-scores were grouped into four weight categories based on the International Obesity Taskforce (IOTF) criteria for healthy-weight, overweight and obesity (Cole et al., 2000), and the recently proposed criteria for underweight (thinness grades 1, 2 or 3) (Cole et al., 2007). In addition, the healthy-weight group was subdivided into 'lower-healthy-weight' (≤50th centile) and 'higher-healthy-weight' (>50th centile but not meeting criteria for overweight) to create an additional sub-division of largest sub-group. Because of small numbers in the obese category, obese and overweight were combined into an 'overweight/obese' category.

No mother perceived her child as either 'very underweight' or 'very overweight', so just three categories of perceived weight (underweight, normal weight, overweight) were used in all analyses. Relatively few mothers (n=30) were 'concerned', 'fairly concerned' or 'very concerned' about their child's weight, so these categories were combined to form a single category named 'concerned' (vs 'a little concerned' or 'unconcerned'). Analyses were done using SPSS v 14.0 (SPSS Inc., Chicago, IL).

The patterning of each maternal feeding practice across weight groups was examined using trend analysis in SPSS one-way ANOVA, both unadjusted and adjusted for demographic factors (child sex and age, maternal ethnicity and education). Because the weight distribution was similar to UK norms (HSE, 2006, www.data.archive.co.uk), weighted rather than unweighted linear terms were used in all trend analyses, derived from SPSS one-way ANOVA. Similarly, the patterning of each feeding practice across weight perception groups and weight concern groups was examined using trend analysis both unadjusted and adjusted for socio-demographic factors (child sex and age, maternal ethnicity and education) to determine the suitability for correlation analyses.

Pearson's bivariate correlations were run to test the first three (of four) steps in mediation analysis: (a) that the predictor (BMI-SD-score) is associated with the outcome (feeding practices) (b) that the predictor is associated with the mediators (perceptions or concerns), and (c) that the mediator is associated with the outcome. To quantify the predictive value of BMI SD-score and perceptions and concerns on maternal feeding practices, and of BMI SD-score on perceptions and concerns, variables that were significantly correlated were entered into separate regression models. To test step four of the mediation analysis, child BMI SD-score (the predictor variable) must significantly predict maternal feeding style (outcome variable) in the absence of perceptions/concerns about child weight (mediator variables) and perceptions/concerns should be associated with both predictor and outcome variables. Mediation is assumed if the association between the predictor and the outcome is significantly reduced by inclusion of the mediator in the regression model (Baron and Kenny, 1986). In this case, if the association between child adiposity and maternal feeding style is reduced when maternal weight perception or concern is added into the regression model, perceptions and concerns are implicated as mediators. As a stronger test of mediation, the Preacher and Hayes' (2004) bootstrapping approach to the Sobel test (Sobel, 1982) was used to demonstrate the significance of an indirect effect of adiposity on maternal feeding styles via perceptions and concerns.

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Results

Maternal and child characteristics are shown in table 1. As intended in the sampling procedure, there was high ethnic diversity with 38% of mothers classified as non-white; compared with national statistics (ONS, 2005, www.ons.gov.uk). There were no significant differences in children's characteristics betwee those whose parents responded or did not respond to the parental questionnaire. Differences in BMI SD-scores between boys and girls approached significance (t=(211)1.89, p=.06), with girls (M=−.07, SD=1.29) being slightly thinner than boys (M=.26, SD=1.28). Prevalence of overweight and obesity (16%) was lower than the general population (33%) (www.dh.gov.uk), which may be due to families with heavier children choosing not to participate in the study.

Trend analysis: Maternal feeding practices across child weight groups

Linear trend analysis demonstrated a significant negative trend across child weight groups for 'pressure to eat' in the adjusted (F(3,190)=3.78, p=.012) and unadjusted models (F(1,208)=6.93, p=.003), and a significant positive trend across weight groups for 'restriction' in the adjusted (F(3,189)=2.95, p=.034) and unadjusted models (F(1,206)=6.25, p=.01). No significant trends were found for 'monitoring' across the weight groups in either unadjusted or adjusted models. Mean CFQ subscale scores by child weight group are presented in figure 1.

Maternal perceptions and concerns by child weight category are presented in table 2. Most mothers (n=169) perceived their child to be 'normal weight'. Only 41% of underweight children were perceived as underweight, and only 44% of overweight or obese children were perceived as overweight. For concern about overweight, 50% of mothers of children classified as overweight/obese were concerned or very concerned about their child staying or becoming overweight in the future.

Trend analysis: Maternal perceptions and concerns across child weight groups

There was a significant linear trend for perceived weight across child weight groups in unadjusted (F(1,209)=76.69, p<.001) and adjusted (F(3,188)=28.51, p<.001) analyses, indicating that although mothers' perception of their child's weight was often incorrect, relative perception was correct. Concern about overweight showed a significant linear trend across child weight groups in the unadjusted (F(1,209)=33.48, p<.001) and adjusted models (F(3,202)=17.49, p<.001).

Trend analysis: Maternal feeding practices across child weight perception and concern groups

Mean CFQ subscale scores across categories of perceived weight and concern for overweight are illustrated in table 3. There was a significant linear trend for 'pressure to eat' across perceived weight categories in the adjusted (F(2,188)=4.79, p= .009) and unadjusted models (F(1,208)=11.15, p=.001), with lower use of pressure for children who were perceived to be more overweight. No significant trends were found for restriction or monitoring across perceived weight groups.

There was a significant linear trend for 'restriction' across categories of concern about overweight in both unadjusted (F(1,206)=21.24, p<.001) and adjusted models (F(2,188)=9.60, p<.001), with restriction increasing among mothers who were more concerned about overweight.

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Mediation analysis

Table 4 illustrates the bivariate correlations between BMI SD-score, perceptions, concerns and maternal feeding practices. BMI SD-score, perception of child weight and maternal pressure to eat were intercorrelated, as was BMI SD-score, concern and restriction; fulfilling the criteria to test mediation and were taken forward into two separate mediation analyses. Monitoring was not included, because it was not associated with BMI SD-score or mediators.

Linear regression analysis showed that BMI SD-score significantly predicted 'pressure to eat' (β=0.23, p=.001), restriction (β=.16, p=.02), concern about weight (β=.39, p<.001), and perception of weight (β=.56, p<.001). Perception of weight significantly predicted 'pressure to eat' (β=−.023, p=.001), and concern about overweight significantly predicted 'restriction' (β=.31, p<.001) [1].

Following Baron and Kenny's criteria (Baron and Kenny, 1986), mediation analysis was appropriate for 'pressure to eat' and 'restriction'. 'Restriction' was the only feeding practice significantly associated with both child weight group and maternal concern about overweight, and 'pressure' was the only feeding practice associated with both child weight group and perception of child weight. Table 5 presents results of change in associations between BMI SD-score, and maternal feeding practices upon the addition of maternal perceptions or concerns.

When concern for child overweight was added into the regression model, the association between child BMI SD-score and 'restriction' became non-significant (β=.04, p=.44), but concern remained a significant predictor (β=.30, p<.001), with the full model explaining 9.9% of the variance. Using bootstrapping, the Sobel test confirmed the significance of an indirect effect of the association between child adiposity and restriction (z=3.29, p=.001), indicating that maternal concern about child overweight mediates the relationship between the child's actual weight and parental use of restrictive feeding.

When perception of child weight was added to the model to predict 'pressure to eat', the effect was reduced, but the association between child BMI SD-score and pressure remained significant (β=−.17, p=.04) with the full model explaining 7.1% of the variance. The Sobel test did not demonstrate a significant indirect effect.

Discussion

This study demonstrated that mothers' concern about their child's weight significantly mediated the association between their use of restrictive feeding practices and their child's adiposity. This supports our hypothesis that restriction is more likely to be a response to maternal concern about overweight than a cause of weight gain. Consistent with previous findings (Blissett et al., 2006; Carnell and Wardle, 2007; Spruijt-Metz et al, 2002), child adiposity was inversely associated with the 'pressure to eat' feeding style, but neither maternal perception of the child's weight, nor their concern about their child being overweight in the future mediated this effect.

That maternal concern about child overweight mediates the association between child adiposity and 'restriction' suggests a plausible causal relationship: mothers who are not concerned about their child staying or becoming overweight in the future see no need to restrict their child's intake of unhealthy foods, while concerned mothers limit their child's intake in an attempt to control weight gain. Restriction may therefore be a *result* of maternal

[1]Carrying out each analysis by sex separately gave comparable results, so findings are presented on the full sample.

concern rather than a *cause* of weight gain. The cross-sectional nature of our study means causality is only implicated, not confirmed, but some support comes from a longitudinal study of 7-14 yr old African- and White-American children in which maternal concern about child weight was associated with lower increase in fat mass 3 years later (Spruijt-Metz et al., 2006). If maternal concern results in greater control in child feeding, this may be protective against childhood weight gain.

Perceptions of child weight did not fully mediate the association between child adiposity and pressure to eat, but there was little variation in mother's perception of their child's weight with most mothers perceiving their child as normal-weight. However, concern for overweight also did not mediate the association between child adiposity and pressure to eat. Previous research in a sample of mothers and their infants (n=634) showed that maternal concern about their child being underweight was associated with pressure to eat (Baughcum et al., 2001); suggesting that mothers who perceive their child as underweight use more pressuring strategies. A similar trend across perceived weight groups was found in the present study. A more sensitive measure of concern for underweight might help test whether 'pressure to eat' is, like 'restriction, also a child-responsive parental feeding practice, rather than accepting the more unlikely hypothesis that pressure to eat is protective against weight gain. However, pressure is more likely to be related to diet quality generally than weight specifically because it is often exerted to ensure that healthy foods are consumed. Mothers who are worried about the quality of their child's diet might also be expected to exert more pressure, but perceptions of diet quality were not assessed in this study.

One limitation of this study is that the measurement of maternal concerns was limited to a single question asking about both current and future weight concerns. It is therefore not possible to know whether the concern was about either current or future overweight or a combination of the two. Furthermore, maternal concerns are likely to extend beyond weight to include the child's eating and activity patterns. Studies assessing the influence of such concerns on controlling feeding practices and their future consequences on children's weight are needed. There was limited variance in the measure of maternal perceptions and concerns, making it necessary to combine response options into three categories, and thereby lose detail. Another limitation is the cross-sectional nature of this study, precluding causal inference. In these analyses, the child's body size (BMI SD-score) was treated as the independent variable rather than outcome, but the alternative model in which concern causes restriction and thereby weight gain cannot be ruled out. Other possible interpretations, such as overlap of the concern and restriction categories, or that another untapped variable is relevant to how parents feed their children, may account for the findings. Importantly, the current study has identified a significant mediating factor in the relationship between child adiposity and parental feeding practices proving the need for further research. Because PEACHES is a longitudinal study, future work will be able to assess longitudinal associations between child weight, maternal concern and maternal feeding practices, allowing more explicit testing of causal relationships. Another weakness is that the sample was lean relative to the wider population; which we believe to be due to heavier children electing not to participate. However, a greater spread across the weight trajectory should strengthen rather than weaken the associations observed here. The socio-economic and ethnic diversity of the sample is a strength, allowing greater generalisability of the findings.

Our results indicate that attributing overweight to excessive maternal control in feeding, in particular to mothers' use of restriction, is unjustified. Mothers appear to adopt specific restrictive feeding strategies in response to their concerns about their child's weight. Instead of blaming parents for influencing childhood weight through detrimental feeding practices, future work should explore maternal concerns and beliefs about feeding in more detail, and identify the type and degree of control that is effective for optimal diet and growth.

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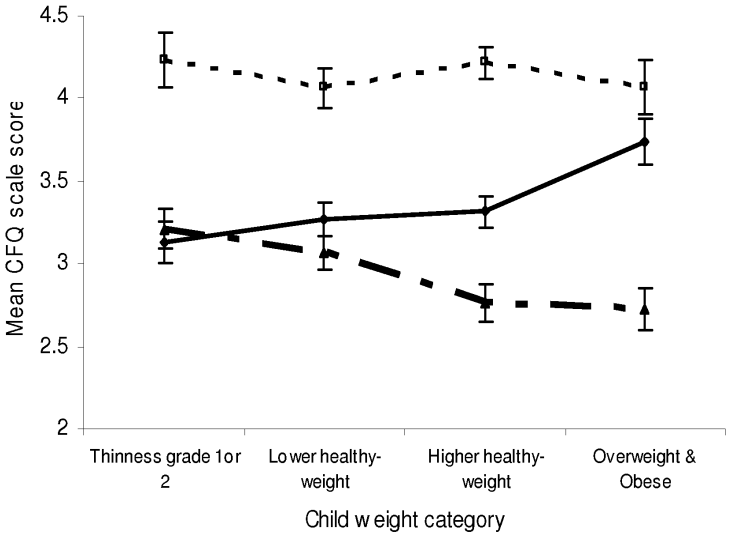

Figure 1.

Mean maternal feeding score by child weight category (adjusted for maternal education, ethnicity, child age and sex).

CFQ scales

Pressure

Monitoring

Restriction

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Table 1

Mother and child characteristics in the sample

	N	% (unless stated)
Maternal characteristics		
Age mean (sd)	203	38.8 (6.3)
Ethnicity *		
White	133	62.4
Non-white	80	37.6
Black and mixed black	31	14.6
Asian/mixed Asian	38	17.8
Other	11	5.2
Highest educational qualification		
% GCSEs/equivalent or below	73	34.3
% A levels/equivalent or above	126	59.2
Missing	14	6.6
Child characteristics		
Sex		
Female	103	48.4
Male	110	51.6
Age mean (sd)	213	8.3 (.63)
Height (cms) mean (sd)	213	130.8 (.07)
Weight (kg) mean (sd)	213	28.4 (6.2)
BMI (kg/m^2) mean (sd)	213	16.4 (2.5)
BMI s.d. score mean (sd)	213	.10 (1.3)
Weight group		
Underweight	28	13.1
Lower healthy-weight	75	35.2
Higher healthy-weight	76	35.7
Overweight	26	12.2
Obese	8	3.8

* 9 mothers did not report their ethnicity and so child ethnicity is used as a proxy

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Table 2

Number and percentage of children in each weight category by maternal perception and concern groups (n=210).

	Child's measured weight status			
	Underweight (n=27)	**Lower healthy-weight (n=75)**	**Higher - healthy weight (n=74)**	**Overweight/ Obese (n=34)**
Maternal perception of child's weight status	**n (%)**	**n (%)**	**n (%)**	**n (%)**
Underweight (n=25)	11 (40.7)	10 (13.3)	4 (5.4)	-
Normal weight (n=169)	16 (59.3)	65 (86.7)	69 (93.2)	19 (55.9)
Overweight (n=16)	-	-	1 (1.4)	15 (44.1)
Maternal concern for child staying or becoming overweight in the future	**n (%)**	**n (%)**	**n (%)**	**n (%)**
Unconcerned (n=94)	19 (70.4)	47 (62.7)	26 (35.1)	2 (5.9)
A little concerned (n=64)	5 (13.3)	18 (24.0)	26 (35.1)	15 (44.1)
Concerned/very concerned (n=52)	3 (11.1)	10 (13.3)	22 (29.7)	17 (50.0)

Table 3

Mean CFQ subscale scores across perceived weight and concern for overweight categories*

	Restriction	Pressure	Monitoring
Perceived weight (n=210)	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**
Underweight (n=25)	3.4 (.75)	3.4 (.75)[1]	4.2 (.96)
Normal weight (n=169)	3.3 (.90)	2.9 (.90)	4.2 (.93)
Overweight (n=16)	3.6 (.83)	2.5 (.83)	4.0 (1.0)
Concern about overweight (n=210)			
Unconcerned (n=94)	3.10 (.78)[2]	3.04 (.86)	4.2 (.83)
A little concerned (n=86)	3.41 (.82)	2.83 (.87)	4.1 (.98)
Fairly – very concerned (n=30)	3.97 (.14)	3.02 (1.07)	4.2 (1.1)

*Shaded columns indicate a significant linear trend.

[1]Pressure-perception of weight linear trend : unadjusted ($F(2,188)=4.79$, $p= .009$) and adjusted model ($F(1,208)=11.15$, $p=.001$)

[2]Restriction-concern about overweight: unadjusted ($F(1,206)=21.24$, $p<.001$) and adjusted model ($F(2,188)=9.60$, $p<.001$)

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Table 4

Correlation matrix of the associations between BMI SD-score (predictor), perceptions and concerns (mediator), and maternal feeding practices (outcome).

	1	2	3	4	5	6
1. Pressure	-					
2. Monitoring	−.15*	-				
3. Restriction	.14*	−.01	-			
4. Concern	.03	−.02	.31**	-		
5. Perception	−.23**	−.05	.05	.23**	-	
6. BMI SD-score	−.23**	.02	.16*	.39**	.56**	-

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Table 5

Linear regression results of the effect of maternal concern or perception of overweight on the association between child BMI SD-score and maternal feeding practice.

Variable			Standardised β		Unstandardised B (SE)		R^2
Predictor (x)	Mediator (m)	Outcome (y)	β (x)	β (m)	B (SE) (x)	B (SE) (m)	
BMI SD-score	-	Restriction	.16	-	0.10(.05)	-	0.026
BMI SD-score	Concern	Restriction	.04	0.3	0.02 (.05)	0.35 (.09)	0.099
BMI SD-score	-	Pressure	−.23	-	−0.16(.05)	-	0.055
BMI SD-score	Perception	Pressure	−.17	−0.13	−0.12 (.06)	−0.27 (.17)	0.071