

## Determinants of overweight in children under 4 years of age

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### Abstract

**Objectives:** To describe the prevalence of and factors associated with overweight in children under 4 years of age in Feira de Santana, state of Bahia, Brazil.

**Methods:** Cross-sectional study nested within a birth cohort of 793 children born in Feira de Santana, Brazil. Independent variables were related to infant characteristics, social and demographic factors, maternal reproductive aspects, and diet of the child at age 4 months. The dependent variable was nutritional status, as assessed by weight-for-height ratio compared to Multicentre Growth Reference Study standards and obtained with the use of the software ANTHRO. Z scores of -2 and +2 above or below the median for the reference population were established as normality cutoff points. Child height and weight were measured with an anthropometer and digital scales, respectively; all measurements were taken in triplicate. The study was approved by the Research Ethics Committee of the Universidade Estadual de Feira de Santana (CEP/UEFS), under registration number 096/2006.

**Results:** The prevalence of overweight was 12.5%. Adequate birth weight (RR 2.75; 95%CI 1.50-5.05), primiparity (RR 1.61; 95%CI 1.09-2.35), and maternal employment outside the home at age 4 months (RR 1.73; 95%CI 1.16-2.59) were associated with overweight.

**Conclusions:** In this study, adequate birth weight, primiparity and maternal employment outside the home were associated with overweight in children. The rate of overweight found, which surpassed that reported by other studies conducted across the country (including Bahia), point to a risk of child obesity in Feira de Santana.

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### Introduction

Assessment of the nutritional status of Brazilian children shows that changes are underway, although the epidemiological context shows a clear coexistence of the still-recurring issue of malnutrition with overweight and obesity, even as the latter become more widespread. This panorama has been reported in key studies, such as the National Family Expenditure Survey (Estudo Nacional

de Despesa Familiar, ENDEF), the National Health and Nutrition Examination Survey (NHANES), and the National Demographic and Health Survey (Pesquisa Nacional sobre Demografia e Saúde, PNDS).<sup>1,2</sup>

Therefore, in recent years, while malnutrition rates have decreased in certain subgroups and regions of Brazil, increasing rates of overweight and obesity have stood out as

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major public health issues.<sup>3</sup> This coexistence of contrasting malnutrition and obesity trends constitutes one of the most striking characteristics of the nutritional transition process underway in the country.

In response to certain provisions established by the World Health Organization (WHO) in 1978, child growth monitoring was instituted as a focal point of primary health care for children in the 1970s, at which point detection of growth deficits was considered the most adequate means of diagnosing health and nutrition risks in early life.<sup>2</sup>

Accelerated weight gain in childhood has been used as a predictor of later obesity risk. There is no clear definition, however, of which factors influence dietary intake and weight gain in these children. It has been established that childhood energy intake is a determining factor of weight gain, and may influence the risk of developing obesity in adolescence and adulthood.<sup>4</sup>

There is a relative consensus on the multifactor etiology of overweight and obesity, with general acceptance that their development may be effected by a single genetic, environmental, behavior, social, or cultural factor or by the sum of many such factors.<sup>5,6</sup>

Notably, geographic differences entail different pathogeneses of overweight and obesity. Indeed, findings reported in the literature<sup>7</sup> point to a higher prevalence of overweight and obesity in higher-income regions, which would explain the difference in the epidemiological scenarios found in the Northeast and Southeast Regions of Brazil.

However, a new trend has been recorded in recent years: increasing obesity in low-income regions.<sup>1</sup> Although the highest rates of overweight among women aged 15 to 49 and children under the age of 5 are still found in the South and Southeast Regions of Brazil, the results of the latest PNDS (2006) show a decrease in inter-regional disparity.<sup>8</sup>

The present study sought to describe the prevalence of and factors associated with overweight in children under 4 years of age in the municipality of Feira de Santana, Brazil.

## Methods

This was an epidemiological, cross-sectional study, nested within a population-based birth cohort of children from Feira de Santana, Bahia, seeking to assess the prevalence of and factors associated with overweight in children under 4 years of age.

The cohort comprised a sample of liveborn infants delivered in all hospitals in Feira de Santana over the course of two consecutive months, between July 2004 and March 2005, and who resided in the municipality.

The study sample was calculated with finite population correction according to the following parameters: reference

population size, estimated prevalence of study event, population size, level of the confidence interval, and desired precision around the estimated event prevalence. We assumed 6.0% prevalence of overweight among children under the age of 5 in the Northeast Region,<sup>8</sup> 95% confidence interval (95%CI), and 1.25% precision around the estimated prevalence, for a population size of 977. Sample size was thus calculated as 573 children. To this number, we added 20% to account for presumptive loss of sample size, for a total of 688 subjects. However, we ultimately obtained and analyzed data on 793 children.

Independent (predictor) variables were related to infant characteristics (sex and birth weight), maternal social, demographic, and reproductive factors (parity, level of education, age at time of delivery, prenatal care, and maternal employment at age 4 months) and the child's diet at age 4 months (exclusive breastfeeding, predominant breastfeeding, mixed feeding, or weaned). All independent variables were obtained from the databases of the respective original studies, and constituted the secondary data of the present study.

The dependent variable was nutritional status, as assessed by weight-for-height ratio compared to the new WHO growth curves generated from the 2006 Multicentre Growth Reference Study.

Height and weight were measured at each subject's home with a portable anthropometer (capable of measuring height up to 2.16 m and precise to 0.1 cm) and a digital scale with 150 kg capacity and 100 g resolution respectively. All measurements were taken in triplicate by the researcher himself and by a group of four students from the undergraduate Physical Education program of the Universidade Estadual de Feira de Santana (UEFS) at Feira de Santana. These measurements constitute the primary data of the present study.

Weight-for-height was calculated with the ANTHRO software package,<sup>9</sup> defining z scores of -2 and +2 (above or below the median for the reference population) as cutoff points. It bears noting that the new reference growth curves were constructed on the basis of a study conducted from 1997 to 2003 – in which data were collected from approximately 8,500 children in Brazil, Ghana, India, Norway, and Oman – and constitute the current height and body mass reference, establishing breastfed children as the basis for growth standards.

The present study was conducted in accordance with National Health Council Resolution no. 196/96 and was approved by the UEFS Research Ethics Committee (REC) with registration number 096/2006. Mothers whose children took part in the study were given a plain-language overview of the study's rationale and objectives, and expressed their acceptance by signing a Free and Informed Consent form. Throughout the study, the parents and/or guardians

of children found to have nutritional status changes were notified accordingly and informed of the necessary referrals.

The new database was entered into the Statistical Package for Social Sciences (SPSS) 10.0 package using a two-pass verification method (double data entry) and validated with the Validate module of the Epidata software package. All calculations at the bivariate analysis stage of the study were performed within the SPSS environment; prevalence ratios (PR) were computed with a 95% confidence interval by means of the chi-square statistic.

## Results

Table 1 presents the characteristics of the 793 children under 4 years of age included in the sample. Weight and height ranged from 8.9 to 24.8 kg [mean, 14.3 kg; standard deviation (SD), 2.29 kg] and 73.0 to 112.2 cm (mean, 91.9 cm; SD, 5.1 cm) respectively. At the time of data collection, age of the subjects ranged from 22.7 to 45.8 months (mean, 31.7; SD, 4.1).

As shown in Table 2, which contains all results of bivariate analysis, the overall prevalence of overweight was 12.5% – 11.2% among girls and 13.7% among boys; the sex difference did not reach statistical significance ( $p = 0.276$ ).

In our sample, 14.9% of children with birth weight adequate birth weight (ABW) were found to be overweight, vs. 5.4% of those born small for gestational age (low birth weight). Overweight was thus nearly three times more prevalent among children with adequate birth weight ( $p = 0.000$ ).

The prevalence of overweight was also higher among children whose mothers had higher levels of education.

Parity and maternal employment at child age 4 months were also positively associated with overweight. In children whose mothers were primiparous, the rate of overweight was 1.6-fold higher ( $p = 0.014$ ), and 1.7 times higher among children whose mothers worked outside the home as early as their fourth month of life ( $p = 0.008$ ).

Maternal age at time of delivery, prenatal care, and practice and pattern of breastfeeding at age 4 months were not associated with overweight.

## Discussion

In the present study, the prevalence of overweight in children as assessed by weight-for-height ratio (12.5%) was superior to that found among children under the age of 7 in public daycare centers run by the city of São Paulo, SP (5.0%)<sup>10</sup> and to that found among children from three municipal daycare centers in Brasília, DF (6.1%).<sup>11</sup>

**Table 1 -** Sample characteristics

Characteristics	n (%)
Nutritional status (weight/height)	
Weight deficit	4 (0.5)
Well-nourished	690 (87.0)
Overweight	99 (12.5)
Sex	
Male	408 (51.5)
Female	385 (48.5)
Birth weight	
ABW	590 (74.4)
LBW	203 (25.6)
Maternal age at time of delivery	
< 20 years	136 (17.2)
≥ 20 years	657 (82.8)
Maternal education	
Illiterate/primary education	264 (33.3)
Secondary education	454 (57.3)
Higher education	75 (9.5)
Parity	
Primiparous	405 (51.1)
Multiparous	388 (48.9)
Prenatal care	
Adequate (≥ 6 visits)	609 (76.8)
Inadequate (< 6 visits)	184 (23.2)
Mother working at age 4 months	
Yes	141 (17.8)
No	652 (82.2)
Breastfed at age 4 months	
Yes	666 (84.0)
No	127 (16.0)
Pattern of breastfeeding at 4 months	
Exclusive	186 (23.5)
Predominant	124 (15.6)
Mixed	356 (44.9)
Weaned	127 (16.0)

ABW = adequate birth weight; LBW = low birth weight.

Furthermore, the rate of overweight found was superior to those reported in the latest PNDS (2006), both for the country as a whole (6.6%) and for the North (5.2%), Northeast (6.0%), Southeast (6.7%), South (8.8%), and Midwest (7.0%) Regions.<sup>8</sup>

As the incidence of overweight and obesity increases in children under the age of 5 throughout Brazil, in a phenomenon that has paralleled a systematic reduction in malnutrition rates,<sup>8</sup> we highlight the case of Feira de Santana,<sup>12</sup> a municipality in which high prevalence rates of overweight (9.3%) and obesity (4.4%) have been reported in children attending private and public schools; notably, overweight and obesity rates were higher among children attending a private school (13.4 and 7.0% respectively) than among those attending public school (6.5 and 2.7%). Thus far, however, no population-based data on the frequency

**Table 2** - Overweight in children under 4 years of age, Feira de Santana (BA), according to child characteristics and maternal sociodemographic and reproductive factors

Characteristics	Total children	Overweight children	%	PR	95%CI	p
Sex						
Male	408	56	13.7			
Female	385	43	11.2	1.23	0.85-1.78	0.276
Birth weight						
ABW	590	88	14.9			
LBW	203	11	5.4	2.75	1.50-5.05	0.000
Maternal age at time of delivery						
< 20 years	136	15	11.0			
≥ 20 years	657	84	12.8	1.16	0.69-1.94	0.573
Maternal education						
Illiterate/primary education	264	25	9.5			
Secondary education	454	62	13.7	1.44	0.93-2.24	0.097
Higher education	75	12	16.0	1.69	0.89-3.20	0.109
Maternal parity						
Primiparous	505	62	15.3			
Multiparous	388	37	9.5	1.61	1.09-2.35	0.014
Prenatal care						
Adequate (≥ 6 visits)	609	78	12.8			
Inadequate (< 6 visits)	184	21	11.4	1.12	0.71-1.76	0.616
Mother working outside the home at age 4 months						
Yes	141	27	19.1			
No	652	72	11.0	1.73	1.16-2.59	0.008
Breastfed at 4 months						
Yes	666	79	11.9			
No	127	20	15.7	1.33	0.84-2.09	0.225
Pattern of breastfeeding at 4 months						
Exclusive	186	17	9.1			
Other/weaned	607	82	13.5	1.48	0.90-2.43	0.115

95%CI = 95% confidence interval; ABW = adequate birth weight; LBW = low birth weight; PR = prevalence ratio.

and distribution of overweight among preschoolers in the municipality, to which we could better compare the results of the present study, were available.

We found no sex difference in the prevalence of overweight, as previously reported among preschoolers in the city of São Paulo.<sup>13</sup>

To a certain extent, this finding may be explained by hormonal factors da faixa etária das crianças, as previously reported in another study conducted in Feira de Santana.<sup>14</sup> These results differ from those reported in a study conducted in Florianópolis (SC), which found a 6.8% prevalence of overweight in a group of children under 6 years of age, and most predominantly among girls, those under the age of 2, and those not living in low-income areas.<sup>15</sup>

In the present study, adequate birth weight was positively associated with child overweight, as previously reported in a systematic review.<sup>16</sup> One could argue that this result broadens the evidence base supporting the hypothesis of a positive association between higher birth weight and likelihood of childhood obesity, in which case low birth

weight would constitute a protective factor. However, taking into account that ABW is an adequate health parameter, external factors (such as diet) may have an influence on the expression of overweight during childhood in the children included in our sample, and an association between low birth weight and growth deficit is possible.

Furthermore, the association between low birth weight and overweight in childhood is not a linear one. Therefore, both low birth weight and high birth weight infants may develop childhood obesity, although the likelihood of obesity is greater in those born adequate or large for gestational age.<sup>16</sup>

As in studies conducted elsewhere,<sup>10,12,17</sup> children in Feira de Santana showed a tendency toward higher overweight prevalence in association with higher levels of maternal education, although this association did not reach statistical significance. We must stress that women who are more educated may also have higher purchasing power, which increases their odds of purchasing industrialized, high-calorie foods. Social and economic conditions may thus

have a significant influence on the occurrence of childhood overweight and obesity.<sup>17</sup> The increasing prevalence of overweight in children has been reported in association with age, maternal education beyond primary education, parental professional skills, and per capita family income equal to or higher than two minimum wages.<sup>17</sup>

Likewise, we found a higher prevalence of overweight among children born to primiparous mothers. Having two or more siblings has been reported in the literature as a protective factor against overweight<sup>3</sup> and as a risk factor for nutritional deficit.<sup>18</sup>

Unlike previous reports,<sup>17</sup> the present study found maternal employment at age 4 months to be a risk factor for overweight. We must consider the hypothesis set forth in previous studies that children whose mothers start working as early as the fourth month postpartum are weaned sooner and exposed earlier to foods consumed by the rest of the family, which makes them more susceptible to overweight.<sup>19</sup> Furthermore, mothers who work outside the home tend to give their children treats and snacks, which are usually high in calories and of little nutritional value.

In the present study, we found no positive association between breastfeeding, feeding regime at age 4 months and overweight. The results obtained are consistent with current evidence that suggests no strong correlation between breastfeeding and childhood overweight,<sup>20</sup> although some published studies have stressed the protective effect of breast milk against development of obesity.<sup>21-25</sup>

Notably, breastfeeding has been extensively reported as having real influence on child growth and nutritional status up to the first year of life.<sup>21-25</sup> On the other hand, a study conducted among preschoolers aged 2 to 6 years in the city of São Paulo found a protective effect against overweight and obesity with 6 months of exclusive breastfeeding and 24 months or more of any breastfeeding.<sup>13</sup> This should prompt investigation into current food intake of the children in our sample and their food intake between the fourth month of life and the time of data collection (around age 30 months), as it may have influenced weight gain.

Finally, it bears stressing that, until recently, most studies on child growth and/or nutritional status employed growth curves that do not take breastfeeding into account as the optimal form of nutrition in terms of child growth and development.

In the present study, however, we employed the new WHO-recommended growth curves,<sup>9</sup> which were recently adopted by the Brazilian Ministry of Health. Compared to previous reference curves, such as the 1977 National Centers of Health Statistics (NCHS) standards and the 2000 growth charts of the Centers for Disease Control and Prevention (CDC), the new growth standards for breastfed children will lead to an increase in overweight rates as measured

by weight-for-height.<sup>26</sup> Hence, the higher prevalence of overweight found among children in Feira de Santana, as compared to those reported in various studies conducted elsewhere in the country, may have been due to this effect.

We conclude that, in the present study, birth weight adequate for gestational age, primiparity, and maternal employment at child age 4 months were associated with overweight. The rate of overweight detected, which surpasses those reported in previous studies conducted throughout the country, highlights the possible risk of obesity and its consequences among children in the municipality of Feira de Santana. Although a more pronounced trend toward overweight was found among children whose mothers had higher levels of education, there is a need to implement health education policies that reach all social groups – most importantly, primiparous mothers and those who work outside the home – to warn of the risks of overweight and obesity, as well as prevention measures that may be employed to curtail its rise among young children in the municipality.

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