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# Controlling and less controlling feeding practices are differentially associated with child food intake and appetitive behaviors assessed in a school environment

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## Summary

**Background:** Child food intake and appetitive behaviors show an inconsistent pattern of associations with parental feeding practices. Relationships likely vary depending on parent feeding style, and on the method by which child eating behaviors are measured.

**Objectives:** We tested relationships of controlling and less controlling forms of parental promotion and limitation of eating with food intake and appetitive behaviors assessed in preschoolers' normal school environments.

**Methods:** As part of a 5-day protocol, preschoolers consumed standardized lunches, and caloric compensation, eating rate and eating in the absence of hunger were assessed. Feeding practices were measured using the Child Feeding Questionnaire (CFQ) and Parent Feeding Styles Questionnaire (PFSQ). CFQ-Pressure to eat and CFQ-Restriction were controlling forms of promotion/limitation of child intake, and CFQ-Monitoring and PFSQ-Prompting to eat were less controlling forms.

**Results:** Children (3–5y, $n$ = 70) of parents with higher CFQ-Pressure to eat scores showed lower total intake, consuming significantly fewer calories from bread, snacks and fruits and vegetables. Higher PFSQ-Prompting to eat was associated with lower fruit and vegetable intake only. CFQ-Restriction and CFQ-Monitoring scores were unassociated with food intake. Higher CFQ-Pressure to eat was associated with slower eating rate, while higher CFQ-Monitoring was associated with lower intake in absence of hunger.

**Conclusions:** Parental promotion and limitation of intake were associated with preschoolers' eating behaviors assessed in an ecologically valid setting, without parents present. Controlling and less controlling forms showed differential patterns of associations. Results were consistent with child-to-parent and parent-to-child effects, but research using longitudinal designs is needed to test bidirectional relationships.

KEYWORDS
appetitive trait, controlling and less controlling feeding, dietary intake, food parenting, meal tests

  

## 1 | INTRODUCTION

Family or home environments play a vital role in child development. Thus, family food environment factors such as parents' direct attempts to encourage children's intake of healthy foods or limit intake of unhealthy foods have unique potential to influence children's dietary intake[1] and appetitive behaviors.[2] This is particularly true when children are of preschool age and often in the presence of their parents.[3] Parents frequently make attempts to promote children's intake and to limit children's intake. However, promoting and limiting practices exist on a continuum progressing from controlling, non-responsive behaviors to less controlling, more child-responsive, behaviors.[4] To understand the long-term implications of these different types of promotion and limitation for child obesity risk, it is important to investigate their impact on eating behaviors in children. In particular, we need to understand their effects in situations where the parent is absent and thus unable to directly influence intake, since the frequency of such situations will increase through development.

Parental promotion of intake normally has the goal of increasing intake of meal-time foods considered to be more healthy. However, it can be enacted in more and less controlling ways.[5] For example, the commonly used Child Feeding Questionnaire (CFQ) scale "Pressure to eat",[6] assesses a rather demanding and inflexible (i.e. controlling) form of promotion of intake. Notably it also captures perceived parental responding to low child appetite (e.g., *If I did not guide or regulate my child's intake he would not eat enough*). In contrast, the less commonly used Parent Feeding Styles Questionnaire (PFSQ) scale "Prompting to eat",[7] assesses a less intrusive negotiation of child's food consumption that is more covert and child-responsive, containing elements of autonomy support (e.g. *I praise my child if s/he eats what I give him/her*) as well as structure (e.g. *I present food in an attractive way to my child*)[4] (i.e. less controlling form). Parental limitation of intake constitutes an attempt to decrease children's consumption, typically of high-energy nutrient-poor snack foods. However, parents' attempts to limit the child's food consumption can also vary. For example, items included in the commonly-used CFQ-Restriction scale,[6,8] suggest a rigid form of control (i.e. controlling), as well as the perception of responding to avid appetite in children (e.g. *I have to be sure that my child does not eat too many high fat foods*). In contrast, the CFQ-Monitoring scale (e.g. *How much do you keep track of the sweets that your child eats?*), suggests more subtle methods with a focus on structural rather than coercive limitations (i.e. less controlling form).[6] Parents largely engage in promotion and limitation behaviors with the goal of encouraging healthy eating habits and healthy food intake in children. However, influential developmentally-informed theories advanced by Leann Birch and others[1,6,9,10] have argued that controlling parent feeding practices risk counterproductive effects, with Pressure to eat potentially creating aversion to healthy foods and repressing responding to internal satiety cues, and Restriction enhancing the desire to eat unhealthy foods when available, thus resulting in poor diet quality paired with damaged satiety recognition in the child.[1]

There is evidence to support the theory that controlling parent feeding practices may have undesirable effects on children's diets. For example, a recent review concluded that, while cross-sectional results have been inconsistent, results from longitudinal and school- or laboratory-based studies converge to suggest that, in general, children exposed to more Pressure to eat or Restriction are more likely to consume unhealthy foods (i.e. sugar-sweetened beverages, palatable snack foods, calorie-dense food items) than children exposed to lower levels of food control.[11] Studies investigating the relationship of less controlling forms of promotion and limitation of eating—e.g. Prompting to eat and Monitoring—with child food intake are relatively scarce, particularly as evaluated in a school/laboratory setting without parents present. However, one study[12] found a relationship between contemporaneous observations of maternal prompting behaviors and greater caloric intake in 3.5 year-olds during a videotaped laboratory standard buffet lunch. Another[13] found that 2–4 year-old children of parents who used prompting strategies in combination with modelling during a laboratory meal test sampled more novel fruit. Together these studies support straightforward immediate effects of promoting intake, with potentially positive direct consequences for intake, depending on the food encouraged. Further, consistent with the prediction that less controlling forms of limitation should have more beneficial effects on child intake, Monitoring has been associated with lower intake of sugar-sweetened beverages assessed via 24 h dietary recall in 5–10 year-olds[14] and decreased consumption of foods high in fat, sugar and salt assessed via food frequency questionnaire (FFQ) among preschoolers[15,16] and school-aged children.[17] However, a Portuguese study including 4 year-old children reported that greater Monitoring (i.e. less controlling form of promoting intake) but also greater Restriction (i.e. controlling form of limiting intake), were associated with lower odds of fruits and vegetable consumption (assessed via FFQ) failing to meet dietary recommendations.[15] To more fully understand the impact of different types of parent feeding, studies that contrast controlling and less controlling forms of promotion and limitation, and that administer reliable assessments of children's intake in a naturalistic situation without parents present, are needed.

Parent feeding may also impact appetitive behaviors, with the potential for significant cumulative effects on long-term intake and adiposity. The majority of parent feeding studies assessing child appetite have used parent-report measures such as the Child Eating Behavior Questionnaire (CEBQ).[18] For example in a previous study using the CEBQ,[18] our group reported that Restriction was associated with greater child Food responsiveness, while parental Monitoring was not, and that Pressure to eat was associated with greater child Satiety responsiveness, while Prompting was not.[5] However, parent-report measures of child behavior are vulnerable to bias. Very few studies have examined relationships between parental feeding practices and behavioral tests of appetite including caloric compensation, eating in the absence of hunger and eating rate. Caloric compensation and eating in the absence of hunger tests evaluate how individuals react to situations in which they may overeat.[19] The caloric compensation test uses a preloading paradigm to assess the ability to regulate energy intake by compensating in one meal for calories consumed in a recent meal/snack, thus assessing an individual's modulation of intake by internal, physiological cues to hunger and satiety (e.g. gastric distension, other postingestive satiety signals).[20] Birch and Deysher performed the first study of caloric compensation in young children.[21] Eating in the absence of hunger, a behavioral test first applied in children by Birch and team, assesses intake of palatable snack foods when given simultaneous access to desirable play activities shortly after eating to satiety, thus giving an indication of the extent to which external cues drive eating in the absence of physiologic hunger.[9,22,23] Eating rate is considered an additional indicator of satiety sensitivity and appetite avidity, with slower eating and deceleration through the meal thought to indicate a stronger response to internal satiety signals, and faster eating rate thought to indicate greater motivation to eat.[24]

Extant findings for the three indices described above (i.e. caloric compensation, eating in the absence of hunger and eating rate) have been mixed, but on the whole suggest that controlling forms of promotion and limitation are associated with poorer appetite self-regulation. For example, Tripicchio et al.[25] as well as Remy et al.[19] investigated associations of *caloric compensation* with Pressure to eat, Restriction and Monitoring in twins aged 4–7 years in the laboratory and 3–6 year-olds at school, respectively. No associations were found, except for one: more Restriction was used for the poorer compensating (and therefore overconsuming) twin.[25] Notably, these two studies found no association between *eating in absence of hunger* and Monitoring. However, Liang et al. found greater Monitoring was related to a *greater* percent of total calories consumed from sweets in an eating in the absence of hunger test among treatment-seeking 7–12 year-olds with overweight or obesity.[26] With regard to Restriction, one study found no link with intake at a post-meal snack composed of different foods, among French preschool children.[19] However Restriction was associated with greater eating of snack foods in the absence of hunger in 7 and 9 year-olds,[9] and in 3–5 year-olds who were given unlimited access to snack foods in a laboratory setting following a snack restriction period.[27] While two studies found no association between Pressure to eat and eating in the absence of hunger as assessed at school[19] and in a laboratory setting[23] where no parent was present, one study found that higher scores were associated with *greater* consumption of snack foods in the absence of hunger among preschool-aged boys in a home setting where the mother was present.[28] Finally, in classic observation studies, greater observed maternal prompting behaviors have been positively correlated with child *eating rate*,[12] and the mere presence of mothers during a laboratory eating test with greater eating rate in children with obesity.[29] As with the findings above, these results suggest that promoting intake has the immediate effect of increasing intake, but do not speak to situations where the parent is absent. To our knowledge, associations of behaviorally-assessed eating rate with Pressure to eat, Restriction and Monitoring have not been investigated.

Potential sources of the variability observed in the results described above include the assessment of parent feeding practices, children's food intake and appetitive behaviors. For example, many studies, particularly those assessing associations with behavioral tests of child appetite, relied solely on sub-scales from the CFQ which assesses Pressure to eat, Restriction and Monitoring, but does not assess the less controlling form of promoting consumption.[23,28,30,31] The vast majority of studies reporting on child diet have used parent-report data (i.e. FFQ, 24 h dietary recall).[16,30,32] Parent-reports of child diet are vulnerable to recall errors and bias,[33] and are known to overestimate child consumption, particularly at preschool age.[34] Further, many of the studies utilizing behavioral tests of appetite have taken place at home or in laboratory settings.[9,35,36] The latter (laboratory meal tests) allow for controlled manipulations of different food options and enable objective, standardized comparisons of objectively measured intake, but these artificial settings could also influence children's food consumption, especially when tests are administered on just one occasion. As far as we are aware, no parent feeding studies have included multiple administrations of standardized meals containing both healthy and unhealthy foods, or multiple administrations of behavioral tests of appetite. It is also unclear if the observed associations described above translate/generalize to occasions where the parent is absent and the child can exert more autonomy, for instance within the school setting.

The present study aimed to advance understanding of relationships between parent feeding and child eating behavior by simultaneously addressing the need for studies that contrast controlling and less controlling forms of parent feeding practices, and studies that rigorously and objectively assess child eating behavior in a naturalistic environment, without the presence of the parent. To do this, we assessed controlling and less controlling forms of parental promotion and limitation of child food intake, as well as child food intake and performance on behavioral tests of appetite, in a school-based setting. Specifically, we examined intake of 3-to-5-year-old school children during five standardized, multi-item lunches over 5 weeks following different preloads, and obtained indices of caloric compensation, eating rate, and eating in the absence of hunger. We hypothesized that children experiencing controlling practices at home would show a less healthy pattern of food intake and evidence for poorer appetitive self-regulation, and those experiencing less controlling practices would show a more healthy pattern of food intake and evidence for better appetitive self-regulation. In adjusted analyses, we also explored whether parental concern relating to children's eating and weight might explain observed associations between parent and child variables. Similar to the majority of studies reviewed above, we employed a cross-sectional design, which is unable to establish causal effects and therefore does not allow definitive conclusions about whether parent feeding impacts child eating behavior as laid out in Birch's original theory. Since important recent studies have demonstrated cyclic or bidirectional relationships between parent feeding and child eating, in which parents' behavior is based on a response to children's behavior or body size,[37-41] we take care to discuss our results in context of both parent-to-child and child-to-parent interpretations.

## 2 | METHODS

### 2.1 | Overview

A total of 149 children aged 3–5 years from five London primary school classes ($n$ = 12–16 per class) participated in a 5-day eating behavior protocol taking place over 5 weeks (1-test day each week), in classrooms familiar to participating children. On day 1, children's heights, using a Leicester height measure, and weights in kilograms to one decimal place, using a TANITA digital weighing scale, were measured. Body mass index (BMI, $kg/m^2$) was calculated and converted into age- and sex-adjusted SD scores (BMI z-scores) according to 1990 British reference data.[42] On each of the 5 test days, students were given a standardized lunch, accompanied by water. Food items were weighed before and after, and start and finish times were noted. Additionally, children participated in caloric compensation Test A on days 2–3, and caloric compensation Test B on days 4–5. For these tests, children consumed a liquid preload approximately half an hour prior to the standardized lunch, with preloads differing as described below. Following Day 3, children additionally underwent an eating in the absence of hunger test. Questionnaires assessing demographic information and parental feeding practices and attitudes were distributed to parents. Further information on these measures is provided below, with additional details available elsewhere.[22,43,44]

## 2.2 | Child food intake

Food groups presented within the standardized lunches were as follows: 1) Protein: five chicken slices (Sainsbury's Chicken Slices, J Sainsbury plc), four cheese slices (Sainsbury's Medium Cheddar Slices, J Sainsbury plc); 2) Bread: three halves of white bread roll (Tesco's Bridge Rolls, Tesco plc / Sainsbury's Hot Dog Rolls, J Sainsbury plc), extra pre-weighed bread rolls were also available to ensure the children's satiety; 3) Snacks: approximately 35 g of mini cheese crackers (McVities Mini Cheddars), approximately 50 g of mini chocolate cookies (McVities Mini Chocolate Digestives); 4) Fruits and vegetables: approximately 98 g of green grapes; eight cherry tomatoes for the first class and 225 g carrot sticks for the remaining four classes (based on reports of low liking for the tomatoes by many children in the first class). Remaining weights were subtracted from original weights for each item to generate consumed volumes (g) for each item. Energy intakes (kcal) for each item were then calculated based on manufacturers' information or, where this was unavailable, on information from McCance and Widdowson's Composition of Foods (Food Standards Agency) and used to create total intake values. We also calculated mean intake values for each food group. For example, snack food intake on each test day was calculated as the mean of the total chocolate cookie intake and total cheese cracker intake for that day. Since analyses reported elsewhere[44] demonstrated high consistency of intake values by food group (ICCs 0.86–0.91), we then created mean values for total intake and for intake by food group, averaged across the 5 days of the protocol.

## 2.3 | Child appetitive behaviors

*Caloric compensation*. Children underwent caloric compensation Test A on days 2–3, and caloric compensation Test B on days 4–5. On each of these days, children were presented with a liquid preload followed by the standardized lunch described above, approximately 30 min later. However, on one day within each test, the preload had a high energy content, and on the other the preload had a low energy content (order counter-balanced). Test A used a conventional preloading paradigm such that sensory cues to energy content were disguised, with the low energy preload being 200 mL of orange-flavored beverage (5 kcal), and the high energy preload being 200 mL of the same beverage with added maltodextrin (200 kcal). Test B used a novel paradigm in which preloads were familiar beverages containing a range of naturally occurring caloric cues, with the low energy preload being 200 mL of water (0 kcal) and the high energy preload being 200 mL of strawberry milk. To obtain an index of the degree of caloric compensation displayed for Test A and Test B, caloric compensation (COMPX) scores were calculated using the following equation: COMPX = ((lunch calories after low energy preload - lunch calories after high energy preload) / (high energy preload calories - low energy preload calories)) x 100.[45] The output of the equation is a percentage, where 0% indicates no compensation, 1–99% indicates some amount of compensation, 100% indicates perfect compensation, greater than 100% indicates over-compensation, and less than 0% indicates the opposite effect has occurred. Since COMPX scores for each test showed some evidence for correlation ($r = .23$, $p = 0.082$[43]), we also calculated average compensation across the two tests by averaging the two COMPX scores.

*Eating rate*. Eating rate was calculated based on data obtained from lunches administered on days 2–5. The length of time spent eating was calculated using recorded start and finish times for each child. On day 2 time spent eating ranged from 10 to 48 min ($M = 23.6$, SD 6.59), on day 3 the range was 9 to 60 min ($M = 24.5$, SD 8.24), on day 4 the range was 15 to 75 min ($M = 30.14$, SD 8.95), and on day 5 the range was 13 to 60 min (M = 31.09, SD 7.63). Eating rates for each day were calculated by dividing intake (kcal) consumed in the meal by meal duration (minutes), and mean values were created by averaging all available values.

*Eating in the Absence of Hunger test*. Each child was taken out of the classroom individually, approximately half an hour after lunch. Following assessment of hunger level, children were offered a clear plastic bag containing approximately 15 mini cookies (McVities Mini Jammie Dodgers). Children were told they could take the bag back to their classroom activities and eat as many cookies as they liked, though they could not share and bags would be collected in 10 min. They also had the option to refuse the bag. 10 min after distribution, each child's bag was collected and weighed for generation of consumed volume (g), and thereby energy intakes (kcal), based on manufacturers' information.

## 2.4 | Parent feeding practices and attitudes

Primary parent feeding variables were subscales selected from the Child Feeding Questionnaire (CFQ)[6]: Restriction (8 items), Monitoring (3 items) and Pressure to eat (4 items). Responses were rated on 1–5

Likert scales with endpoints "Disagree" and "Agree", or "Always" and "Never". In addition, Prompting to eat was taken from the Parental Feeding Styles Questionnaire (PFSQ)[7] (8 items). Responses were given on a 5-point Likert scale, ranging from "I never do" to "I always do". To explore whether parental concern relating to children's eating and weight might explain observed associations between parent and child variables, we utilized the subscale "Concern about child overweight" (3 items), taken directly from the CFQ,[6] and the subscale "Concern about child underweight" (3 items), which was adapted from the same questionnaire by changing the expression "eating too much" to "eating too little", and the words "diet" to "eat more", and 'overweight' to 'underweight'. Responses were rated on 1–5 Likert scales with endpoints ranging from "Unconcerned" to "Very concerned".[8]

### 2.5 | Statistical analysis

To ensure comparability of results for child food intake variables and child appetitive behavior variables, the latter of which had more missing data due to lower participation in Days 4–5 and requirements for completing all of the preloads, we took the conservative approach of performing primary statistical analyses using only data from subjects with complete data who participated on all days of the study ($n$ = 70). First, in order to investigate relationships between CFQ and PFSQ subscale scores, and both mean food group and total intake in kcal, Spearman's correlations were used, as intake variables were not normally distributed. Significant correlations were next followed-up with generalized linear models (GLM), computing β coefficients and 95% confidence intervals (95%CI). Child food intake variables were considered dependent variables while parental feeding practices were considered independent variables. Models were then adjusted for 1) child age, sex, parent age and education; 2) Model 1 plus concern about child overweight/eating (for CFQ-Restriction and CFQ-Monitoring) or child underweight/eating (for CFQ-Pressure to eat and PFSQ-Prompting); and 3) Model 1 and 2, plus child BMI z-score. The selection of the potential confounders for Model 1 (child age, child sex, parent age, parent education) was based on previous literature.[1,19,46] Next, parental concerns about child under–/overweight were included to test whether relationships could potentially be explained by parents adjusting their feeding strategies according to their concerns about their child's weight or eating.[4,8,46] Finally, we added child BMI z-score. This step was taken to see whether relationships could be explained by unmeasured confounding variables connected with child weight, for example, parents pressuring a smaller child to eat, even in the absence of explicit concern relating to their weight. We included it only in the final step as child BMI z-score could be considered downstream of child diet and eating behavior in a causal model and therefore not a classical confounder. Spearman's correlations followed by GLM models assessing relationships of feeding practices with appetitive behaviors (COMPX scores, eating rate, eating in the absence of hunger test intake) were examined next. For the GLM analyses, no further adjusted models were estimated when the previous model was non-significant (i.e. $P$ > 0.05). Finally, to test whether limiting our analyses to completers affected our results, we reran unadjusted correlations using all available data ($n$ = 108–111). Since the results did not substantially differ, we present only the results from the reduced sample here. All analyses were conducted using IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp. released 2017. All analyses were two-tailed, and significance was determined at ≤ 0.05.

### 2.6 | Ethical statement

The study protocol and consent procedures were approved by the University College London Ethics Committee.

## 3 | RESULTS

Thirty-seven of the study children were boys, median age was 5 years and mean BMI z-score was 0.5. Approximately 31% of mothers ($n$ = 19) reported their highest education level to be General Certificate of Secondary Education (GCSE) or equivalent, median age was 36 years, and 40% were not employed at the time of the study. The majority of mothers (73.8%) considered themselves as white British. Their median BMI, based on self-reported height and weight, was 23.3 kg/m$^2$ (Table 1). Median COMPX scores for Test A were 67.1% and for Test B, 52.4%, with a median of 60.4% for the averaged value. Median eating rate was 0.3 kcal/min, and median intake in the EAH test ranged from 0 to 95.8 kcal, with a median value of 57.7 kcal. Child food intake varied from a median intake of 20.3 kcal for fruits and vegetables to a median of 273.4 kcal for snacks, with a median total intake of 445.5 kcal (Table 2).

Correlations between the four parental feeding practices and child intake by food group as well as total intake are displayed in Table 3. No significant correlations were found between CFQ-Restriction or CFQ-Monitoring and total intake or intake by food group. Higher scores on CFQ-Pressure to eat were associated with lower intake for all food groups except protein (rho for bread = −0.35; snacks = −0.33; fruits and vegetables = −0.25), as well as lower total intake (rho = −0.50). Higher PFSQ-Prompting to eat scores were associated with lower intake of fruits and vegetables only (rho = −0.26).

Next, significant correlations emerging between CFQ-Pressure to eat and PFSQ-Prompting to eat and child food intake variables were further investigated using GLM (see Table 4). For each point increase on CFQ-Pressure to eat, children consumed 11.33 kcal less from bread, and this was independent of child's age, sex, parent age, education, concern about child's underweight/eating and child BMI z-score. Higher scores on CFQ-Pressure to eat were also associated with lower intake of snacks ($\beta$ = −20.10 kcal, adjusting for demographics - Adj. Model 1), but this association disappeared when further adjusting for parental concern about child's underweight/eating. Higher CFQ-Pressure to eat scores were also associated with lower intake of fruits and vegetables ($\beta$ = −3.80 kcal, crude model only), and lower total intake ($\beta$ = −52.35 kcal, adjusting for all potential confounders - Adj. Model 3). In addition, higher PFSQ-Prompting to eat scores were associated with lower intake of fruits and vegetables ($\beta$ = −10.93 kcal), even following adjustment for all potential confounders.

Correlations between parent feeding practices and children's appetitive behaviors are shown in Table 5. Higher CFQ-Pressure to eat scores were associated with slower average eating rate (rho = −0.36). GLM results (Table 6) showed that for each point increase on CFQ-Pressure to eat, average eating rate was 7.30 kcal/min lower, independent of child's age, sex, parent age and education (Adj. Model 1), with the relationship disappearing with adjustment for parental concern about child underweight/eating. Higher CFQ-

**TABLE 1** Child and parent demographic, anthropometric characteristics (*n* = 70)

| | M (SD) [Range] / n (%) |
|---|---|
| *Child's characteristics* | |
| Sex (n(%)) | |
| Female | 33 (47.1) |
| Male | 37 (52.9) |
| Age (Md[IQR]) | 5.0 (0.5) [4.7-5.6] |
| BMI z-score | 0.5 (1.0) [−2.5-2.7] |
| Weight status | |
| Underweight | 4 (6.2) |
| Normal weight | 47 (72.3) |
| Overweight | 12 (18.5) |
| Obesity | 2 (3.1) |
| *Mother's characteristics* | |
| Age (y) (Md[IQR]) | 36.0 (6.0) [31.0-50.0] |
| Education | |
| GCSEs/O-levels/NVQ/GNVQ | 19 (31.3) |
| A-levels/ National diploma | 14 (23.0) |
| College degree/ further degree | 28 (45.9) |
| Ethnicity (n(%)) | |
| White British | 48 (73.8) |
| White European | 6 (9.2) |
| Black African | 5 (7.7) |
| Other | 6 (9.2) |
| Occupational status | |
| Full-time employment | 16 (24.6) |
| Part-time employment | 19 (29.2) |
| Not employed | 26 (40.0) |
| Other (e.g. self-employed, student, disabled, retired, etc.) | 4 (6.2) |
| Marital status | |
| With partner | 58 (89.2) |
| Without partner | 7 (10.8) |
| BMI (kg/m$^2$) (Md[IQR]) | 23.3 (4.7) [18.6-37.1] |
| Weight status | |
| Underweight (<18.5 kg/m$^2$) | 0 (0) |
| Normal weight (18.5-24.9 kg/m$^2$) | 36 (64.3) |
| Overweight (25-29.9 kg/m$^2$) | 12 (21.4) |
| Obesity (≥30 kg/m$^2$) | 8 (14.3) |

*Note:* M: Means; SD: Standard deviation; Md: Median; IQR: Interquartile range. Note that summary values are M(SD) unless specified as Md(IQR), calculated for variables with non-normal distributions. BMI: Body Mass Index; GCSE: General Certificate of Secondary Education; O-level: General Certificate of Education (GCE) Ordinary Level; NVQ: National Vocational Qualification; GNVQ: General National Vocational Qualification; A-level: General Certificate of Education Advanced Level. BMI and weight status based on parent-reported information. *Weight status was calculated according to 1990 British reference data[42].

**TABLE 2** Child appetitive behaviors, food intake and parent feeding behaviors and attitudes (*n* = 70)

| | M(SD) [Range] |
|---|---|
| *Child appetitive behaviors (Md(IQR))* | |
| COMPX Test A (%) | 67.1 (101.6) [−87.0–1323.0] |
| COMPX Test B (%) | 52.4 (91.4) [−167.5–659.1] |
| Average COMPX (%) | 60.4 (81.9) [−127.2–636.3] |
| Average eating rate (kcal/min) | 0.3 (0.1) [0.2–0.6] |
| Eating in absence of hunger (EAH) test intake (kcal) | 57.7 (44.1) [0–95.8] |
| *Child food intake in kcal (Md(IQR))* | |
| Protein | 87.2 (99.5) [2.8–252.0] |
| Bread | 76.3 (70.0) [1.8–225.9] |
| Snacks | 273.4 (140.8) [63.1–456.4] |
| Fruits and vegetables | 20.3 (36.7) [0–74.8] |
| Total intake | 445.5 (156.0) [259.1–963.1] |
| *Parent feeding practices* | |
| CFQ-Restriction | 3.9 (0.8) [1.3–5.0] |
| CFQ-Monitoring | 4.3 (0.7) [2.7–5.0] |
| CFQ-Pressure to eat | 2.9 (1.3) [1.0–5.0] |
| PFSQ-Prompting to eat | 4.1 (0.5) [2.8–5.0] |
| *Parent attitudes* | |
| CFQ-Concern about overweight/eating | 1.6 (0.9) [1.0–5.0] |
| CFQ-Concern about underweight/eating | 2.0 (1.1) [1.0–5.0] |

*Note:* COMPX: Caloric compensation; M: Means; SD: Standard deviation; Md: Median; IQR: Interquartile range. Note that summary values are M(SD) unless specified as Md(IQR), calculated for variables with non-normal distributions. CFQ: Child Feeding Questionnaire (possible range, 1–5).[6] PFSQ: Parent Feeding Styles Questionnaire (possible range, 1–5).[7]

**TABLE 3** Bivariate correlations between CFQ and PFSQ scale scores and child mean intake (kcal) by food group and total intake

| Parent feeding practices | Protein rho (95% CI) | Bread | Snacks | Fruits and vegetables | Total |
|---|---|---|---|---|---|
| CFQ-Restriction | −0.08(−0.16;0.32) | 0.14(−0.11;0.37) | −0.01(−0.25;0.23) | 0.17(−0.08;0.40) | 0.09(−0.16;0.33) |
| CFQ-Monitoring | −0.11(−0.34;0.14) | −0.04(−0.03;0.21) | 0.13(−0.12;0.36) | −0.16(−0.40;0.09) | 0.00(−0.24;0.24) |
| CFQ-Pressure to eat | −0.21(−0.43;0.04) | −0.35*(−0.55;-0.11) | −0.33*(−0.53;-0.09) | −0.25*(−0.47;-0.01) | −0.50**(−0.66;-0.29) |
| PFSQ-Prompting to eat | −0.10(−0.34;0.15) | −0.21(−0.43;0.04) | −0.04(−0.28;0.21) | −0.26*(−0.48;-0.02) | −0.10(−0.34;0.15) |

*Note:* rho: Spearman's correlation; CI: confidence interval. *$P \leq 0.05$; **$P \leq 0.001$. CFQ-Restriction[6] ($n$ = 65; range:1.3–5.0); CFQ-Monitoring[6] ($n$ = 65; range: 2.7–5.0); CFQ-Pressure to Eat[6] ($n$ = 64; range: 1.0–5.0); PFSQ Prompting to eat[7] ($n$ = 64; range: 2.8–5.0).

**TABLE 4** Generalized linear models showing relationships of CFQ-Pressure to eat and PFSQ-Prompting to eat subscales with child mean bread, snacks, fruits and vegetables and total intake (kcal)

| Parent feeding practices | Crude β (95% CI) | Adj. Model 1 | Adj. Model 2 | Adj. Model 3 |
|---|---|---|---|---|
| | Bread | | | |
| CFQ-Pressure to eat | **−14.12 (−23.12;−5.11)** | **−14.96 (−24.63;−5.28)** | **−15.07 (−26.01;−4.14)** | **−11.33 (−22.13;−0.54)** |
| | Snacks | | | |
| | **−24.27 (−40.93;−7.62)** | **−20.10 (−37.02; −3.18)** | −16.83 (−35.85; 2.18) | - |
| | Fruits and vegetables | | | |
| | **−3.80 (−7.29; −0.32)** | −3.36 (−7.01; 0.29) | – | – |
| | Total | | | |
| | **−52.35 (−75.45; −29.25)** | **−52.35 (−75.45; −29.25)** | **−52.35 (−75.45; −29.25)** | **−52.35 (−75.45; −29.25)** |
| PFSQ-Prompting to eat | Fruits and vegetables | | | |
| | **−9.84 (−18.60;−1.09)** | **−11.74 (−21.17; −2.30)** | **−10.85 (−20.66;−1.04)** | **−10.93 (−20.80;−1.07)** |

*Note:* Models adjusted for 1: child age, sex, parent age and education; 2: Model 1 plus CFQ-Concern about underweight/eating[6]; 3: Models 1 and 2 plus child BMI z-score. -: No model was estimated due to the IV failing to reach the significance threshold in the previous model. **Bold** values indicate statistical significance ($P \leq 0.05$).

**TABLE 5** Bivariate correlations of CFQ and PFSQ subscale scores with child caloric compensation, eating rate and eating in the absence of hunger test intake

| Parent feeding practices | COMPX Test A rho (95% CI) | COMPX Test B | Average COMPX | Average eating rate | EAH |
|---|---|---|---|---|---|
| CFQ-Restriction | 0.02(−0.22;0.26) | −0.16(−0.39;0.09) | −0.07(−0.31;0.18) | −0.07(−0.27;0.14) | −0.08(−0.32;0.17) |
| CFQ-Monitoring | −0.03(−0.27;0.22) | 0.07(−0.18;0.31) | 0.12(−0.13;0.35) | 0.07(−0.17;0.31) | −0.26*(−0.48;−0.01) |
| CFQ-Pressure to eat | 0.02(−0.23;0.26) | −0.05(−0.29;0.20) | −0.06(−0.30;0.19) | −0.36*(−0.56;−0.13) | 0.01(−0.24;0.26) |
| PFSQ-Prompting to eat | −0.05(−0.29;0.20) | −0.16(−0.39;0.09) | −0.13(−0.36;0.12) | −0.03(−0.27;0.22) | −0.13(−0.37;0.13) |

*Note:* rho: Spearman's correlation; CI: confidence interval. COMPX: Caloric compensation; EAH: Eating in absence of hunger; *$P \leq 0.05$. CFQ-Restriction[6] ($n$ = 65; range:1.3–5.0); CFQ-Monitoring[6] ($n$ = 65; range: 2.7–5.0); CFQ-Pressure to Eat[6] ($n$ = 64; range: 1.0–5.0); PFSQ-Prompting to eat[7] ($n$ = 64; range: 2.8–5.0).

Monitoring scores were associated with lower intake in the eating in the absence of hunger test (rho = −0.26) (Table 5), with GLM results (Table 6) showing that this small but significant relationship remained present after adjustment for all potential covariates (Adj. Model 3).

## 4 | DISCUSSION

We demonstrate here that controlling and less controlling parental feeding practices are differentially associated with intake of different food groups, as well as performance on behavioral tests of appetite, in preschool age children. Specifically, the controlling form of limitation of eating assessed by CFQ-Restriction was not significantly associated with any outcome while the controlling form of promotion of eating, CFQ-Pressure to eat, was associated with lower bread, snack, fruit and vegetable, and total intake, as well as slower eating rate. In contrast, the less controlling form of eating promotion, PFSQ-Prompting to eat, was associated with lower fruit and vegetable intake only, while the less controlling form of limitation, CFQ-Monitoring, was associated with lower intake in the eating in the absence of hunger

**TABLE 6** Generalized linear models showing relationships between CFQ subscales and child appetitive behaviors ($n$ = 70)

| Parent feeding practices | Crude β (95% CI) | Adj. Model 1 | Adj. Model 2 | Adj. Model 3 |
|---|---|---|---|---|
| | Eating in the absence of hunger | | | |
| CFQ-Monitoring | **−11.82 (−21.51; −2.13)** | **−17.19 (−27.88; −6.51)** | **−17.03 (−27.68; −6.39)** | **−16.34 (−27.11; −5.57)** |
| | Average eating rate | | | |
| CFQ-Pressure to eat | **−5.79 (−9.49; −2.09)** | **−7.30 (−11.61; −2.98)** | −4.28 (−8.97; 0.42) | - |

*Note:* Models adjusted for 1: child age, sex, parent age and education; 2: Model 1 plus CFQ-Concern about underweight/eating or concern about overweight/eating[6]; 3: Models 1 and 2 plus child BMI z-score.
*Note:* No model was estimated due to the IV failing to reach the significance threshold in the previous model. **Bold** values indicate statistical significance ($p \leq 0.05$).
[Correction added on 11 September 2020, after online publication: In Table 6, the values of associations between CFQ-Monitoring and Eating in the absence of hunger were previously incorrect and have been amended in this current version.]

test. Importantly, we observe these associations with child eating behavior as displayed in a naturalistic, school-based setting, independent of parental influence.

The strongest substantive finding emerging from our results was that higher scores on CFQ-Pressure to eat were almost globally associated with lower intake. This was true across multiple food categories, including snack foods, and the majority of associations were maintained even when adjusted for other variables that could independently affect the independent and dependent variables, namely child age, child sex, child BMI z-score, parent age and parent education. The relationship we saw between higher pressure and lower intake of snack foods was in opposition to previous work suggesting an association between controlling practices including pressure to eat and greater intake of unhealthy foods,[11] and may be because this previous work has largely relied on parent reports of child intake,[30,47] which may produce global overestimates of intake. In contrast, the relationship we observed between CFQ-Pressure to eat and fruit and vegetable intake is more consistent with previous work, which suggests that although parent pressure may have the immediate effect of increasing intake in a contemporaneous meal, it is associated with lower habitual intake of healthy foods measured via dietary assessments.[10,11,31,48-50] It should be noted, though, that the association between CFQ-Pressure to eat and intake of fruits and vegetables became non-significant when adjusted for our first model. Post-hoc investigation revealed that parent education, specifically, was rendering the association non-significant, as has previously been found in mothers of preschoolers.[51] Therefore parent education acted as a confounder here and we cannot confirm the presence of a direct relationship between higher pressure and lower fruit and vegetable intake. Importantly, we also observed that CFQ-Pressure to eat was associated with a smaller appetite, as indicated by slower eating rate. This is not consistent with results from laboratory tests[12] but is consistent with previous questionnaire studies[16,52] showing an association between pressure to eat and food avoidance behaviors in children such as Slowness in eating and Satiety responsiveness.

A number of interpretations are possible for the associations we observed. One interpretation is that children may develop an aversion to foods that they are coerced to eat, which in turn may lower their interest in the "pressured" foods, resulting in lowered intake of those foods and a slower overall rate of eating, driven by slow consumption of those foods. According to this interpretation, the experience of ongoing pressure to eat at home has a pervasive reduction effect on food consumption outside the home. However, this explanation of findings is perhaps less persuasive for the robust relationship we observed here between higher pressure to eat and lower intake of high-calorie snacks, in contrast with the less robust relationship between higher pressure to eat and lower intake of fruits and vegetables. Since high-calorie snacks are generally the subject of restriction, rather than pressure to eat, we would not expect to see pressure to eat decreasing their intake.

An alternative explanation is that these results reflect a "parent response", or "child effects", model. That is, parents respond to children who show lesser appetite for multiple foods in multiple situations (i.e. at school as well as at home) by pressuring them to eat. Consistent with this interpretation, we found that relationships between CFQ-Pressure to eat and child snack intake, as well as eating rate, attenuated once concern about child underweight/eating was included in the model, with post-hoc analyses showing that greater concern about underweight/eating was significantly associated with both lower snack intake (rho = −0.31, $P$ = 0.014) and slower eating rate (rho = −0.48, $P < 0.001$). These findings may emerge partly because the CFQ-Pressure to eat scale contains an element of perceived parental response to low appetite in the child, and is consistent with findings from other groups demonstrating that the relation between CFQ-Pressure to eat and child eating behaviors, especially food fussiness, were mediated by concern about child underweight and inadequate nutrient intake,[53] and that maternal concern about child fussy eating fully mediated the relationship between maternal-reported child fussy eating and persuasive feeding (similar to Pressure to eat).[54] It is also consistent with studies demonstrating prospective relationships between child weight and parent feeding,[37-41] and relationships between parent feeding and obesity- and appetite-associated genetic variation in children.[55] However, it was notable that relationships of CFQ-Pressure to eat with child bread intake and total intake remained after controlling for concern about underweight/eating. This argues against a simple parent-response explanation, although findings could still potentially be driven by an attitude not captured here, for example, concern that the child does not eat enough filling core foods such as bread. Even if the current data were best explained by 'parent-response', this interpretation does not rule out the possibility of negative long-term impacts on the child. Longitudinal and interventional research is needed to draw conclusions about bidirectional relationships.

Based on the theories of Birch and others, and on studies showing that parental prompts can be successful in encouraging children to try new fruits and vegetables,[13,48] we had anticipated that the less controlling form of intake promotion that we measured (PFSQ-Prompting to eat) would be associated with a healthier pattern of child food intake. Contrary to this expectation, higher PFSQ-Prompting to eat scores were associated with decreased consumption of fruits and vegetables. As above, the relationship could therefore reflect either negative consequences of parents' attempts to encourage healthy food intake, or ineffectual attempts by the parent to encourage healthy food intake in a child with low interest in those foods. Of note, the relationship between higher prompting and lower fruit and vegetable intake (unlike, for example, the relationship between higher pressure and lower snack intake), withstood control for concern about child underweight/eating. If a parent-response model were to apply here, then, it would be more likely driven by parents' specific desires for a child with intrinsically low motivation to consume fruits and vegetables to consume those foods, rather than a more general concern about low intake or body weight.

Also based on Birch et al's original theory, as well as the existing small body of evidence from laboratory studies, we had expected to see that the controlling form of intake limitation, CFQ-Restriction, would be associated with a more obesogenic eating profile, while the less controlling form, CFQ-Monitoring, would be associated with a less obesogenic profile. We instead observed just one weak relationship between parent feeding and child eating behavior, such that parental monitoring was negatively associated with eating in the absence of hunger. This is consistent with a potentially beneficial effect of this practice on child eating self-regulation, but we cannot rule out that children who ate a greater amount of snacks in the EAH challenge elicited a lower degree of monitoring in parents. We did not find in our adjusted models that the relationship was explained by parental concern about overweight/eating. However, regardless of reported concern, a parent with a highly snack-responsive child might find tracking their intake difficult due to there being more snack occasions, or monitoring causing conflict, resulting in lower CFQ-Monitoring scores. If this were the case, one would think that similar results might be found for CFQ-Restriction, which contains items suggesting a parental response to high child appetite for the restricted foods. However, mean scores for CFQ-Monitoring were higher than those for CFQ-Restriction, so it is possible that CFQ-Monitoring, by capturing more frequently occurring behaviors, was more sensitive. Regardless of the interpretation, further investigation of the exact behaviors parents refer to when they endorse items on this scale is warranted.

The strength of our study design lies in the fact that consumption patterns at a series of standardized meals, and performance on repeated behavioral tests of appetite conducted under naturalistic settings, are likely a better reflection of the child's independent eating behaviors in the absence of direct parental influences, than those displayed in a laboratory setting, or as reported by parents. Notwithstanding the rigor, ecological validity and relevance of the child eating behavior measures, some limitations should be highlighted. A major limitation is the cross-sectional design, which precludes inference of causal relationships between parental feeding practices and child eating behavior. Also, the generalizability of the current results is limited, since it included families with relatively high education levels, and with relatively low concern about overweight/eating compared to, for example, the classic Girls NEEDS study.[6] It is possible that our results might be different in a less educated sample and/or one with greater concern about overweight/eating, or greater or lesser concern about underweight/eating. In addition, as with the majority of parent feeding research, practices were self-reported and not directly observed, so social desirability bias may have been present. We did not assess children's familiarity and regular intake of the foods administered and therefore cannot tell whether these variables influenced results. For example, perhaps rather than Monitoring protecting against eating in the absence of hunger, children who were monitored had not been previously exposed to Jammie Dodgers and therefore ate less due to neophobia. This seems unlikely though, given the near universal exposure of children to cookies, the similarity (and thus generalizability) of Jammie Dodgers to other items in the cookie category, and the focus of food neophobia on fruits and vegetables (rather than popular processed snack foods). Our study was relatively small; a larger sample size could have rendered certain associations detectable. Finally, increasing research demonstrates the effect of educators/teachers or peers on child intake[56,57]; their role was not considered here. Future studies should also investigate the role of consistency between feeding practices within the home and the school setting, and potential influences of consistency or inconsistency on child food intake and appetitive behaviors.

To conclude, we found here that parental promotion and limitation of intake were modestly associated with preschoolers' eating behaviors objectively assessed in an ecologically valid setting, without parents present. In this sample of UK preschoolers, feeding practices focused on the promotion of eating demonstrated more associations with child food intake and appetitive behaviors than feeding practices focused on the limitation of eating. Within analyses of parent feeding practices promoting intake, the controlling form (Pressure to eat) showed more associations with eating behavior (lower overall intake, slower eating rate) than the less controlling form (Prompting to eat; lower fruit and vegetable intake only), with some of these associations being partly explicable by parental concern about underweight/eating. Within analyses of parent feeding practices limiting intake, only Monitoring, the less controlling form, showed a relationship with eating behavior, specifically, a negative association with eating in the absence of hunger. Notwithstanding the acknowledged study limitations, our results as they stand support some updates and extensions to Leann Birch et al.'s original theory, which has been both stimulating and impactful. Namely, if our results reflect influence flowing from parent to child, then it seems that while less controlling forms of limiting eating may have small but measurable beneficial carryover effects on eating behavior in the absence of parents, controlling forms of intake promotion may in some populations not only decrease motivation to eat pressured foods, but also unpressured ones including snacks, producing globally lower intake. This could have benefits for obesity reduction, but be a potential risk factor for undernutrition, although notably no children were currently underweight in our sample. Certainly, though, contextual and cultural variation therefore affects the relevance of certain parts of the original theory, as has been widely recognized.[58] Alternatively, should our results reflect child-to-parent influence, they advocate for incorporation of interactions between child eating predispositions and parent behaviors to provide a more complete account of parent-child feeding relationships, and to allow the discernment of parental influence over and above child-driven effects.[59] More explicit measurement of the motivations for parents' feeding behaviors, moving beyond the measurement of concern relating to weight and eating to incorporate other relevant factors,[60] could be of value to help understand the kind of cross-sectional relationships we observed here. However, longitudinal and interventional research will be of most help in understanding dynamic bidirectional relationships between child and parent behaviors around food throughout development.

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## CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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