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TITLE

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RUNNING TITLE

Maternal eating behaviors and feeding practices

ABBREVATIONS

CFPQ: Comprehensive Feeding Practices Questionnaire

TFEQ: Three-Factor Eating Questionnaire

ABSTRACT

Few studies have examined the associations between parents' own eating behaviors and their feeding practices. We aimed to study the associations between maternal eating behaviors and feeding practices in toddlerhood. In this cross-sectional analysis, maternal eating behaviors and feeding practices were assessed at 2-year follow-up by using the Three-Factor Eating Questionnaire (TFEQ-R21) and the Comprehensive Feeding Practices Questionnaire (CFPQ), respectively, among mothers of 1322 children from the EDEN mother-child cohort. Depending on their distributions, scores from the two questionnaires were considered continuous or binary variables, according to the median. Linear or logistic regression models were used as appropriate to assess the associations between maternal eating behaviors, considered simultaneously in a combined model, and their feeding practices. Maternal cognitive restraint was positively associated with maternal restriction for health and restriction for weight. Maternal uncontrolled eating was positively associated with pressure to eat and use of food to regulate the child's emotions. Maternal uncontrolled eating was also negatively associated with restriction for weight, but only among boys. This study supports that mothers' own eating behaviors are associated with their feeding practices in toddlerhood. Further studies are needed to understand the role of parental feeding practices in the familial transmission of eating behavior.

KEYWORDS

Eating behaviors, feeding practices, birth cohort, toddlerhood, coercive practices

1 INTRODUCTION

According to the Developmental Origins of Health and Disease concept, early life is an opportunity window (1), notably characterized by the establishment of early eating behaviors and parental feeding practices that predict later eating behaviors in childhood and adolescence (2, 3). Parents play a key role in the establishment of eating behaviors of their children, especially in toddlerhood. Indeed, they decide the feeding time, the food offered to the child and the portion sizes (2). Parents also play a model role in eating (4, 5). Previous studies documented a familial transmission of eating behaviors, with similarities between maternal and children's eating behaviors (6-10). Maternal emotional eating (i.e., eating in response to emotional cues) or uncontrolled eating (i.e., the tendency to overeat when feeling hungry or when exposed to external stimuli) were found positively associated with children's emotional eating in childhood (8-10), with some differences by child's sex (9). Moreover, mother's own cognitive restraint (i.e., conscious restriction of food intake to control body weight or to promote weight loss) was found associated with a daughter's poor self-regulation of energy intake (11).

Parental feeding practices are defined as the strategies (actions or behaviors) parents use to try to influence their child's food intake or eating behavior (2, 12). Some parental feeding practices have been found to be associated with children's eating behaviors (13-16) (e.g., parental pressure to eat may increase food dislikes). Some determinants of feeding practices, such as parental education level or cultural background, have been examined (17), but more behavioral characteristics need to be further explored. In particular, to understand the role of parental feeding practices in the familial transmission of eating behavior, few studies have assessed the associations between mothers' own eating behavior and their feeding practices (7, 10, 18-22). A recent study notably found that the positive association between maternal and child's emotional overeating was partially mediated by both maternal

use of food as a reward and overt restriction, considered simultaneously in the same model (10). Similar mediation pathway was found for the positive association between maternal and child's food responsiveness (10). Nevertheless, these studies are characterized by a relative low sample size (7, 10, 18-22), which highlights the need for studies with larger samples. Moreover, some studies focused on only a unique dimension of maternal eating behavior: maternal restraint (18, 19) or maternal emotional eating (21), but these dimensions are not independent. Then, it would be of great interest to consider simultaneously the different dimensions of maternal eating behavior when examining the association with their feeding practices. A better understanding of the complex associations between maternal eating behaviors, feeding practices and children's characteristics (eating behaviors and weight status) could inform the development of appropriate child feeding or obesity-prevention interventions.

In this context, our objective was to study, with a cross-sectional design, the associations between different dimensions of mothers' own eating behavior and their feeding practices in toddlerhood, in a large sample of the EDEN mother-child cohort. From previous literature, we hypothesized that: 1) maternal cognitive restraint is positively associated with maternal coercive practices (i.e., restrictive feeding practices and pressure to eat) and that 2) maternal emotional eating is positively associated with maternal use of food for non-nutritional purposes (i.e., using food as a reward or to regulate the child's emotions) and with maternal restrictive feeding practices.

2 MATERIAL AND METHODS

2.1 Study population

The EDEN mother–child study is a prospective cohort that investigates the prenatal and postnatal determinants of child growth, development and health (23). Briefly, 2002 pregnant

women were recruited before a gestational age of 24 weeks in two French university hospitals (Nancy and Poitiers) from 2003 to 2006. Exclusion criteria were multiple pregnancies (i.e., mothers who were expecting twins, triplets or more children), known diabetes before pregnancy, illiteracy and planning to move outside the region in the next 3 years. The study was approved by the ethics committee of the university hospital of Kremlin- Bicêtre (ID 0270 of 12 December 2002) and data files were declared to the National Committee for Processed Data and Freedom (CNIL, ID 902267 of 12 December 2002). Written consent was obtained from both parents.

The present analyses are mainly based on data collected at the 2-year follow-up (i.e., at age 2 of the child).

2.2 Maternal eating behaviors

Maternal eating behaviors were assessed at 2-year follow-up with the French translation (24) of the 21-item revised version of the Three-Factor Eating Questionnaire (TFEQ-R21) (25). This questionnaire assesses 3 dimensions of eating behavior: cognitive restraint (6 items; in the EDEN cohort, Cronbach's $\alpha = 0.82$); uncontrolled eating (9 items; Cronbach's $\alpha = 0.85$); and emotional eating (6 items; Cronbach's $\alpha = 0.93$). Responses to each of the 21 items are scored from 1 (definitely false or never) to 4 (definitely true or almost always). Item scores are summed within each subscale and transformed to a scale of 0 to 100 with the following equation: [100 * (raw score – lowest possible raw score) / possible raw score range] (24, 26). Each maternal eating behavior score was considered as continuous variable.

2.3 Maternal feeding practices

Maternal feeding practices were also assessed at 2-year follow-up with the French version (27) of the Comprehensive Feeding Practices Questionnaire (CFPQ) (28). Three scales of the CFPQ were considered to characterize maternal coercive feeding practices: restriction for health (4 items; in the EDEN cohort, Cronbach's $\alpha = 0.79$), restriction for weight (4 items;

Cronbach's α = 0.69) and pressure to eat (3 items; Cronbach's α = 0.55). Two other scales of the CFPQ were considered to characterize maternal use of food for non-nutritional purposes: using food as a reward (Rewards, 3 items; Cronbach's α = 0.47) and using food to regulate the child's emotions (Emotion regulation, 3 items; Cronbach's α = 0.68). Each item is scored from 1 (disagree or never) to 5 (agree or always). Item scores are averaged within each subscale. Coercive maternal feeding practices (i.e., restriction for health, restriction for weight and pressure to eat) were considered continuous variables. Because of the skewed distribution of their scores, maternal use of food as a reward and to regulate the child's emotions were considered binary variables, according to the median in our sample. "Low use" of a specific maternal feeding practice was defined by a score below the median and "high use" by a score equal to or above the median.

Regarding the low Cronbach's α for food as reward in the EDEN mother-child cohort, we decided to present all results based on this score in supplementary material.

2.4 Other variables

Maternal characteristics were collected at inclusion or at delivery: maternal age at delivery (years), primiparity (yes/no), maternal education level (< high school diploma, high school diploma, and 2-year and 5-year university degree) and household income (≤ €1,500/month, €1,501 to €,2300/month, €2,301 to €3,000/month and >3000€/month).

Moreover, mothers self-reported their weight at 2-year follow up. At 1-year and 3-year follow-up, maternal weight was measured to the nearest 0.1 kg by using electronic scales (Terraillon SL-351, Hanson Ltd, Hemel Hempstead, UK) (29). Maternal height was measured to the nearest 0.2 cm by using a wall-mounted stadiometer (Seca-206, Seca, Hamburg, Germany) (29). As in a previous study (29), to limit missing data and because eating behavior was assessed at 2-year follow-up, we used (in the following order) 2-year self-reported weight

(56%), the mean of 1-year and 3-year measured weights (15%), or 1-year measured weight (29%). Maternal body mass index (BMI) was classified into 4 categories (underweight: <18.5 kg/m^2, reference BMI: ≥18.5 kg/m^2 to <25 kg/m^2, overweight: ≥25 kg/m^2 to <30 kg/m^2 and obese: ≥30 kg/m^2).

Child's sex was also considered in the analyses. Because height and weight were collected in the child's health booklet, these data vary among children in number and timing and then are difficult to analyze directly (30). Then, Jenss-Bayley growth curve modeling was used to obtain individual growth curves and to derive height and weight at a given age for all children (23, 31). From these data, we calculated the WHO BMI-for-age z-score at 2 years, used as a covariate in sensitivity analyses.

2.5 Sample selection

Of the 2002 recruited women, 76 women were excluded because they left the study before or at the time of delivery; 24 because of miscarriages, intrauterine death, or discontinuation of pregnancy for medical reasons; and 9 because they delivered outside the study hospitals. Data on birthweight were available for 1899 newborns. Individuals with missing data for at least one maternal feeding practice (n=492), maternal eating behaviors (n=3) and potential confounders (n=82) were then excluded (Figure 1). These exclusions led to a sample of 1322 individuals for complete-case analysis of the association between mothers' own eating behaviors and their feeding practices.

As compared with excluded children (n=680), included children (n=1322) were more likely to be born to mothers who were older (mean age 30 vs 29 years, p<0.0001), employed (79% vs. 65%, p<0.0001), primiparous (47% vs. 38%, p=0.0002), with higher education level (36% vs. 23% with at least a 5-year university degree, p<0.0001), higher household income (30% vs. 21% with > €3,000 per month, p<0.0001), and lower maternal BMI (mean 24.0 vs. 25.2 kg/m^2, p=0.0004).

2.6 Statistical analyses

Comparisons between included and excluded populations were assessed by chi-square and Student *t* tests. Pearson correlation analyses were used to study the correlations between maternal eating behaviors. Univariable analyses between mothers' own eating behaviors and their feeding practices involved unadjusted linear and logistic regression models (one model per maternal eating behavior).

Associations between maternal own eating behaviors and feeding practices (one combined model including all studied maternal eating behaviors) were tested with linear regression models for coercive maternal feeding practices and with logistic regression models for maternal use of food for non-nutritional purposes. Analyses were run separately for each of the 5 outcomes.

For adjusted analyses, potential confounders were identified from the literature and selected by using the Directed Acyclic Graphs method (32). Models were adjusted for study center, maternal characteristics (age at delivery, primiparity, education level, employment status, household income, BMI) and child's sex. To deal with the problem of multiple comparisons when studying large numbers of biological factors, we used the false discovery rate (FDR) procedure with the Benjamini and Hochberg method (SAS, PROC Multtest, FDR option) (33) with a q-value cut-off of 0.10 (34).

Because previous literature suggested that parental feeding practices may differ by child's sex (35, 36) and that associations between maternal and child's eating behavior may also differ by child's sex (9), we tested the interaction between maternal eating behavior and child's sex for each maternal feeding practice, and analyses were stratified when relevant.

Because mothers could use different feeding practices depending on their perception of their child's weight status (37), a sensitivity analysis further adjusted for child's WHO BMI z-score at 2 years was performed. We first conducted analyses on complete cases. Then,

multiple imputations were used to deal with missing data on potential confounders. The number of missing data ranged from 0% to 5.0% per variable (Supplemental table 1). Data were assumed to be missing at random, and 5 independent datasets were generated with the fully conditional specification method (MI procedure, FCS statement, NIMPUTE option), then pooled effect estimates were calculated (SAS MIANALYSE procedure). Continuous variables were imputed with predictive mean matching, and logistic regressions were used for categorical variables. To generate significance testing of categorical variables, the median of the p-values from the imputed data analyses in each dataset was used, as proposed by Eekhout et al. (38).

Analyses were conducted with SAS v9.4 (SAS Institute, Cary, NC, USA). P <0.05 was considered statistically significant.

3 RESULTS

The characteristics of the study population, maternal eating behaviors and maternal feeding practices are in Table 1. Maternal eating behaviors were significantly positively correlated. The strongest correlation was between maternal uncontrolled eating and emotional eating (r=0.66, p<0.0001). The correlation coefficients between maternal cognitive restraint and uncontrolled eating and between maternal cognitive restraint and emotional eating were respectively of r=0.24, p<0.0001 and r=0.32, p<0.0001.

3.1 Maternal eating behaviors and maternal feeding practices at 2 years

On univariable analyses, all 3 eating behaviors were positively related to almost all feeding practices (Tables 2 and 3, Supplemental table 2).

3.1.1 Coercive feeding practices

When maternal eating behaviors were considered simultaneously in the same model (Table 2), maternal cognitive restraint was positively associated with restrictive feeding practices

(restriction for health and restriction for weight), whereas maternal uncontrolled eating was positively associated with pressure to eat. The negative association between maternal uncontrolled eating and restriction for weight was found for boys but not girls (boys: β [95% CI] = -0.04 [-0.08; -0.01], girls: β [95% CI] = -0.01 [-0.04; 0.02]; $p_{interaction}$=0.04). No other modulating effect of child's sex was found for the association between maternal eating behavior and maternal coercive practices (all $p_{interaction}$ >0.05). Maternal emotional eating was not related to coercive feeding practices in this model.

3.1.2 Use of food for non-nutritional purposes

When maternal eating behaviors were considered simultaneously in the same model, maternal cognitive restraint was positively associated with high use of food as a reward (Supplemental table 2), whereas maternal uncontrolled eating was positively associated with high use of food both as a reward and to regulate the child's emotions (Table 3 and Supplemental table 2). Maternal emotional eating was not related to the use of food for non-nutritional purposes in this model. No modulating effect of child's sex was highlighted for the association between maternal eating behavior and maternal use of food for non-nutritional purposes (all $p_{interaction}$ > 0.05).

Similar results were highlighted after further adjustment for child's WHO BMI z-score at 2 years (Supplemental tables 3 and 4), when missing data were accounted for with the multiple imputation method (Supplemental tables 3 and 4), or after the correction of multiple comparisons (Tables 2, 3 and Supplemental table 2).

4 DISCUSSION

In the EDEN mother–child cohort, maternal cognitive restraint was positively associated with maternal restrictive feeding practices and maternal use of food as a reward in toddlerhood. Moreover, maternal uncontrolled eating was positively related to maternal pressure to eat and

use of food for non-nutritional purposes (as a reward or to regulate the child's emotions), and negatively associated with restriction for weight among boys only. Maternal emotional eating was not related to maternal feeding practices.

As in previous literature, maternal cognitive restraint was found to be positively associated with restrictive feeding practices (18-20). Maternal use of restrictive feeding practices seems to be influenced by the mother's personal struggles with weight and eating (19), which suggests that mothers who have trouble controlling their food intake, and feel the need to restrict themselves, assume that their children have the same trouble (18). In previous literature, notably cross-sectional studies, parental restrictive practices were often found positively associated with child's weight status (39, 40). However, results of longitudinal studies are more inconsistent, and some studies have shown that parents may adopt such feeding practices in response to their child's high appetite (41, 42) or weight status (43-46). The inconsistent findings on the associations between parental restrictive feeding practices and child's weight status may be explained in part by the nature of the control used by parents. Indeed, a previous study found that maternal overt control (perceived by the child) was negatively associated with the child's later BMI, with no prospective association found for maternal covert control (not perceived by the child) (47). However, these results may need to be confirmed in further studies. In adults, restriction was found to be a moderating factor between genetic susceptibility to obesity and adult BMI (29). Then, contrary to results from some cross-sectional studies, restrictive feeding practices may be a teaching action from parents to offspring to manage weight gain. This hypothesis is also supported by previous studies suggesting that restrictive feeding practices could be associated with a lower risk of excessive weight in preschool children (48). However, in our study, maternal cognitive restraint was also positively associated with maternal use of food as a reward, which could have a counterproductive effect because this feeding practice may impair children's self-

regulation of energy intake (49). A potential explanation of the positive association between maternal cognitive restraint and maternal use of food as a reward could be that mothers with high cognitive restraint pay particular attention and importance to food and might tend to be more likely to use food as a reward for their child. This explanation is only speculative and further studies are required to confirm this result.

Previous studies highlighted that mothers who struggle to resist tempting food have children with similar eating behaviors (8). This finding could be explained in part by the feeding practices used by the mother. Indeed, in the EDEN mother-child cohort, maternal uncontrolled eating was found positively associated with maternal use of food for non-nutritional purposes, as in the literature (20), and with maternal pressure to eat. Moreover, according to our results, a recent study found a positive association between maternal food responsiveness and maternal use of food as a reward (10). Previous studies found positive associations between parental use of food for non-nutritional purposes or pressure to eat and child's obesogenic eating behaviors, such as emotional eating and overeating (14). In another study, parental pressure to eat was associated with a lower intake of healthy foods by children (15). Moreover, in the present study, maternal uncontrolled eating was negatively associated with restriction for weight, but among boys only. This result was not found in a previous study where maternal food responsiveness was positively associated with maternal overt restriction (10). It may be due to differences in studied subscales or sample sizes. This result, found among boys only, may be explained by the differential perception of ideal body weight according to the child's sex: mothers tend to be less concerned with boys' weight status or rapid weight gain as compared with girls. Indeed, a previous study found a positive association between weight gain and parental use of restrictive feeding practices among girls only (35). The authors suggested that this association may be a sign of a sensitivity to societal expectations: girls should be slim while boys could have social and physical advantages of

283 being larger (35).This literature supports the result that mothers with uncontrolled eating use
284 less restriction for weight for boys than girls.

285 Maternal emotional eating was previously found related to maternal use of food for
286 non-nutritional purposes: as a reward (10, 20, 21) and to regulate the child's emotions (7, 20).
287 In our study, this association was found only when maternal eating behaviors were considered
288 in separate models (data not shown), probably because of the strong correlation between
289 maternal uncontrolled eating and maternal emotional eating. These associations must also be
290 examined in light of the mediating effect of emotional or uncontrolled eating in the
291 association between genetic susceptibility to obesity and BMI in adults (29), which supports
292 the hypothesis of a role of maternal feeding practices in the familial transmission of eating
293 behaviors (10, 22). Because feeding practices are modifiable factors, they could be targeted
294 during toddlerhood to prevent the establishment of obesogenic eating behaviors. Moreover,
295 this study highlights the need to consider maternal eating behavior as a potential modifiable
296 factor associated with maternal feeding practices, children's eating behavior and weight
297 status. Prevention of childhood obesity and public health policies should advise parents to
298 recognize and learn to limit the eating behaviors and parental feeding practices that have been
299 shown to be associated with adverse outcomes in children.

300 In the present study, both maternal eating behavior and feeding practices were
301 assessed by using validated questionnaires (25, 28) found applicable in a French sample (24,
302 27). The internal consistency of the different scales was satisfactory, except for maternal use
303 of food as a reward, which had a lower Cronbach's α, which could limit the interpretation of
304 the results. Nevertheless, our results for this scale are consistent with previous findings (7, 10,
305 20), which suggests the reliability of our results. Because previous literature suggested that
306 mothers could differ in their use of feeding practices by their perceptions of their child's
307 weight status (37), a supplemental adjustment on child's WHO BMI z-score at 2 years was

performed. Results after this further adjustment were very similar to results of the adjusted models. Nevertheless, because mothers could have inaccurate perceptions of their child's weight status, further studies should assess the associations between maternal eating behaviors and feeding practices, accounting for maternal concerns about child's weight. Moreover, given the cross-sectional design of the analysis, further longitudinal studies are needed to confirm our results. Another limitation of the current study is the self-reported data concerning maternal eating behaviors and feeding practices. Thus, the present results may be subject to bias to social desirability or a lack of awareness of feeding practices (50).

The mothers of the EDEN mother–child cohort have higher socio-economic position than the French population (23), so further studies are needed to assess the replicability of our findings among lower socio-economic populations. Moreover, maternal feeding practices and maternal eating behaviors may differ among cultures (17, 51), notably based on different societal expectations dealing with child's weight status, so our findings may not be generalizable to other high-income settings in other cultures.

5 CONCLUSION

This study supports that mothers' own eating behaviors are associated with their feeding practices. Future longitudinal studies are warranted to confirm these associations or identify other relevant factors associated with specific parental feeding practices. This would help assess the role of parental feeding practices in the familial transmission of eating behaviors and include them as a key target in childhood obesity prevention strategies.

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AUTHORSHIP

CG and BLG designed the research, analysed the data and wrote the manuscript. BH, AF and MAC oversaw the EDEN study. BH and MAC were responsible for data collection in EDEN. BLG had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. All authors reviewed drafts, provided critical feedback, read and approved the final manuscript, were responsible for the final content of the paper and agreed to be accountable for all aspects of the work.

COMPETING INTEREST STATEMENT

None of the authors have any financial relationships or conflict of interest to disclose.

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DATA AVAILABILITY

The data underlying the findings cannot be made freely available for ethical and legal restrictions imposed because this study includes a substantial number of variables that together could be used to re-identify the participants based on a few key characteristics and then used to access other personal data. Therefore, the French ethics authority strictly forbids making these data freely available. However, they can be obtained upon request from the EDEN principal investigator. Readers may contact barbara.heude@inserm.fr to request the data. The code book and analytic code will be made available upon request pending application and approval.

REFERENCES

1. Anzman SL, Rollins BY, Birch LL. Parental influence on children's early eating environments and obesity risk: implications for prevention. Int J Obes (Lond). 2010;34(7):1116-24.
2. Savage JS, Fisher JO, Birch LL. Parental influence on eating behavior: conception to adolescence. J Law Med Ethics. 2007;35:22-34.
3. Ashcroft J, Semmler C, Carnell S, van Jaarsveld CH, Wardle J. Continuity and stability of eating behaviour traits in children. Eur J Clin Nutr. 2008;62(8):985-90.
4. Brown R, Ogden J. Children's eating attitudes and behaviour: a study of the modelling and control theories of parental influence. Health Educ Res. 2004;19:261-71.
5. Carper JL, Orlet Fisher J, Birch LL. Young girls' emerging dietary restraint and disinhibition are related to parental control in child feeding. Appetite. 2000;35:121-9.
6. Kral TV, Rauh EM. Eating behaviors of children in the context of their family environment. Physiol Behav. 2010;100(5):567-73.
7. Wardle J, Sanderson S, Guthrie CA, Rapoport L, Plomin R. Parental Feeding Style and the Inter-generational Transmission of Obesity Risk. Obes Res. 2002;10(6):453-62.
8. Yelverton CA, Geraghty AA, O'Brien EC, Killeen SL, Horan MK, Donnelly JM, et al. Breastfeeding and maternal eating behaviours are associated with child eating behaviours: findings from the ROLO Kids Study. Eur J Clin Nutr. 2020.
9. Jahnke DL, Warschburger PA. Familial transmission of eating behaviors in preschool-aged children. Obesity. 2008;16(8):1821-5.
10. Miller N, Mallan KM, Byrne R, de Jersey S, Jansen E, Daniels LA. Non-responsive feeding practices mediate the relationship between maternal and child obesogenic eating behaviours. Appetite. 2020;151:104648.
11. Johnson SL. Improving Preschoolers' self-regulation of energy intake. Pediatrics. 2000;106(6):1429-35.
12. Vaughn AE, Ward DS, Fisher JO, Faith MS, Hughes SO, Kremers SP, et al. Fundamental constructs in food parenting practices: a content map to guide future research. Nutrition reviews. 2016;74(2):98-117.
13. Scaglioni S, De Cosmi V, Ciappolino V, Parazzini F, Brambilla P, Agostoni C. Factors Influencing Children's Eating Behaviours. Nutrients. 2018;10(6).
14. Rodgers RF, Paxton SJ, Massey R, Campbell KJ, Wertheim EH, Skouteris H, et al. Maternal feeding practices predict weight gain and obesogenic eating behaviors in young children: a prospective study. Int J Behav Nutr Phys Act. 2013;10:24.
15. Galloway AT, Fiorito LM, Francis LA, Birch LL. 'Finish your soup': counterproductive effects of pressuring children to eat on intake and affect. Appetite. 2006;46:318-23.
16. Webber L, Cooke L, Hill C, Wardle J. Associations between children's appetitive traits and maternal feeding practices. J Am Diet Assoc. 2010;110:1718-22.
17. McPhie S, Skouteris H, Daniels L, Jansen E. Maternal correlates of maternal child feeding practices: a systematic review. Matern Child Nutr. 2014;10(1):18-43.
18. Birch LL, Fisher JO. Mothers' child-feeding practices influence daughters' eating and weight. Am J Clin Nutr. 2000;71(5):1054-61.
19. Francis LA, Hofer SM, Birch LL. Predictors of maternal child-feeding style: maternal and child characteristics. Appetite. 2001;37(3):231-43.
20. de Lauzon-Guillain B, Musher-Eizenman D, Leporc E, Holub S, Charles MA. Parental feeding practices in the United States and in France: relationships with child's characteristics and parent's eating behavior. J Am Diet Assoc. 2009;109(6):1064-9.

411 21. Kröller K, Jahnke D, Warschburger P. Are maternal weight, eating and feeding
412 practices associated with emotional eating in childhood? Appetite. 2013;65:25-30.
413 22. Morrison H, Power TG, Nicklas T, Hughes SO. Exploring the effects of maternal
414 eating patterns on maternal feeding and child eating. Appetite. 2013;63:77-83.
415 23. Heude B, Forhan A, Slama R, Douhaud L, Bedel S, Saurel-Cubizolles MJ, et al.
416 Cohort Profile: The EDEN mother-child cohort on the prenatal and early postnatal
417 determinants of child health and development. Int J Epidemiol. 2016;45:353-63.
418 24. de Lauzon B, Romon M, Deschamps V, Lafay L, Borys JM, Karlsson J, et al. The
419 Three-Factor Eating Questionnaire-R18 is able to distinguish among different eating patterns
420 in a general population. J Nutr. 2004;134(9):2372-80.
421 25. Tholin S, Rasmussen F, Tynelius P, Karlsson J. Genetic and environmental influences
422 on eating behavior: the Swedish Young Male Twins Study. Am J Clin Nutr. 2005;81(3):564-
423 9.
424 26. Karlsson J, Persson LO, Sjöström L, Sullivan M. Psychometric properties and factor
425 structure of the Three-Factor Eating Questionnaire (TFEQ) in obese men and women. Results
426 from the Swedish Obese Subjects (SOS) study. Int J Obes Relat Metab Disord.
427 2000;24(12):1715-25.
428 27. Musher-Eizenman D, de Lauzon-Guillain B, Holub SC, Leporc E, Charles MA. Child
429 and parent characteristics related to parental feeding practices. A cross-cultural examination
430 in the US and France. Appetite. 2009;52:89-95.
431 28. Musher-Eizenman D, Holub S. Comprehensive Feeding Practices Questionnaire:
432 validation of a new measure of parental feeding practices. J Pediatr Psychol. 2007;32:960-72.
433 29. de Lauzon-Guillain B, Clifton EA, Day FR, Clement K, Brage S, Forouhi NG, et al.
434 Mediation and modification of genetic susceptibility to obesity by eating behaviors. Am J
435 Clin Nutr. 2017;106:996-1004.
436 30. Botton J, Scherdel P, Regnault N, Heude B, Charles MA. Postnatal weight and height
437 growth modeling and prediction of body mass index as a function of time for the study of
438 growth determinants. Ann Nutr Metab. 2014;65(2-3):156-66.
439 31. Botton J, Heude B, Maccario J, Ducimetière P, Charles MA. Postnatal weight and
440 height growth velocities at different ages between birth and 5 y and body composition in
441 adolescent boys and girls. Am J Clin Nutr. 2008;87(6):1760-8.
442 32. Ferguson KD, McCann M, Katikireddi SV, Thomson H, Green MJ, Smith DJ, et al.
443 Evidence synthesis for constructing directed acyclic graphs (ESC-DAGs): a novel and
444 systematic method for building directed acyclic graphs. International journal of epidemiology.
445 2020;49(1):322-9.
446 33. Benjamini Y, Hochberg Y. Controlling the false discovery rate: a practical and
447 powerful approach to multiple testing. Journal of the Royal statistical society: series B
448 (Methodological). 1995;57(1):289-300.
449 34. Streiner DL. Best (but oft-forgotten) practices: the multiple problems of multiplicity-
450 whether and how to correct for many statistical tests. The American journal of clinical
451 nutrition. 2015;102(4):721-8.
452 35. Rhee KE, Coleman SM, Appugliese DP, Kaciroti NA, Corwyn RF, Davidson NS, et
453 al. Maternal feeding practices become more controlling after and not before excessive rates of
454 weight gain. Obesity (Silver Spring, Md). 2009;17(9):1724-9.
455 36. Fisher JO, Birch LL. Restricting access to foods and children's eating. Appetite.
456 1999;32(3):405-19.
457 37. Freitas FR, Moraes DEB, Warkentin S, Mais LA, Ivers JF, Taddei J. Maternal
458 restrictive feeding practices for child weight control and associated characteristics. J Pediatr
459 (Rio J). 2019;95(2):201-8.

460 38. Eekhout I, van de Wiel MA, Heymans MW. Methods for significance testing of
461 categorical covariates in logistic regression models after multiple imputation: power and
462 applicability analysis. BMC Med Res Methodol. 2017;17(1):129.
463 39. Gubbels JS, Gerards SM, Kremers SP. The association of parenting practices with
464 toddlers' dietary intake and BMI, and the moderating role of general parenting and child
465 temperament. Public Health Nutr. 2020:1-9.
466 40. Blissett J, Bennett C. Cultural differences in parental feeding practices and children's
467 eating behaviours and their relationships with child BMI: a comparison of Black Afro-
468 Caribbean, White British and White German samples. Eur J Clin Nutr. 2013;67:180-4.
469 41. Jansen E, Williams KE, Mallan KM, Nicholson JM, Daniels LA. Bidirectional
470 associations between mothers' feeding practices and child eating behaviours. Int J Behav Nutr
471 Phys Act. 2018;15:3.
472 42. Guivarch C, Charles MA, Forhan A, Ong KK, Heude B, de Lauzon-Guillain B.
473 Associations between Children's Genetic Susceptibility to Obesity, Infant's Appetite and
474 Parental Feeding Practices in Toddlerhood. Nutrients. 2021;13(5).
475 43. Shloim N, Edelson LR, Martin N, Hetherington MM. Parenting Styles, Feeding Styles,
476 Feeding Practices, and Weight Status in 4-12 Year-Old Children: A Systematic Review of the
477 Literature. Front Psychol. 2015;6:1849.
478 44. Webber L, Cooke L, Hill C, Wardle J. Child adiposity and maternal feeding practices:
479 a longitudinal analysis. Am J Clin Nutr. 2010;92:1423-8.
480 45. Derks IP, Tiemeier H, Sijbrands EJ, Nicholson JM, Voortman T, Verhulst FC, et al.
481 Testing the direction of effects between child body composition and restrictive feeding
482 practices: results from a population-based cohort. Am J Clin Nutr. 2017;106:783-90.
483 46. Eichler J, Schmidt R, Poulain T, Hiemisch A, Kiess W, Hilbert A. Stability,
484 Continuity, and Bi-Directional Associations of Parental Feeding Practices and Standardized
485 Child Body Mass Index in Children from 2 to 12 Years of Age. Nutrients. 2019;11.
486 47. Afonso L, Lopes C, Severo M, Santos S, Real H, Durao C, et al. Bidirectional
487 association between parental child-feeding practices and body mass index at 4 and 7 y of age.
488 Am J Clin Nutr. 2016;103:861-7.
489 48. Campbell K, Andrianopoulos N, Hesketh K, Ball K, Crawford D, Brennan L, et al.
490 Parental use of restrictive feeding practices and child BMI z-score. A 3-year prospective
491 cohort study. Appetite. 2010;55:84-8.
492 49. Powell EM, Frankel LA, Hernandez DC. The mediating role of child self-regulation of
493 eating in the relationship between parental use of food as a reward and child emotional
494 overeating. Appetite. 2017;113:78-83.
495 50. Russell CG, Haszard JJ, Taylor RW, Heath AM, Taylor B, Campbell KJ. Parental
496 feeding practices associated with children's eating and weight: What are parents of toddlers
497 and preschool children doing? Appetite. 2018;128:120-8.
498 51. Korani M, Rea DM, King PF, Brown AE. Maternal eating behaviour differs between
499 ethnic groups: Considerations for research and practice. Matern Child Nutr.
500 2018;14(4):e12630.

501

FIGURE LEGENDS

Figure 1. Flow of participants in the study

TABLES

Table 1. Characteristics of the study population (n=1322)

	% (n) or Mean (SD) or Median (Q1-Q3)
Parental characteristics	
Center	
Poitiers	47.4% (627)
Nancy	52.6% (695)
Maternal education level	
< High school diploma	22.9% (303)
High school diploma	17.9% (237)
2 years university degree	23.4% (309)
5 years university degree	35.8% (473)
Employed mothers	79.0% (1045)
Household income (€/month)	
≤ 1500	12.3% (162)
1501-2300	29.3% (387)
2301-3000	28.7% (379)
>3000	29.8% (394)
Maternal age at delivery (years)	29.9 (4.7)
Primiparous	47.4% (626)
Maternal BMI at 2-year follow-up (kg/m^2)	
<18.5	5.8% (77)
18.5 to <25	61.0% (806)
25 to <30	22.1% (292)
≥ 30	11.1% (147)
Maternal eating behaviors (0-100 scores)	
Cognitive restraint	33.2 (21.4)
Uncontrolled eating	23.8 (17.9)
Emotional eating	34.8 (27.5)
Maternal feeding practices (1-5 scores)	
Restriction for health	3.4 (1.0)
Restriction for weight	1.7 (0.6)
Pressure to eat	2.3 (0.8)
Food as a reward	1.3 (1.0 - 1.7)
Emotional feeding	1.3 (1.0 - 1.7)
Child characteristics	
Boys	52.0% (688)
BMI at 2 years (kg/m^2)	16.2 (1.1)
WHO BMI z-score at 2 years	0.2 (0.9)

Table 2. Associations between maternal eating behaviors and maternal coercive feeding practices

	Restriction for health		Restriction for weight		Pressure to eat	
	β [95% CI]	P	β [95% CI]	P	β [95% CI]	P
Univariable analyses (n=1322)						
Cognitive restraint	0.07 [0.05; 0.10]	<0.0001	0.07 [0.06; 0.09]	<0.0001	0.02 [0.00; 0.04]	0.07
Uncontrolled eating	0.06 [0.03; 0.09]	0.0001	0.01 [0.00; 0.03]	0.1	0.04 [0.01; 0.06]	0.003
Emotional eating	0.04 [0.02; 0.06]	0.0005	0.02 [0.01; 0.04]	0.0001	0.01 [-0.01; 0.02]	0.5
Adjusted analyses (n=1322)						
Eating behaviors considered simultaneously						
Cognitive restraint	0.07 [0.04; 0.10]	<0.0001 ***	0.07 [0.06; 0.09]	<0.0001 ***	0.02 [0.00; 0.04]	0.08
Uncontrolled eating	0.04 [0.00; 0.08]	0.05	-0.02 [-0.05; 0.00] ¥	0.06	0.06 [0.03; 0.09]	0.0007 **
Emotional eating	0.01 [-0.02; 0.03]	0.6	0.02 [0.00; 0.03]	0.06	-0.02 [-0.04; 0.00]	0.08

Linear regression models adjusted for: study center, maternal age at delivery, primiparity, maternal education level, maternal employment status, household income, child's sex and maternal BMI at 2-year follow-up. Estimations are given per 10 points of maternal eating behavior scores.

¥: Significant modulating effect of child's sex.

After the correction of multiple comparisons using the false discovery rate (FDR) procedure: * q<0.1, ** q<0.01, and *** q<0.0001

Table 3. Associations between maternal eating behaviors and maternal feeding practice of using food to regulate child's emotions

	High use of food to regulate child's emotions (Ref=Low)	
	OR [95% CI]	P
Univariable analyses (n=1322)		
Cognitive restraint	1.06 [1.01; 1.12]	0.02
Uncontrolled eating	1.27 [1.19; 1.36]	<0.0001
Emotional eating	1.12 [1.07; 1.16]	<0.0001
Adjusted analyses (n=1322)		
Eating behaviors considered simultaneously		
Cognitive restraint	1.01 [0.95; 1.07]	0.7
Uncontrolled eating	1.26 [1.15; 1.38]	<0.0001 ***
Emotional eating	1.02 [0.96; 1.08]	0.5

Logistic regression models adjusted for: study center, maternal age at delivery, primiparity, maternal education level, maternal employment status, household income, child's sex and maternal BMI at 2-year follow-up. Estimations are given per 10 points of maternal eating behavior scores.

After the correction of multiple comparisons using the false discovery rate (FDR) procedure: * $q<0.1$, ** $q<0.01$, and *** $q<0.0001$

SUPPLEMENTAL TABLES

File name: Supplemental Tables_Appetite_R3

File format: Word file (.docx)

Text summary: Supplemental table 1. Details regarding multiple imputations (N=1404)

Supplemental table 2. Association between maternal eating behaviors and maternal feeding practice of using of food as a reward

Supplemental table 3. Sensitivity analyses: Associations between maternal eating behaviors and maternal coercive feeding practices

Supplemental table 4. Sensitivity analyses: Associations between maternal eating behaviors and maternal feeding practices of using foods for non-nutritional purposes