



Growth of exclusively breastfed infants in the first 6 months of life

Rosa F. S. V. Marques¹, Fábio A. Lopez², Josefina A. P. Braga³

Abstract

Objective: To evaluate the growth of exclusively breastfed infants from birth to 6 months of life.

Methods: This was a longitudinal study of 184 children who received primary care at a public institution (Exclusive Breastfeeding Stimulation Program, PROAME) in Belém, state of Pará, Brazil, between February 2000 and January 2001. A total of 102 children completed the study. All were born at full term with a birth weight greater than or equal to 2,500 g. No events were recorded during the neonatal period and the infants were exclusively breastfed, on demand, since their birth. The infants were followed up monthly, and the weight and length measured at birth and at the end of the first, fourth and sixth months of life were compared to the 50th percentile line of the NCHS growth charts and to other previous studies of Brazilian children who were exclusively breastfed.

Results: Growth was adequate for all the children, who doubled their weight before the fourth month of life. Despite a slow-down in weight and height gain after the fourth month, the weight averages at 6 months were greater than the standards used for comparison.

Conclusions: The average weight of these exclusively breastfed children was above the 50th percentile of the NCHS curve at 6 months, thus confirming the nutritional advantages of breast milk, especially when the mothers receive guidance regarding the appropriate techniques for breastfeeding.

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Introduction

Healthy growth is achieved through correct diet. During the initial stage of life, human milk is, undoubtedly, the food that most unites the ideal nutritional characteristics, with the correct balance of nutrients. Furthermore, it aids in the development of innumerable immunological and psychological advantages which are important to the reduction of infant morbidity and mortality. Breastfeeding is important to the child, the mother, their family and society in general.¹⁻⁸

During the first year of life, a period when growth is rapid, weight and length are the most important variables for assessing the nutritional status of a child and, thereby, monitor their growth.⁴

Standards for growth during the second semester need further work. There is a need for longitudinal studies of the growth and feeding habits of healthy children, with reference values that are internationally recognized in order that comparisons be valid.^{9,10}

Available research into infant nutrition and growth conclude that there is no available growth curve for infants fed exclusively at their mothers' breasts, in view of their partially discordant results. There is consensus that exclusive maternal breastfeeding provides optimal growth from zero to three months. From three to 6 months, the weight-gain curve of such children, in developing countries, drops slightly in comparison with available reference curves. The interpretation of this phenomenon is not

1. Master's Degree, School of Medicine, Universidade Federal de São Paulo (UNIFESP), São Paulo, SP, Brazil.
2. Associate professor, Department of Pediatrics, School of Medicine, Universidade Federal de São Paulo (UNIFESP). Professor, Department of Pediatrics, Universidade Santo Amaro (UNISA), São Paulo, SP, Brazil.
3. Associate professor, Department of Pediatrics, School of Medicine, Universidade Federal de São Paulo (UNIFESP), São Paulo, SP, Brazil.

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unanimous. Some authors see this as a growth deficiency, for others the growth is normal and the curves are out of line.^{1,4,5,9}

The fact that a Program for the Protection, Promotion and Support of Breastfeeding (PPPSB) exists, which monitors infants until they are 6 months old, stimulating exclusive maternal breastfeeding, has made it possible to perform a cohort study describing the gain in weight and stature of children who have human breast milk as their only source of nutrients during this phase of their lives.

Methods

The initial sample consisted of 184 children selected from the 409 registered with the PPPSB at the *Unidade de Referência Especializada Materno Infantil e Adolescente*, Belém - Pará, during the period between February 2000 and January 2001. The following were established as inclusion criteria: full term newborns, with birth weight greater than or equal to 2,500 g, gestational age between 38 and 42 weeks, no neonatal intercurrent conditions and being exclusively breastfed since birth. The original sample size was calculated using the BioEstat¹¹ software package.

One hundred and two infants completed the study having maintained exclusive maternal breastfeeding, without establishing the time, duration, or number of times of suckling, until 6 months old. Fifty-five point four three percent of the original sample were excluded during the study because they had been given some other type of foodstuff or because they did not attend consultations set for anthropometry sessions.

The World Health Organization (WHO) definition of exclusive breastfeeding is: *the child receives only breast milk (including expressed milk or milk from a wet nurse) and no other liquid or solid with the exception of drops or syrups (of vitamins, minerals, medicines).*¹²

Initially the children were monitored fortnightly, and then, from 2 to 6 months, monthly. At every appointment the mothers took part in a lecture on the importance and advantages of exclusive breastfeeding, received guidance on correct breastfeeding technique and had any breastfeeding doubts cleared up. After the lecture, the children received individual care, were measured and weighed and physically examined. Breasts were also observed. Mothers were motivated to feed their children exclusively at the breast for their first 6 months, had appointments set and were given *carte blanche* to return whenever they felt the need. At 6 months they were discharged from the program and given instructions on initiating weaning.

The research protocol was analyzed and approved by the Committee for Ethics in Research at the Universidade Federal de São Paulo/Hospital São Paulo. CEP number 264/01.

Weight and length were recorded at all consultations by the same, trained, nursing auxiliary in all cases.

Measurements taken at birth at the respective maternity units and those taken at the follow-up appointments closest to 30 days, four months and 6 months postpartum were used for the study in order that comparisons be made with the 50th percentile of the NCHS scale and with measurements found by Murahovschi and Chaves in similar studies of Brazilian infants on exclusive maternal breastfeeding.^{1,13,14}

Children were weighed, unclothed, on a baby-weigh scale by Filizola with a maximum capacity of 16 kg, certified by INMETRO (National Institute of Metrology, Standardization and Industrial Quality) at the start of the study. Length was measured using an anthropometric ruler, standardized by the Brazilian Society of Pediatrics, with the child recumbent in decubitus dorsal, the head secured by an adjutant, with the knees straight and feet forming an angle of 90 °C, supported by the base of the ruler. Readings were taken in grams and centimeters, respectively.

Statistical analysis was performed using the Statistical Package for the Social Sciences - SPSS for Windows, version 8.0 (1997) and Microsoft Excel 97. Descriptive statistical analyses were performed by calculating summary values, taking the nature of the variables into account. Parametric and non-parametric tests were used for the inferential analysis, taking the nature of value distribution or the variation in measurements into account. For all tests 0.05 or 5% ($\alpha < 0.05\%$) was set as the cut off for rejection of null hypotheses and significant values were marked with an asterisk(*).

Results

Fifty-seven (55.88%) of the 102 children participating were male and 44.12% (45) were female.

Comparing average weights by sex, we found that the male babies were lighter at birth, equaled the females at 1 month, and were heavier from the fourth month onwards (Table 1).

Male babies, on average, gained 36.24 g/day during the first month, from the first to the fourth, 31.72 g/day and from the fourth to the sixth month 15.51 g/day. Female children had an average weight gain of 35.03 g/day during the first month, 27.57 g/day from the second to the fourth and 15.55 g/day from the fourth to sixth months. These results revealed that, irrespective of sex, the children exhibited a reduction in daily weight gain rates of 50% after the fourth month. If, however, we take the first sixth months as a whole (in this study an average of 184 days) we observe that children on exclusive maternal breastfeeding gained an average of 26.12 g/day and all children had doubled their birth weight by four months, reaching 6 months well-nourished.

The female babies were also born longer than the males, with an average length of 49.2 cm compared with 48.7 cm, although from the fourth month onwards this was reversed (Table 1).

Table 1 - Measures of weight (g) and length (cm) of children at different ages according to sex (PROAME, Belém, PA, 2000/2001)

	n		Mean		Minimum		Maximum		SD*	
	M †	F †	M	F	M	F	M	F	M	F
Birth weight	57	45	3,254	3,291	2,580	2,500	4,500	4,300	373	364
Weight at 1 month	57	45	4,305	4,308	2,940	3,130	5,630	5,800	567	500
Weight at 4 months	57	45	7,319	6,927	5,370	5,600	9,390	8,670	870	738
Weight at 6 months	57	45	8,250	7,860	6,200	6,200	10,430	10,580	921	874
Length at birth	47 ‡	40 ‡	48.7	49.2	45.0	45.0	54.0	52.0	1.93	1.69
Length at 1 month	57	45	53.7	53.5	49.0	50.5	57.0	58.0	1.90	1.76
Length at 4 months	57	45	63.2	62.4	57.5	57.5	67.5	66.00	1.86	2.11
Length at 6 months	57	45	66.6	65.5	61.5	61.0	72.0	69.5	1.93	2.27

* SD = standard deviation.

† M = male; F = female.

‡ Loss: 15 children were not measured at birth.

During the first 6 months of life the male children had grown 17.9 cm and the females 16.4. The male children, however, had already grown, on average, 14.5 cm by 4 months, which is 81% of their total average growth. For the girls these figures were 14.2 cm and 86.5%. The monthly average linear growth reduced by approximately 50% between the fourth and sixth months.

Discussion

At the end of the seventies, after a long period in decline, the return to favor of maternal breastfeeding began in a search for better infant nutrition and consequent reduction in infant mortality. Since then innumerable studies have been performed of human milk and its advantages, its composition and its effect on infant growth.^{6,8,15}

The number of studies on nutritional and growth standards is immense, but as search criteria are refined to define age group and type of feeding the number begins to drop, getting smaller still when restricted to exclusive maternal breastfeeding up to 6 months, since this is a very select, and ever rarer, population.¹⁶

The importance of maternal breastfeeding to children is indisputable and there is consensus that exclusive maternal breastfeeding, particularly during the first 6 months, is the most suitable and ideal method of feeding a child, supplying all their nutritional requirements to maintain growth within normal limits during these first months of life.^{3,12,17,18}

The growth analysis of our population was compared with the worldwide standard reference curves, from the National Center for Health Statistics (NCHS, 1977),¹³ with the standard growth curves developed by Murahovschi for children on exclusive maternal breastfeeding¹ and with a study by Chaves¹⁴ because of the similarity between the two studies.

Average birth weights were in agreement with those found by Nóbrega *et al.*,¹⁹ with an average weight for newborn Brazilians of 3,253 g for males and 3,139 g for females.

To avoid our assessments becoming erroneous, we need internationally accepted reference standards, based on children fed exclusively on human milk until 6 months, in accordance with WHO recommendations,²⁰ which implies exclusive maternal breastfeeding until 4 to 6 months. In the absence of such reference values, we use the NCHS¹³ curves despite the fact that they are considered inadequate because they only have weight and length measurements for birth and at 1, 3 and 6 months and also because they are based on children who were predominantly fed artificially during their first 6 months.^{4,21,22}

When we compared the averages for weight and length, respectively, with the NCHS¹³ reference values at birth, at 1 month and at 6 months we found that 41.16% of the children had weight greater than or equal to the 50th percentile at birth and that, at 6 months, 71.56% were above the 50th percentile (Tables 2 e 3).

When Murahovschi *et al.*,¹ constructed growth curves in Brazil for infants fed exclusively on breast milk, for two

Table 2 - Results of the comparison between the average weight (g) at different ages according to sex in this study and the NCHS reference values ($p < 0.05$)

Age	Sex	PROAME average	NCHS average	Descriptive level (p)	Conclusion
At birth	Male	3,254	3,400	0.006*	Study average weight < NCHS
1 month		4,305	4,210	0.207	Study average weight = NCHS
6 months		8,250	7,820	0.001*	Study average weight > NCHS
At birth	Female	3,291	3,250	0.448	Study average weight = NCHS
1 month		4,308	3,970	< 0.001*	Study average weight > NCHS
6 months		7,860	7,200	< 0.001*	Study average weight > NCHS

* Student's *t* test for an average.**Table 3** - Results of the comparison between the average length (cm) at different ages according to sex in this study and the NCHS reference values ($p < 0.05$)

Age	Sex	PROAME average	NCHS average	Descriptive level (p)	Conclusion
At birth	Male	48.7	49.9	< 0.001*	Study average length < NCHS
1 month		53.7	54.8	< 0.001*	Study average length < NCHS
6 months		66.6	67.6	< 0.001*	Study average length < NCHS
At birth	Female	49.2	49.3	0.926	Study average length = NCHS
1 month		53.5	53.8	0.261	Study average length = NCHS
6 months		65.6	65.7	0.922	Study average length = NCHS

* Student's *t* test for an average.

very different social classes, they found figures that were superior to those from the NCHS¹³ and concluded that children on natural feeding have optimum growth, irrespective of social class.

When we compared our results with those of Murahovschi *et al.*,¹ because of the similarities in terms of study location and nutrition, we found similar or higher figures, with statistically significant differences in weight between the two groups of boys at 4 and 6 months and between the girls from the first month onwards (Table 4). Statistical differences in length measurements between the two samples only occurred at the sixth month when girls from the present study were longer ($p = 0.018$) than were those studied by Murahovschi *et al.* (Table 5).

When comparisons were made with Chaves' findings,¹⁴ despite our sample having 53.92% of birth weights between 3,000 g and 3,500 g, and Chaves 45.2%, we found statistically significant differences at two of the ages compared (Table 6).

Figures 1 and 2 describe the growth pattern of the PROAME children (Belém-PA), compared with the NCHS,¹³

Murahovschi¹ and Chaves¹⁴ reference curves for weight and height, for the three ages at which comparison is possible. We observe that they have the same tendency and are even superimposed one upon another in places. At 6 months, however, the weight curve for the present study is superior.

Published data is contradictory in terms of growth or speed of growth of breastfed children. In addition it is difficult to compare because of the diversity of methodologies. Some authors have demonstrated that breastfed children have growth deficiencies after three months,²³⁻²⁶ while others have demonstrated satisfactory growth among both exclusively and predominantly breastfed children; data that agrees with ours where birth weight was doubled before the fourth month.^{5,10,18,27}

Without doubt, the optimal weight gain observed in our study is the result of all the support and guidance that the mothers receive on the breastfeeding program, so that feeds are given "on demand" with the correct technique, the baby latches on correctly and develops sufficient suction to obtain all types of milk, particularly

Table 4 - Results of the comparison between the average weight (g) at different ages according to sex in this study and Murahovschi et al.¹ reference values, (p < 0.05)

Age	Sex	PROAME average	Murahovschi average	Descriptive level (p)	Conclusion
At birth	Male	3,254	3,280	0.613	Study average weight = Murahovschi et al.
1 month		4,305	4,300	0.937	Study average weight = Murahovschi et al.
4 months		7,319	6,900	0.001*	Study average weight > Murahovschi et al.
6 months		8,250	7,710	< 0.001*	Study average weight > Murahovschi et al.
At birth	Female	3,291	3,200	0.448	Study average weight = Murahovschi et al.
1 month		4,308	4,100	0.008*	Study average weight > Murahovschi et al.
4 months		6,927	6,550	0.001*	Study average weight > Murahovschi et al.
6 months		7,860	7,400	0.001*	Study average weight > Murahovschi et al.

* Student's *t* test for an average.**Table 5** - Results of the comparison between the average length (cm) at different ages according to sex in this study and Murahovschi et al.¹ reference values (p < 0.05)

Age	Sex	PROAME average	Murahovschi average	Descriptive level (p)	Conclusion
At birth	Male	48.7	49.0	0.389	Study average length = Murahovschi et al.
1 month		53.7	54.0	0.256	Study average length = Murahovschi et al.
4 months		63.2	63.5	0.260	Study average length = Murahovschi et al.
6 months		66.6	67.0	0.167	Study average length = Murahovschi et al.
At birth	Female	49.2	49.0	0.310	Study average length = Murahovschi et al.
1 month		53.5	54.0	0.064	Study average length = Murahovschi et al.
4 months		62.4	63.0	0.113	Study average length = Murahovschi et al.
6 months		65.6	66.5	0.018*	Study average length > Murahovschi et al.

* Student's *t* test for an average.**Table 6** - Results of the comparison between the average weight (g) at different ages according to sex in this study and Chaves¹⁴ reference values (p < 0.05)

Age	PROAME average	Chaves average	Descriptive level (p)	Conclusions
At birth	3,270	3,372	0.007*	Study average weight < Chaves
1 month	4,307	4,315	0.883	Study average weight = Chaves
6 months	8,078	7,600	< 0.001*	Study average weight > Chaves

* Student's *t* test for an average.

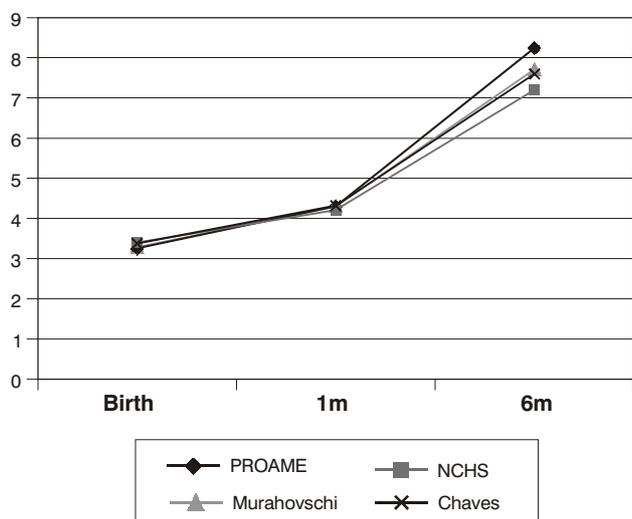


Figure 1 - Comparison of mean weight curves in four studies

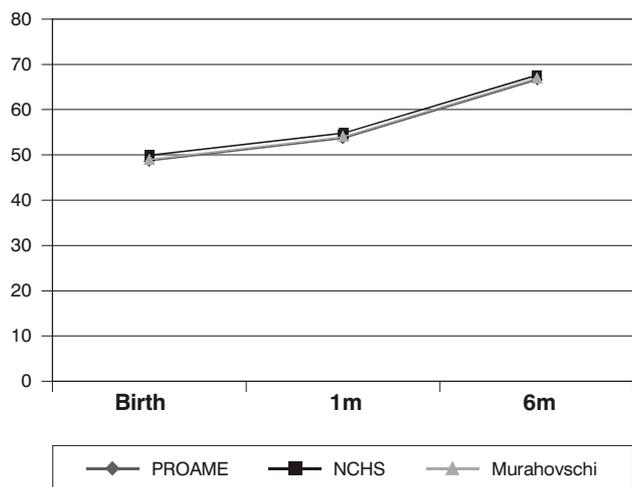


Figure 2 - Comparison of mean length curves in three studies

the hindmilk, which is rich in fats and has a high energy value, all of which leads to greater weight gain. The program also seeks to demonstrate all the advantages that maternal breastfeeding can offer the mother, her child and her family.

Conclusions

Children who were exclusively fed at the breast for 6 months exhibited satisfactory weight gain when compared with existing standards. This gain is accentuated during the first four months and later decelerates; all children doubled their birth weights by

the fourth month, reaching 6 months well-nourished and with average weights above those in the reference standards.

Growth in stature was also satisfactory, decelerating after four months and with differences between sex detectable only after 6 months by which point boys were taller than girls.

We thus prove that breast milk as the only source of nutrients is the ideal food for satisfactory growth during the first 6 months of life. There is no need for complementary foodstuffs, it is enough to give the mother the support, guidance and incentives she needs to succeed breastfeeding exclusively.

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Corresponding author:

Rosa Vieira Marques
Rua Boaventura da Silva, 567/501
CEP 66055-090 - Belém, PA, Brazil
Tel.: +55 (91) 224.7309 – Fax: +55 (91) 242.1206
E-mail: alvimar@amazon.com.br