Received: 27 October 2022 | Accepted: 30 January 2023

DOI: 10.1111/jhn.13151

JHND Journal of Human Nutrition and Dietetics | BDA The Association of UK Dietitians

Parental child-feeding practices at 4 years of age are associated with dietary patterns of 7-year-olds

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Funding information

Fundação para a Ciência e a Tecnologia

Abstract

Background: Parental child-feeding practices have been associated with child body mass index (BMI) and specific food group consumption; however, their role in the development of dietary patterns is less understood. We aim to study the association between parental child-feeding practices at 4 years old and dietary patterns at 7 years that explain BMI z-scores at age 10.

Methods: Participants were children from the Generation XXI birth cohort ($n = 3272$). Three patterns of feeding practices at 4 years were previously identified: 'Perceived monitoring', 'Restriction' and 'Pressure to eat'. At 7 years, two dietary patterns were derived: 'Energy-dense foods', higher consumption of energy-dense foods and drinks and processed meats and lower consumption of vegetable soup (significantly associated with BMI z-scores at 10 years) and 'Fish-based', higher in fishery intake and lower in energy-dense food intake. Associations were estimated by linear regression models, adjusted for potential confounders (mother's age, education and pre-pregnancy BMI).

Results: Girls whose parents used more Restriction, Perceived monitoring and Pressure to eat at 4 years were less likely to follow the 'Energy-dense foods' dietary pattern at 7 years ($\hat{\beta} = -0.082$; 95% confidence intervals [CI]: −0.134; −0.029; $\hat{\beta} = -0.093$; 95% CI: −0.146; −0.039; $\hat{\beta} = -0.079$; 95% CI: −0.135; −0.04, respectively). In both sexes, children whose parents used more Restriction and Perceived monitoring at 4 years were more likely to follow the 'Fish-based' dietary pattern at 7 years (girls: $\hat{\beta} = 0.143$; 95% CI: 0.077; 0.210; $\hat{\beta} = 0.079$; 95% CI: 0.011; 0.148; boys: $\hat{\beta} = 0.157$; 95% CI: 0.090; 0.224; $\hat{\beta} = 0.104$; 95% CI: 0.041; 0.168).

Conclusions: Children whose parents used more Restriction and Perceived monitoring at preschool age were more likely to follow healthier dietary patterns at age 7.

KEYWORDS

child, cohort studies, diet, feeding behaviour, feeding practices

Key points

- Parents, through their child-feeding practices in preschool age, seem to influence dietary patterns at school age; the associations differed based on each practice and were more consistent in girls.

- Children whose parents used more Restriction (limiting the type and amount of foods consumed) and Perceived monitoring (overseeing what and how much the child eats) at preschool age were more likely to follow healthier dietary patterns at age 7.
- Feeding is a reciprocal process that depends not only on children but also on parents. Parents must be aware of their important role in influencing dietary patterns of young children.

INTRODUCTION

Parents are primarily responsible for the availability and accessibility of food in the family environment and can play a role in the development of children's dietary habits and weight.[1,2] Early childhood is a period of rapid growth, in which the adoption of healthy eating habits is essential for its establishment and tracking throughout life.[2,3] Parents use specific feeding practices aiming to improve the quantity and/or quality of their children's food intake, such as restriction (limiting the type and amount of foods consumed), monitoring (overseeing what and how much the child eats) and pressure to eat (encouraging or demanding the child to eat more).[4,5]

Studies evaluating the effects of parental child-feeding practices on children's weight status have shown contradictory results. Some studies in laboratory settings have found that restricting child's access to certain foods is associated with higher body mass index (BMI).[6,7] In contradiction, a prospective cohort study with children aged 5–6 and 10–12 suggested that restricting energy-dense foods may be protective of unhealthy weight gain in younger children (i.e., 5–6-year olds), but not among the older age group.[8] When examining the bidirectional association between child-feeding practices and BMI, from 4 to 7 years of age, restriction and covert control (a type of restriction mainly based on the modification of the food environment) were found to be responsive to child's BMI but, in turn, did not prospectively affect child's weight.[9] Pressure to eat also showed a bidirectional association with weight, in which the strongest effect was observed from the child's BMI to this feeding practice.[9] Despite the bidirectional associations between some feeding practices and child's BMI, with parents and children mutually influencing each other, parental child-feeding practices appear to be mainly a response to child's eating behaviours or concerns about child weight status, rather than a cause of child's BMI.[10,11]

The bidirectional effects between parental child-feeding practices and child's weight status may be due to the child's diet. Certain feeding practices seem to have unintended effects on eating behaviours. Previous research has found that children increase their preference for restricted foods[6,12] and decrease the intake of pressured foods.[1] A cross-sectional study of children aged 4–7 found that the consumption of fruit and vegetables was associated with higher levels of overt and covert control and less pressure to eat.[13] Pressure to eat was also linked to lower fruit and vegetable consumption in children aged 2–6.[14,15] The majority of studies have found that this coercive practice decreases children's consumption of healthy foods.[16,17] Studies evaluating the effect of restrictive practices have yielded heterogeneous results, but these practices have consistently been associated with increases in children's snack foods intake.[16,17]

Although some previous studies have explored the relationship between parental child-feeding practices and the consumption of specific food groups, the role of these practices in the development of dietary patterns is not well understood. A cohort study in Norway, of 14,122 mother and child dyads, identified two dietary patterns in 3-year-old children, namely, an unhealthy pattern (rich in energy-dense foods) and a wholesome pattern (rich in vegetables, fruit and fish). The study found that mothers who used more pressure to eat had children who followed a less wholesome and more unhealthy dietary pattern and that mothers' restrictive feeding practices were associated with children following a more wholesome and less unhealthy dietary pattern.[18] These findings were, however, assessed in one time point only (3-year follow-up). Very little is known on the prospective relationship between child-feeding practices and child dietary patterns.

Dietary patterns provide a more useful way to summarise diet and relate overall diet to health outcomes for which multiple dietary components are relevant.[19,20] More recently, hybrid methods, such as reduced rank regression and partial least squares (PLS), have been increasingly used to identify dietary patterns that explain a specific outcome of interest, such as child's cardiometabolic health and weight.[19,21]

This study aims to explore the prospective effect of parental child-feeding practices at 4 years of age on dietary patterns identified on 7-year-olds that explain the BMI z-scores later in life (at age 10). We hypothesised that parental monitoring would be prospectively associated with a healthier dietary pattern 3 years later (a dietary pattern associated with a lower BMI z-score) and that restriction and pressure to eat would be prospectively associated with a less healthy dietary pattern 3 years later (a dietary pattern associated with a higher BMI z-score).

MATERIALS AND METHODS

Study design and participants

Participants were children from an ongoing Portuguese population-based birth cohort Generation XXI.[22,23] The recruitment phase occurred from April 2005 to August 2006, during which 8647 newborns and 8495 mothers were recruited from all public maternity hospitals in the Porto metropolitan area (Northern Portugal). These maternity units were responsible, at enrolment, for 91.6% of the deliveries in the whole catchment population. Among the invited mothers, 91% agreed to participate. At 4 years of age, all the participants were invited to a follow-up ($n = 7459$, 86% of participation) and again when children were 7 ($n = 6889$, 80% of participation) and 10 years of age ($n = 6397$, 76% of participation).

This study includes data of the children at birth, 4, 7 and 10 years old. Children who lacked data on variables of interest ($n = 2452$), twins ($n = 222$) and children with congenital anomalies or diseases that might influence dietary intake, such as celiac disease, food allergy, food intolerance and phenylketonuria ($n = 20$), were excluded, totalling a final sample of 3272 children. When comparing the characteristics of the study sample ($n = 3272$) with the remaining cohort ($n = 5375$) at baseline, mothers in the study sample were slightly older (mean = 30.1 years old; standard deviation [SD] = 5.0 vs. mean = 28.3; SD = 5.8) and more educated (mean = 11.6 years of education; SD = 4.3 vs. mean = 9.8; SD = 4.1) than mothers in the remaining cohort. Based on Cohen's effect size values, the magnitude of differences was not high[24] (Cohen's $d = 0.33$ for maternal age and 0.42 for maternal education).

All the phases of the study complied with the Ethical Principles for Medical Research Involving Human Subjects expressed in the Declaration of Helsinki. Generation XXI was approved by the University of Porto Medical School/São João Hospital Centre Ethics Committee and by the Portuguese Data Protection Authority. Each participant was informed about the benefits and potential discomforts, together with information on all examinations and procedures to be performed during the evaluation, at baseline and in the subsequent follow-up evaluations. The legal representative of each participant was informed about the benefits and potential discomfort, and written informed consent was obtained. Participants of the cohort did not receive any incentives to participate.

Data collection

Data at birth, 4, 7 and 10 years were collected by trained interviewers through standardised questionnaires and physical examinations or retrieved from medical records and parental self-completed questionnaires.

Parental child-feeding practices

Parental child-feeding practices were self-reported by parents at 4 years of age through an adapted questionnaire, which combined the seven subscales of the Child Feeding Questionnaire (CFQ) developed by Birch et al.[5] and the two scales of overt and covert control by Ogden et al.[25] Overt control refers to a firm behaviour by parents that is perceived by the child in relation to what should be eaten, whereas Covert control refers to a behaviour that is not perceived by the child and primarily occurs through the modification of the food environment.[25] In the current study, parental child-feeding practices included the following nine subscales: Perceived responsibility (three items, e.g., *When your child is at home, how often are you responsible for feeding her?*), Perceived parent weight (four items, e.g., *your childhood* [*5–10 years old*]), perceived child weight (three items, e.g., *your child during the first year of life*), Concern about child weight (three items, e.g., *How concerned are you about your child eating too much when you are not around her?*), Restriction (three items, e.g., *I have to be sure that my child does not eat too many sweets* [*candy, ice cream, cake or pastries*]), Pressure to eat (five items, e.g., *My child should always eat all of the food on her plate*), Monitoring (three items, e.g., *How much do you keep track of the sweets* [*candy, ice cream cake, pies, pastries*]?), Overt control (four items, e.g., *How often are you firm about what your child should eat?*) and Covert control (five items, e.g., *How often do you avoid buying sweets and crisps and bringing them into the house?*).[26] Parents or caregivers answered the items on a five-point Likert scale with different anchors ('never' to 'always'; 'unconcerned' to 'very concerned'; 'disagree' to 'agree'; 'very low' to 'very high' and 'markedly underweight' to 'markedly overweight'). Items in each subscale were summed, and their mean scores were calculated; higher scores indicated a greater level or higher agreement of each feeding practice. The combination of the seven subscales of the CFQ and the expanded parental control subscales were previously adapted and validated among parents of preschool Portuguese children.[26] The final questionnaire presented a global good fit (Confirmative Fit Index = 0.961, Tucker–Louis Index = 0.973 and Root Mean Square Error of Approximation = 0.057).[26] In addition, good internal consistency within the subscales was shown (Cronbach's α coefficients ranging from 0.684 [for pressure to eat] to 0.899 [for monitoring]).[26]

A previous study on 4724 children from the current cohort at 4 years of age identified, from the five dimensions of the CFQ (Perceived responsibility, Concern about child weight, Restriction, Pressure to eat and Monitoring) and the two dimensions of Overt and Covert control, using a Principal Component Analysis,[27] three parental child-feeding patterns: Restriction (including Covert control, Restriction and Concern about child weight – explained variance of 20.56%), Perceived

monitoring (including Monitoring, Perceived responsibility and Overt control – explained variance of 21.03%) and Pressure to eat (including Pressure to eat and Overt control – explained variance of 16.83%). These three dimensions were used in this study to summarise parental child-feeding practices.[27]

Dietary patterns

At 7 years of age, the child's diet was measured through a food frequency questionnaire (FFQ) answered by parents or main caregivers. The FFQ consists of 38 items/groups and nine response options, ranging from 'never' to 'more than four times a day'. This questionnaire was previously tested in Generation XXI at 4 and 7 years of age by comparing data with 3-day food records and biomarkers and showed to be a reasonably good instrument to estimate dietary intake in children.[28]

Two dietary patterns were previously identified by our research group after applying a hybrid research method (PLS) to data obtained by the FFQ at 7 years of age.[21,29] PLS is considered a hybrid method because it balances the explained variance of predictor variables (usually the food groups) and the response variables (usually nutrients or biomarkers as an intermediate step to explain a certain outcome).[19] In this previous study, the predictor variables were the 38 food items/groups from the FFQ at 7 years of age, and the response variable was BMI z-score at age 10.[21] Two dietary patterns were derived, explaining 10.1% of variance of food groups and 4.2% of BMI z-score. The 'Energy-dense foods' dietary pattern was characterised by higher consumption of processed meats and energy-dense foods and drinks and lower consumption of vegetable soup (a traditional Portuguese dish). This pattern was significantly associated with BMI z-score at 10 years old ($\hat{\beta} = 0.032$; 95% confidence intervals [CI]: 0.017; 0.047). The 'Energy-dense foods' dietary pattern explained 4.14% of variance of food groups at 7 years old and 3.74% of variance of BMI z-score at 10 years old. The second dietary pattern, named 'Fish-based', was related to a higher fishery intake and lower intake of energy-dense foods. This pattern explained a higher variance of the food groups (5.92%), but it only managed to explain 0.49% of the outcome (BMI z-score at 10 years). The 'Fish-based' dietary pattern was negatively (although not statistically significantly) associated with BMI z-score at 10 years ($\hat{\beta} = -0.001$; 95% CI: −0.012; 0.011).[21]

Sociodemographic and anthropometric characteristics

At baseline, information on maternal age, education, anthropometric measures, gestational age and child birthweight was recorded. Maternal BMI, as weight divided by squared height before pregnancy, was calculated. Physical examinations performed on children at both 7 and 10 years old were conducted by trained staff members, based on standard procedures. Child's age- and sex-specific BMI z-scores were computed according to the World Health Organization (WHO) criteria, and children were classified as without (BMI z-score ≤ 2 SD) or with obesity (BMI z-score > 2 SD).[30] Regular practice of physical exercise at 7 years of age was reported by the main caregiver, based on a dichotomous question (no vs. yes) (*Does the child practice any kind of scheduled and regular sport at school or out of school*?).

Statistical analysis

Characteristics of mothers and children are described as mean and standard deviation (SD) for continuous variables. Categorical variables are reported as counts and percentages (*n* [%]). Multivariable linear regression models were performed to estimate the associations between parental child-feeding patterns (independent variables) and child dietary patterns (dependent variables). Beta-regression coefficients ($\hat{\beta}$) and their respective 95% CI were described. A sex modification effect in the associations was observed and, for this reason, all analyses were stratified by sex. Three models are presented: an unadjusted model (Model 0); a model adjusted for mother's age, education and pre-pregnancy BMI (Model 1) and a model adjusted for the covariates from Model 1 plus child BMI z-score at 4 years of age (Model 2). We also tested if the practice of physical activity at 7 years would influence the results; however, the inclusion of this variable in the model did not change the magnitude of estimates and for this reason was not included in the final models.

Statistical significance was set at 5%, and all tests were two-tailed. All statistical analyses were performed using IBM SPSS Statistics (Version 25.0. Armonk, NY, USA: IBM Corp).

RESULTS

Table 1 summarises the characteristics of mothers and their children included in this study for the entire sample and stratified by sex. Mothers were, on average, 30.1 years old at baseline (SD = 4.98), had 11.6 years of education (SD = 4.27) and a pre-pregnancy BMI of 23.9 kg/m^2. Regarding the children, the mean birth weight was 3194 g (SD = 483.8), with boys weighing more than girls ($p < 0.001$), and the mean gestational age was 38.7 weeks (SD = 1.67). At 7 years old, 68.5% of boys and 72.2% of girls had a regular practice of physical activity ($p = 0.015$). The mean BMI z-score at 4, 7 and 10 years was 0.60 (SD = 1.05), 0.70 (SD = 1.68) and 0.70 (SD = 1.22), respectively.

TABLE 1 Characteristics of mothers and children from the Generation XXI birth cohort ($n = 3272$)

Maternal and children's characteristics	Total	Boys ($n = 1684$)	Girls ($n = 1588$)	p-Value
Maternal age (years) at baseline, mean (SD)	30.1 (4.98)	29.98 (4.89)	30.19 (5.07)	0.183
Maternal education (years), mean (SD)	11.6 (4.27)	11.60 (4.23)	11.63 (4.32)	0.903
Maternal BMI before pregnancy (kg/m^2), mean (SD)	23.94 (4.22)	23.88 (4.14)	24.01 (4.30)	0.183
Child's gestational age (weeks), mean (SD)	38.7 (1.67)	38.61 (1.68)	38.70 (1.65)	0.117
Child's birth weight (g), mean (SD)	3194 (483.8)	3232 (491.7)	3154 (472.0)	**<0.001**
Regular physical activity at 7 years old (yes), n (%)	2301 (70.3)	1154 (68.5)	1147 (72.2)	**0.015**
BMI z-score at 4 years old,[a] mean (SD)	0.60 (1.05)	0.56 (1.03)	0.63 (1.07)	0.055
BMI z-score at 7 years old,[a] mean (SD)	0.70 (1.68)	0.70 (1.21)	0.71 (1.13)	0.724
BMI z-score at 10 years old,[a] mean (SD)	0.70 (1.22)	0.73 (1.25)	0.66 (1.19)	**0.019**

Abbreviations: BMI, body mass index; SD, standard deviation.

[a]BMI z-scores defined according to World Health Organization (WHO) criteria.[30] Statistical significance is highlighted in bold-type.

TABLE 2 Association of parental child-feeding patterns at 4 years of age with the dietary patterns followed at 7 years of age, stratified by sex ($n = 3272$)

	Dietary patterns at 7 years old			
	'Energy-dense foods'[a]		'Fish-based'[b]	
Parent child-feeding patterns at 4 years old	Girls	Boys	Girls	Boys
	$\hat{\beta}$ regression coefficients (95% confidence intervals)			
Restriction[c]				
Crude Model	−0.036 (−0.089, 0.017)	0.016 (−0.040, 0.073)	**0.167 (0.100, 0.235)**	**0.189 (0.121, 0.257)**
Model 1	−0.047 (−0.099, 0.004)	0.025 (−0.030, 0.080)	**0.173 (0.108, 0.238)**	**0.174 (0.108, 0.240)**
Model 2	**−0.082 (−0.134, −0.029)**	−0.003 (−0.058, 0.053)	**0.143 (0.077, 0.210)**	**0.157 (0.090, 0.224)**
Perceived monitoring[d]				
Crude Model	**−0.088 (−0.144, −0.032)**	−0.036 (−0.091, 0.019)	0.056 (−0.016, 0.127)	**0.090 (0.024, 0.156)**
Model 1	**−0.099 (−0.154, −0.045)**	−0.038 (−0.091, 0.016)	**0.072 (0.003, 0.141)**	**0.104 (0.040, 0.168)**
Model 2	**−0.093 (−0.146, −0.039)**	−0.034 (−0.086, 0.019)	**0.079 (0.011, 0.148)**	**0.104 (0.041, 0.168)**
Pressure to eat[e]				
Crude Model	**−0.069 (−0.123, −0.015)**	−0.033 (−0.089, 0.024)	**−0.207 (−0.275, −0.139)**	**−0.179 (−0.248, −0.111)**
Model 1	**−0.110 (−0.163, −0.057)**	**−0.079 (−0.135, −0.023)**	**−0.146 (−0.213, −0.078)**	**−0.113 (−0.180, −0.045)**
Model 2	**−0.079 (−0.135, −0.024)**	−0.026 (−0.084, 0.032)	**−0.100 (−0.170, −0.030)**	**−0.083 (−0.153, −0.013)**

Notes: Model 1: adjusted for maternal age, education and pre-pregnancy body mass index (BMI); Model 2: adjusted for Model 1 plus BMI z-score at 4 years of age. Statistical significance is highlighted in bold-type.

[a]Derived previously by partial least squares,[21] pattern characterised by a higher consumption of processed meats, energy-dense foods and drinks and lower consumption of vegetable soup. It explains 4.14% of variance of food groups and 3.74% of variance of BMI z-scores at age 10.

[b]Derived previously by partial least squares,[21] pattern characterised by a higher consumption of fishery and a lower consumption of energy-dense foods. It explains 5.92% of variance of food groups and 0.49% of variance of BMI z-scores at age 10.

[c]Derived previously by principal component analyses[26] and is composed of the subscales of covert control, restriction and concerns about child's weight.

[d]Derived previously by principal component analyses[26] and is composed of the subscales of monitoring, perceived responsibility and overt control.

[e]Derived previously by principal component analyses[26] and is composed of the subscales of pressure to eat and overt control.

Table 2 shows the associations between the derived child-feeding patterns at 4 years (Restriction, Perceived monitoring and Pressure to eat) and the dietary patterns at 7 years of age. The results of the multivariable linear regression models showed that girls whose parents used more Restriction at 4 years of age had lower scores in the dietary pattern rich in energy-dense foods ('Energy-dense foods') at age 7 (Model 2: $\hat{\beta} = -0.082$;

95% CI: −0.134, −0.029). No significant associations were observed in boys. For Perceived monitoring and Pressure to eat, the results were in the same direction; higher scores in those practices at 4 years of age were negatively associated with the 'Energy-dense foods' dietary pattern at 7 years, with significant associations only among girls (Model 2: $\hat{\beta} = -0.093$; 95% CI: −0.146, −0.039, and $\hat{\beta} = -0.079$; 95% CI: −0.135, −0.024, respectively).

Regarding the associations with the 'Fish-based' dietary pattern, children whose parents used more Restriction at 4 years showed higher scores in this dietary pattern at 7 years of age (Model 2: $\hat{\beta} = 0.157$; 95% CI: 0.090, 0.224 in boys; $\hat{\beta} = 0.143$; 95% CI: 0.077, 0.210 in girls). Perceived monitoring was also positively associated with the 'Fish-based' dietary pattern in both sexes (Model 2: $\hat{\beta} = 0.104$; 95% CI: 0.041, 0.168 in boys; $\hat{\beta} = 0.079$; 95% CI: 0.011, 0.148 in girls). In addition, children whose parents used more Pressure to eat showed a lower probability of following the 'Fish-based' dietary pattern 3 years later (Model 2: $\hat{\beta} = -0.083$; 95% CI: −0.153, −0.013 in boys; $\hat{\beta} = -0.100$; 95% CI: −0.170, −0.030 in girls) (Table 2).

DISCUSSION

This study aimed to examine the prospective associations between parental child-feeding practices engaged at 4 years of age with child dietary patterns at 7 years of age. Our results showed that children whose parents used more Restriction, Perceived monitoring and Pressure to eat at 4 years of age had a lower probability of following the 'Energy-dense foods' pattern at 7 years of age, which is characterised by a higher intake of processed and energy-dense foods and a lower intake of vegetable soup. A sex modification effect was found, as these associations were significant only in girls. In addition, these child-feeding practices showed to have a consistent association with the dietary pattern higher in fishery and lower in energy-dense foods ('Fish-based' dietary pattern, which is not related to BMI z-scores at age 10).[21] The associations were positive for Restriction and Perceived monitoring and negative for Pressure to eat, in both sexes.

According to a Dutch birth cohort that studied 2578 families with 2-year-old children, two diet-related restrictive parenting practices clusters were associated with lower intake of sweets, chocolates and cookies and higher intake of fruits and vegetables.[31] Another study evaluating the effect of restriction on dietary patterns also found that this coercive feeding practice was associated with a more wholesome and less unhealthy eating pattern at 3 years of age.[18] Our study suggests that practices such as restricting child's access to unhealthy foods (by ensuring that the child does not eat these foods and avoiding buying them), parental covert control and parental concern about child weight (both also included in the current Restriction subscale) at 4 years are inversely associated with the 'Energy-dense foods' dietary pattern 3 years later, which was previously shown to be significantly associated with BMI z-score at 10 years of age.[21] Previous evidence has shown that parents' concern about their child's overweight is associated with controlling feeding practices, such as restriction, and restricting the consumption of energy-dense foods may be linked to a lower child's BMI.[32,33] In contrast to our results, a longitudinal study by Boots and colleagues found that both lower restrictive practices and higher covert control predicted children's preference for healthy foods, namely, fruit and vegetables.[34] In this sense, it is important to consider that there is a body of evidence suggesting that restriction is associated with overeating and excess weight gain in children, as it can interfere with child's innate ability to self-regulate energy intake, and finally promote eating in the absence of hunger.[35] However, it has been proposed that children can vary widely in their self-regulatory abilities, and these results should be interpreted in the context of the food environment that reflects children's predispositions.[36] Some authors suggest that instead of directly attempting to restrict access to certain foods, parents are advised to create a structured environment and boundaries, which can include a form of restriction that is undetected by the child and involves managing the child's home and social environment (covert control).[25,36] Research exploring the role of parental restriction in children's diet has often produced conflicting results, because this practice may be more complex than we think. The practice of restriction may reflect parental concerns about the perceived unhealthy weight development of their children, and it is questionable whether there are beneficial effects to recommend this practice.[10] In addition, restrictive feeding practices have been linked to the development of disordered eating behaviours in adolescence, which are particularly prevalent among girls.[37,38] As such, although these practices may have a positive effect on diet in childhood, they may ultimately have negative consequences in the long term. On the contrary, covert control is another mechanism of parental control used when a weight problem is detected; however, it is believed to reduce unhealthy snacking behaviours.[25,39]

Perceived monitoring (which includes practices of perceived responsibility, such as determining the size and type of food offered to the child, overt control, which consists of strictly defining what the child should eat, and monitoring, which involves overseeing child's food consumption) at 4 years of age was positively associated with the 'Fish-based' dietary pattern later in life. This pattern is characterised by a higher intake of fishery but lower intake of energy-dense foods, and the association found is consistent with that of other studies.[40,41] Also supporting our findings, other studies have concluded that monitoring strategies are associated with the consumption of more healthy and less unhealthy foods

in children.[42,43] However, this feeding practice may promote a healthy diet to a certain extent, depending on child's age, temperament and eating style, but when taken to the extreme, it could have counterproductive effects on the child's diet.[4] Parental perceived responsibility about child eating, which is included in this subscale, has been previously associated with healthier eating, corroborating with our results and supporting the fact that parental involvement in child eating confers benefits to their diet.[41] Overt control, which is also included in the perceived monitoring subscale, has been previously associated with lower child energy-dense snacking and sugar-sweetened beverages intake among 9-year-olds in the Netherlands,[39] corroborating with the current results, and higher intake of healthy snacks in 4–11-year-olds.[25]

In our study, Pressure to eat (which includes practices such as pressuring the child to eat more food and overt control) at 4 years of age was negatively associated with the 'Fish-based' dietary pattern, characterised by higher consumption of fishery and lower consumption of energy-dense foods, at 7 years of age in both sexes. Pressure to eat consists of encouraging or even demanding the child to eat more, regardless of child's hunger, satiation or food preferences.[4] This practice usually reflects parental attempt to improve the quality of child's food intake (e.g., forcing a child to eat carrots, despite not liking that food)[4] and/or to increase child's weight.[44] However, pressure to eat seems to have negative effects on children's affective responses to food[45] and on the intake of healthy foods.[16] In addition, it has been hypothesised that this practice may lead to lower weight outcomes over time, as described in a recent systematic review.[10] Contrary to our results, parental overt control has shown positive cross-sectional effects on child food consumption, such as increased intake of healthy snacks[25] and higher likelihood of consuming fruit and vegetables above the recommended amount.[40] Additional studies using a longitudinal design are therefore warranted.

In terms of dietary patterns, according to a Norwegian cohort study, children of mothers who engage in pressure to eat were more likely to have a less wholesome and unhealthier diet, because of their aversion to the foods they are pressured to eat.[18] However, in girls, we found a negative association between Pressure to eat and the obesity-related dietary pattern (i.e., 'Energy-dense foods'). Cross-sectional and longitudinal studies have shown that pressure to eat appears to be related to a range of less desirable child eating and weight outcomes, including decreased fruit consumption in infancy, lower overall food intake in preschool age,[15] besides predicting higher snacking and sugar-sweetened beverages consumption, and lower weight in school age.[46,47] This practice appears to be related to child's sex, with studies describing parents using more pressure to eat with their daughters.[48] Mothers tend to apply more pressure to eat when daughters are thinner and when they perceive them as having underweight.[48] Parents also seem to be more dissatisfied with their daughter's silhouette/body compared to their sons',[49] and this could encourage the use of child-feeding practices aiming to change their weight.

Previous studies have shown that pressure to eat seems to be bidirectionally associated with child's BMI, with the strongest path being from BMI to the feeding practice than the reverse, demonstrating that parents are reactive to child's low weight.[9] This interaction between pressure to eat and child's weight status that flows in both directions is the more plausible explanation for our results, in which parents seem to respond to their perception of child being underweight by attempting to increase their weight.

It is also important to understand that child's sex may differently impact and influence the feeding practices parents use. In this study, a sex modification effect was found between parental child-feeding practices and the obesity-related dietary pattern (i.e., the 'Energy-dense foods' dietary pattern) 3 years later. Previous research has reported that parental control over child's eating impacts girls differently than boys[42] and that parents apply more restrictive practices on girls.[50,51] When parents set boundaries in relation to eating, such as avoiding extremely restrictive behaviours and no or low limit setting, boys are less likely to eat unhealthy.[42] These findings show that parents may have different priorities for boys and girls concerning the feeding practices and understand the nature of the weight problem differently.[50] These differences, found particularly in girls, may reflect the societal pressures or the greater importance placed on weight and body shape issues among girls.[49]

This study has several strengths and limitations that need further discussion. The inclusion of a large sample of parent–child dyads from a population-based cohort, allowing for comparisons at different moments in the life course and controlling for several potential confounders, assessed by standardised methods, is of particular importance. Parental child-feeding practices were assessed by a questionnaire adapted and validated in this birth cohort, which was answered by parental self-report.[26] Although this methodology may decrease social desirability bias, it also precludes a lower response rate. When comparing those included in the current study with the remaining cohort, no substantial differences were found, giving external validity to our results. This study also benefits from previous analysis conducted, including the identification at 4 years of age of three child-feeding patterns, overcoming the high correlation between these feeding practices. However, only attitudes and practices of mothers were studied. The literature supports the importance of also including fathers in future analysis because they are progressively more involved in child-feeding.[52] We used dietary patterns to characterise food intake, which has several advantages

over studying single foods and is least used. A previous study from our cohort derived the analysed dietary patterns by a hybrid method (PLS).[21] These hybrid methods focus on explaining variance among foods and also incorporate information on biological pathways.[19] Finally, diet was assessed through an FFQ (38 foods/food groups) that has been previously validated in this birth cohort contributing to the internal validity of the study.[28]

Restriction, Perceived monitoring and Pressure to eat at 4 years of age were inversely associated with an obesity-related dietary pattern ('Energy-dense foods') at 7 years old, but only among girls. Children of both sexes whose parents used more Restriction and Perceived monitoring had a higher probability of following a healthier dietary pattern, higher intake of fishery and lower intake of energy-dense foods 3 years later, whereas Pressure to eat showed the inverse association. These results provide relevant insights into which parent feeding strategies engaged during preschool years may play a role in a child's dietary patterns later in childhood. Ultimately, parents who are aware of their role and potential influence of the child-feeding process may shape or moderate the expression of their children's dietary behaviours, allowing them to achieve a healthy growth.

AUTHOR CONTRIBUTIONS

C.B. was responsible for data analysis and interpretation and drafting of the manuscript. A.C., S.W. and C.L. were responsible for interpretation of data and critical revision of the manuscript for important intellectual content. A.O. was responsible for study concept and design, interpretation of data and critical revision of the manuscript for important intellectual content. All authors approved the final manuscript as submitted and agreed to be accountable for all aspects of the work.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the families enrolled in Generation XXI for their kindness, all members of the research team for their enthusiasm and perseverance and the participating hospitals and their staff for their help and support. They also acknowledge the support from the Epidemiology Research Unit (EPI-Unit: UIDB/04750/2020; POCI-01-0145-FEDER-006862). Generation XXI was funded by the Health Operational Programme – Saúde XXI, Community Support Framework, Community Support Framework III and the Regional Department of Ministry of Health. This study was supported through Fundo Europeu de Desenvolvimento Regional (FEDER) from the Operational Programme Factors of Competitiveness (COMPETE) and through national funding from the Foundation for Science and Technology (FCT-Portuguese Ministry of Education and Science) under the projects 'Appetite regulation and obesity in childhood: a comprehensive approach towards understanding genetic and behavioral influences' (POCI-01-0145-FEDER-030334; PTDC/SAUEPI/30334/2017) and 'Appetite and adiposity – evidence for gene-environment interplay in children' (IF/01350/2015), and through the Investigator Contract (IF/01350/2015 – Andreia Oliveira). It received support also from the Calouste Gulbenkian Foundation, Portugal.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

Data described in the manuscript will be made available upon reasonable request to the corresponding author.

TRANSPARENCY DECLARATION

The lead author affirms that this manuscript is an honest, accurate and transparent account of the study being reported. The reporting of this work is compliant with STROBE guidelines. The lead author affirms that no important aspects of the study have been omitted and that any discrepancies from the study as planned have been explained.

PEER REVIEW

The peer review history for this article is available at https://www.webofscience.com/api/gateway/wos/peer-review/10.1111/jhn.13151

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Barbosa C, Lopes C, Costa A, Warkentin S, Oliveira A. Parental child-feeding practices at 4 years of age are associated with dietary patterns of 7-year-olds. J Hum Nutr Diet. 2023;36:1339–1348. https://doi.org/10.1111/jhn.13151