ORIGINAL ARTICLE / *ARTIGO ORIGINAL*

Nutritional status of exclusive breastfed infants in the state of Pernambuco

Estado nutricional de crianças em amamentação
exclusiva prolongada no Estado de Pernambuco

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ABSTRACT: *Introduction:* Exclusive breastfeeding (BF), after the sixth month of life, as a single food source is not recommended. It is believed that it is not possible to supply the caloric needs of protein, iron and vitamin without adequate food supplementation. *Objective:* To compare the nutritional status of children with exclusive breastfeeding (BF) for more than 6 months *versus* children with other breastfeeding practices. *Method:* Cross-sectional exploratory study with 685 children (39 BF > 6 months and 646 with other breastfeeding practices). Situations of anthropometric deficit were considered by values < - 2 in Z score, anemia evaluated by hemoglobin < 11 g/dL, and deficient/low levels of vitamin A by serum retinol < 1.05 μmol / L. *Results:* There were no cases of deficit in the anthropometric ratios of weight/height, weight/age and body mass index (BMI) among children BF > 6 months, while the comparison group was approximately 0.5%. In the height/age ratio, the deficit was around 2.6% in both groups. In the weight/height ratio and BMI, the results ranged from 28.7 to 31.9% for overweight in group comparisson. The average Hb, serum retinol, weight and height were similar between the groups. *Discussion:* The low prevalence (≤ 0.6%) of protein energy malnutrition in both groups represents a surprising finding, below the values found in reference to normal international reference, WHO standard. *Conclusion:* Children who maintained BF after six months exhibited equivalent nutritional status to those of children with other breastfeeding practices.

Keywords: Breastfeeding. Breast milk. Maternal and child health. Child nutrition.

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RESUMO: *Introdução:* O aleitamento materno exclusivo (AME), após o sexto mês de vida, como fonte alimentar única não é recomendado. Acredita-se que não é possível suprir às necessidades calórico proteicas, de ferro e vitaminas sem a devida complementação alimentar. *Objetivo:* Comparar a situação nutricional de crianças com AME por mais de seis meses *versus* crianças com outras práticas de amamentação. *Método:* Estudo transversal/exploratório com 685 crianças (39 em AME > 6 meses e 646 com outras práticas de amamentação). Situações de déficit antropométrico foram consideradas por valores < - 2 no escore Z, anemia avaliada por hemoglobina (Hb) < 11 g/dL e níveis deficientes/baixos de vitamina A por retinol sérico < 1,05 μmol/L. *Resultados:* Não ocorreram déficits nas relações de peso/altura, peso/idade e índice de massa corporal (IMC) no grupo de crianças em AME > 6 meses, enquanto no grupo de comparação esse índice foi de aproximadamente 0,5%. O déficit na relação altura/idade foi de aproximadamente 2,6% nos dois grupos. Na relação peso/altura e no IMC, os resultados variaram de 28,7 a 31,9% para excesso de peso no grupo de comparação. As médias de Hb, retinol sérico, peso e altura foram similares nos grupos. *Discussão:* A baixa prevalência (≤ 0,6%) de desnutrição energético proteica (DEP) nos dois grupos representa um achado, surpreendentemente, abaixo dos valores encontrados em população de referência de normalidade internacional, padrão da Organização Mundial da Saúde (OMS). *Conclusão:* As crianças que se mantiveram em AME após seis meses apresentaram situação nutricional equivalente àquelas com outras práticas de amamentação.

Palavras-chave: Aleitamento materno. Leite materno. Saúde materno-infantil. Nutrição infantil.

INTRODUCTION

A simultaneous and interactive set of beneficial effects (immunological, metabolic, nutritional, psychosomatic, economic and even ecological) make breastfeeding the best alternative for the protection of children in their first months, when breast milk, in almost all cases, can and should be maintained as a complete and sufficient source of energy supply, micro and macronutrients and water[1-6]. Based on these evidences, the World Health Organization (WHO), the United Nations Children's Fund (UNICEF) and the Food and Agriculture Organization of the United Nations (FAO) unified their positions on the proposal for breastfeeding (BF) in the first six months of life, recommending, from then on, the progressive complementation of breastfeeding up to 24 months, when the children can already participate in the usual diet of the family, according to habits of food consumption that distinguish the culture of each people[6-9].

The transition from exclusive breast milk to complementary feeding is justified considering that, at around six months, human milk as a single food source would no longer cover the more general nutritional requirements, such as caloric and protein demands, or more specific ones, as may occur with dietary iron and vitamin A[10,11]. On the other hand, the morphophysiological development of the child already provides skills for chewing, swallowing, digestion, absorption, metabolic utilization and excretion of nutrients from exogenous sources carried by other foods, including milk and its derivatives of other animal species[6-9].

Considering these two strands of argumentation, the recommendation for the phasing-in of other foods from six months onwards is supported. With the support of this logic, we could expect the occurrence of deficiency situations derived from the deficient relation demand × energy / nutrient supply in the situations in which BF is continued after the sixth months of life, particularizing the deficiency of calories, protein, vitamin A and dietary iron.

Following these and other references, the objective of the present study was to compare the nutritional status of children in BF for more than six months with those with other types of feeding. Therefore, without the intention of proposing new cut-off points over the duration of BF in relation to the six-month reference, the following question is expected to be answered: children who continued to breastfeed for more than six months present a higher risk situation in relation to other children who presented other types of breastfeeding, regarding the expected normality standards established by the nutrition manuals for the first year of life?

METHOD

A cross-sectional, exploratory study was carried out from the database of the III State Health and Nutrition Survey (III *Pesquisa Estadual de Saúde e Nutrição* – PESN)[12], which represents a prevalence survey on health, nutrition and service provision conditions in the state of Pernambuco between May and October 2006, as a joint initiative of the Nutrition Department of the Federal University of Pernambuco (*Departamento de Nutrição da Universidade Federal de Pernambuco* – DN / UFPE) and Professor Fernando Figueira Institute of Integral Medicine (*Instituto de Medicina Integral Professor Fernando Figueira* – IMIP), with the support of the National Council for Scientific and Technological Development (*Conselho Nacional de Desenvolvimento Científico e Tecnológico* – CNPq). This basic survey, which is in phase of replication with a perspective of completion in 2018, aimed to update and expand the diagnosis of the health, nutrition, food and socioeconomic conditions of the state population, emphasizing the maternal-child group in its different geoeconomic strata: urban (metropolitan region of Recife and urban countryside) and rural.

The original sample that served as reference for III PESN was calculated from the main objectives of the project (estimated prevalence of protein energy malnutrition (PEM), anemia, hypovitaminosis A, diarrhea and acute respiratory infection), with a population of children under five years of age in the state, estimated then at 785,522 children. With a focus on these problems, their prevalence and the admission of estimation errors between 1.5 and 3.0%, samples of different sizes were calculated: 852 in the urban sector (metropolitan area of Recife = 431 and urban countryside = 421) and 798 in rural areas, thus giving a total value of 1,650 children.

Sampling, of the probabilistic type, was chosen in multiple stages, by sequential draw selection of the municipalities, census areas and households, and finally regrouped to represent two geoeconomic strata: urban and rural. As sample cases, children under five years of age from 18 municipalities of Pernambuco, with probability of inclusion proportional to the population in each mesoregional territory (coastal, agreste and backwood areas) were included as family index cases.

From the original file, an *ad hoc* data bank was generated to respond to the objectives of the present study, from which 74 children were excluded due to lack of information about breastfeeding practices, thus representing a loss of 4.5%. Among the 1,576 children identified, 39 cases were exclusively breastfed for more than six months (minimum of 192 days / 6.5 months and maximum of 426 days / 14 months, average of 243 days, that is, about eight months).

We sought to obtain a comparison group that reproduced the general characteristics of the case group (gender and age) and differed only with regard to the duration of exclusive breastfeeding; thus, 891 children who did not meet the pre-established matching criteria were excluded and the sample analyzed was 685 children (39 cases of infants in BF for more than 6 months of life and 646 controls that reproduced the general characteristics of the group of cases, with ages varying according to the pairing criterion adopted).

For the individual pairing by age, differences of up to 1 month were considered as criteria for children with 6 to 12 months of age; up to 2 months for the age of 1 to 2 years; and up to 3 months for those aged 3 years to 59 months. The gender (male / female) condition, imposed as a preliminary pairing criterion, is self-explanatory.

The control group represented the modalities of breastfeeding found in the general population: children who never breastfed and those who did it for different times of one, two, three, four, five months or more, exclusively, predominantly or complementarily.

Maternal age was grouped into two categories — < 20 and ≥ 36 years and 20 to 35 years of age — according to a history of BF for at least six months, considered in a previous unpublished work, in which the maternal age of 20 to 35 years revealed an *odds ratio* (OR) of 2.5 and a 95% confidence interval (CI) of 1.4 – 4.5 when compared to the range of < 20 and ≥ 36 years of age.

The anthropometric evaluation of the children in the III PESN was performed at the time of the interview, and the recommendations of the WHO were applied[13]. Weight was verified in a digital scale (Model MEA-03200 / Plenna) with a capacity of up to 150 kg and a scale of 100 g, and the height of children up to two years old was measured with an infantometer made from a wooden bar with a width of 100 cm and 0.1 cm subdivisions. The height of those older than two years of age was determined by millimetric portable stadiometer (Alturaexata, Ltda.), with a precision of 1 mm throughout its length.

To evaluate the nutritional status, four indices were used: weight by age (W / A) = ratio between observed and normal or reference weight by age; height by age (H / A) = ratio between height observed and reference by age; weight per height (W / H) = ratio between observed weight and reference height; and body mass index (BMI) by age = ratio between observed BMI and age. The reference standard used for comparison of weight and height measures was that of the WHO[14], through the application of ANTHRO plus software[15], to calculate the Z score of the children evaluated, considering as deficit situations Z-score values below -2. The classification of overweight included risk of overweight, overweight and obesity for weight / height rates and BMI.

Hemoglobin (Hb) was measured in blood samples by means of the HEMOCUE equipment, which is immediately readable. The diagnosis of anemia was established based on

the criteria recommended by the WHO, and children with Hb < 11 g/dL[16] were considered anemic. Serine retinol was processed at the Laboratory of the Micronutrient Research Center (*Centro de Investigação em Micronutrientes* – CIMICRON), University Hospital Lauro Wanderley, Federal University of Paraíba (UFPB) and analyzed by the high pressure liquid chromatography (HPLC) method, according to a technique recommended by Furr et al.[17]. CIMICRON is accredited by WHO as a reference for the determination of retinol. For the classification of the results, the WHO categorization criterion was considered (deficient levels: < 0.35 mmol/L, low levels: < 0.70 µmol/L, tolerable levels: 0.70 to 1.05 µmol/L; and normal levels: > 1.05 µmol/L). In the analysis of the results, only the cut-off point < 1.05 µmol/L was used, discriminating, together, the deficient and low levels[18].

Data were analyzed using Stata 12.1 SE® software. The Pearson χ^2 and Fisher's Exact tests were used for the statistical comparison of the sample, anthropometric nutritional and biochemical characteristics according to BF for more than six months and, by extension, for the comparison group. To analyze the means, the Student's *t*-test was used, considering $p < 0.05$ as the statistical significance of difference. The study was approved by the Research Ethics Committee of the IMIP. It should be noted that there was no conflict of interests.

RESULTS

The characterization of the sample, presented descriptively in Table 1 through 17 items, bringing together socioeconomic, demographic and environmental variables, access to services, health and biological actions regarding children, their mothers and families indicate that the results obtained in the comparison of children who exclusively breastfed after six months of life did not differ, statistically, from the rest of the other children who did not practice BF according to the conditions thus specified. The comparison group reproduces the general characteristics of the group of cases, differing in their heterogeneity, in terms of feeding, since it reunites children who have never breastfed and those who have breastfed for varying times of one, two, three, four, five or more months, exclusively, predominantly or complementarily.

Considering the relationships between weight and height, weight and age and BMI and age, the results described in Table 2 demonstrate that there were no cases of anthropometric deficit in the group of children who exclusively breastfed for more than six months, while in the comparison group its occurrence was around 0.5%. In the relation between height and age, the occurrence of anthropometric deficit was respectively 2.6 and 2.5% in the two groups compared. Regarding the excess weight, expressed in the relation between weight and height and BMI, the results ranged from 28.7 to 31.9%, without statistically significant differences in the comparative analysis of the two groups.

The parametric findings of biochemical indicators (serum retinol and hemoglobin) and anthropometry, as well as the prevalence of cases representing vitamin A deficiency (VAD) and occurrence of anemia are described in Table 3. It is observed that only three children (one in the group of BF for more than six months and two in the comparison group) presented

Table 1. Socio-environmental and demographic characteristics, access to health actions, maternal obstetric history and distribution by gender of children aged six to 59 months according to the practices of breastfeeding in the state of Pernambuco, 2006.

Characterization variables / Specification of results	Sample*	BF > 6 months		p-value**
		Yes n (%)	No n (%)	
Age of the mothers (years)				
< 20 and ≥ 36	685	6 (15.4)	184 (28.5)	0.076
20 to 35		33 (84.6)	462 (71.5)	
Literacy				
Yes	685	31 (79.5)	520 (80.5)	0.878
No		8 (20.5)	126 (19.5)	
Elementary school				
Yes	684	8 (20.5)	165 (25.6)	0.479
No		31 (79.5)	480 (74.4)	
***Per capita* family income (MW)**				
< 0.5	676	33 (84.6)	526 (82.6)	0.744
≥ 0.5		6 (15.4)	111 (17.4)	
Area				
Urban	685	22 (56.4)	320 (49.5)	0.404
Rural		17 (43.6)	326 (50.5)	
Region				
Metropolitan region of Recife	685	12 (30.8)	159 (24.6)	0.388
Countryside		27 (69.2)	487 (75.4)	
Potable water[a]				
Yes	685	23 (59.0)	361 (55.9)	0.706
No		16 (41.0)	285 (44.1)	
Number of people in the household				
1 to 3	685	9 (23.1)	142 (22.0)	0.873
4 or more		30 (76.9)	504 (78.0)	

Tabela 1. Continuation.

Characterization variables / Specification of results	Sample*	BF > 6 months Yes n (%)	BF > 6 months No n (%)	p-value**
Prenatal care				
Yes	681	38 (97.4)	616 (96.0)	0.644
No		1 (2.6)	26 (4.0)	
Number of prenatal consultations				
< 6	626	11 (29.7)	183 (31.1)	0.864
≥ 6		26 (70.3)	406 (68.9)	
Guidance on breastfeeding in prenatal care				
Yes	643	34 (89.5)	522 (86.3)	0.577
No		4 (10.5)	83 (13.7)	
Type of delivery				
Normal	685	30 (76.9)	447 (69.2)	0.308
Cesarean		9 (23.1)	199 (30.8)	
Child's registration in FHS				
Yes	684	26 (66.7)	442 (68.5)	0.808
No		13 (33.3)	203 (31.5)	
Regular visitations of health agents				
Yes	683	35 (89.7)	547 (84.9)	0.412
No		4 (10.3)	97 (15.1)	
Distance from the nearest health service				
<1 km	317	8 (57.1)	154 (50.8)	0.644
≥1 km		6 (42.9)	149 (49.2)	
Gender of the child				
Male	685	17 (43.6)	336 (52.0)	0.307
Female		22 (56.4)	310 (48.0)	
Weight at birth (g)				
< 2,500	684	2 (5.3)	64 (10.2)	0.321
≥ 2,500		36 (94.7)	562 (89.8)	

*Variations of the sample in each category are due to possible lack of information; **Pearson's χ^2 and Fisher's exact tests when necessary; BF: breastfeeding; MW: minimum wage; [a]tap and treated water; FHS: Family Health Strategy. Source: III National Health and Nutrition Survey of the state of Pernambuco, 2006.

serum retinol levels compatible with the "deficient" and "low" vitamin A ratings, with no statistically significant differences between the two groups. Discriminant values of anemia (Hb below 11 g/dL) as well as mean Hb did not show statistically significant differences between the two groups. The prevalence of anemia was 57.9% in the group of BF for more than six months and 61.0% in the comparison group.

DISCUSSION

The results of nutritional anthropometry show that, in relation to all indicators analyzed, there were no statistically significant differences between the children who remained in BF after six months of life when compared to those who, from the point of view of breastfeeding, represent a broad spectrum of situations in relation to their history of breastfeeding.

Table 2. Distribution of the anthropometric nutritional status of children aged six to 59 months, due to exclusive breastfeeding for more than six months in the state of Pernambuco, 2006.

Variables / Specification of results	BF > 6 months		
	Yes n (%)	No n (%)	p-value*
Weight/height (W/H)			
Deficit	0 (0.0)	4 (0.6)	
Normal	27 (71.1)	447 (70.7)	1.00
Overweight*	11 (28.9)	181 (28.7)	
Height/age (H/A)			
Deficit	1 (2.6)	16 (2.5)	1.00
Normal	37 (97.4)	616 (97.5)	
Weight/age (W/A)			
Deficit	0 (0.0)	3 (0.5)	
Normal	37 (97.4)	596 (94.3)	0.760
Overweight	1 (2.6)	33 (5.2)	
Body Mass Index (BMI)/age			
Deficit	0 (0.0)	3 (0.5)	
Normal	27 (71.1)	427 (67.6)	0.881
Overweight*	11 (28.9)	202 (31.9)	

Source: III National Health and Nutrition Survey of the state of Pernambuco, 2006.
BF: Breastfeeding; *risk for overweight, overweight and obesity.

In addition, in both groups or in the total number of observations, the deficit situations behave within or below the expected values for a standard normality population, such as the latest WHO standard table[14]. As a very peculiar record, according to three anthropometric indicators, there is no case of deficit in the restricted group of prolonged BF after six months of life. It is, therefore, a group with optimized characteristics from the point of view of nutrition and its international standards of recommendations. On the other hand, the comparisons of anthropometric values, composing rates and their variations as continuous measures, confirm the categorical distribution data, that is, they do not reveal significant differences in the comparison between the two groups.

In this regard, it should be noted that, according to the recent literature consulted by the authors, in Brazil, there are no studies addressing the potentially adverse consequences of BF after six months of life, mainly as risk factors for caloric deficiency, affecting, at first, body growth parameters, i.e., weight, height and their combined values. In fact, results contradict the expectation of an energy and protein gap derived from the exclusive use of breast milk.

It should be pointed out that the anthropometric evaluation reveals an admittedly favorable process of the nutritional situation of children in the State of Pernambuco in relation to the control of PEM, as observed by Figueiroa et al.[19]. In fact, the unexpectedly low prevalence, that is, equal to or below 0.6% in both groups, including the absence of deficit cases according to weight/height, weight/age and BMI, is surprisingly below values found in a reference population of international normality, in this case the WHO standard[14]. And even

Table 3. Frequency distribution of biochemical nutritional status and comparison of means + standard deviation (SD) of height, weight, serum retinol and hemoglobin of children aged six to 59 months, due to exclusive breastfeeding for more than six months in the state of Pernambuco, 2006.

Variables / Specification of results	Sample	BF > 6 months		
		Yes	No	p-value
Serum retinol				
< 1.05 µmol/L, n (%)	422	1 (4.4)	2 (0.5)	0.155*
Mean ± SD (n)		(38.9 ± 27.1) 23	(40.2 ± 22.5) 399	0.803**
Hemoglobin				
< 11 g/dL, n (%)	646	22 (57.9)	371 (61.0)	0.702***
Mean ± SD (n)		(11.1 ± 1.0) 38	(11.2 ± 1.3) 608	0.540**
Weight (kg)				
Mean ± SD (n)	670	(12.5 ± 3.3) 38	(12.8 ± 3.2) 632	0.604**
Height (cm)				
Mean ± SD (n)	670	(85.9 ± 10.9) 38	(87.3 ± 11.3) 632	0.455**

Source: III National Health and Nutrition Survey of the state of Pernambuco, 2006.
*Fisher's exact test; **Student's *t*-test; ***Pearson's χ^2 test; BF: breastfeeding.

in the most representative situation of the epidemiological problem of PEM in children in Brazil (the stature deficit), taken as a cumulative indicator of the nutritional past, that is, of the so-called "previous malnutrition" by some authors, the frequencies of 2.5 and 2.6% below -2 Z score are within the probabilities of occurrence of a normal population. It is a result, therefore, that should be valued as a point of reflection.

Contrary to conventional thinking, instead of the predicted deficit in the protein-calorie nutrition state expected by insufficient protein and energy intake from human milk after six months of breastfeeding, what has surprisingly occurred was a high prevalence of overweight (overweight/obesity) of 28.7%, statistically equivalent to the comparison group. This result still reflects the situation also found in children of the state of Pernambuco, of the region and of the country[20-22]. It should be pointed out that, in itself, that is to say, without considering the issue of anemia and VAD, this situation represents a worrying result, in technical terms, depending on the conventional foundations of the nutritional status of children. Although not an objective of the present study, this condition singles out a contribution from this exploratory study.

The information reported on the vitamin A nutrition status leads to observations very similar to those that apply to the state of caloric-protein nutrition. That is, the possible VAD, represented by deficient and low levels of serum retinol (≤ 1.05 µmol/L) — 4.4% in the BF group and 0.5% in the comparison group — is fully compatible with a situation in which VAD does not manifest itself as a health problem[18]. By the way, these occurrences are well below prevalences found in population-based surveys of Brazilian children[20,21], including in the state of Pernambuco[22]. Therefore, based on these observations, it could not be said that prolonged BF as the only food source for children aged six to 14 months acted as a risk factor for VAD under biochemical criteria.

The same would not apply to the case of anemia. Although there are no statistically significant differences between the two groups, the prevalence found in both groups is indicative of the fact that, due to its magnitude, anemia is an important problem in children, affecting approximately 60% of the sample evaluated. It would be further confirmation that this is the most generalized deficiency problem prevalent in Brazilian children[23,24], as in children around the world[16]. Therefore, the admirably favorable picture described in relation to the state of caloric-protein nutrition and the vitamin A situation does not reproduce in relation to the anemia.

We know of the possibility of bias when using data collection questionnaires in children under five years of age, in field studies on breastfeeding and its modalities. Specifically, since the outcome related to breastfeeding occurs in a brief stage of the child's life, such as the first months of lactation, a situation is established in which the independent variables (income, schooling, maternal age and others) collected *a posteriori* from the outcome are faced with a problem of formal logic: the response reported prior to the recording of the prediction factors. In other words, in addition to the impropriety of the antecedent/consequent relationship, well suited to cross-sectional studies, it is doubtful whether one, two, three, four or five years ago these factors would be the same or if they acted with the same intensity in relation to the outcomes analyzed. Indeed, the ideal solution would be cohort studies, using incidence indicators, from exposure to outcome. Thus, the registration of

this limitation, being pertinent, relativizes the consistency of the results, besides safeguarding the external comparability and the inferences of the internal validation, because, in this case, the same limitation would exist for the cases and controls.

It is also understood as fragility of the research the inclusion in the comparison group of children who never breastfed and those who breastfed for different times, exclusively, predominantly or complementarily. Ideally, the comparison should be made with infants who exclusively breastfed up to six months and then started supplementary feeding, however the restriction of information from the database used did not allow this approach. This would justify the realization of new studies, including in the comparison group only children in BF until the sixth month of life and who started complementary feeding after this period.

CONCLUSION

The theoretical and empirical evidence that exclusive breastfeeding after six months of life represents a risk factor for iron deficiency in children may actually be more consistent with anemia than with other nutritional deficiencies. The same logic could not be used in regard the other problems questioned here, that is, BF cannot be attributed to an unquestionable risk factor of general deficiencies, such as PEM, or specific ones, such as anemia, since children who remained in BF after six months, in Pernambuco, presented nutritional status equivalent to those with other breastfeeding practices.

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