British Journal of Nutrition (2023), 129, 1581–1588 doi:10.1017/S0007114522001258

Early weaning and family characteristics are associated with greater sodium intake in children between 13 and 35 months: BRISA birth cohort

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(Submitted 1 July 2021 – Final revision received 31 March 2022 – Accepted 11 April 2022 – First published online 25 April 2022)

Abstract

Children are consuming less healthy foods, and this eating behaviour exposes the child to greater Na intake. The association between family, maternal and child characteristics with Na intake by children aged 13–35 months was evaluated. A study carried out with retrospective data on 1,185 children from the Brisa cohort. The children's dietary Na intake was assessed by a 24-h diet recall survey. Values ≥ 1200 mg were considered excessive intake. The association between Na intake and independent variables was assessed by a three-level logistic hierarchical regression model. Variables with *P*-value < 0·05 were retained in the model. Most children were male (51·2 %), eutrophic (63·2 %) and not exclusively breast-feeding (EBF) for 6 months (58·4 %). The average Na intake was 925 mg (±410·4). The prevalence of excessive Na intake was 18·5 % and was associated with the variables children of younger mothers (< 20 years old OR = 4·04, 95 % CI 1·64, 9·99; ≥ 20 to < 35 years old OR = 2·48, 95 % CI 1·10, 5·63), having four or more children (OR = 2·51, 95 % CI 1·29, 4·89), lower family income (≥ 1 and < 3 minimum wages OR = 0·60, 95 % CI 0·39, 0·93; ≥ 3 minimum wages OR = 0·50, 95 % CI 0·30, 0·82) and not being EBF until 6 months (OR = 1·64, 95 % CI 1·14, 2·34). The average Na intake of children was higher than the recommendation for adequate intake, pointing to a high consumption of this micronutrient in the first years of life. Excessive Na intake seems to be linked to unfavourable socio-economic conditions. Avoiding early weaning is the only possible intervention in this scenario.

Key words: **Child: Sodium: Eating habits: Weaning**

Nutrition in early childhood is determinant for the child's growth and development, maintenance of health and formation of eating habits. At this stage of development, WHO recommends exclusive breast-feeding (EBF) up to 6 months postpartum and should be maintained until 2 years of age, in combination with complementary healthy feeding[1].

However, the inappropriate introduction of complementary food, poor timing and/or unsuitable food, is one of the difficulties for the good feeding practices in this period of life. In the last decades, the population's eating patterns have been changing[2,3] and, at an early age, children are consuming less healthy foods such as fresh or minimally processed foods and are exposed to ultra-processed foods[4,5].

Processed and ultra-processed foods have high energy density, high contents of free sugar, Na and saturated fat and low content of essential nutrients compared with fresh or minimally processed foods[6,7]. However, it is possible that their high palatability, availability and convenience, as well as the fierce marketing make them preferred substitutes for fresh or minimally processed foods[8,9].

Thus, this eating behaviour exposes the child to greater Na intake. It is known that most of the salt in the modern dietary pattern derives from commercially prepared food components and not from the salt added by consumers at homemade meal preparation or at the time of consumption[10]. Studies indicate that Na intake among children is excessive and may be associated with higher blood pressure and hypertension in childhood[11,12], in addition to a higher prevalence of CVD and increased mortality in adulthood.

Research on CVD, hypertension and diet has been among the priority areas for decades, but there are still numerous

Abbreviations: EBF, exclusive breast-feeding; 24HR, 24-h diet recall survey.

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knowledge gaps[10], and recent studies suggest a need for greater efforts to reduce Na intake among children[11]. In this context, Dietary Reference Intakes established a recommendation of less than 1200 mg/d of Na intake among children aiming to reduce the risk of future chronic diseases[10].

Diet is notably one of the modifiable environmental factors involved in the health-disease process[13], and socio-economic and demographic characteristics[14,15] and family life habits influence children's food preferences[16–18]. Thus, the objective of this study was to evaluate the association between family, maternal and child characteristics with Na intake by children aged between 13–35 months.

Materials and methods

A retrospective cohort study, part of the birth cohort *Etiology of Preterm Birth and Consequences of Perinatal Outcomes for Child Health: Birth Cohorts in Two Brazilian Cities – BRISA*, was conducted. This study used only data from the city of São Luís, MA, including information on mothers and their children, who participated follow-up in the second year of life of this cohort and who were assessed by a 24-h diet recall survey (24HR). Children with incomplete 24HR data or whose mothers reported an atypical day of food intake were not included.

The sample size calculation for the BRISA birth cohort established a minimum of 5,000 women. The BRISA birth cohort sought to evaluate 1/3 of the 21 401 births that occurred in São Luís City in 2010. Among 7133 women selected at random, 5475 were eligible for the study for residing in São Luís. Due to mothers' refusal and early discharges, 5236 births were considered for the study, and after excluding seventy stillbirths, the sample ended in 5166 live births (Fig. 1). More information on the cohort methodology is described in Silva *et al.*[19].

For the follow-up of the second year of life and due to the infeasibility of applying the 24HR to all children, a sub-sample was calculated. This sub-sample was composed of the sum of the number of preterm births, low birth weight babies and or twins (853 children). We also added 1·5 times the number of term children, non-low birth weight babies and non-twins (1282), totalling 2135 children. The non-return rate was 41·8 % (893 children) because of the difficulty in locating participants and refusal. Thus, 1242 children were assessed for food consumption, from April 2011 to March 2013. Of these children, 4·6 % were excluded for having an incomplete or atypical 24HR, hence a final sample of 1185 children (Fig. 1)[4].

The minimum required sample size was calculated using the OpenEpi programme version 3.03ae considering the type 1 error of 5 %, power of study 80 %, exposed and non-exposed ratio of 1, with the mother's low level of education as an exposure factor, OR of 2, resulting in an initial sample of 422 children. Data of total eligible children (*n* 1185) were used since this study is part of the BRISA birth cohort.

The demographic and nutritional conditions of the child were assessed using the following variables: sex, skin colour reported by the mother (white, black, brown and yellow), age (months), nutritional status according to BMI, EBF up to 6 months (yes and no) and Na intake. The demographic and socio-economic variables of the mother were age (years), skin colour self-declared (white, black, brown and yellow), marital status (married, consensual union and without a partner), education (≤9 years, > 9 and ≤ 12 years, and > 12 years), maternal paid activity (yes and no), family income (minimum wages), number of children and number of residents in the household. The variables beneficiary of the 'Bolsa Família' programme and registered with the Family Health Strategy were also included.

The child's nutritional status was assessed using the BMI. The criterion established by the WHO was adopted, which provides cut-off points for BMI for specific children by sex and age, corresponding to low weight (z-score < –2), normal weight (z-score ≥ –2 and < 1) and risk of overweight/obesity (z-score ≥ 1).

A 24HR assessed the dietary Na intake by recording the intake of solid and liquid foods from the day before the interview with the mothers. The 24HR was applied by trained nutritionists.

The mothers reported the typical children's diet based on the question: 'Yesterday, did the child eat as usual?'. A negative response indicated an atypical 24HR day. However, regardless of the answer, a detailed description of the food, preparation method, brand and quantification of the items consumed in household measures was requested. At the time, a photograph album with serving sizes was used to help mothers to recall the items ingested by the children. Due to the influence of the day of the week and the season on food consumption, a 24HR was applied randomly on different days of the week and months of the year.

Data were entered into Virtual Nutri Plus® (version 2010) application (University of São Paulo). If the application had no information on the composition of the food, the Table of the Assessment of Food Consumption by Household Measures[20] or the food information label was assessed. The foods were converted into nutrients, and the amount of Na was estimated. The data were exported to an Excel® spreadsheet (version 2010).

In this study, the Na intake assessment considered the Dietary Reference Intakes for children aged 13–35 months. Values above Chronic Disease Risk Reduction Intake (> 1200 mg/d) were considered excessive Na intake[10]. The food intake assessment of only 1 d may not represent the individuals' usual consumption. Thus, the inter- and intra-personal variabilities were adjusted using *The Multiple Source Method*® (MSM) version 1.0.1 by assessing food intake of a sub-sample of 206 children with three 24HR.

For children who were still being breastfed and because of the difficulty of collecting data on breast milk intake, the methodology proposed by Drewett[21] was used. The method is fast, low cost and estimates the volume of breast milk consumed with the equation that involves the energy consumption (in kcal) of the complementary food and the child's age (in days).

Quantitative variables were presented as means and standard deviation and qualitative variables as frequencies and percentages. Variable normality was assessed using the Shapiro Wilk test.

In this study, the sampling design was complex (all children who were born with low birth weight, preterm or twins and 1·5 times their number of controls) and there was a loss of children due to lack of data on food consumption. In view of this, the probability of follow-up was calculated for each category of

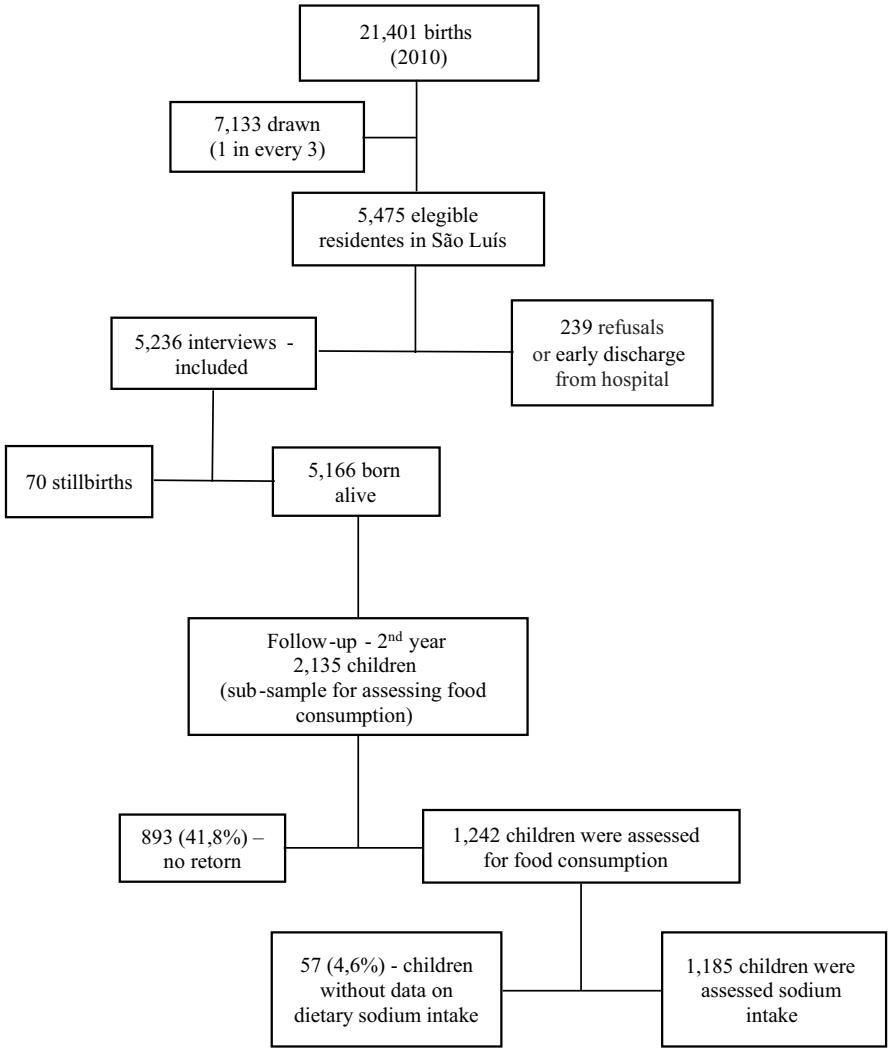

Fig. 1. Flow chart of the sample of São Luís birth cohort, baseline and follow-up. BRISA birth cohort, Brazil, 2010–2013.

variables. According to the results of the χ^2 test, the variables that showed significant differences ($P < 0{\cdot}05$) in the probability of follow-up were used to calculate the weighting factor. A logistic model with preterm birth, low birth weight and/or twinning, mother's education and socio-economic class was performed to predict the likelihood of attendance for each child, and the weighting factor used corresponded to the inverse of the probability predicted by the model. Therefore, all analyses were weighted by the inverse probability of selection, which accounted for the complex sampling design and for losses to follow-up.

The logistic regression assessed the association between excessive Na intake and the independent variables. The hierarchical theoretical model was organised into three levels that included the variables based on evidence from the literature. Excessive Na intake (yes/no) was used as the outcome variable. The variables maternal age, maternal status, maternal education (years of school), family income (minimum wage), maternal paid activity, number of residents in the household and number of children composed the distal level. The intermediate level was constituted by the variables beneficiary of the 'Bolsa Família' programme (cash transfer) and registration in the Brazil's Family Health Strategy. The variables child's age, BMI and EBF up to 6 months were in the proximal level (Fig. 2).

The variables that showed statistical significance (P-value $< 0{\cdot}05$) from the first level were retained in the model for the evaluation of the next level. The software used to analyse the data was Stata® (version 14.0), with a 95 % CI.

The BRISA birth cohort study was approved by the Research Ethics Committee of the UFMA University Hospital (Clinical Opinion nº 223/2009) and the Clinical Hospital of the Ribeirão Preto Medical School (Official Letter nº 4116/2008), meeting the criteria of Resolution 196/96 of the National Health Council and complementary laws in force at the time.

Results

The sample evaluated in this study corresponded to 1185 children aged 13–35 months, predominantly male (51·2 %),

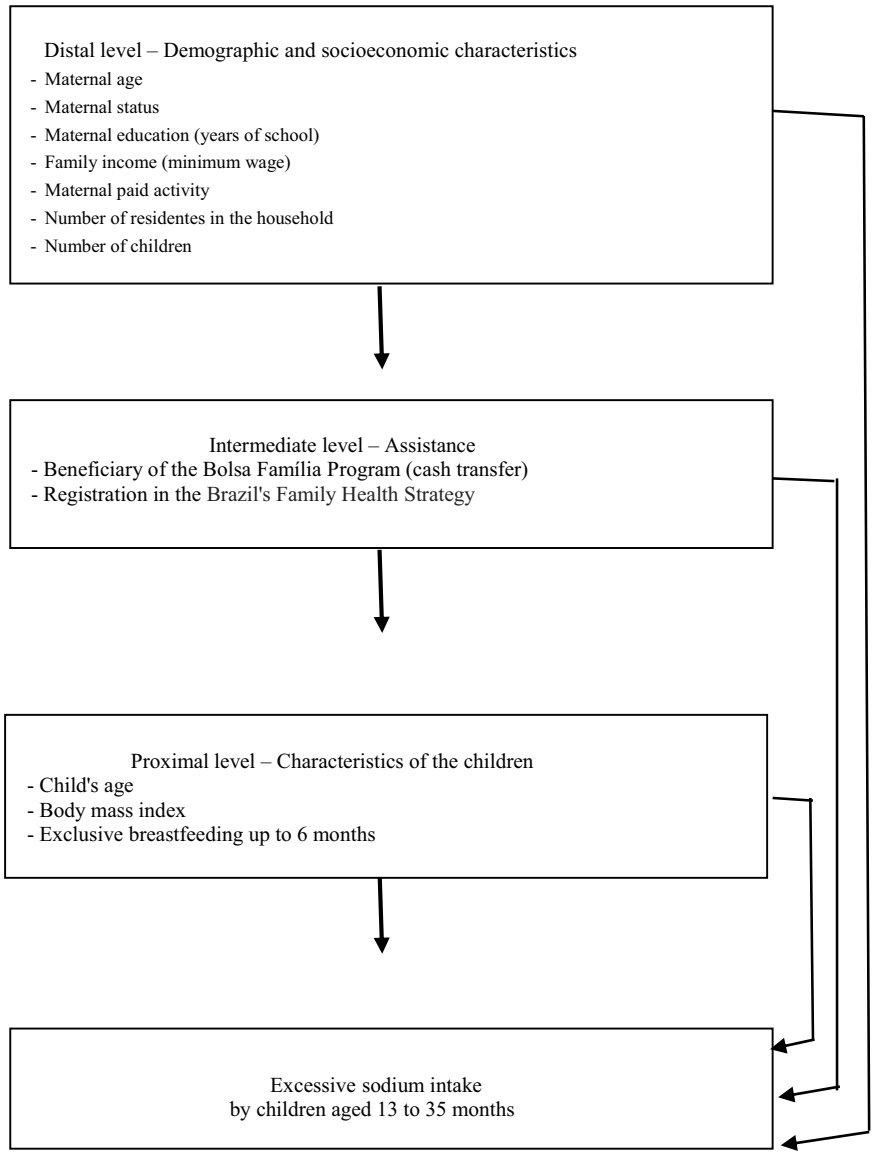

Fig. 2. Hierarchical model proposed to evaluate the association between excessive Na intake and family characteristics among children aged 13–35 months. BRISA birth cohort, São Luís, Maranhão State, Brazil, 2010–2013.

eutrophic (63·2 %) and who were not EBF until 6 months (58·4 %) (Table 1). The median EBF was 3 months (P25–P75:1–4) for children who did not exclusively breastfed until 6 months of life and 6 months for children who exclusively breastfed for 6 months of life. The majority of the mothers aged from 20 to 34 years old (70·1 %), self-declared brown skin colour (66·0 %), lived in a consensual union (59·9 %) and had no paid outside activity (66·0 %). The other socio-economic and demographic characteristics of the mothers are described in Table 2.

The average Na intake among the children in this study was 925·0 (SD 410·4) mg (Md: 864·4 mg, P25:742·1 mg and P75:1109·4 mg) and the prevalence of excessive Na intake (above Chronic Disease Risk Reduction Intake) was 18·5 % in this group. The average K intake was 1868·7 (SD 760·9) mg. In addition, the energy contribution of ultra-processed foods in the diet of the children evaluated was 24·7 %, being the main source of Na in the children's diet. When we evaluated the consumption of ultra-processed foods in tertiles, as the consumption of these foods increased, so did the mean Na (tercile 1:865·5 mg/d, tercile 2:890·9 mg/d; tercile 3:1017·0 mg/d; $P < 0·001$) (data not shown in the table).

The multivariate hierarchical analysis of the explanatory variables structured in three blocks in relation to the outcome variable excessive Na intake is presented in Table 3. The final analysis showed that children of younger mothers (< 20 years of age OR = 4·04; 95 % CI 1·64, 9·99 and ≥ 20 to < 35 years of age OR = 2·48; 95 % CI 1·10, 5·63), family income (≥ 1 and < 3 minimum wages OR = 0·60; 95 % CI 0·39, 0·93; ≥ 3 minimum wages OR = 0·50; 95 % CI 0·30, 0·82), not exclusively breastfed until 6 months (OR = 1·64; 95 % CI 1·14, 2·34) and whose mothers had four or more children (OR = 2·51; 95 % CI 1·29, 4·89) were associated with excessive Na intake (above Chronic Disease Risk Reduction Intake).

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Table 1. Demographic, socio-economic and behavioural characteristics of children aged 13–35 months with assessed Na intake, 2010–2013 (Numbers and percentages)

Variables	*n*	%
Child's sex		
Female	578	48·8
Male	607	51·2
Child's age (months)*		
< 18	679	57·4
≥ 18 and < 24	332	28·0
≥ 24	173	14·6
Child's skin colour		
White	301	25·5
Brown	802	67·9
Black	76	6·4
Yellow	3	0·2
BMI*		
Low weight	16	1·4
Eutrophy	749	63·2
Risk of overweight/obesity	420	35·4
Exclusive breast-feeding up to 6 months*		
Yes	473	41·6
No	663	58·4
Na intake		
< 1200 mg/d	966	81·5
≥ 1200 mg/d	219	18·5

* *n* < 1185.

Table 2. Demographic, socio-economic and behavioural characteristics of the families of children aged 13–35 months with assessed Na intake, 2010–2013 (Numbers and percentages)

Variables	*n*	%
Maternal age (years)		
< 20	234	21·4
≥ 20 and < 35	849	70·1
≥ 35	102	8·5
Maternal colour		
White	218	18·4
Brown	782	66·0
Black	173	14·6
Yellow	12	1·0
Maternal status		
Married	251	20·8
Consensual union	708	59·9
Without a partner	226	19·3
Maternal education (years of school)*		
≤ 9	260	22·3
> 9 and ≤ 12	727	62·3
> 12	180	15·4
Maternal remunerated activity		
Yes	403	34·0
No	782	66·0
Family income (minimum wage)*		
≤ 1	163	16·6
> 1 and ≤ 3	505	51·5
> 3	312	31·9
Number of residents in the household		
1–3	596	50·3
4–5	368	31·0
> 5	221	18·7
Number of children		
1	606	51·2
2–3	505	42·6
≥ 4	74	6·2
Beneficiary of the Bolsa Família programme (cash transfer)*		
Yes	362	30·6
No	822	69·4
Registration in the Brazil's Family Health Strategy*		
Yes	248	21·0
No	935	79·0

* *n* 1185.

Discussion

In the present study, the prevalence of excessive Na intake was 18·5 % and was associated with the variables low maternal age, mothers with four children or more, lower family income and early weaning.

This study evaluated the Na intake of a representative sample of children from a birth cohort. These findings point to worrying results among children in early childhood, as 18·5 % of children had excessive Na intake, according to Chronic Disease Risk Reduction Intake. It is emphasised that the Na intake evaluated in this study refers only to that inherent to food, not to addition salt. It is possible that if the Na from the addition salt is taken into account, the average intake of this nutrient is even higher.

The excessive Na intake among children has been demonstrated in other studies[11,22–28], which predisposes to the future development of chronic diseases such as hypertension and CVD[10,29].

The present study demonstrated that children between 13 and 35 months who have not been breastfed until the sixth month of life are at greater risk of excessive Na intake. We emphasise that the highest consumption of Na ingested by children came from ultra-processed foods. EBF until 6 months of life is associated with the formation and perpetuation of better eating habits in childhood and throughout life[30–34]. According to Fonseca *et al.*[33], children who remained in EBF until the fourth month of life consumed less ultra-processed foods and more fruits and vegetables. Other studies also demonstrate that children who do not exclusively breastfed have an increased consumption of ultra-processed foods, high in Na, in early childhood[34–37].

The relationship between the duration of EBF and the children's diet can be attributed, in part, to the mother's diet, because when breastfed, children are exposed to a variety of flavours of breast milk. This favours the acceptance of different tastes later on and the formation of healthy eating habits from childhood[32].

Excessive Na intake in children is associated with a high participation of ultra-processed foods early in the diet such as sugary drinks, sweet and filled biscuits, fast foods, snacks, treats and instant noodles[3,38]. A possible explanation for the high Na intake in this sample is the early consumption of ultra-processed foods aimed at children, as the energy contribution of ultra-processed foods in the diet of the children evaluated was 24·7 %.

Family characteristics were also associated with excessive Na intake by the children. Younger mothers tend to have less experience and less knowledge about the child's proper and healthy diet. Thus, it is possible that the younger mothers would feed the children with more ultra-processed foods due to their availability and convenience and the false feeling of providing healthy foods. Older mothers are expected to have better discernment of healthy eating markers. The aggressive marketing of the ultra-processed food industry also has an important influence

Table 3. Unadjusted and adjusted hierarchical analyses of the association between the characteristics of children aged 13–35 months and high Na consumption, and their families, 2010–2013 (Odds ratios and 95 % confidence intervals)

	Distal level			Intermediate level			Proximal level		
Variables	OR	95 % CI	*P*	OR	95 % CI	*P*	OR	IC 95 % CI	*P*
Maternal age (years)									
< 20	4·52	1·78, 11·48	0·002	3·70	1·58, 8·66	0·003	4·04	1·64, 9·99	0·002
≥ 20 and < 35	2·76	1·22, 6·28	0·015	2·42	1·13, 5·21	0·024	2·48	1·10, 5·63	0·029
≥ 35	REF								
Maternal status									
Married	REF								
Consensual union	0·84	0·53, 1·33	0·462						
Without a partner	1·34	0·76, 2·35	0·312						
Maternal education (years of school)									
≤ 9	REF								
≥ 9 and ≤ 12	1·18	0·75, 1·84	0·474						
> 12	1·15	0·58, 2·28	0·694						
Family income (minimum wage)									
< 1	REF								
≥ 1 and < 3	0·61	0·39, 0·94	0·025	0·61	0·40, 0·94	0·024	0·60	0·39, 0·93	0·023
≥ 3	0·53	0·31, 0·92	0·023	0·51	0·31, 0·83	0·007	0·50	0·30, 0·82	0·006
Maternal paid activity									
Yes	REF								
No	1·06	0·72, 1·57	0·768						
Number of residents in the household									
1–3	REF								
4–5	1·27	086, 1·87	0·234						
> 5	0·88	0·53, 1·47	0·627						
Number of children									
1	REF								
2–3	1·34	0·92, 1·97	0·131	1·32	0·91, 1·92	0·137	1·27	0·87, 1·85	0·210
≥ 4	2·64	1·28, 5·43	0·008	2·49	1·28, 4·85	0·007	2·51	1·29, 4·89	0·007
Beneficiary of the Bolsa Família programme (cash transfer)									
Yes				REF					
No				1·17	0·79, 1·74	0·434			
Registration in the Brazil's Family Health Strategy									
Yes				REF					
No				1·05	0·69, 1·59	0·821			
Child's age (months)									
< 18				REF					
≥ 18 and > 24						0·94	0·63, 1·40	0·748	
≥ 24							1·21	0·75, 1·95	0·443
BMI									
Low weight							3·31	0·39, 27·82	0·270
Eutrophy							REF		
Risk of overweight/obesity							2·74	0·32, 23·24	0·354
Exclusive breast-feeding up to 6 months									
Yes							REF		
No							1·64	1·14, 2·34	0·007

on the mothers' decision and children's food preferences leading to a greater consumption of these foods and the consequent higher Na intake[9].

Having a larger number of siblings was also associated with excessive Na intake. It is possible that the diet of older siblings influences the younger ones as they are exposed to less healthy foods early. In addition, the mother's workload to care for her children may be associated with greater nutritional vulnerability among younger children. The greater number of children at home may demand a greater need for domestic work on the part of the mother, lowering the quality of care for children, including those related to food and health. In addition, the greater number of children in the household can lead to greater demand for food to meet nutritional needs, which are not always available in quantity and quality adequate for their support, especially in the strata of lower socio-economic status and per capita income[38].

Situations of multiple social vulnerabilities can influence and hinder the conditions of access to food, favouring the formation of inappropriate eating habits[35]. In this study, the lowest family income was also associated with excessive Na intake by children. Lower per capita income is an economic indicator with strong influence on dietary patterns, compromising access to adequate and healthy foods and favouring the greater consumption of ultra-processed foods, which are rich in Na[39].

A limitation of this method is the random error, because even though the individuals have a stable eating pattern, the diet is considered a random event; however, in this study, the assessment of food consumption was corrected for the intrapersonal variance of a sub-sample of children with the application of 3 24HR, using the software *The MultipleSourceMethod* (MSM). Another limitation is the sample losses that the study showed, which are common in cohort studies. To minimise selection bias,

the variables of interest were weighted by the inverse of the selection probability.

As strengths of this study, we can mention the characteristics of the population and the robust size of the sample. Furthermore, this study brings relevant contributions, such as warning about the excessive Na intake at such an early stage of life.

Conclusion

This study points to the high Na intake of children in the first years of life. Not being exclusively breastfed until 6 months and family characteristics (younger mothers, lower family income and larger number of children) represented a risk for greater Na consumption, reinforcing the need to strengthen public policies aimed at social security and family planning.

EBF until 6 months of life was a protective factor against excessive Na intake, demonstrating that in addition to all the other benefits, breast-feeding helps children form better eating habits in the future.

The findings of this study emphasise the importance of promoting breast-feeding and healthy eating in childhood, in order to promote the reduction of Na and ultra-processed foods consumption, promoting homemade meals rich in fresh and minimally processed foods.

Acknowledgements

D. R. S. Contributed to the conception of the study design, statistical analysis and data interpretation. In writing the manuscript and critically reading the scientific content, it approves the final version and assumes responsibility for the work; A. K. T. C. F. Contributed to statistical analysis, data interpretation, manuscript writing and critical reading of the scientific content. Approves the final version and assumes responsibility for the work; M. C. V. C. Contributed to statistical analysis, data interpretation, manuscript writing and critical reading of the scientific content. Approves the final version and assumes responsibility for the work; P. C. A. F. V. Collaborated with statistical analysis, data interpretation, manuscript writing and critical reading of the scientific content. Approves the final version and assumes responsibility for the work; N. O. P. Contributed to writing the manuscript and critically reading the scientific content. Approves the final version and assumes responsibility for the work and F. L. F. Collaborated with the design of the study design, statistical analysis and data interpretation. In writing the manuscript and critically reading the scientific content, it approves the final version and assumes responsibility for the work.

The financial support was received from the Brazilian funding agencies: Brazilian National Council of Scientific and Technological Development (CNPq – process number 471923/2011-7 e 561058/ 2015-5); University Level Professional Training Center (CAPES – FINANCE CODE 001); Foundation for the Support of Research and Scientific and Technological Development of Maranhao (FAPEMA – process number 0035/2008); Research Support Foundation of the State of Sao Paulo (FAPESP process number 2008-53593-0) through the BRISA Project; and by Supporting Programs for Centers of Excellence (PRONEX). The authors declare no conflict of interest.

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