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Breastfeeding and obesity in Brazilian children

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Background: The association between breastfeeding and obesity is inconsistent by the literature. This study aims to assess whether obesity is associated to occurrence of breastfeeding and to duration of total and exclusive breastfeeding in Brazilian children. **Methods:** A cross-sectional study was conducted with 764 children enrolled in public and private schools from Viçosa, Minas Gerais, Brazil. Obesity (outcome variable) was defined as body mass index above the +2 standard deviations score using sex and age specific standards of World Health Organization. Exposure was the occurrence and duration of breastfeeding. Potential confounders were controlled by multiple logistic regression analysis and were divided in two groups: children (gender, age, birth weight, gestational age, order of birth, number of siblings, number of persons in the residence, type of school, physical activity patterns and time watching television) and mothers (age, nutritional status, level of education, weight gain during pregnancy, smokes currently and during the pregnancy). **Results:** Prevalence of obesity was 10.7%; 6.8% of the children were not breastfed and 59.0% did not receive exclusive breastfeeding. After adjustment for confounding variables by logistic regression analysis, no statistically significant association was observed between obesity and the occurrence and/or duration of total and exclusive breastfeeding. There was no dose–response effect of duration of breastfeeding on prevalence of obesity. **Conclusion:** Our results do not support the hypothesis that breastfeeding promotion would reduce obesity in this population. Controversial findings regarding this association by literature indicate a need for further investigations.

Introduction

Breastfeeding is an interaction that creates a strong link between the mother and the infant in the extra-uterine environment, similar to the placental link between mother and fetus before birth.[1] Breastfeeding has other advantages, including nutritional, immunological, psychological, economic and environmental benefits.[2] The hypothesis that breastfeeding has a protective effect against the development of obesity is biologically sound and has received support from epidemiological studies.

Obesity is an emergent public health problem in Brazil and many other countries. It is one of the most serious nutrition problems affecting children, with potentially severe consequences for physical and mental health. Obesity has multiple causes and consequences, representing a challenge for health professionals who work with children. Preventive measures can avoid long-term harmful consequences of organic or psychosocial origin, so that low-cost preventive measures should be favoured. If a protective role for breastfeeding is confirmed, it could represent an effective weapon against obesity, adding to its many other already known advantages.[3]

Many hypotheses have been proposed to explain why breastfeeding may protect children against obesity. Protective mechanisms would involve since the specific and unique composition of human milk to the influence of environmental and behavioural factors such as socio-economic status (SES), maternal education, dietary patterns and physical activity. Different factors, such as bioactive substances present in human milk, the diminished intake of energy and/or protein and a unique hormonal response, could contribute to decrease the risk of childhood obesity.[4] The protective role of human milk against obesity may be explained by different biological mechanisms involving its unique composition as well as the metabolic and physiological responses it induces. Human milk is qualitatively and quantitatively different from any milk formula, due to the presence of bioactive substances that influence adipocyte proliferation and differentiation and, as such, tissue growth and development.[3] Breastfeeding has also the advantage of allowing the control of the amount of ingested milk, based on satiety control.[5] As the flavor of breast milk is influenced by the mother's diet, breastfed children accept more easily different diets and tend to have healthier dietary habits.[6]

Some studies have shown that breastfeeding is protective against the development of childhood obesity, in a dose-dependent manner.[7,8] Other groups, however, did not observe a statistically significant association, so that the relationship between breastfeeding and obesity is still under debate.[1,9] The existence of contradictory findings in studies evaluating the association between breastfeeding and childhood obesity may be due

to differences between studies. These can be on the design, sample size and control of potential confounding variables—particularly, birth weight, maternal obesity and SES.[10]

Studies with Brazilian children and adolescents did not detect dose–response relationship between breastfeeding and obesity.[10–12] Non-breastfeeding is not a risk factor, like smoking or alcohol, to which one is either exposed on unexposed. Infants who are not breastfed must receive other types of food, and these may vary markedly between the rich and the poor, and between high- and low-income countries. Therefore, findings from a given setting may not be necessarily applicable to another environment.[11] This highlights the need for additional studies from low- and middle-income countries. Caution when generalizing findings is required.

The present study aimed to assess whether obesity in children aged 6–10 years from Viçosa (MG, Brazil) is associated to occurrence of breastfeeding and to the duration of total and exclusive breastfeeding.

Methods

Population and design

The city of Viçosa, located in the region of Minas Gerais in Southeast Brazil, has a population of around 64 800 inhabitants of which 59 792 (92.2%) live in the urban area.[13] A cross-sectional study was conducted with 764 school-children aged between 6 and 10 years, enrolled in the two larger public ($n=2$) and private ($n=2$) schools in city of Viçosa, Minas Gerais, Brazil during 2005/2006. The sample size was calculated using the following premises: overweight prevalence (8%),[14] the desired level of precision of 2%, 95% of power, 5% of significant level and estimated loss of 10%.

The authors contacted 1066 children and 305 refused to participate in the study because: did not have parental permission to participate due to lack of time (37) or by reason of the child already be under monitoring of another professional (8), no localization of parents by phone (215) and unrequited message to those who had no telephone (42).

Data collection and analysis

The parents were informed on the objectives of the study. Parents who authorized the participation of children were invited for nutritional consultation to anthropometric evaluation of their children, to receive advise on dietary reeducation and changes in life style. The consultations were conducted in the Laboratory of Nutritional Evaluation of the Department of Nutrition and Health of Federal University of Viçosa. Children with nutritional dystrophy (underweight, risk of obesity or obesity) were seen in four different consultations, 1-month apart, to follow-up the correction of the nutritional state.

Anthropometric measurements of weight and height were performed according Jelliffe.[15] Weight was assessed with a portable digital electronic scale, with 150 kg capacity and 50 g sensitivity. Height was assessed with a 2 -m long stadiometre, divided into centimetres and subdivided into millimetres. The body mass index (BMI) was calculated from the weight and height measures (kg/m^2).

A questionnaire was applied preferably to the mothers during the consultation. The questionnaire evaluated family characteristics, conditions of the mother during pregnancy, child's birth, duration of breastfeeding and practice of physical activities by the children. The duration of exclusive and total breastfeeding was registered after information of the mother, and classified according to exclusive breast milk intake and intake of breast milk independent of any other solid or liquid food, including non-human milk, respectively.[16] Pregnancy weight gain was considered excessive when over 16 kg, in accordance to guidelines of the Brazilian Health Ministry.[17] Birth weight <2500 g, 2500–3000 g and ≥3000 g were considered as low, insufficient and normal, respectively.[16] Premature, full- and post-term pregnancies were considered as <37 weeks, between 37 and 41 weeks, and ≥42 weeks, respectively.[16]

The nutritional status of the mothers was evaluated. Weight was assessed with a portable digital electronic scale, with 150 kg capacity and 50 g sensitivity, and height was determined with a 2-m long stadiometre, divided into centimetres and subdivided into millimetres. These measurements were made according to Jelliffe.[15] The BMI was determined from weight and height, and the nutritional status was classified by WHO.[18] The term pre-obese was replaced by overweight, whereas obesity classes I, II and III were all grouped and designated as 'obesity'.

All anthropometric evaluations and applications of questionnaires were conducted by the same researcher in order to avoid possible biases in the measurements (JN).

The outcome variable of the study was obesity in children, and the explanatory variables referred to occurrence of breastfeeding and duration of total and exclusive breastfeeding. Obesity was defined as BMI above the +2 standard deviation score (SDS) using sex- and age-specific standards of World Health Organization.[19]

Potential confounding variables of the study were divided into two groups. One is related to the child (gender, age, birth weight, gestational age, order of birth, number of siblings, number of persons in the residence, type of school, physical activity patterns and time watching television) and the other group to the mothers (age, nutritional status, level of education, weight gain during pregnancy, smokes currently and during the pregnancy).

Statistical analysis

Database construction and statistical analyses used the softwares Epi Info 6.0,[20] Sigma-Stat 2.03[21] and SPSS 15.0 for Windows (SPSS Inc., Chicago, IL, USA). The results were first analysed as categorical variables. The chi-square test or Fisher's test were used for bivariate comparisons with obesity prevalence, with determination of the odds ratio (OR) and 95% confidence interval (95% CI) for each of the variables. Variables were adjusted with multiple logistic regression, and the cut-off for inclusion was a $P<0.2$ in the bivariate analysis with obesity. The variables were included in the regression analysis according to descending OR values with the enter method, for analysis of occurrence of breastfeeding and duration of total and exclusive breastfeeding.

The adjusted OR was compared between two groups: obesity (BMI > 2SD) and no-obesity (BMI ≤ 2 SD). For the analysis of occurrence of breastfeeding, confounding variables were considered as those associated to the outcome and modifying the OR of the first category of breastfeeding in at least 10%. Factors independently associated to the outcome in the final model of multiple logistic regression were considered as confounding variables in the analysis of duration of total and exclusive breastfeeding.

The Kolmogorov–Smirnov normality test was used to determine if the distribution of values was normal to all variables. According to the distribution of variables in the normal curve, the Student's *t*-test, Mann–Whitney test, one-way analysis of variance and the Kruskal–Wallis test were used to compare means or medians of the variables. Pearson or Spearman correlation tests were also employed. Values of $P<0.05$ were considered to be statistically significant.

This study was approved by the Research Ethics Committee of Federal University of Minas Gerais (protocol number 0392/05). Participation in the study was entirely voluntary: child consent and signed informed consent of the parents or legal guardians of each participant were obtained prior of the study.

Results

A total of 764 schoolchildren were evaluated in this study. The prevalence of obesity was 10.7%. The total percentage of boys was 49.9%. The majority of children (92.6%) were breastfed during infancy. Only 23.2% of children were exclusively breastfed at least 4 months. The median duration of total and exclusive breastfeeding was 8.6 and 1.5 months, respectively.

Table 1 presents that the prevalence of obesity among children was not associated with who had not been breastfed ($P=0.113$) or who had not been exclusively breastfed ($P=0.193$). The same result was observed between the prevalence of obesity and duration of total and exclusive breastfeeding ($P=0.185$ and $P=0.446$, respectively, table 1).

No significant correlations were observed between the BMI of the children and duration of total ($r = -0.02$; $P = 0.566$) and exclusive ($r = -0.008$; $P = 0.826$) breastfeeding. Similarly, no statistically significant differences were observed among median BMI of children who had received total breastfeeding during defined periods (no breastfeeding: 16.5 kg/m^2; ≤1 month: 16.2 kg/m^2; ≥1 year: 16.6 kg/m^2—$P = 0.443$) and exclusive breastfeeding during defined periods (no exclusive breastfeeding: 16.5 kg/m^2; 4 months: 16.5 kg/m^2; 6 months: 17.1 kg/m^2; between 4 and 6 months: 16.5 kg/m^2—$P = 0.712$).

The prevalence of premature babies (19.2 vs. 6.3%; $P = 0.002$) and maternal concurrent obesity status (34.0 vs. 12.7; $P < 0.001$) was higher in the group of non-breastfed than among breastfed children. Prematurity ($P = 0.002$) were associated to lower duration of total breastfeeding, whereas lower birth weight ($P = 0.015$) was associated to lower duration of exclusive breastfeeding. No relationships were observed between the birth order and smoking during pregnancy with occurrence or duration of breastfeeding (table 2).

Table 1 Prevalence of obesity in children according to history and duration of breastfeeding in Viçosa, MG, Brazil

History and duration of breastfeeding	BMI/age > 2 SD *n* (%)	BMI/age ≤ 2 SD *n* (%)	*P*-value[a]
Breastfeeding			
Yes	73 (89.0)	639 (93.7)	0.113
No	9 (11.0)	43 (6.3)	
Duration of total breastfeeding (months)			
0	9 (11.0)	43 (6.3)	0.185
<3	20 (24.4)	130 (18.9)	
3–5	15 (18.3)	124 (18.0)	
6–11	17 (20.7)	216 (31.4)	
≥12	21 (25.6)	174 (25.3)	
Duration of exclusive breastfeeding (months)			
0	55 (67.1)	399 (58.8)	0.446
<1	3 (3.7)	19 (2.8)	
1–3	10 (12.2)	106 (15.6)	
4–6	14 (17.1)	155 (22.8)	

a: Chi-square test

Positive correlations were observed between birth weight and duration of total ($r = 0.10$; $P = 0.004$) and exclusive ($r = 0.11$; $P = 0.001$) breastfeeding. However, no correlations were seen between weight gain during pregnancy or maternal age at the time of the child's birth with duration of total and exclusive breastfeeding ($P > 0.05$). Current maternal BMI showed inverse correlation with duration of exclusive breastfeeding ($r = -0.10$; $P = 0.03$), but not with duration of total breastfeeding ($r = -0.02$; $P = 0.546$).

In the bivariate analysis, some of the variables presented statistically significant association with obesity among the children: gender ($P = 0.001$); age ($P = 0.009$); number of siblings ($P = 0.012$); daily time watching television programmes ($P = 0.004$); practice physical education classes in school ($P = 0.032$); mother's educational level ($P = 0.012$); weight gain during pregnancy ($P = 0.034$); smoking during pregnancy ($P = 0.045$), mother smokes currently ($P = 0.043$) and mother's nutritional state ($P < 0.001$). Other variables were also included in the multiple logistic regression analysis, when presenting a *P*-value < 0.2 in the bivariate analysis with children obesity: living with both parents ($P = 0.134$) and children's activities during week days ($P = 0.195$) (table 3 and table 4).

The multiple logistic regression model for occurrence of breastfeeding showed that obesity in school-aged children was not associated with absence of breastfeeding (OR: 0.91; 95% CI: 0.36–2.34; $P = 0.856$). The confounding variables in the analysis of occurrence of breastfeeding, or those associated to the outcome and modifying the OR in the first category of breastfeeding by at least 10% in the final model, were: gender, practice physical education classes in school, daily time watching television programmes, number of siblings, mothers' nutritional state and smoking during pregnancy. The models of multiple logistic regression analysis for duration of total and exclusive breastfeeding showed no dose–response relationship with childhood obesity. The confounding variables for both models, i.e. those remaining independently associated to the outcome, were: gender, physical education classes in school, daily time watching television programmes, number of siblings, mothers' nutritional state, smoking during pregnancy and mothers' smoking currently) (table 5).

It is important to stress that the analysis of the prevalence of weight excess (overweight + obesity) among school children did not show statistically significant association with occurrence of breastfeeding

Table 2 Relationship between history and duration of breastfeeding and the characteristics of children and their mothers in Viçosa, MG, Brazil

History and duration of breastfeeding	Birth weight, median (g)	Pre-term (%)	First son (%)	Smoking during pregnancy (%)	Weight gain during pregnancy, median (kg)	Maternal age at child's birth, $\bar{x} \pm SD$ (years)	Obese mothers (%)
Breastfed child							
Yes	3200	6.3	50.7	9.1	12.0	27.4 ± 6.0	12.7
No	3150	19.2	44.4	8.7	11.0	25.9 ± 4.6	34.0
P-value	0.137[a]	**0.002**[b]	0.412[b]	0.593[b]	0.147[a]	0.093[c]	**<0.001**[b]
Duration of total breastfeeding (months)							
0	3150	19.2	44.4	8.7	11.0	25.7 ± 4.8	30.8
<3	3100	10.0	55.7	11.4	12.0	27.7 ± 6.3	10.0
3–5	3200	5.1	49.3	11.6	13.0	26.3 ± 6.1	12.9
6–11	3200	5.6	51.7	6.4	12.0	27.4 ± 5.8	9.9
≥12	3220	5.1	46.7	10.3	12.0	26.7 ± 5.9	15.9
P-value	0.067[d]	**0.002**[e]	0.054[e]	0.543[e]	0.054[e]	0.443[f]	0.332[e]
Duration of exclusive breastfeeding (months)							
0	3150	7.7	52.4	10.5	12.0	26.7 ± 6.0	14.3
<1	3230	13.6	50.0	4.5	12.5	28.8 ± 5.7	4.5
1–3	3175	7.9	46.9	13.0	12.0	26.7 ± 6.1	12.9
4–6	3300	4.7	47.3	4.7	12.0	27.8 ± 5.5	12.4
P-value	**0.015**[d]	0.293[e]	0.102[e]	0.115[e]	0.876[d]	0.494[f]	0.503[e]

The significant *P*-values ($P < 0.05$) are given in bold type
a: Mann–Whitney test
b: Chi-square test
c: Student's *t*-test
d: Kruskal–Wallis test
e: Linear Trend test
f: ANOVA

Table 3 Prevalence of obesity and crude OR (95% CI) according to the children characteristics in Viçosa, MG, Brazil

Children characteristics	BMI/age >2 SD (%)	BMI/age ≤2 SD (%)	Crude OR (95% CI)	*P*-value[a]
Gender				
Female	7.0	93.0	1.0	**0.001**
Male	14.3	85.7	2.2 (1.4–3.6)	
Age group (years)				
6–8	7.2	92.8	1.0	**0.009**
9–10	13.3	86.7	1.9 (1.2–3.2)	
Birth weight (g)				
≥2500	10.8	89.2	1.0	0.673
<2500	7.8	92.2	0.7 (0.3–1.8)	
Gestational age				
Full term and post-term	10.3	89.7	1.0	0.364
Pre-term	14.5	85.5	1.5 (0.7–3.3)	
Order of birth				
Second child or more	8.2	91.8	1.0	0.066
First child	12.6	87.4	1.6 (0.9–2.6)	
Number of siblings				
≥1	9.2	90.8	1.0	**0.012**
Only child	16.4	83.6	1.9 (1.2–3.2)	
Type of school				
Public	10.5	89.5	1.0	0.901
Private	11.0	89.0	1.0 (0.7–1.7)	
Living with both parents?				
With both parents or only with the mother	10.3	89.7	1.0	0.134
Only with the father or with none	19.4	80.6	2.1 (0.8–5.3)	
Number of persons in the residence				
≥4	9.5	90.5	1.0	0.063
<4	14.9	85.1	1.7 (0.9–2.8)	
Activities during week days				
Bicycle, skates, hide-and-seek, plays ball or plays with dolls, doll house, car toys or drawings	11.3	88.7	1.0	0.195
Watches television or plays videogame	6.0	94.0	0.5 (0.2–1.3)	
Activities during weekends				
Bicycle, skates, hide-and-seek, plays ball or plays with dolls, doll house, car toys or drawings	11.4	88.6	1.0	0.484
Watches television or plays videogame	9.7	90.3	0.8 (0.5–1.3)	
Time watching television per day (h)				
≤2	6.0	94.0	1.0	**0.004**
≥3	12.9	87.1	2.3 (1.3–4.1)	
Attends physical education classes in school?				
Yes	10.3	89.7	1.0	**0.032**
No	33.3	66.7	4.3 (1.3–14.8)	
Practices physical activities outside school?				
Yes	12.6	87.4	1.0	0.257
No	9.9	90.1	0.7 (0.5–1.2)	
Weekly frequency of physical practice				
≥3	13.2	86.8	1.0	0.823
≤2	12.4	87.6	0.9 (0.4–2.3)	

The significant *P*-values ($P < 0.05$) are given in bold type
a: Fisher test

($P = 0.646$) or dose–response relationship with duration of total ($P = 0.338$) and exclusive ($P = 0.601$) breastfeeding, even after adjusting for confounding variables by regression analysis.

Discussion

The existence of a relationship between breastfeeding and obesity has been under debate for >20 years, but until now no conclusive evidences have been produced for a definitive answer to this question. This study did not reveal neither association between obesity in school-aged children and breastfeeding nor a dose–response relationship with a duration of total and exclusive breastfeeding, even after adjustment for confounding variables by regression analysis. The key variables that was responsible for changes in the magnitude of OR was mothers' obesity and practice of physical activities in school. This confirms that environmental factors influenced the association of breastfeeding and obesity. Similar results have been reported in previous studies, which did not detect associations between obesity and breastfeeding.[10–12,22–24] In contrast, a protective role of breastfeeding against childhood obesity has been observed in many studies.[8,12,23,25–32]

The literature on the association between breastfeeding and obesity is inconsistent. A meta-analysis of 17 studies showed that the results give strong support to a dose–response association between long duration of breastfeeding and lower risks for obesity, with a 4% decrease in this risk for each month of breastfeeding.[27] In a systematic review of 28 published studies, however, Owen *et al.*[30] observed that breastfeeding has a protective effect against obesity, although the intensity of the effect is not clear. This inverse association was particularly strong in studies with samples smaller than 500 individuals (OR: 0.43; 95% CI: 0.33–0.55), when compared to studies with 500 or more participants (OR: 0.88; 95% CI: 0.85–0.90). The authors concluded that additional studies are necessary for the analysis of biases represented by confounding factors and publications (studies with smaller samples, in which no associations are observed, are many times not published). In a systematic review of 36 published and non-published studies, Owen *et al.*[33] observed that mean BMI was lower among breastfed individuals. The difference,

however, was small and probably influenced by publication bias and confounding factors. The results suggested that it is not probable that breastfeeding reduces the mean BMI since in 11 of the studies, after adjusting the results for socio-economic level, smoking during pregnancy and maternal BMI, the protective effect of breastfeeding on BMI was eliminated (OR: −0.10; 95% CI: −0.14 to −0.06 before adjustment; OR: −0.01; 95% CI: −0.05 to 0.03 after adjustment).

Scholtens *et al.*[12] observed that 1-year-old children who had been breastfed for over 4 months presented in average a reduction of $0.20\,kg\,m^{-2}$ in BMI as compared with non-breastfed children. In children between 1 and 7 years old, the association was weakened by adjustment of confounding variables, and no statistically significant differences were seen. The authors suggested that the association between breastfeeding and BMI is weakened after the first year of life by dietary and life habits, which can partially neutralize the moderate effect initially exerted by breastfeeding on BMI. With increasing age, the impact of the protective physiological mechanisms of breastfeeding observed during the first years of life tend to diminish, an effect more clearly seen in adults.[34]

Different definitions of exposure and outcome make the comparison among different studies difficult.[35] It is important to stress that the controversial results reported for studies involving breastfeeding and obesity are mainly due to ethical issues involved with the establishment of a controlled screening, in which the individuals are randomized to different groups. In this type of study, that would mean assigning the babies to groups being breastfed or formula-fed, which is clearly unethical. Any conclusion must, therefore, be based in observational studies in which the use of different methodologies may introduce variations which may explain the differences observed. In these studies, furthermore, different definitions of breastfeeding (exclusive or non-exclusive) are used, and sometimes there is not a clear definition on the use of the standard World Health Organization definition. The large sample size necessary for adjustment of confounding factors may also contribute with the controversial findings. Additional efforts, aiming at reporting complete and accurate definitions and the measurement of all variables of interest, are important for the understanding of the complex factors involved with childhood obesity.[36,37]

Some limitations of the present study would be considered. Relatively little is known about the quality of retrospectively collected infant-feeding data that are based on maternal recall of events.[38] Some studies have shown that there is reasonable accuracy of the mothers' information on the duration of breastfeeding their children.[39,40] However, it is possible that such information was not precise enough in this study and may partially explain the lack of association between breastfeeding and obesity. Furthermore, the long time elapsed since exposure (breastfeeding) until the outcome (obesity) may have resulted in the attenuation of a protective effect of breastfeeding, already classified as 'modest' in the literature,[5,12] by potential risk factors for obesity currently present in the child's life style, such as sedentarism and maternal obesity. These risk factors may exert greater influence on obesity than breastfeeding during the first year of life, 'masking' any possible protective effect of breastfeeding after adjustment for confounding variables. This situation was observed in the present study, since the associations of obesity with the occurrence and duration of breastfeeding showed smaller values after adjustment for confounding variables. Another limitation was that the association between breastfeeding and obesity may depend on additional dietary patterns. In the analysis, we did not adjust for other components of infant diet. More detailed information about infant nutrition would provide additional information. Other limitation is that the present study is part of a project whose main objective was to assess the prevalence of

Table 4 Prevalence of obesity and crude OR (95% CI) according to the maternal characteristics in Viçosa, MG, Brazil

Maternal characteristics	BMI/age >2 SD (%)	BMI/age ≤2 SD (%)	Crude OR (95% CI)	*P*-value[a]
Education (years)				
>13	12.1	87.9	1.0	**0.012**
≤13	5.6	94.4	2.3 (1.2–4.6)	
Weight gain during pregnancy (kg)				
≤16	9.6	90.4	1.0	**0.034**
>16	16.6	83.4	1.9 (1.1–3.2)	
Smoked during pregnancy				
No	9.7	90.3	1.0	**0.045**
Yes	18.1	81.9	2.0 (1.1–3.9)	
Smokes currently				
No	9.8	90.2	1.0	**0.043**
Yes	16.7	83.3	1.8 (1.0–3.2)	
Current nutritional status				
Underweight, eutrophic and overweight	7.4	92.6	1.0	**<0.001**
Obese	32.0	68.0	5.9 (3.6–9.8)	
Current age (years)				
23–50	10.5	89.5	1.0	0.657
>50	14.3	85.7	1.4 (0.3–6.5)	

The significant *P*-values ($P < 0.05$) are given in bold type
a: Fisher test

Table 5 Main effects revealed by univariate analysis and multiple logistic regression models for obese (BMI/age > 2 SD, $n = 82$) and non-obese (BMI/age ≤ 2 SD, $n = 682$) according to history and duration of breastfeeding of children in Viçosa, MG, Brazil

History and duration of breastfeeding	BMI/age >2 SD (%)	BMI/age ≤2 SD (%)	Crude OR (95% CI)	Adjusted OR[a] (95% CI)	*P*-value[a]
Breastfed child					
Yes	89.0	93.7	Reference	Reference	0.856
No	11.0	6.3	1.8 (0.8–4.1)	0.91 (0.36–2.34)	
Duration of total breastfeeding (months)					
≥12	25.3	25.6	Reference	Reference	0.564
6–11	31.4	20.7	1.5 (0.7–3.1)	0.7 (0.4–1.5)	
3–5	18.0	18.3	1.0 (0.5–2.1)	0.9 (0.4–2.0)	
<3	18.9	24.4	0.78 (0.4–1.6)	1.4 (0.7–2.8)	
0	6.3	11.0	0.58 (0.2–1.5)	1.2 (0.5–2.9)	
Duration of exclusive breastfeeding (months)					0.713
4–6	22.8	17.1	Reference	Reference	
1–3	15.6	12.2	0.9 (0.4–2.4)	0.8 (0.3–2.1)	
<1	2.8	3.7	0.6 (0.1–2.8)	1.7 (0.4–7.7)	
0	58.8	67.1	0.7 (0.3–1.2)	1.2 (0.6–2.3)	

a: Adjusted for characteristics of the mother (nutritional state and smoked during pregnancy) and of the child (gender, practices of physical education classes in school, time watching television per day and number of siblings) for history of breastfeeding. Adjusted for characteristics of the mother (nutritional state, smoked during pregnancy and smokes currently) and of the child (gender, practices of physical education classes in school, time watching television per day and number of siblings) for duration of total and exclusive breastfeeding

obesity in children. Thus, the sample size calculation was based on other hypothesis which can affect the statistical power of the present study.

Some strengths of our study should also be considered. First, the control of potential confounding variables constituted an important characteristic of this study, since the most important of these variables, according to the literature, were included (gender, age, birth weight, gestational age, birth order, number of siblings, educational level and nutritional state of the mother, weight gain during pregnancy and smoking during pregnancy and presently). Second, is the availability of detailed information about the duration and exclusivity of breastfeeding. This enable us to investigate the influence of duration of breastfeeding and whether results differ among children who were exclusivity or partially breastfed. Third, all anthropometric evaluation, hypertension measurements and application of questionnaires were collected by the same researcher, which contributes for reduction of biases in the evaluations. Finally, our study is one for the few outside high-income countries to evaluate this association. The likelihood of residual confounding by SES is lower in our study than in most of the literature, because breastfeeding is not associated with high SES in Brazil.[11]

Our results do not support the hypothesis that breastfeeding promotion would reduce obesity in our population. Nevertheless, it is still of utmost importance to promote and stimulate breastfeeding, due to the many other benefits for the baby and the mother. Future studies are thus necessary for a better understanding of a protective effect of breastfeeding against obesity in children of developing countries like Brazil.

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Key points

- The prevalence of obesity was 10.7%. Most of the children did not receive exclusive breastfeeding (59.0%) and 6.8% were not breastfed.
- This study did not show a protective effect of breastfeeding against obesity in school-aged children or a dose–response relationship, even after adjustment for confounding variables. Our results do not support the hypothesis that breastfeeding promotion would reduce obesity in Brazilian children population.
- Non-breastfeeding is not a risk factor to which one is either exposed on unexposed. The types of foods received by children who are not breastfed may vary between high- and low-income countries. This highlights the need for additional studies on more detailed dietary patterns in developing countries, like Brazil.
- Implications for public health policy and practice are that the protective effect of breastfeeding against obesity is small as compared to other influencing factors such as sedentary habits and obesity of the mothers. Nevertheless, it is still of utmost importance to promote and stimulate breastfeeding, due to the many other benefits for the baby and the mother.

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Tracking of blood pressure from childhood to adolescence in a Greek cohort

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Background: Studies have reported tracking of blood pressure (BP) from childhood to adulthood but with inconsistent results mainly due to methodological and ethnic differences. We aimed to examine BP tracking during a 7-year period in a Greek cohort. **Methods**: This is a longitudinal school-based study conducted during 1990–96 in Athens, Greece. Children underwent BP and anthropometric measurements on two to three visits annually (averaged to annual values) for 7 years. **Results:** A total of 166 children with complete yearly follow-up data for the examined period were included (mean baseline age 9 ± 1.7 years, range: 5–12 years, 89 boys). At baseline, the prevalence of pre- and hypertension was 22.9 and 24.1% respectively and at the end of the follow-up 24.1% (P = NS vs. baseline) and 13.3% ($P = 0.02$ vs. baseline) respectively. Systolic/diastolic BP tracking correlation coefficients between 1990 and 1996 were 0.38 ($P < 0.001$)/0.20 ($P = 0.06$) for boys and 0.30 ($P = 0.007$)/0.22 ($P = 0.06$) for girls. Among children with baseline BP $\geq$90th centile (systolic and/or diastolic), 44% remained in the same BP range after 7 years. In stepwise multiple regression analysis, baseline systolic BP, male gender, baseline body mass index (BMI) and change in BMI from baseline to the end of the follow-up (ΔBMI) were significant predictors of systolic BP levels at the end of the follow-up. Baseline diastolic BP, baseline BMI and ΔBMI were significant predictors of diastolic BP at the end of the follow-up. **Conclusions:** These data suggest that the risk of developing high BP during adolescence can be predicted by BP and BMI at childhood.

Introduction

In the last two decades there is increasing interest in the field of hypertension in children and adolescents.[1,2] It is now recognized that hypertension in children is not as uncommon as previously believed and in most cases represents early onset of essential rather than secondary hypertension.[1,2] School-based screening studies have reported a prevalence of high blood pressure (BP) in children and adolescents ranging from 2% to 24%.[3–8] More importantly, recent data suggest increasing trends of average BP in children and adolescents which appear to be mainly attributed to the increasing prevalence of obesity.[7,9]

Although there are many cross-sectional studies on the relationship of BP with age and body mass index (BMI), only few have investigated these associations longitudinally during childhood and adolescence. Moreover, the results are rather inconsistent partly due to differences in protocols and methodology used, as well as differences in the ethnic background.[10–13] Despite the inconsistency in these results, it seems that increased BP in childhood is predictive of high BP and hypertension in early adulthood.[10–13] This fact may have important implications in terms of cardiovascular health since it allows the early identification of individuals at high-risk for developing sustained hypertension.

In Greece, a country with a predominant place regarding childhood obesity and hypertension, there are no longitudinal data on BP levels in children and adolescents. The aim of this study was to examine BP tracking during a 7-year period in a Greek cohort.

Methods

Subjects and measurements

This is a longitudinal study conducted from 1990 to 1996 in Athens, Greece. An open invitation was sent to six randomly selected public schools of Athens districts inhabited mostly by children of middle-to-upper class. Inclusion criteria were Greek nationality, age from 5 to 12 years and willingness to participate in the study. Students with persistently high levels of systolic/diastolic BP suspected for secondary hypertension were excluded from the study and referred for investigation. All the 1021 children that accepted to participate in the study were enrolled. The study protocol was approved by the Ministry of Education and written consent was obtained by the participants' guardians.

Anthropometric and BP measurements were carried out every 4–6 months for 7 years. All measurements were performed in a quiet and tempered room at school by a single physician (K.P.). At each examination standing height was measured by portable Harpenden stadiometer to the nearest mm, and body weight with a Soehnle electronic weighing