Parental feeding practices as potential moderating or mediating factors in the associations between children's early and later growth

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TITLE

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COMPETING INTEREST STATEMENT

The authors declare that they have nothing to disclose.

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RUNNING TITLE

Parental feeding practices and children's growth

ABSTRACT

Background: Given inconsistent results in the literature, our objective was to examine the role of early parental feeding practices in children's growth.

Methods: Analyses were based on 1245 children from the EDEN mother–child cohort. Parental feeding practices were assessed at the 2-year follow-up by using the Comprehensive Feeding Practices Questionnaire. International Obesity Task Force BMI z-scores were derived from weight and height assessed at 2, 4, 6 and 8 years. Associations between parental feeding practices and child BMI z-scores at 4, 6 and 8 years were assessed by multivariable linear regressions, notably adjusted for 2-year BMI z-score. Analyses were stratified by child sex when relevant. Moreover, interaction and mediation analyses were respectively performed to assess whether parental feeding practices could moderate or mediate the associations between early and later growth.

Results: For a given BMI z-score at 2 years, parental restriction for weight at 2 years was positively associated with child BMI z-scores from 4 to 8 years (at 8 years: β [95% CI] = 0.09 [0.01; 0.16]). Among boys only, high use of food as a reward was positively associated with later BMI z-scores (at 8 years: β [95% CI] = 0.15 [0.03; 0.27]). Parental feeding practices were not moderating factors in the associations between early and later growth. Parental restriction for weight was a mediating factor in the associations between 2-year BMI z-score and BMI z-scores up to 8 years (mediation: 2.69% [0.27%; 5.11%] of the total effect at 8 years).

Conclusions: Restriction for weight reasons, often used by parents in response to the child's high appetite in infancy, appears to lie on the pathway between early and later BMI, but not restriction for health, suggesting that parental way of restricting the child's food intake matters.

KEYWORDS

Parental feeding practices; growth; BMI; birth cohort; mediation

INTRODUCTION

Childhood overweight and obesity affects 39 million children under the age of 5 years worldwide (1) and is associated with short- and long-term adverse outcomes, such as adulthood obesity, cardiovascular diseases and psychosocial difficulties (1, 2). According to the concept of the developmental origins of health and disease, the first 1000 days of life (i.e., from conception to age 2 years) constitute an opportunity window to prevent overweight and obesity (3). It is notably suggested that the factors related to eating behaviors may be easier to modify during their development in the first years of life than later in life (3).

Early eating behaviors and eating habits have been found to be associated with eating behaviors and food intake later in childhood or in adolescence (4-6). The previous literature showed that child early appetite or eating behaviors could be associated with later BMI: appetite, enjoyment of food, emotional overeating and food responsiveness in early life have been found to be positivity associated with BMI later in childhood, whereas slowness in eating and satiety responsiveness have been found to be negatively related to BMI later in childhood (7-9). However, early BMI has also been found to be positively or negatively associated with the same aspects of later child eating behavior (9-12).

Parents play a key role in the development of their child's eating behaviors and eating habits, especially in the first years of life, by being role models (13, 14) and by deciding the type of foods and the portion size offered to the child as well as the feeding time (15). Parental feeding practices are strategies (actions or behaviors) parents adopt to influence their child's food intake or eating behavior (16-18). Several studies assessed the associations between these feeding practices and children's growth, summarized in literature reviews that mainly focused on coercive parental feeding practices (i.e., restriction for health, restriction for weight or pressure to eat) (19). The conclusions of these literature reviews are inconsistent (12, 18, 20-24). Nevertheless, the recent systematic review and meta-analysis of Ruzicka et al.

(based on 31 cross-sectional studies, 13 longitudinal studies and 7 randomized control trials) found a positive association between parental restriction and child weight and a negative association between parental pressure to eat and child weight and concluded that more longitudinal studies are required to examine the direction of this association (25).

Overall, recent literature reviews concluded that more longitudinal studies are required to assess the complex associations between parental feeding practices and childhood BMI, notably by accounting for the child's eating behavior (21, 23, 25). As parental feeding practices are modifiable, to develop strategies to prevent childhood obesity, it would be of great importance to examine whether parental feeding practices could be considered as potential lever to modulate early growth (moderating factor), by attenuation or reinforcement of the associations between early and later growth, or whether they could lie on the pathway between early and later growth (mediating factor). In this context, the first objective of this prospective study was to assess the associations between parental feeding practices in toddlerhood and children's BMI up to 8 years. The second objective was to examine whether parental feeding practices may be considered as moderating or mediating factors in the associations between early and later child BMI.

MATERIAL AND METHODS

Study population

The EDEN mother–child study is a French prospective cohort that investigates the prenatal and postnatal determinants of child growth, development and health (26). A total of 2002 pregnant women before 24 weeks of amenorrhea were recruited in two university hospitals (Nancy and Poitiers) from 2003 to 2006. Exclusion criteria were multiple pregnancies, known diabetes before pregnancy, French illiteracy and planning to move outside the region in the next 3 years. Written consent was obtained from both parents. The study was approved by the ethics committee of the university hospital of Kremlin- Bicêtre (ID 0270 of December 12,

2002) and data files were declared to the National Committee for Processed Data and Freedom (CNIL, ID 902267 of December 12, 2002).

Child growth

The child's weight and length/height were measured at each clinical examination (at birth, 1, 3 and 5 years) (26). Moreover, at each follow-up (at 4, 8 and 12 months, 2, 3, 4, 5 and 8 years), parents reported weight and length/height data, collected in the child's health booklet (26). In order to study children's anthropometric measurements exactly at the same age, individual growth curves for weight and length/height were computed by using the Jenss-Bayley growth curve model, as described previously (26, 27). To account for the increase in BMI variability with child's age, the data from the individual growth curves were used to calculate the child's BMI z-scores at ages 2, 4, 6 and 8 years, using the International Obesity Task Force references (28).

Parental feeding practices

Parental feeding practices were assessed at the 2-year follow-up (i.e., when the child was 2 years old) with the French version (29) of the Comprehensive Feeding Practices Questionnaire (30). In the present analysis, five scales of the questionnaire were used: restriction for health (4 items; in the EDEN mother–child cohort: Cronbach $\alpha = 0.79$), restriction for weight (4 items; Cronbach $\alpha = 0.67$), pressure to eat (3 items; Cronbach $\alpha = 0.59$), using food as a reward (Rewards, 3 items; Cronbach $\alpha = 0.45$) and using food to regulate the child's emotions (Emotion regulation, 3 items; Cronbach $\alpha = 0.66$). Each item is associated with a score from 1 (never or disagree) to 5 (always or agree). Item scores are averaged within each scale. Scores of coercive parental feeding practices (i.e., restriction for health, restriction for weight and pressure to eat) were considered as continuous variables. Because of the skewed distribution of scores, parental feeding practices of using food as a reward or to regulate the child's emotions were considered as binary variables, according to

130 the median in our sample. “Low use” of a specific parental feeding practice was defined by a
131 score below the median and “high use” by a score equal to or above the median.

132 **Other variables**

133 The baseline questionnaire administered during pregnancy or at birth was used to collect
134 information on parental characteristics, including maternal age at delivery (in years),
135 primiparity (yes/no), maternal education level (< high school diploma, high school diploma,
136 and 2-year and ≥ 5-year university degree), household income (in €/month: ≤ €1500, €1501 to
137 €2300, €2301 to €3000 and > 3000€), maternal smoking status during pregnancy (yes/no) and
138 parental BMI. Maternal BMI was classified into 4 categories (underweight: < 18.5 kg/m2,
139 normal BMI: ≥ 18.5 to < 25 kg/m^2, overweight: ≥ 25 to < 30 kg/m^2 and obese: ≥ 30 kg/m^2).
140 Paternal BMI was studied in 3 categories because of the low number of underweight fathers
141 (underweight or normal BMI: < 25 kg/m^2, overweight: ≥ 25 to < 30 kg/m^2 and obese: ≥ 30
142 kg/m^2).

143 Data on child characteristics were collected at birth and during the first year of life and
144 included sex, birth weight (in kg), preterm birth (yes/no) and any breastfeeding duration (< 1
145 month, 1 to < 4 months and ≥ 4 months). Moreover, maternal perception of the child’s
146 appetite was assessed with one item at 4, 8, 12 and 24 months. A 4-to-24-month appetite
147 indicator in 3 categories (low, intermediate and high appetite) was then developed, as
148 previously described (31).

149 **Sample selection**

150 Of the 2002 recruited women, 76 were excluded because they left the study before or at the
151 time of delivery; 24 because of miscarriage, intrauterine death, or discontinuation of
152 pregnancy for medical reasons and 9 because they delivered outside the study hospitals. Data
153 on birthweight were available for 1899 newborns. Individuals with missing data for at least

one parental feeding practice (n=492), child growth (n=6) and potential confounders (n=156) were excluded, which led to a complete-case sample of 1245 (Figure 1).

Statistical analyses

Comparisons between excluded and included participants were assessed by chi-squared tests for categorical variables and Student *t* tests for continuous variables.

Associations between 2-year parental feeding practices and BMI z-scores at 4, 6 and 8 years were investigated with multivariable linear regression models. One model was run per parental feeding practice (exposure variable) and per child BMI z-score (outcome, i.e., at each age). Potential confounders were identified from the literature and selected according to the directed acyclic graph method (32): study center, parental characteristics (primiparity, maternal age at delivery, maternal education level, household income, maternal smoking status during pregnancy, parental BMI) and child's characteristics (sex, preterm birth, any breastfeeding duration, 4-to-24-month appetite and 2-year BMI z-score). In preliminary analyses, child sex significantly modified the associations between parental use of food as a reward and later child growth (i.e., $p_{interaction} \leq 0.10$). Then, these analyses were stratified by child sex.

Moderation occurs when the association between the exposure and the outcome differs depending on the level of a third variable, called moderating factor (33). In the current study, moderation analyses were used in order to examine whether parental feeding practices could be considered as potential lever to modulate early growth, by attenuation or reinforcement of the associations between early and later child growth. To assess whether parental feeding practices could be moderating factor in the associations between the exposure (i.e., 2-year BMI z-score) and the outcome (i.e., BMI z-score at 4, 6 or 8 years), an interaction term (2-year BMI z-score * parental feeding practice) was added in each multivariable linear regression model. One model was performed per potential moderating factor and per outcome

(i.e., at each age). All models were adjusted for study center, primiparity, maternal age at delivery, maternal education level, household income, maternal smoking status during pregnancy, parental BMI, child sex, preterm birth, any breastfeeding duration and 4-to-24-month appetite. When the $p_{interaction}$ was ≤ 0.10, analyses were stratified by parental feeding practices.

Mediation occurs when a third variable lies on the causal pathway between the exposure and the outcome (33). In the current study, mediation analyses were used to study if parental feeding practices could lie on the pathway between early and later growth. To study whether parental feeding practices could be mediating factors in the associations between child 2-year BMI z-score and later child BMI z-scores at 4, 6 and 8 years, mediation analyses using the counterfactual framework were performed (CAUSALMED procedure, SAS statistical software) (34, 35). This method was used because it allows for mediation analyses of a continuous or binary mediating factor or exposure, continuous outcome and categorical or continuous covariables. Covariables included in the mediation models were the same as the adjustment factors included in moderation analyses. Supplemental analyses were performed by adding an interaction term between the exposure and the potential mediating factor, as suggested previously (36). Because this interaction term did not modify the results (data not shown), we present the mediation analyses without this interaction term.

The main analyses were conducted on the complete-case sample. In sensitivity analyses, missing data on adjustment factors were handled by using the hot deck method, which replaces each missing value with an observed data of respondents sharing the same characteristics (37). Analyses were conducted with SAS v9.4 (SAS Institute, Cary, NC, USA). The code book and analytic code will be made available upon request.

RESULTS

As compared with excluded children (n=757), included children (n=1245) were more frequently born to mothers who were older (30 vs 29 years, $p < 0.0001$), primiparous (48% vs 39%, $p = 0.0003$), with higher education level (37% vs 23% with at least a 5-year university degree, $p < 0.0001$), with higher household income (31% vs 20% with > 3000€/month, $p < 0.0001$), and with lower BMI before pregnancy (23.1 vs 23.5 kg/m^2, $p = 0.05$) and who less frequently smoked during pregnancy (21% vs 36%, $p < 0.0001$). As compared with excluded children, included children were breastfed longer (36% vs 25% breastfed for at least 4 months, $p < 0.0001$). Included participants were similar to excluded ones regarding paternal BMI, child sex, birth weight and preterm birth. Characteristics of included participants are in Table 1.

Associations between parental feeding practices and child growth

Even after accounting for 2-year BMI z-score, parental restriction for weight was positively associated with child BMI z-scores between 4 and 8 years (Table 2). Among boys only, parental use of food as a reward was positively associated with child BMI z-scores between 4 and 8 years (Table 3). Parental restriction for health, pressure to eat and use of food to regulate the child's emotions were not related to child BMI z-scores between 4 and 8 years (Table 2).

Similar results were found after the hot deck imputation, except for parental restriction for health, which was positively associated with child BMI z-scores at 6 and 8 years (Tables 2 and 3).

Moderation and mediation analyses

Parental feeding practices were not moderating factors in the associations between child early and later BMI z-scores (all $p_{interaction} > 0.10$).

Parental restriction for weight was a mediating factor in the associations between early and later BMI z-scores (Table 4). The effect of parental restriction for weight on BMI z-score is providing by the natural indirect effect (Table 4). The percentage of the association explained by restriction for weight ranged from 0.78% [0.03%; 1.52%] at 4 years to 2.69% [0.27%; 5.11%] at 8 years (Table 4). Similar results were found after hot deck imputation (Table 4). Among boys, parental use of food as a reward was not a mediating factor in the associations between early and later BMI z-scores (Table S1).

DISCUSSION

In this prospective study, parental restriction for weight and high use of food as a reward (among boys) at 2 years were positively associated with child BMI z-scores up 8 years. Parental feeding practices were not moderating factors in the association between early and later BMI z-scores. Moreover, parental restriction for weight lied on the pathway between 2-year BMI z-score and BMI z-scores between 4 and 8 years.

Several studies assessed the associations between parental restrictive feeding practices and children's later BMI, providing inconsistent findings. Of note, most studies examining parental restrictive practices used the Child Feeding Questionnaire (38), with global score on parental restriction, whereas the Comprehensive Feeding Practices Questionnaire (30), used in the present study, distinguishes between parental restriction for health reasons or to prevent weight issues. This discrepancy may limit some comparisons. A recent systematic review and meta-analysis highlighted a weak but significant association between restrictive feeding practice and child weight and considered that more longitudinal studies are needed to conclude on the direction of the association (25). Indeed, this meta-analysis was mainly based on cross-sectional studies, and findings were less consistent in other narrative or systematic reviews including more longitudinal studies (21, 22). In a systematic review including only prospective studies, restrictive feeding practices were not considered related to later growth

parameters (23). In the current study, parental restriction for weight was positively related to later BMI up to 8 years in all analyses, and the positive association with restriction for health was found only at 6 and 8 years after hot deck imputation. Further prospective studies are needed to confirm these results.

Results concerning the association between parental pressure to eat and child BMI are inconsistent in the literature (22). Most literature reviews concluded a negative association (18, 20, 21, 25). Nevertheless, in line with the results of the current study, a literature review and a recent study concluded that parental pressure to eat was not associated with children's BMI (23, 39). More prospective studies are needed to explore this issue.

Concerning parental use of food for non-nutritional purposes, in a recent review, parental use of food as a reward was positively associated with children's later BMI, with no association found for parental use of food to regulate the child's emotions (23). In line with these results, we did not find any association between parental use of food to regulate the child's emotions but rather a positive association between parental use of food as a reward and later BMI, among boys only. Further studies are needed to confirm this result and to investigate the mechanisms that could explain the potential moderating effect of child sex.

If some studies examined whether children's eating behaviors could lie on the pathway between parental feeding practices and child BMI (40), to our knowledge, no study has examined whether parental feeding practices could lie on the pathway between early and later BMI. Because parental feeding practices are modifiable factors that could be targeted by strategies to prevent childhood obesity, it seems important to understand their potential role in this association. In the current study, parental feeding practices were not moderating factors in the associations between early and later BMI. In others words, favoring a given feeding practice does not appear to be a promising lever to inflect the BMI curve. Moreover, parental restriction for weight lied on the pathway between early and later child BMI. Overall, our

results suggest that parental restriction for weight does not seem effective in limiting later child BMI and could even be counterproductive, and should therefore be avoiding by parents to limit childhood obesity. These findings are contradictory to what was found in adult populations, in which cognitive restraint seems to attenuate the association between genetic susceptibility to obesity and BMI (41). For children, parents seem to use these restrictive feeding practices to deal with their child's high appetite in toddlerhood (31). Differences regarding potential impact of restriction on BMI among children and adults could be explained in part by adults choosing to restrict their own food intake, whereas young children do not decide for themselves. Interestingly, contrary to restriction for weight, restriction for health was not a mediating factor in the associations between early and later child BMI. This difference could partly be explained by what distinguishes these restrictive feeding practices. Indeed, restriction for health (i.e., parental control of the child's food intake with the purpose of limiting less healthy foods and sweets (30)) could refer to the restriction of foods with high levels of salt, sugar or fat, whereas restriction for weight (i.e., parental control of the child's food intake with the purpose of decreasing or maintaining the child's weight (30)) could refer to the restriction of food quantities consumed by the child, in order to limit child's later BMI. These results suggest that parental restriction per se could not be problematic, but parental way of doing it. Moreover, as it is suggested in the literature that parental restriction could be perceived or not by the child (overt vs covert restriction) (42), distinguishing the nature of the parental restriction in the associations between parental feeding practices and growth will be of great interest. Future studies are warranted to investigate how to advise parents whose children are perceived as having a high appetite in toddlerhood to prevent the risk of childhood obesity.

Most previous studies investigating associations between parental feeding practices and child growth focused on controlling feeding practices, so further studies focusing on parental responsive feeding practices are needed.

In the present study, parental feeding practices were reported by parents, which could imply a social desirability bias (43). To limit this bias, parental feeding practices were assessed by using a validated questionnaire (30) applicable in a French sample (29). The internal consistency of parental feeding practices was acceptable, except for the scale of parental use of food as a reward, which had a low Cronbach α, thus limiting the interpretation of the results concerning this feeding practice. However, our results concerning this feeding practice seem to be consistent with those of the literature (23), thereby suggesting the reliability of the present findings. Families included in the EDEN mother–child cohort have a higher socio-economic position than the French population (26); hence, these findings should be confirmed in more vulnerable families.

This study highlights that restriction for weight, often used by parents to deal with children's high appetite in infancy, may lie on the pathway between early and later BMI. Future longitudinal studies are needed to identify which parental feeding practices, notably responsive feeding practices, could attenuate the association between early and BMI later in childhood in order to target them in childhood obesity prevention strategies.

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AUTHOR CONTRIBUTIONS

CG and BLG designed the research, analysed the data and wrote the manuscript. AHC analysed the data. BH 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

The authors declare that they have nothing to disclose.

DATA AVAILABILITY STATEMENT

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 be 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.

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FIGURE LEGEND

Figure 1. Flow of participants in the study

TABLES

Table 1. Characteristics of the study population (n=1245)

	% (n) or Mean (SD) or Median (Q1-Q3)	Missing value % (n) [a]
Parental characteristics		
Center		0
Poitiers	47.6% (593)	
Nancy	52.4% (652)	
Maternal age at delivery (year)	29.9 (4.7)	0
Primiparous	47.6% (592)	0.1% (2)
Maternal education level		0.5% (7)
< High school diploma	22.1% (275)	
High school diploma	17.7% (220)	
2 years university degree	23.8% (296)	
≥ 5 years university degree	36.5% (454)	
Household income (€/month)		0.6% (9)
≤ 1500	11.1% (138)	
1501-2300	29.7% (370)	
2301-3000	28.4% (354)	
> 3000	30.8% (383)	
Smoker during pregnancy	21.3% (265)	2.2% (31)
Maternal BMI before pregnancy (kg/m^2)	23.1 (4.3)	1.9% (27)
Paternal BMI before pregnancy (kg/m^2)	25.0 (3.5)	7.0% (98)
Parental feeding practices (1-5 scores)		
Restriction for health	3.4 (1.0)	0
Restriction for weight	1.7 (0.6)	0
Pressure to eat	2.3 (0.8)	0
Food as a reward	1.3 (1.0 - 1.7)	0
Emotional feeding	1.3 (1.0 - 1.7)	0
Child characteristics		
Boys	52.0% (647)	0
Birth weight (kg)	3.3 (0.5)	0
Preterm birth (< 37 gestational weeks)	5.4% (67)	0
Any breastfeeding duration (month)		0.1% (1)
< 1	32.9% (410)	
1 to < 4	31.5% (392)	
≥ 4	35.6% (443)	
4-to-24-month appetite		0
Low	10.8% (135)	
Intermediate	78.3% (975)	
High	10.8% (135)	
IOTF BMI z-scores		
At 2 years	-0.4 (0.9)	0
At 4 years	-0.1 (0.9)	0
At 6 years	0.3 (0.9)	0
At 8 years	0.2 (0.9)	0

IOTF: International Obesity Task Force.

[a] These missing values were imputed using the hot deck method (37), and were used in supplemental analyses (after hot deck imputation, N=1401).

Table 2. Associations between parental feeding practices and child BMI z-scores (main sample)

	4-year BMI z-score β [95% CI]	p	6-year BMI z-score β [95% CI]	p	8-year BMI z-score β [95% CI]	p
Unadjusted analyses (N=1245)						
Restriction for health (1-5 score)	0.05 [0.00; 0.10]	0.05	0.06 [0.01; 0.10]	0.02	0.06 [0.01; 0.11]	0.01
Restriction for weight (1-5 score)	0.33 [0.25; 0.41]	<0.0001	0.27 [0.19; 0.35]	<0.0001	0.23 [0.15; 0.31]	<0.0001
Pressure to eat (1-5 score)	-0.10 [-0.16; -0.04]	0.001	-0.08 [-0.14; -0.02]	0.01	-0.07 [-0.13; -0.01]	0.03
High emotional feeding [a]	0.08 [-0.02; 0.19]	0.1	0.08 [-0.02; 0.17]	0.1	0.07 [-0.03; 0.17]	0.2
Adjusted analyses (N=1245) [b]						
Restriction for health (1-5 score)	0.01 [-0.02; 0.03]	0.7	0.02 [-0.01; 0.06]	0.2	0.04 [0.00; 0.08]	0.08
Restriction for weight (1-5 score)	0.05 [0.00; 0.09]	0.03	0.07 [0.01; 0.14]	0.02	0.09 [0.01; 0.16]	0.02
Pressure to eat (1-5 score)	0.00 [-0.03; 0.03]	0.9	0.00 [-0.04; 0.05]	1	0.00 [-0.05; 0.05]	1
High emotional feeding [a]	0.01 [-0.04; 0.06]	0.7	0.02 [-0.06; 0.09]	0.6	0.02 [-0.06; 0.11]	0.6
Adjusted analyses, after imputation (N=1401) [b]						
Restriction for health (1-5 score)	0.01 [-0.01; 0.04]	0.2	0.04 [0.00; 0.07]	0.04	0.05 [0.01; 0.09]	0.01
Restriction for weight (1-5 score)	0.05 [0.01; 0.09]	0.01	0.08 [0.02; 0.14]	0.008	0.10 [0.03; 0.17]	0.008
Pressure to eat (1-5 score)	0.00 [-0.03; 0.03]	1	0.00 [-0.04; 0.04]	1	0.00 [-0.06; 0.05]	0.8
High emotional feeding [a]	0.02 [-0.03; 0.07]	0.4	0.03 [-0.04; 0.10]	0.4	0.03 [-0.05; 0.11]	0.5

[a] High parental emotional feeding is defined by a score equal to or above the median.

[b] Linear regression models adjusted for study center, maternal age at delivery, primiparity, maternal education level, household income, maternal smoking status during pregnancy, parental BMI, child sex, preterm birth, any breastfeeding duration, 4-to-24-month appetite and 2-year BMI z-score.

One model was performed for each parental feeding practice and at each age.

Table 3. Associations between parental use of food as a reward and child BMI z-scores, by child sex

Exposure: high use of food as a reward [a]	4-year BMI z-score β [95% CI]	p	6-year BMI z-score β [95% CI]	p	8-year BMI z-score β [95% CI]	p
Boys						
Unadjusted analyses (N=1245)	0.01 [-0.14; 0.16]	0.9	0.06 [-0.07; 0.20]	0.4	0.08 [-0.06; 0.22]	0.2
Adjusted analyses (N=1245) [b]	0.09 [0.02; 0.17]	0.01	0.14 [0.03; 0.25]	0.01	0.15 [0.03; 0.27]	0.01
Adjusted analyses, after imputation (N=1401) [b]	0.08 [0.01; 0.15]	0.03	0.12 [0.02; 0.22]	0.02	0.14 [0.02; 0.26]	0.02
Girls						
Unadjusted analyses (N=1245)	0.09 [-0.05; 0.23]	0.2	0.09 [-0.04; 0.23]	0.2	0.10 [-0.04; 0.24]	0.2
Adjusted analyses (N=1245) [b]	-0.04 [-0.11; 0.04]	0.3	-0.03 [-0.13; 0.08]	0.6	0.00 [-0.13; 0.12]	0.9
Adjusted analyses, after imputation (N=1401) [b]	-0.02 [-0.09; 0.05]	0.6	0.00 [-0.10; 0.10]	1	0.02 [-0.10; 0.14]	0.8

[a] High parental use of food as a reward is defined by a score equal to or above the median.

[b] Linear regression models adjusted for study center, maternal age at delivery, primiparity, maternal education level, household income, maternal smoking status during pregnancy, parental BMI, preterm birth, any breastfeeding duration, 4-to-24-month appetite and 2-year BMI z-score. One model was performed for each parental feeding practice and at each age.

Table 4. Mediation analyses of parental restriction for weight in the associations between 2-year BMI and later BMI

	4-year BMI z-score		6-year BMI z-score		8-year BMI z-score	
	β [95% CI]	p	β [95% CI]	p	β [95% CI]	p
Exposure: 2-year BMI z-score, complete-case analyses (N=1245)						
Total effect	0.86 [0.83; 0.89]	<0.0001	0.59 [0.55; 0.64]	<0.0001	0.44 [0.39; 0.49]	<0.0001
Natural direct effect	0.85 [0.82; 0.88]	<0.0001	0.58 [0.54; 0.63]	<0.0001	0.42 [0.37; 0.48]	<0.0001
Natural indirect effect	0.01 [0.00; 0.01]	0.04	0.01 [0.00; 0.02]	0.03	0.01 [0.00; 0.02]	0.03
Percentage mediated by restriction for weight	0.78 [0.03; 1.52]	0.04	1.69 [0.17; 3.21]	0.03	2.69 [0.27; 5.11]	0.03
Exposure: 2-year BMI z-score, imputed analyses (N=1401)						
Total effect	0.86 [0.83; 0.89]	<0.0001	0.59 [0.55; 0.63]	<0.0001	0.43 [0.38; 0.48]	<0.0001
Natural direct effect	0.85 [0.82; 0.88]	<0.0001	0.58 [0.54; 0.62]	<0.0001	0.42 [0.37; 0.47]	<0.0001
Natural indirect effect	0.01 [0.00; 0.01]	0.02	0.01 [0.00; 0.02]	0.01	0.01 [0.00; 0.02]	0.01
Percentage mediated by restriction for weight	0.88 [0.14; 1.61]	0.02	1.96 [0.43; 3.50]	0.01	3.14 [0.68; 5.59]	0.01

Mediation analyses adjusted for study centre, maternal age at delivery, primiparity, maternal education level, household income, maternal smoking status during pregnancy, parental BMI, child sex, preterm birth, any breastfeeding duration and 4-to-24-month appetite. One mediation analysis was performed at each age.

SUPPLEMENTAL MATERIAL

Table S1. Mediation analyses of parental use of food as a reward in the associations between 2-year BMI and later BMI, among boys only

	4-year BMI z-score		6-year BMI z-score		8-year BMI z-score	
	β [95% CI]	p	β [95% CI]	p	β [95% CI]	p
Exposure: 2-year BMI z-score, complete-case analyses (N=647)						
Total effect	0.88 [0.84; 0.93]	<0.0001	0.61 [0.55; 0.67]	<0.0001	0.43 [0.37; 0.50]	<0.0001
Natural direct effect	0.88 [0.84; 0.93]	<0.0001	0.61 [0.55; 0.67]	<0.0001	0.44 [0.37; 0.50]	<0.0001
Natural indirect effect	0.00 [-0.01; 0.00]	0.7	0.00 [-0.01; 0.01]	0.7	0.00 [-0.01; 0.01]	0.7
Percentage mediated by use of food as a reward	-0.11 [-0.62; 0.40]	0.7	-0.23 [-1.32; 0.85]	0.7	-0.36 [-2.02; 1.31]	0.7
Exposure: 2-year BMI z-score, imputed analyses (N=729)						
Total effect	0.88 [0.84; 0.92]	<0.0001	0.60 [0.54; 0.66]	<0.0001	0.43 [0.36; 0.50]	<0.0001
Natural direct effect	0.88 [0.84; 0.92]	<0.0001	0.61 [0.55; 0.66]	<0.0001	0.43 [0.36; 0.50]	<0.0001
Natural indirect effect	0.00 [-0.01; 0.00]	0.5	0.00 [-0.01; 0.00]	0.5	0.00 [-0.01; 0.00]	0.5
Percentage mediated by use of food as a reward	-0.14 [-0.56; 0.28]	0.5	-0.32 [-1.26; 0.61]	0.5	-0.53 [-2.06; 1.01]	0.5

Mediation analyses adjusted for study centre, maternal age at delivery, primiparity, maternal education level, household income, maternal smoking status during pregnancy, parental BMI, preterm birth, any breastfeeding duration and 4-to-24-month appetite.
One mediation analysis was performed at each age.

Parental feeding practices as potential moderating or mediating factors in the associations between children's early and later growth. Guivarch C., Cissé A.H., Charles MA., Heude B., de Lauzon-Guillain B. Supplemental Material.

Table S2. STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	3
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5-8
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5-8
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	5-8
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	NA
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-9
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6-9
Bias	9	Describe any efforts to address potential sources of bias	9
Study size	10	Explain how the study size was arrived at	7-8 Figure 1
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6-9
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8-9
		(*b*) Describe any methods used to examine subgroups and interactions	8-9
		(*c*) Explain how missing data were addressed	9

		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	8-9
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Figure 1
		(b) Give reasons for non-participation at each stage	7-8 Figure 1
		(c) Consider use of a flow diagram	Figure 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9-10 Table 1
		(b) Indicate number of participants with missing data for each variable of interest	Table 1
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	Table 1
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	10-11 Tables 2, 3, 4
		(*b*) Report category boundaries when continuous variables were categorized	6-7
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	9-11 Suppl. table 1
Discussion			
Key results	18	Summarise key results with reference to study objectives	11
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	11-14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other	11-14

		relevant evidence	
Generalisability	21	Discuss the generalisability (external validity) of the study results	13-14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	1-2

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.