

Growth of exclusively breast-fed infants from a poor urban population

Rubens G. Ricco, Carlos A. Nogueira-de-Almeida, Luiz A. Del Ciampo, Júlio C. Daneluzzi, Maria Lúcia Silveira Ferlin, Gerson Muccillo

Department of Pediatrics, Faculty of Medicine of Ribeirão Preto, University of São Paulo, Brazil

SUMMARY. The growth of two groups of infants were evaluated, one of them exclusively breast-fed (105 infants) and the other exclusively bottle-fed (61 infants), and compared with one another and with international standards (NCHS). All infants were evaluated by anthropometry at 1, 2, 3, 4, 5 and 6 months of age. A fourth order polynomial was adopted for each infant and for each anthropometric measurement in order to estimate individual growth, and the 5th, 50th and 95th percentiles for weight and length were obtained. For the age of 6 months, the weights of breast-fed boys and girls were always statistically equal to or higher than those of infants fed cow's milk or those of NCHS standards. Breast-fed boys presented significantly longer length than bottle-fed boys but shorter than NCHS standards, and breast-fed girls presented significantly shorter length than both bottle-fed girls and than NCHS standards. The greater weight of exclusively breast-fed infants when compared to NCHS standards at six months of age, which differentiates the present study from several other ones carried out in developing countries, was probably due to the association of the beneficial effects of breast-feeding with those of pediatric follow-up.

Key words: Breast-feeding, growth, nursing infants.

RESUMO. Crescimento de crianças exclusivamente amamentadas ao seio em população urbana pobre. O crescimento de dois grupos de crianças foi avaliado, um deles amamentado exclusivamente ao seio (105 crianças) e o outro exclusivamente de forma artificial (61 crianças), comparando-os entre si e com os padrões internacionais (NCHS). Todas as crianças foram avaliadas por antropometria nas idades de 1, 2, 3, 4, 5 e 6 meses. Adotou-se um polinômio de quarta ordem para cada criança e para cada medida antropométrica, a fim de estimar o seu crescimento individual, obtendo-se os percentis 5, 50 e 95, para peso e comprimento. Para a idade de 6 meses, os pesos de meninos e meninas em aleitamento natural foram sempre estatisticamente maiores ou iguais em relação às crianças que usaram leite de vaca ou em relação aos padrões do NCHS. Os meninos em aleitamento natural apresentaram comprimento estatisticamente superior àqueles em aleitamento artificial mas inferior aos padrões do NCHS; as meninas em aleitamento natural apresentaram comprimento estatisticamente inferior tanto em relação àquelas em aleitamento artificial quanto aos padrões do NCHS. Ressalta-se que, provavelmente, o grande sucesso obtido em relação ao peso das crianças em aleitamento materno exclusivo ainda aos seis meses de idade, diferenciando esse estudo de vários outros realizados em países em desenvolvimento, deva-se à somatória dos efeitos benéficos do aleitamento materno ao acompanhamento de Puericultura.

Palavras chave: Amamentação, crescimento, lactentes.

INTRODUCTION

When breast-feeding is compared to artificial feeding, two clearly distinct realities are observed, one for developed countries and the other for the third world. In the former, maternal milk is almost always replaced with artificial formulas of high quality in nutritional terms, and actually having hypoallergenic characteristics. The advantage of natural feeding would still be in terms of non-nutritional factors, especially with respect to protection against infectious-contagious diseases. However, the health conditions of richer countries, such as good vaccination coverage, basic sanitation, and efficient medical care, among others, minimize this benefit, providing bottle-fed infants a

sufficient, greater or even exaggerate growth compared to that provided by mother's milk (1,2). In contrast, in poor countries mother's milk is almost always replaced with non-modified whole cow's milk, leading to early allergic sensitization, contamination of the digestive tract, and occult blood loss in the feces (3). Under these conditions, the classical picture of diarrhea and malnutrition easily occurs, often ending in death or almost always leading at least to growth retardation. Thus, comparative studies conducted in poor countries tend to show a better growth of breast-fed infants compared to early weaned infants.

The objective of the present study was to evaluate comparatively the growth of two groups of Brazilian infants, one of them exclusively breast-fed and the other exclusively

bottle-fed, in an attempt to understand the behavior of these groups when compared to each other and to international standards (NCHS) and also to verify the adequacy of this standards in the evaluation of growth of exclusively breast-fed infants within the reality of an underdeveloped country where non-modified whole cow's milk is the major substitute of mother's milk, actually being used in official programs of alimentary supplementation.

METHODS

The present study was carried out at the Community Medical Social Center of Vila Lobato (CMSCVL), located in a peripheral neighborhood of the city of Ribeirão Preto, Brazil. This health unit is involved in programs of teaching-assistance-research integration developed through a successful partnership between the official health service, the Faculty of Medicine of Ribeirão Preto, University of São Paulo, and the community, directed at a population of low socioeconomic condition.

The study comprised all children registered at the CMSCVL, in a period of four years, who received complete longitudinal follow-up, attending all the visits scheduled for the ages of 1, 2, 3, 4, 5 and 6 months, with a tolerance of ± 5 days for the day when they reached these ages. All were born at term, weighing more than 2500 g, and remained healthy during follow-up. Inclusion criteria were: complete follow-up and definition of the type of feeding on the occasion of the first visit, i.e., exclusively artificial feeding, with no breast-feeding at any time during the day since the first month of life, or exclusively breast-feeding, i. e. no form of food complementation, except boiled water no more than one time a day, up to six months of age. The infant feed practices were self-selected by the mothers. Artificially fed infants did not receive any type of industrialized baby formula, but only non-modified whole cow's milk prepared according to the routine of the service, i.e., diluted at the proportion of two parts of milk to one part of boiled water when used *in natura*, or diluted 10% when used in powdered form, with 5% sugar being added to both preparations. In this group, the babies received fruit juice at 7 weeks of age, cereals at 2 and one half months, homogenized fruit at 3 months, and homogenized vegetables at 4 months, with egg yolk being introduced at 5 months of age. All the mothers were rigorously trained to observe the orientations about the time of introduction of complementary foods.

On the basis of these criteria, 166 infants were included in the study, 105 of them assigned to the breast-fed group, and 61 to the bottle-fed group. All infants were submitted to anthropometric measurements obtained by one only trained personnel using scales and anthropometric equipment in

perfect conditions and regularly checked for accuracy and standardized according to rigorous recommended methodological norms (4). The weight and length of all infants were obtained. The prospective longitudinal method was used. Each child was studied at each age, appearing obligatorily for the 6 scheduled monthly visits, when anthropometry and physical examination were performed. The information provided by the mother about the feeding of her child was periodically verified, also by unscheduled home visits, which are part of the routine of the service itself. The difficulties inherent in the method and in the rigor of the conditions for group formation may explain the relatively small sample and the use of four consecutive years of study.

The statistical method used for the construction of the polynomials was that of Srivastava and Carter, (5) which consists of the adoption of a fourth order polynomial for each child and for each anthropometric measurement for the estimate of individual growth. Using this method, the 5th, 50th and 95th percentiles for weight and length were obtained for the ages of 1, 2, 3, 4, 5, and 6 months, separated by sex and type of feeding. The results obtained were compared in order to study the growth of Brazilian infants exclusively breast-fed and of infants exclusively receiving cow's milk, with NCHS (6) standards used as reference.

Data concerning weight and length of boys and girls at the age of six months were analyzed by the *t*-test for one sample in order to test the hypothesis (H_0) that, at 6 months of age, breast-fed infants present weight and length equal to or higher than those of infants receiving cow's milk or than reference NCHS values ($\alpha = 5\%$). The software use for analysis was the Office Package, from Microsoft Corporation.

The study was approved by the local Ethics Committee.

RESULTS

During the study period, 430 infants that might have been included in the study were registered at the CMSCVL, but only 81 girls (48.8%) and 85 boys (51.2%) satisfied all the requirements. With respect to the characteristics of the sample, 85% of the children were from families with a monthly per capita income of less than 1 minimum salary (approximately US\$ 80.00). With respect to maternal educational level, 76.51% of the mothers had completed primary school at most. These characteristics were proportionally distributed in the breast-fed and bottle-fed groups.

Table 1 shows the distribution of the 5th, 50th and 95th percentiles of weight for the ages from 1 to 6 months for the two groups and for the NCHS. The NCHS data refer only to the ages of 1, 3 and 6 months, which are those listed in the original publication.

TABLE 1
Distribution of the 5th, 50th and 95th percentiles of weight for the ages from 1 to 6 months for the two groups (breast-fed and bottle-fed) and for the NCHS

AGE (months)	BOYS									GIRLS								
	5 th Percentile			50 th Percentile			95 th Percentile			5 th Percentile			50 th Percentile			95 th Percentile		
	Breast feed	Bottle feed	NCHS	Breast feed	Bottle feed	NCHS	Breast feed	Bottle feed	NCHS	Breast feed	Bottle feed	NCHS	Breast feed	Bottle feed	NCHS	Breast feed	Bottle feed	NCHS
1	4,19	3,47	3,19	4,43	3,84	4,21	4,67	4,22	5,23	3,88	3,38	3,08	4,09	3,95	3,97	4,31	4,51	4,81
2	5,16	4,37	*	5,46	4,81	*	5,76	5,25	*	4,78	4,25	*	5,02	4,77	*	5,27	5,29	*
3	6,01	5,19	4,38	6,35	5,69	6,01	6,71	6,21	7,42	5,51	4,98	4,11	5,79	5,58	5,41	6,06	6,17	6,78
4	6,72	5,91	*	7,11	6,48	*	7,48	7,06	*	6,11	5,71	*	6,42	6,32	*	6,73	6,94	*
5	7,27	6,52	*	7,69	7,15	*	8,11	7,78	*	6,61	6,35	*	6,95	6,94	*	7,29	7,53	*
6	7,63	7,08	6,22	8,13	7,68	7,82	8,62	8,28	9,46	7,04	6,75	5,81	7,41	7,39	7,2	7,76	8,03	8,74

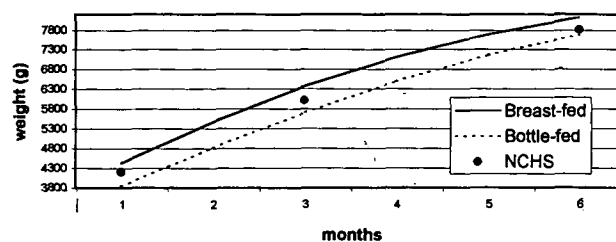
Table 2 shows the distribution of the 5th, 50th and 95th percentiles of length for the ages from 1 to 6 months for the two groups and for the NCHS. Again, the NCHS data refer only to the ages of 1, 3 and 6 months, which are those listed in the original publication.

TABLE 2
Distribution of the 5th, 50th and 95th percentiles of length for the ages from 1 to 6 months for the two groups (breast-fed and bottle-fed) and for the NCHS

AGE (months)	BOYS									GIRLS								
	5 th Percentile			50 th Percentile			95 th Percentile			5 th Percentile			50 th Percentile			95 th Percentile		
	Breast feed	Bottle feed	NCHS	Breast feed	Bottle feed	NCHS	Breast feed	Bottle feed	NCHS	Breast feed	Bottle feed	NCHS	Breast feed	Bottle feed	NCHS	Breast feed	Bottle feed	NCHS
1	53,2	51,3	51,1	54,2	52,9	54,8	55,2	54,6	58,4	51,7	50,3	49,8	52,8	52,4	53,8	53,8	54,5	56,7
2	57,1	55,2	*	58,1	56,8	*	59,1	58,3	*	55,1	54,3	*	56,2	56,3	*	57,4	58,3	*
3	60,1	58,4	56,2	61,1	59,8	61,2	62,1	61,3	65,8	57,7	57,1	55,1	58,8	59,1	59,6	59,9	61,1	63,7
4	62,4	60,9	*	63,4	62,5	*	64,4	64,1	*	60,1	59,6	*	61,1	61,5	*	62,1	63,5	*
5	64,2	63,1	*	65,3	64,7	*	66,4	66,4	*	62,1	62,1	*	63,1	64,1	*	64,2	66,1	*
6	65,8	64,6	63,6	66,9	66,4	67,6	68,1	68,2	72,1	63,6	63,6	61,6	64,6	65,6	65,7	65,6	67,7	70,1

Figures 1 and 3 show the 50th percentile curves for boys constructed on the basis of the mathematical model used for the two feeding groups, as well as the points for the 50th percentile of NCHS for weight and length, respectively. Figures 2 and 4 show the same curves for girls. For the age of 6 months, the weights of breast-fed boys and girls were always statistically higher than or equal to those of the infants fed cow's milk and those reported by NCHS. Breast-fed boys presented a significantly longer length than bottle-fed boys but shorter than NCHS standards, and breast-fed girls presented a significantly shorter length than both bottle-fed girls and NCHS standards.

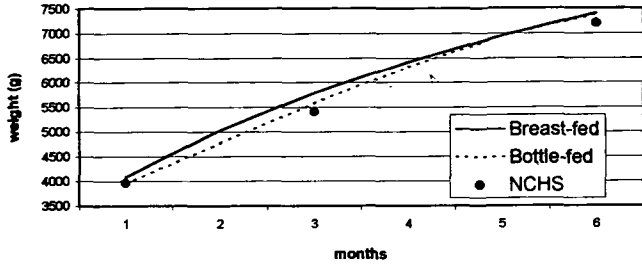
FIGURE 1
Evolution of weight (50th Percentile) of exclusively breast-fed boys compared to exclusively bottle-fed boys and to NCHS standards



At 6 months of age: breast-fed vs NCHS, $t = 2.08 > -1.67$ ($\alpha = 5\%$);
breast-fed vs bottle-fed, $t = 3.12 > -1.67$ ($\alpha = 5\%$).

FIGURE 2

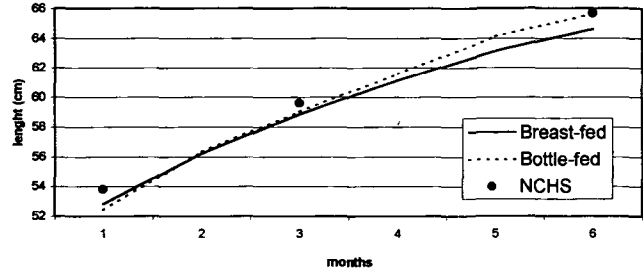
Evolution of weight (50th Percentile) of exclusively breast-fed girls compared to exclusively bottle-fed girls and to NCHS standards



At 6 months of age: breast-fed vs NCHS, $t = 2.23 > -1.67$ ($\alpha = 5\%$); breast-fed vs bottle-fed, $t = 0.23 > -1.67$ ($\alpha = 5\%$).

FIGURE 4

Evolution of length (50th Percentile) of exclusively breast-fed girls compared to exclusively bottle-fed girls and to NCHS standards

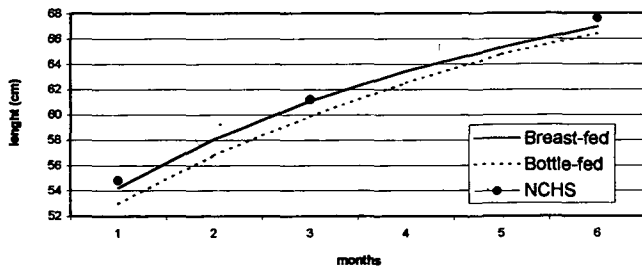


At 6 months of age: breast-fed vs NCHS, $t = -3.92 < -1.67$ ($\alpha = 5\%$); breast-fed vs bottle-fed, $t = -4.10 < -1.67$ ($\alpha = 5\%$).

DISCUSSION

FIGURE 3

Evolution of length (50th Percentile) of exclusively breast-fed boys compared to exclusively bottle-fed boys and to NCHS standards



At 6 months of age: breast-fed vs NCHS, $t = -2.16 < -1.67$ ($\alpha = 5\%$); breast-fed vs bottle-fed, $t = 1.66 > -1.67$ ($\alpha = 5\%$).

The question of infant growth according to type of feeding has been considered in countless scientific reports all over the world, with a series of doubts still persisting, especially with respect to the first six months of life (7). These doubts have become particular relevant after the observation that exclusively breast-fed infants may show a lower than expected growth on the basis of growth curves. Most studies on the growth of nursing babies have shown that exclusively breast-fed infants show above average growth during the first three months when evaluated by the NCHS Reference Curve, but a lower than expected growth thereafter (8). Indeed, in contrast to Waterlow and Thomson, (9) who recommend exclusive breast-feeding only up to the third month, knowing that the NCHS curves were basically constructed with data for bottle-fed infants, (10) leading to a bias in the curves, which no longer represented normal growth, i.e. growth obtained with natural feeding, it must be considered that it is the curve that is inadequate and not natural feeding. Several studies have shown that, in fact, in developed countries bottle-fed infants grow more than breast-fed infants, and are currently considered to be overfed. In developing countries, however, breast-fed infants tend to grow better than bottle-fed infants, but even so their growth is below that reported in international growth curves, especially after 4 months of age. This has led the WHO to consider current curves to be inadequate and in 1995 the WHO Working Group on Infant Growth, based on different worldwide studies, recommended the construction of new curves based on infants fed according to WHO recommendations, i.e., exclusive breast-feeding up to 4-6 months (11,12).

In the service where the present study was conducted, we always observed in an empirical manner that exclusively breast-fed infants who received adequate pediatric follow-up were those who presented the best growth and development at least up to 6 months of age, when complementation with other foods was routinely started. The results obtained clearly show that this initial impression indeed corresponds to reality since at six months of age both breast-fed boys and girls presented statistically identical or higher weight than infants receiving cow's milk or than NCHS standards. Analysis of Figures 1 and 2 clearly shows this tendency and it is important to note that the weight of bottle-fed girls was equal to or higher than NCHS standards, while the growth of boys was always lower. This shows that the existence of genetic factors leading to a higher weight of these Brazilian infants in general is unlikely, and supports the hypothesis that indeed the crucial factor in this case must have been maternal milk. I should also be pointed out that the statistical test was applied at 6 months, leading us to conclude that the age limit to be recommended for breast-feeding should be 6 and not 4 months. Similar results were also obtained in Brazil at other University Pediatric services (13,14).

At six months, boys and girls maintained the growth trend observed at 1 month, a fact that probably reflects birth length, with NCHS values being significantly higher than those of the infants studied here, regardless of type of feeding. Even if there was also a superiority of maternal milk in terms of linear growth, this superiority had no time to manifest since length, compared to weight, is considered to be an indicator less sensitive to acute modifiers of nutritional status.

Thus, we conclude that in the present study, at 6 months of life exclusively breast-fed infants had a weight equal to or higher than NCHS standards and higher than that of infants receiving cow's milk; with respect to length, these infants were shorter than NCHS standards but this trend was already present at 1 month of age, and may eventually be considered residual. It should be pointed out that the great success obtained in terms of weight for exclusively breast-fed infants as late as at 6 months of age, differentiating this study from several others carried out in developing countries, may probably have been due to the combination of the beneficial effects of breast-feeding and pediatric follow-up, which stimulates breast-feeding as one of its successful priorities (15) but at the same time provides guidelines and support to the mothers and their children throughout the period of growth and development.

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