Early Life Characteristics Associated with Appetite-Related Eating Behaviors in 7-Year-Old Children

Gabriela Albuquerque, MPH[1], Milton Severo, PhD[1,2], and Andreia Oliveira, PhD[1,2]

Objective To assess early life characteristics associated with appetite-related eating behaviors in 7-year-old children.

Study design The participants are children from the population-based birth cohort Generation XXI. Data on sociodemographics, health, and lifestyles and anthropometrics were collected at birth, and 4- and 7-year-old evaluations. A Portuguese version of the Children's Eating Behavior Questionnaire was completed by mothers (n = 3562 children) with children aged 7 years old. A 2-factor solution was identified: factor 1—appetite restraint and factor 2—appetite disinhibition. Associations were estimated through generalized linear models adjusted for maternal age, education, body mass index (BMI) before birth, family structure, number of siblings, and child's sex (β regression coefficients and 95% CIs).

Results Higher appetite restraint at 7 years old was associated with higher maternal age and educational level, families with both parents (1- vs 2-parent: $\beta = -0.074$, 95% CI −0.140, −0.007) and no siblings (≥2 vs 0: $\beta = -0.152$, 95% CI −0.224, -0.081), and more sedentary lifestyles at 4 years old. It was also associated with lower child and maternal BMI and waist circumference at 4 years old. In contrast, higher appetite disinhibition was associated with lower maternal educational background, having a 1-parent family, more sedentary behaviors (≥120 vs <120 min/d of media: $\beta = 0.055$, 95% CI 0.018, 0.093), and higher BMI and waist circumference at 4 years old.

Conclusions Higher maternal age and education, and a family with both parents at 4 years old seem to influence higher appetite restraint, but less appetite disinhibition at 7 years old. More sedentary lifestyles at 4 years old were associated with higher appetite restraint and appetite disinhibition scores later in childhood. These results can be useful for the development of prevention guidelines and educational strategies aimed at improving healthy eating behaviors. *(J Pediatr 2017;180:38-46).*

Eating behaviors develop early in life and result from an interplay between genetic predisposition, natural food responses and preferences, and environmental influences.[1,2] Individual differences in eating behaviors and appetite have been previously associated with differences in children's weight.[3-5] Obese children show more positive responses toward food, hypothesized to promote food intake, and leaner children express more sensitivity to internal cues of satiety and food fussiness (consumption of an insufficient amount or inadequate variety of food through rejection of food items),[6] which is likely to reduce food intake.[4,5,7,8]

Some birth-related and early infancy characteristics have been proposed as potential influencers on the development of eating behaviors. Low birth weight,[9-11] preterm birth, and restrictive intrauterine growth[12] have been associated with later eating difficulty, pickiness, and a higher risk of low appetite and food enjoyment in childhood. Breastfeeding, hypothesized to promote early self-regulation of energy intake, has been associated with higher satiety responsiveness,[13,14] in contrast to formula feeding, which is associated with picky eating[15] (the consumption of an insufficient amount or inadequate variety of food through rejection of food items[6]) and neophobia.[16]

The familial environment also has a strong influence. Children who tend to overeat are more likely to be male, live in a single-parent home, and have both parents overweight or obese.[10] In this study, family income was associated with both overeating and picky eating. In other studies, younger maternal age and parental financial problems have been identified as risk factors for picky eating,[10,15] and having siblings has been shown to be both protective[6] and a risk factor[15] for developing picky eating. The aim of this prospective study is to assess early life characteristics associated with appetite-related eating behaviors at 7 years old.

BMI	Body mass index
CEBQ	Children's Eating Behavior Questionnaire
ICC	Intraclass correlation
PCAs	Principal component analyses
P-CEBQ	Portuguese version CEBQ
WC	Waist circumference

From the [1]Institute of Public Health-Epidemiology Unit, Universidade do Porto, Porto, Portugal; and [2]Faculdade de Medicina, Universidade do Porto, Department of Clinical Epidemiology, Predictive Medicine and Public Health, Porto, Portugal

Generation XXI was funded by the Health Operational Program — Saúde XXI, Community Support Framework III, and the Regional Department of Ministry of Health. This study was supported by FEDER (from the Operational Programme Factors of Competitiveness — COMPETE), national funding from the Foundation for Science and Technology (Portuguese Ministry of Education and Science; PTDC/SAU-EPI/121532/2010 [FCOMP-01-0124-FEDER-021177]), and the Calouste Gulbenkian Foundation. The authors declare no conflicts of interest.

http://dx.doi.org10.1016/j.jpeds.2016.09.011

Methods

This study includes children from Generation XXI, a prospective population-based birth cohort.[17] Participants (8495 mothers and their 8647 children) were recruited from public maternity units in Porto, Portugal between 2005 and 2006 and were all invited to attend the second (2009-2011) and third (2012-2014) cohort evaluations, when children were aged 4 and 7 years old (86% and 80% of participation, respectively).

Responses to the Children's Eating Behavior Questionnaire (CEBQ) were available for 5786 children. Of these, 4485 questionnaires were entirely completed, and after retrieving missing data, 5449 were considered valid. Data were recovered in questionnaires that were missing <50% of data items, by replacement for the average of the remaining questions within each subdomain of the participant. Spearman-Brown prophecy formula showed that 50% of the items was enough to obtain a reliability of 0.7 (**Appendix**; available at www.jpeds.com). The sample was further restricted to 1 twin per family, randomly selected (103 children excluded, 1.19% of the initial sample), and to participants with complete information on the variables of interest (1887 children excluded, 21.8% of the initial sample), a total of 3562 participants.

We compared the study sample (n = 3562) characteristics with the remaining cohort (n = 5085) at baseline, and mothers in this study were slightly older (mean = 29.85; SD = 5.22 vs mean = 28.47; SD = 6.26; $P < .001$) and more educated (mean = 11.27; SD = 4.25 vs mean = 9.88; SD = 4.17; $P < .001$) than mothers in the remaining cohort.

All the study phases complied with the Ethical Principles for Medical Research Involving Human Subjects expressed in the Declaration of Helsinki. The study was approved by the University of Porto Medical School/S. João Hospital Center ethics committee and a signed informed consent, in accordance with Helsinki, was required for all participants, and signed by their legal guardian.

Data were collected during face-to-face interviews by trained researchers. At baseline, maternal age and education, smoking habits during pregnancy, type of delivery, children's sex, birth weight, and gestational age were recorded. Weight for gestational age was defined according to the sex-specific population-based Kramer growth standards (cut points: 10th and 90th percentiles; standards refer only to single births).[18]

At the 4-year-old evaluation, the number of siblings, family structure, any breastfeeding duration, physical activity, and number of media screening hours (television, computer, or game devices) were asked about. The timing of introduction to complementary feeding and the first food eaten in this period were asked about at 7 years old.

Height, weight, body fat, and waist circumference (WC) were measured at 4 and 7 years old according to standard procedures. The children's body mass index (BMI) was classified according to the age- and sex-specific BMI standard z-scores developed by the World Health Organization[19] and recoded into under/normal weight (BMI <2 SD) and overweight/obese (BMI ≥2 SD). WC was measured at the umbilicus level, to the nearest 0.1 cm. This variable was recoded into tertiles (<50.5 cm; 50.5-53.5 cm; ≥53.6 cm). Bioelectric impedance analysis was performed using a tetra-polar device (BIA 101 Anniversary; Akern, Florence, Italy). Fat-free mass was determined using the equation published by Schaefer et al[20]; fat mass was derived accordingly and recoded into tertiles (<12.8%; 12.8%-19.5%; ≥19.5%).

Maternal height and weight before pregnancy were self-recorded at birth and measured at children's 4-year-old follow-up. Maternal BMI was classified according to the World Health Organization criteria into under/normal weight (BMI <24.9 kg/m^2) and overweight/obese (BMI ≥ 25.0 kg/m^2).[21] BMI change represents the change in maternal BMI between the prepregnancy period and 4 years after birth.

Children's Eating Behaviors

Eating behaviors were assessed using the CEBQ, completed by parents at the 7-year-old evaluation (94% were answered by mothers). The original CEBQ[22] includes 35 items related to eating styles among children, and is answered on a 5-point Likert scale, ranging from 1 = never to 5 = always. This questionnaire consists of 8 subdomains related to distinct eating behaviors: satiety responsiveness, slowness in eating, enjoyment of food, food responsiveness, food fussiness, desire for drinks, emotional overeating, and emotional undereating. The CEBQ has demonstrated stability over time and good psychometric properties.[22-29] A version of this questionnaire has been previously validated and adapted to Portuguese children,[23] but in that version children were aged 3-13 years old, and some items were slightly different from those in the original scale. We opted for retranslating the original CEBQ into Portuguese (**Table I**; available at www.jpeds.com), resulting in a new Portuguese version CEBQ (P-CEBQ). The psychometric properties of this most recent version (including 7-year-old children) were tested in the present study (**Appendix** and **Table II**). A 2-factor solution was identified, explaining 62% of the total variance: factor 1—appetite restraint and factor 2—appetite disinhibition, explaining 35% and 26% of the total variance, respectively. The subdomains food fussiness, enjoyment of food, slowness in eating, and satiety responsiveness loaded mostly on factor 1 (loadings: 0.64; −0.78; 0.74 and 0.88) and the subdomains food responsiveness, emotional overeating, emotional undereating, and desire for drinks loaded mostly on factor 2 (loadings: 0.65, 0.82, 0.66, and 0.65) (**Table II**). Thus, appetite restraint was more related to subdomains measuring internal cues of satiety and food fussiness, on which loaded mostly food fussiness, enjoyment of food, slowness in eating, and satiety responsiveness, and appetite disinhibition was more related to subdomains measuring external food cues and emotional responses toward foods, on which loaded mostly food responsiveness, emotional overeating, emotional undereating, and desire for drinks. A short version was proposed for further application in future research.