Original Article

Social and health behavioural determinants of maternal child-feeding patterns in preschool-aged children

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Abstract

Parental child-feeding attitudes and practices may compromise the development of healthy eating habits and adequate weight status in children. This study aimed to identify maternal child-feeding patterns in preschool-aged children and to evaluate their association with maternal social and health behavioural characteristics. Trained interviewers evaluated 4724 dyads of mothers and their 4–5-year-old child from the Generation XXI cohort. Maternal child-feeding attitudes and practices were assessed through the Child Feeding Questionnaire and the Overt/Covert Control scale. Associations were estimated using linear regression [adjusted for maternal education, body mass index (BMI), fruit and vegetables (F&V) intake and child's BMI z-score]. Principal component analysis defined a three-factor structure explaining 58% of the total variance of maternal child-feeding patterns: perceived monitoring – representing mothers with higher levels of monitoring, perceived responsibility and overt control; restriction – characterizing mothers with higher covert control, restriction and concerns about child's weight; pressure to eat – identifying mothers with higher levels of pressure to eat and overt control. Lower socioeconomic status, better health perception, higher F&V intake and offspring cohabitation were associated with more 'perceived monitoring' mothers. Higher maternal F&V intake and depression were associated with more 'restrictive' mothers. Younger mothers, less educated, with poorer health perception and offspring cohabiting, were associated with higher use of 'pressure to eat'. Maternal socioeconomic indicators and family environment were more associated with perceived monitoring and pressure to eat, whereas maternal health behavioural characteristics were mainly associated with restriction. These findings will be helpful in future research and public health programmes on child-feeding patterns.

Keywords: feeding pattern, preschool child, health behaviour, monitoring, restriction, pressure to eat.

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Introduction

Parents play an important role in the development of children's eating habits and weight status as they are responsible for shaping child's family environments, and specifically, their eating environment. Characteristics of these environments include socioeconomic and cultural characteristics (Strauss & Knight 1999; Serra-Majem *et al.* 2006; Friedman *et al.* 2009; Pigeot *et al.* 2009; Griffiths *et al.* 2010), eating styles (Cutting

et al. 1999; Faith *et al.* 2004; Munsch *et al.* 2007; Jahnke & Warschburger 2008) and child-feeding practices (Johnson & Birch 1994; Fisher & Birch 1999a,b; Birch & Fisher 2000). Parents provide children with their first food learning experiences, deciding which foods they make accessible to them, controlling portion sizes, meal or snacks frequencies, timing, social context and setting the emotional tone of eating occasions (Birch & Fisher 1995). In addition, parents use practices such as pressure to eat, restriction of certain foods or groups

of foods, rewards with food, monitoring child's eating and controlling child's food intake in order to attain a healthy development of their children (Birch & Fisher 1995). However, certain parental child-feeding practices and attitudes may compromise the development of healthy eating habits and adequate weight status in children (Birch & Fisher 1995).

Socioeconomic characteristics have been associated with parental child-feeding practices. In a study performed in the United States, mothers with higher family income used more restriction and less pressure to eat with their 5-year-old, non-Hispanic, white daughters (Francis *et al.* 2001). In Germany, the higher the maternal socioeconomic status, the lower the pressure to eat levels used towards children aged 1–10 years (Kroller & Warschburger 2009). Results from other studies carried out across the South England pointed out that parents from higher social classes tended to use more overt control (which can be perceived by the child) with their 5–9-year-old girls (Ogden *et al.* 2006), and parents with higher education levels used more covert control strategies (not perceived by the child) with children aged 4–6 years (Brown *et al.* 2008).

Several parental psychological features have been linked to child-feeding practices. In a longitudinal study from the United Kingdom, analysing predictors of maternal control of feeding in infants, results suggested that higher levels of maternal psychological distress were associated with higher monitoring and restriction of children aged 1 year, and distress subsequently predicted pressure to eat when the child reached 2 years (Blissett & Farrow 2007). In a recent Australian study that explored maternal psychosocial

predictors of controlling child-feeding practices in children aged 5–8 years (Mitchell *et al.* 2009), parenting satisfaction was negatively associated with parental restriction and pressure to eat, whereas parental anxiety was positively associated with restriction and pressure to eat. In the United States, higher levels of depression in non-overweight mothers were linked to higher use of restriction in 5-year-old girls (Francis *et al.* 2001).

Despite the wide range of studies exploring child-feeding attitudes and practices and their relationship with child's characteristics and main caregivers' features, in Portugal, information on these topics is scarce. In a study held in the north of Portugal, mothers of 7–12-year-old children reported high levels of perceived responsibility, monitoring, pressure to eat and restriction in child-feeding, but reported low concerns about child's weight or risk of becoming overweight (Cordeiro 2010). Similar findings were found in a larger sample with mothers of 4-year-old children from Generation XXI (Real 2012). There have been no other published national studies on maternal child-feeding practices.

The complexity of the parental child-feeding attitudes and practices conceptualization and assessment, namely, the use of different, independent and cultural-sensitive dimensions, demands a broad and integrated-based approach able to measure maternal feeding patterns used with children. The present study applies an approach based on maternal child-feeding patterns, rather than exploring single dimensions of practices, being able to clarify the relative contribution of the different feeding practices used with children. Despite the valuable insights relating

Key messages

- This study clarifies the relative contribution of different feeding practices used with children, by exploring the combination of these maternal child-feeding practices, rather than exploring their single dimensions.
- Three patterns were identified: perceived monitoring – representing mothers with higher levels of monitoring, perceived responsibility and overt control; restriction – characterized by mothers with higher covert control, restriction and concerns about child's weight; pressure to eat – identifying mothers with higher levels of pressure to eat and overt control.
- Maternal socioeconomic indicators and family environment were more often associated with perceived monitoring and pressure to eat, while maternal health behavioural characteristics were mainly associated with restriction.

socioeconomic and psychological factors with child-feeding, there is no information available on their relation with maternal child-feeding patterns. Moreover, preschool-aged children are of particular interest as they are in a transition period (i.e. starting preschool programmes or kindergarten). Understanding maternal child-feeding patterns used in this critical period will help to identify at-risk groups and provide insights to prevention strategies.

The current study aimed to identify maternal child-feeding patterns used in preschool-aged children. Additionally, we aimed to evaluate the association of maternal social and health behavioural characteristics with these maternal child-feeding patterns.

Methods

Participants

Participants were evaluated as part of the Generation XXI birth cohort (Alves *et al.* 2012). Generation XXI is a prospective population-based birth cohort established in a well-delimited geographic area in the north of Portugal (Porto). Pregnant women were recruited in five level III maternity units between April 2005 and August 2006. A total of 8647 children and 8495 mothers were enrolled at baseline. Among the invited mothers, 91% accepted to participate.

Participants were re-evaluated when children aged 4–5 years ($n = 7458$, 86% of participation). During this follow-up, data were collected by face-to-face interviews from April 2009 until April 2011 and, for those families who were not able to participate, the evaluation was performed telephonically between April and September 2011 with a shorter version of the questionnaire (20%). Mothers were invited by telephone to participate in the evaluation and, after confirming the acceptance, they received an invitation form and the self-administered child-feeding questionnaire by post mail. They received instructions to return the questionnaire during the face-to-face evaluation. Mothers who forgot to bring the questionnaire received an extra one for filling during the children's evaluation or to return it in a replied paid envelope.

Mothers with multiple birth children and unable to self-complete the questionnaire on maternal child-

feeding attitudes and practices were excluded from the analysis. In the present study, 4724 dyads of mothers and their 4–5-year-old child, with complete information on maternal child-feeding attitudes and practices, were included. We compared characteristics of the present study sample ($n = 4724$) with the remaining cohort ($n = 3771$) at baseline, and significant differences were found for maternal age and education. Mothers in this study were slightly older [mean = 29.7; standard deviation (SD) = 5.27 vs. mean = 28.2; SD = 5.85] and more educated (mean = 11.1; SD = 4.26 vs. mean = 9.6; SD = 4.10) than mothers in the remaining cohort. The Cohen's effect size values were lower than 0.35 (Husted *et al.* 2000).

The project Generation XXI was approved by the Ethical Committee of São João Hospital/University of Porto Medical School and complies with the Helsinki Declaration and the current national legislation. The project was approved by the Portuguese Authority of Data Protection. Legal representatives of each participant were informed about the benefits and potential discomfort, and written informed consent was obtained for the collection of information at baseline and re-evaluations.

Measures

Maternal and child's characteristics

Maternal and child's characteristics were obtained by trained interviewers using standardized questionnaires. Maternal age, education level, current employment status and family structure [i.e. cohabiting with child's father, single mother or other case, and number of offspring (i.e. sons or daughters) cohabiting within the family household] were ascertained. As mothers' role and relationship on child-feeding situations may be influenced by their family structure, we defined two main family types: mothers 'cohabiting with the child's father' when reporting to nuclear families (married or unmarried) and mothers 'non-cohabiting with the child's father' when reporting to all other family structures (i.e. single mother, mother cohabiting with the child's stepfather or mother cohabiting with extended family). A previous

maternal diagnosis of depression was evaluated using the following closed question 'Have you ever been diagnosed with depression by a doctor?'. Maternal perception of their own health status was measured through a 5-point Likert scale ranging from excellent to poor (i.e. 1 to 5, respectively), with lower scores indicating a better health perception. Maternal practice of physical exercise was measured through a closed question 'Do you currently practice any sport or physical exercise?'. Maternal fruit and vegetable (F&V) intake in the previous 12 months was obtained from a qualitative food frequency questionnaire. Response options were rated using a 9-point scale ranging from never to four or more times per day. F&V daily intake resulted from a sum of frequencies of three food items: fruit, vegetables and soup. Mothers also reported child's gender and birthdate (to compute child's age at the evaluation).

Anthropometric measures

Trained staff members obtained height and weight measurements from mothers and children, according to standard procedures. Participants were measured without shoes, and children were measured in light clothing. Weight was measured to the nearest tenth of a kilogram (Tanita® digital scale, Arlington Heights, IL, USA), and height was measured to the nearest tenth of a centimetre (Seca® wall stadiometer, Hamburg, Germany). Mother's and child's body mass index (BMI; in kg m^{-2}) scores were generated. Child's BMI was then computed to a BMI *z*-score standardized to the Portuguese sample (population mean BMI/population SD BMI).

Maternal child-feeding attitudes and practices

Maternal child-feeding attitudes and practices were measured using a questionnaire adapted and validated for the Portuguese population (Real 2012). The questionnaire combined the seven subscales of the Child Feeding Questionnaire (CFQ) (Birch *et al.* 2001) and the overt/covert control measures (Ogden *et al.* 2006). Maternal child-feeding attitudes were evaluated through four subscales of the CFQ: perceived responsibility for child-feeding (three items),

maternal perceived weight status over time (four items), maternal perceived child's weight status (three items), and concerns about child's weight, i.e. concerns about the risk of the child becoming overweight (three items). Maternal control practices used in child-feeding were assessed through restriction of child's access to food (three items), pressure to eat more foods (five items), monitoring the child's eating (three items), overt control (which can be perceived by the child, four items), and covert control (when the child is unable to detect it, five items). Answers to these items were rated using a 5-point Likert scale. Participants received a separate mean score for each of the subscales, with higher scores indicating higher levels in each subscale, i.e. more practices and attitudes in that subscale's domain.

Statistical analyses

All variables were analysed for data accuracy and missing values. Missing data were considered at random. Mean scores for each of the CFQ and overt/covert control dimensions were only calculated for cases with at least 50% of answers in each dimension. Listwise deletion was used to treat missing data in all other statistical analysis.

Proportions were compared using the chi-square test (categorical variables). Continuous variables were compared by the Student's *t*-test and the Mann-Whitney *U*-test (for normally or non-normally distributed variables, respectively).

The five subscales of the CFQ related with child-feeding (i.e. perceived responsibility, concern about child weight, restriction, pressure to eat and monitoring) and the overt/covert control measures were studied by principal components analysis (PCA) in order to identify maternal child-feeding patterns. The subscales 'maternal perceived weight status over time' and 'maternal perceived child's weight status' were not included in the PCA as they reflect weight perceptions instead of measuring maternal child-feeding practices or attitudes directly related with child-feeding. The suitability of data for factor analysis was assessed. The correlation matrix revealed the presence of few coefficients higher than 0.30. The Kaiser-Meyer-Olkin value was 0.642 and the

Barlett's test of sphericity reached statistical significance ($P < 0.001$), supporting the factorability of the correlation matrix. Varimax rotation was performed to simplify the interpretation of the factor's loadings structure. Kaiser's criterion was chosen to select only eigenvalues greater than one for determining the number of components. Cattell's criterion graphically confirmed the number of components. Subscales with factor loadings higher than 0.30 were identified as relevant characteristics of the whole component. Regression scores of the obtained components were used in all subsequent analysis.

Multivariate linear regression analysis was used to test the relative contribution of maternal characteristics to the explanation of variance in maternal child-feeding patterns. Mahalanobis and Cook's distance was calculated to assess for multivariate outliers; however, no significant cases were detected. Statistics of tolerance and the variance inflation factor indicated absence of multicollinearity. Possible interactions among variables were tested and linear regression coefficients were estimated, crude (in model 1) and adjusted for potential confounders: maternal education, BMI and F&V intake (in model 2), as well as for these maternal characteristics and child's BMI z -score (in model 3). Statistical significance was determined at a level of $P \leq 0.05$.

Data were analysed using the Statistical Package for Social Sciences (SPSS), version 20.0 (SPSS, Inc., Chicago, IL, USA).

Results

Maternal and child's characteristics

Table 1 presents the characteristics of mothers included in this study, at the 4–5-year-old follow-up of their children. Mothers had a mean age of 34.1 years ($SD = 5.23$; ranging from 18 to 51 years). Most mothers were married (73.9%) or cohabitating with a partner (16.2%), were currently employed (76.4%), and had, on average, 11 years of education ($SD = 4.21$). Mothers had a median BMI of 25.3 kg m^{-2} (P25–P75: 22.7–29.0). Approximately one-third of mothers had a previous diagnosis of depression (31.9%) and, in general, they had a moderate perception of their

Table 1. Characteristics of mothers included in the study ($n = 4724$), at the 4–5-year-old follow-up of their children (2307 girls and 2417 boys)

Age (years), mean (SD)	34.1 (5.23)
Education (years), mean (SD)	11.3 (4.21)
Professional condition, n (%)	
Employed	3598 (76.4)
Other	1110 (23.6)
BMI (kg m^{-2}), median (P25–P75)	25.3 (22.7–29.0)
Diagnosed depression, n (%)	
Yes	1496 (31.9)
No	3190 (68.1)
Health perception*, mean (SD)	3.0 (1.04)
Practice of physical exercise, n (%)	
Yes	895 (19.4)
No	3711 (80.6)
F&V daily intake, median (P25–P75)	3.6 (2.1–5.3)
Cohabiting with child's father, n (%)	
Yes	4143 (87.8)
No	574 (12.2)
Cohabiting with offspring, n (%)	
Yes	2447 (52.0)
No	2256 (48.0)

BMI, body mass index; F&V, fruit and vegetables; P25–P75, 25th and 75th percentiles; SD, standard deviation. *Ranging from 1 to 5 with lower scores indicating a better health perception.

health status (mean = 3.0; $SD = 1.04$). Concerning lifestyles, 19.4% of mothers reported having regular physical exercise and their median F&V daily intake was around 3.6 portions. Most of the evaluated families had both parents present (87.8%) and nearly half had offspring cohabiting in the family household (52.0%).

The sample of children included 2307 female and 2417 male children aged 46–76 months (median = 51.0; P25–P75: 49.0–54.0).

Maternal child-feeding patterns

Using PCA, a three-factor structure explaining 58.4% of the total variance of the maternal child-feeding patterns was extracted (Table 2). The results showed that monitoring, perceived responsibility and overt control loaded onto component 1. Concern about child's weight, covert control and restriction loaded onto component 2. Pressure to eat and overt control loaded onto component 3. Thus, three maternal child-feeding components, i.e. patterns were characterized.

Table 2. Descriptive statistics and factor's loadings of the five subscales of the Child Feeding Questionnaire and the overt/covert control measures, obtained from principal components analysis*

Subscales	Mean	SD	Component 1	Component 2	Component 3
Monitoring	4.22	0.78	0.776 [†]	0.007	-0.251
Perceived responsibility	4.36	0.62	0.663 [†]	0.028	0.245
Overt control	4.14	0.58	0.605 [†]	0.229	0.407 [†]
Concern about child weight	2.36	1.09	0.027	0.699 [†]	-0.266
Covert control	3.16	0.86	-0.064	0.690 [†]	0.191
Restriction	4.34	0.73	0.231	0.648 [†]	0.113
Pressure to eat	3.68	0.97	0.085	0.021	0.877 [†]
Eigenvalue			1.472	1.439	1.178
% of variance explained			21.03	20.56	16.83
% of cumulative variance explained			21.03	41.59	58.41

SD, standard deviation. *Varimax rotation of three-factor solution. [†]Factor loading > 0.300.

Pattern 1 identifies mothers with higher levels of monitoring, perceived responsibility and overt control (a type of control perceived by the child), named here as 'Perceived monitoring'. Pattern 2 describes mothers with higher covert control (not perceived by the child), concern about child's weight and restriction, named as 'Restriction'. Pattern 3 defines mothers with higher levels of pressuring the child to eat more and overt control, named as 'Pressure to eat'.

Determinants of maternal child-feeding patterns

Associations between maternal characteristics and maternal child-feeding patterns are presented in Table 3. After adjustment for maternal characteristics (education, BMI and F&V daily intake) and child's BMI z-score (model 3, considered as the final model), higher scores in pattern 1 (perceived monitoring) were significantly associated with lower socioeconomic status, measured by both years of education [β -0.089 95% confidence interval (CI) -0.029; -0.014] and employment status (β -0.113 95% CI -0.342; -0.194), but also better health perception (β -0.063 95% CI -0.090; -0.030), higher maternal F&V intake (β 0.087 95% CI 0.029; 0.062), and the presence of offspring cohabiting within the family household (β 0.037 95% CI 0.014; 0.135).

Mothers with higher scores in pattern 3 (pressure to eat) also presented significantly lower socioeconomic

indicators (years of education: β -0.187 95% CI -0.052; -0.037; employment status: β -0.053 95% CI -0.197; -0.054), but also lower age (β -0.055 95% CI -0.016; -0.005), poorer health perception (β 0.038 95% CI 0.008; 0.065) and a family context including offspring cohabitation (β 0.054 95% CI 0.051; 0.167).

Higher scores in pattern 2 (restriction) were mainly associated with maternal health behavioural characteristics such as a previous diagnosis of depression (β 0.038 95% CI 0.019; 0.144) and higher F&V intake (β 0.111 95% CI 0.043; 0.074). A crude positive association between mothers' BMI and pattern 2 was found, remaining significant after adjustment for maternal characteristics, but losing magnitude and significance when adjusted for both maternal characteristics and child's BMI z-score.

Discussion

The present study aimed to identify maternal child-feeding patterns in preschool-aged children and to evaluate their association with maternal social and health behavioural characteristics. A PCA was undertaken in order to identify maternal child-feeding patterns used in preschool-aged children. This analysis identified three maternal child-feeding patterns. The first pattern was defined by a positive correlation with monitoring, perceived responsibility and overt control (named 'Perceived monitoring'). The second pattern was characterized by a positive correlation

Table 3. Linear associations of maternal characteristics with maternal child-feeding patterns

	Pattern 1 (perceived monitoring)			Pattern 2 (restriction)			Pattern 3 (pressure to eat)		
	Model 1 Crude β (95% CI)	Model 2 Adjusted β (95% CI) [†]	Model 3 Adjusted β (95% CI) [‡]	Model 1 Crude β (95% CI)	Model 2 Adjusted β (95% CI) [†]	Model 3 Adjusted β (95% CI) [‡]	Model 1 Crude β (95% CI)	Model 2 Adjusted β (95% CI) [†]	Model 3 Adjusted β (95% CI) [‡]
Age (years)	0.021 (-0.002; 0.010)	0.015 (-0.003; 0.009)	0.013 (-0.004; 0.008)	0.025 (-0.001; 0.010)	-0.002 (-0.006; 0.006)	0.006 (-0.005; 0.007)	-0.070 (-0.019; -0.008)	-0.042 (-0.014; -0.002)	-0.055 (-0.016; -0.005)
Education (years)	-0.061 (-0.021; -0.008)	-0.085 (-0.027; -0.013)	-0.089 (-0.029; -0.014)	-0.004 (-0.008; 0.006)	-0.012 (-0.010; 0.005)	0.003 (-0.007; 0.008)	-0.165 (-0.046; -0.032)	-0.170 (-0.048; -0.033)	-0.187 (-0.052; -0.037)
Employment status(yes)	-0.120 (-0.351; -0.215)	-0.116 (-0.347; -0.199)	-0.113 (-0.342; -0.194)	-0.003 (-0.075; 0.063)	0 (-0.074; 0.074)	-0.003 (-0.079; 0.067)	-0.099 (-0.301; -0.164)	-0.057 (-0.210; -0.062)	-0.053 (-0.197; -0.054)
BMI (kg m ⁻²)	0.005 (-0.005; 0.007)	-0.016 (-0.009; 0.003)	-0.007 (-0.008; 0.005)	0.089 (0.011; 0.023)	0.082 (0.010; 0.022)	0.030 (0; 0.012)	-0.008 (-0.007; 0.004)	-0.045 (-0.015; -0.003)	0.025 (-0.001; 0.011)
Diagnosed depression (yes)	-0.018 (-0.101; 0.024)	-0.023 (-0.114; 0.014)	-0.023 (-0.113; 0.015)	0.041 (0.024; 0.149)	0.043 (0.028; 0.155)	0.038 (0.019; 0.144)	0.010 (-0.042; 0.084)	-0.004 (-0.072; 0.055)	0 (-0.061; 0.062)
Health perception*	-0.049 (-0.074; -0.018)	-0.062 (-0.089; -0.030)	-0.063 (-0.090; -0.030)	0.034 (0.004; 0.061)	0.027 (-0.004; 0.055)	0.023 (-0.007; 0.051)	0.066 (0.035; 0.091)	0.037 (0.006; 0.065)	0.038 (0.008; 0.065)
Practice of physical exercise (yes)	0.006 (-0.060; 0.088)	0.003 (-0.070; 0.084)	0.004 (-0.066; 0.089)	0.025 (-0.011; 0.137)	0.004 (-0.066; 0.088)	0.001 (-0.073; 0.077)	-0.052 (-0.206; -0.058)	-0.024 (-0.138; 0.015)	-0.023 (-0.133; 0.016)
F&V intake (servings per day)	0.069 (0.021; 0.051)	0.088 (0.030; 0.062)	0.087 (0.029; 0.062)	0.119 (0.047; 0.078)	0.116 (0.045; 0.077)	0.111 (0.043; 0.074)	-0.040 (-0.036; -0.005)	0 (-0.016; 0.016)	0.007 (-0.012; 0.019)
Cohabiting with child's father (yes)	0.020 (-0.029; 0.150)	0.020 (-0.032; 0.153)	0.014 (-0.052; 0.136)	-0.010 (-0.121; 0.058)	-0.025 (-0.170; 0.015)	-0.012 (-0.130; 0.053)	0.014 (-0.048; 0.131)	0.030 (0.001; 0.186)	0.013 (-0.049; 0.131)
Cohabiting with offspring (yes)	0.048 (0.037; 0.153)	0.039 (0.017; 0.137)	0.037 (0.014; 0.135)	0.007 (-0.044; 0.072)	-0.013 (-0.087; 0.033)	-0.015 (-0.089; 0.029)	0.056 (0.054; 0.170)	0.055 (0.051; 0.171)	0.054 (0.051; 0.167)

BMI, body mass index; F&V, fruit and vegetables; β , regression coefficient; 95% CI, 95% confidence interval. *Ranging from 1 to 5 with lower scores indicating a better health perception. †Adjusted for maternal characteristics (education, BMI and F&V daily intake). ‡Adjusted for maternal characteristics (education, BMI and F&V daily intake) and child's BMI z-score. Statistically significant results are shown in bold.

with concern with child's weight, covert control and restriction (entitled 'Restriction'). The third pattern was defined by a positive correlation with pressure to eat and overt control (named 'Pressure to eat').

Previous evidence indicates that monitoring is positively associated with responsibility (Birch *et al.* 2001) and overt control (Ogden *et al.* 2006). By other side, restriction is directly associated with maternal perception and concern with their child's weight or risk of becoming overweight (Birch *et al.* 2001), and with the expanded concept of covert control (Ogden *et al.* 2006). It has also been reported that overt control is positively associated with pressure to eat (Ogden *et al.* 2006). This is consistent with our findings of a three-factor structure combining the seven measures of maternal attitudes and practices used in child-feeding. Thereby, our approach improves previous knowledge by clarifying and supporting the relations between different measures of maternal attitudes and practices.

Our results revealed a negative association between the socioeconomic background and maternal 'perceived monitoring' and 'pressure to eat' patterns, and no significant association with 'restriction'. These results are consistent with previous evidence reporting a negative association between socioeconomic status and pressure to eat (Francis *et al.* 2001; Kroller & Warschburger 2009), no association with restrictive practices (Francis *et al.* 2001; Kroller & Warschburger 2009; Gray *et al.* 2010) and, by the other side, positive associations with overt/covert control measures (Ogden *et al.* 2006; Brown *et al.* 2008). Thus, the negative association between socioeconomic features and 'perceived monitoring' (defined by monitoring, overt control and responsibility) was not expected and was found in our study, even after adjustment for possible confounders. This finding may be explained by the complexity of the maternal child-feeding concepts or by the cultural sensitivity to specific child-feeding practices and attitudes in participant's background, such as differences inherent to the specificities of each population, including the maternal role in child rearing.

Family household background comprises important social-environmental aspects, in particular what concerns to family structure (i.e. cohabiting with

child's father, and with offspring other than the evaluated child), that should be considered when studying the determinants of the maternal child-feeding patterns. In our study, we found no associations between family structure (i.e. cohabiting with child's father) and any of the three maternal feeding patterns, an expected outcome as mothers cohabiting with the child's stepfather or cohabiting with extended family may have similar roles to mothers in two-parent families, especially in child-feeding patterns. However, single-mother families hold more difficulties to meet the health care of their children needs (Blackwell 2010), which may lead to differences in their child-feeding patterns. A significant positive association was found between offspring cohabitation and the 'perceived monitoring' and 'pressure to eat' patterns. This new finding suggest that, although cohabiting with child's father is not related to maternal child-feeding patterns, the presence of more than one offspring is related to mother's child-feeding practices in a way they use more monitoring, pressure to eat and overt control towards their preschool-aged child.

Concerning health-related factors, we found a crude positive association between maternal BMI and the 'restriction' pattern, which remained significant after adjustment for maternal characteristics, but that lost magnitude and significance when adjusted for both maternal characteristics and child's BMI *z*-score. These results suggest that child's BMI accounted for a considerable part of the observed associations, being an important confounder that must be considered in further analysis comparing maternal child-feeding patterns and their determinants. Our findings were supported by some studies that described a positive association between maternal BMI and the use of restrictive behaviours over child's feeding (Gray *et al.* 2010), and between maternal and child's BMI (Francis *et al.* 2001; Gray *et al.* 2010).

In our study, maternal health perception was positively associated with pressure to eat and negatively associated with perceived monitoring, while maternal diagnosed depression was found to be directly associated with the restrictive pattern. These relationships are consistent with previous research regarding maternal psychosocial predictors of child-feeding practices (Francis *et al.* 2001; Blissett & Farrow 2007;

Mitchell *et al.* 2009). Lastly, we found a strong and relevant positive association among maternal F&V daily intake and the restrictive pattern. Findings from our study suggest that mothers with poorer health condition (higher BMI and diagnosed depression) and higher F&V consumption are in general more concerned about their child's weight and use more child-feeding restrictive practices. Mothers with poorer health condition may be more aware of their own health risks, as well as more concerned about their child's weight or risk of becoming overweight; therefore, they may try to adopt healthier feeding habits (including higher F&V intake) and try to use more child-feeding restrictive practices. This topic should, however, be developed in future research.

Results related to maternal lifestyles suggest an inverse association between maternal regular practice of physical exercise and the pressure to eat pattern. However, after adjustment for maternal characteristics (i.e. education, BMI and F&V intake), and for these characteristics and child's BMI *z*-score, the magnitude of the associations decreased and the association lost significance, suggesting a considerable effect of these variables on the crude association observed.

Child's BMI revealed an important effect in the relation between social and health behavioural determinants and maternal child-feeding patterns. These findings were expected as parental perceptions and concerns about child's weight are associated with the use of controlling feeding practices (Birch *et al.* 2001; Francis *et al.* 2001) and, additionally, maternal use of restrictive and pressure to eat practices is associated with child's BMI (Francis *et al.* 2001).

Even though the results of the present study were generally consistent with previous research, providing evidence that maternal characteristics were associated with the identified maternal child-feeding patterns, interpretation and generalization of results should be made with caution, and potential limitations and strengths should be discussed.

Given the cross-sectional design of the study, we could not address the temporal sequence of the associations, i.e. if certain characteristics predict child-feeding patterns. Nonetheless, being part of a cohort-based study benefits from data collected at baseline

and in posterior follow-ups and, moreover, data accuracy and quality is assured by an experienced team.

In order to control for multiple birth effects, such as different trends and patterns in child growth and development, or divergent child's exposures including parental attitudes and practices, multiple births were not considered in the present study. Their effect in maternal child-feeding patterns should be analysed separately.

Comparisons between eligible participants of our study and the remaining cohort, concerning their baseline characteristics, found statistical significant differences for maternal age and education. However, the Cohen's effect size values suggested that the magnitude of the differences was not high (i.e. differences were at most part due to the large sample size than due to large differences between participant's characteristics) (Husted *et al.* 2000). Additionally, the main characteristics of mothers evaluated in our study were compared with national or regional statistics, despite some methodological constraints. According to the National Institute of Statistics (Instituto Nacional de Estatística 2012), the women's employment proportion is approximately 77% in the 25–44-year age group. A similar proportion, 76.4%, was reported in the present study. In our last National Health Survey 2005–2006 (Instituto Nacional de Estatística & Instituto Nacional de Saúde Doutor Ricardo Jorge 2009), 16% of women (13% from 35 to 44 years) were obese, measured by self-reported weight and height (it is likely that BMI could be underestimated). In the present study, women had a median BMI of 25.3 kg m⁻² (20.6% of obese), but these data are based on measured weight and height, which could explain these differences. In another study conducted in the north of Portugal between 1999 and 2003, women from all ages reported a mean consumption of 5.8 servings of F&V per day, with higher intakes in older age groups (Oliveira *et al.* 2013). In our study, including women much younger, a median of 3.6 servings per day (corresponding to a mean of 3.8 servings per day) was found; these differences may be explained by the age of women included in each study.

Regarding maternal child-feeding attitudes and practices, participants were instructed to independently self-complete the questionnaire; nevertheless,

we could not exclude the possibility of social desirability bias (Holtgraves 2004). Furthermore, maternal child-feeding patterns were essentially defined by mothers' attitudes and practices. Despite mothers' central role in child-feeding, the role of fathers in child rearing seems to be changing and they are progressively more involved (Mallan *et al.* 2013). Hence, analysing the fathers' role would much benefit future studies, clarifying its effect and allowing for comparisons with studies where mothers have the central role in child-feeding. Eventually, the assessment of the effect of single-mother families on child-feeding patterns would clarify possible feeding tendencies, especially in preschool-aged children.

Future research exploring the determinants of maternal child-feeding patterns would benefit from a longitudinal design to address how maternal and child characteristics relate to maternal child-feeding patterns over time. The assessment of maternal depression would be improved using a short validated questionnaire, instead of selecting only one item to measure previous clinical diagnosis of depression. It would also be relevant that the assessment of different maternal features not included in this study, such as personality traits, and their relation with the different profiles.

In conclusion, we identified three patterns characterizing maternal child-feeding in preschool-aged children. This finding suggests that child-feeding practices and attitudes are related, being combined and employed by mothers in several feeding situations. Assessing the single effect of a feeding practice or attitude may be confounded by different practices. The study also revealed that they were associated with certain maternal characteristics. In particular, 'unperceived monitoring' and 'pressure to eat' were more frequently associated with the socioeconomic background and family environment, while maternal restrictive behaviours over child's eating were more associated with maternal health behavioural characteristics. These results provide relevant insights of the determinants of maternal child-feeding patterns and could be helpful in future research and in family educational programmes, identifying at-risk groups and providing insights to prevention or promotion strategies.

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Conflict of interest

The authors declare that they have no conflicts of interest.

Contributions

IM conceptualized and designed the study, carried out the statistical analyses and interpretation of the data, drafted the initial manuscript, and approved the final manuscript as submitted. MS carried out some statistical analysis and interpretation of data, critically revised the manuscript and approved the final manuscript as submitted. AO conceptualized and designed the study, critically reviewed the manuscript and approved the final manuscript as submitted. CD critically revised the manuscript and approved the final manuscript as submitted. PM critically revised the manuscript and approved the final manuscript as submitted. HB was responsible for the design of the cohort and is the principal investigator. He coordinated and supervised data collection, critically reviewed the manuscript and approved the final manuscript as submitted. CL conceptualized and designed the study, critically reviewed the manuscript and approved the final manuscript as submitted.

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