Prevalence of hypovitaminosis A among preschool children from northeastern Brazil, 1998

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Keywords
Vitamin A deficiency, diagnosis.
Vitamin A deficiency, epidemiology.
Vitamin A, blood. Prevalence.

Abstract

Objective
To determine the prevalence of vitamin A deficiency in a population-based sample.
Methods
This was a cross-sectional study conducted in the State of Sergipe, northeastern Brazil, in May and June, 1998. It involved 607 children aged 6 to 60 months. The information was obtained by means of interviews with the persons responsible for these children, in their homes. Blood samples were collected via venous puncture and serum retinol assays were carried out by means of high performance liquid chromatography (HPLC). In simultaneous analyses of the study variables, $p<0.05$ was accepted for testing statistically significant associations.
Results
A mean serum retinol value of 0.87 µmol/l (±0.38) was found among the children investigated. The prevalence of levels considered low (0.35 to 0.69 µmol/l) was 22.5% and the prevalence of levels considered deficient (<0.35 µmol/l) was 9.6%. Inadequate serum retinol levels were therefore seen in 32.1% of the children. The serum retinol level showed an association with per capita family income and the weight/age indicator. No statistically significant association was found for serum retinol level in relation to the child's age and sex, or the mother's variables.
Conclusion
Vitamin A deficiency among preschool children is an important public health problem. Hypovitaminosis A is mainly related to low per capita family income and low infant weight.

INTRODUCTION

Vitamin A is an essential micronutrient in the processes of differentiation and maintenance of epithelial integrity. It is especially known for the catastrophic effect on vision caused by its deficiency. However, the disturbances associated with deficiency of this vitamin are not restricted to blindness. There is also a relationship with increased morbidity and mortality during childhood.

Hypovitaminosis A is one of the most prevalent nutritional deficiencies in the underdeveloped world (FAO/WHO,[6] 1992; WHO,[14] 1995). On the basis of the clinical occurrence of ocular signs and symptoms and the prevalence of deficient levels of serum retinol, the World Health Organization (WHO) has estimated that vitamin A deficiency is endemic in 39 countries (WHO,[14] 1995), including Brazil.

In this country, it especially affects the northeastern region, particularly among preschool children. The premise that the occurrence of hypovitaminosis A is restricted solely to this region may not be true.

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Partially funded by the Ministry of Health and the United Nations Children's Fund (Unicef).
Based on master's dissertation presented within the postgraduate program of the School of Nutrition, Federal University of Bahia, 2001.
Received on 4/11/2002. Reviewed on 7/1/2004; Approved on 15/4/2004.

Nonetheless, despite a lack of surveys covering the whole country, the studies published have been unanimous in pointing out that marginal lack of vitamin A is an important problem among preschool children in northeastern Brazil.

WHO considers that a prevalence of serum retinol levels <0.70 µmol/l occurring in 20% or more of the population is indicative of a serious public health problem (WHO,[15] 1996). It is thought that 2.8 to 3 million children of preschool age around the world are clinically affected by hypovitaminosis A, and that 251 million present the subclinical form of this deficiency (WHO,[14] 1995).

The United Nations Children's Fund (UNICEF), the World Health Organization (WHO) and the United Nations Food and Agriculture Organization (FAO) have proclaimed the need to institute programs for preventing and controlling this micronutrient deficiency. Vitamin A reduces the mortality rate (Beaton,[3] 1993) and the incidence and severity of infections, especially diarrheal diseases, among preschool children (Barreto,[2] 1994).

The need to combat vitamin A deficiency has gained a new dimension in recent years. Evidence of hypovitaminosis A and xerophthalmia has been documented, especially in the northeastern region of Brazil (Dricot D'ans et al,[5] 1988; Santos et al,[11] 1996; INAN/MS-IMIP,[7] 1998). Even so, the data available on the prevalence of vitamin A deficiency in this region are sparse. For the states of Piauí, Maranhão, Alagoas and Sergipe, there was no information available on this problem until 1998.

The present study had the objective of estimating the prevalence of vitamin A deficiency in a representative sample of preschool children. This would furnish data to enable the definition of public policies and the rationalization of resource application in combating vitamin A deficiency.

METHODS

This was a cross-sectional study performed in the State of Sergipe in May and June 1998. It formed part of a broader investigation under the title of "Third Survey of Mother-Child Health and Nutrition of the State of Sergipe", which was planned with the objective of obtaining statewide health and nutrition indicators for children aged under five years and women aged 15 to 49 years (SES/SE – UFBA,[12] 2001).

The sample size (383 children) was calculated on the basis of a critical prevalence of vitamin A deficiency of 20%. This rate is considered by the World Health Organization (WHO) to be indicative of a serious public health problem. Variability of ±4% in the estimate was accepted, with a 95% confidence interval. For this procedure, the Epi Info 6.02 software was utilized.

Twenty clusters in the 75 municipalities of the State were selected by means of a conglomerate-sampling technique. The probability of selection was proportional to the size of the under-five population , based on the 1996 population census by the Brazilian Institute for Geography and Statistics (Instituto Brasileiro de Geografia e Estatística - IBGE). By utilizing a combination of randomized and systematic sampling techniques, eight census sectors were selected within each conglomerate, stratified according to the urban and rural areas of each municipality, in accordance with the sizes of their populations.

Thus, 160 census sectors in 16 municipalities were surveyed: 68.8% of them were located in urban areas and 31.2% in rural areas. This distribution was compatible with what was found by the 1996 IBGE census for the State: proportions of 70.2 and 29.8% of the urban and rural populations respectively. In each census sector, a number of homes sufficient to furnish a sample of six children were visited. When more than one child within the age group for the study was found, one index child was chosen at random. A sample totaling 607 children aged under five years was thus obtained for the serum retinol analysis.

During the home visit, specially trained nutritionists explained to the parents or guardians what the purposes of the investigation were. These adults responsible for the child remained free to decide whether or not the child should participate in the study. Written informed consent was requested from these adults for the collection of blood samples.

The blood sample collection was arranged for the day following the home visit, at an appropriate location (healthcare unit or center). Guidance was given regarding the need for the child not to eat before blood collection.

While the children were fasting, 5 ml of blood was collected by venous puncture using a disposable needle and syringe. After removal of the coagulant, the blood was centrifuged and an aliquot of the serum was stored in appropriate tubes. Following this, the samples were frozen at -20°C in the reference laboratory in the state capital. This whole procedure was carried out under reduced illumination. The samples collected in regions far from the state capital and/or in rural areas

were, after undergoing the process described above, duly conserved at -18°C in insulated chests lined with cold packs until they were moved to the laboratory. After concluding the fieldwork, all the samples were transported to the nutrition biochemistry laboratory of the School of Nutrition of the Federal University of Bahia. The laboratory determinations of serum retinol levels were performed by means of the high performance liquid chromatography (HPLC) method, using a Shimadzu chromatograph, model LC 10AS.

The anthropometric indicators of weight and height/length were obtained in accordance with the technical recommendations in Lohman[9] (1988), with the use, respectively, of portable electronic balances and anthropometers manufactured specially for this purpose. The measurement instruments were calibrated before, and routinely while, performing the fieldwork. The indicators utilized for the anthropometric evaluation were weight-for-age and height-for-age. The cutoff point of less than minus two standard deviations (<-2 z-scores) in relation to the National Center of Health Statistics (NCHS) reference was adopted for characterizing malnutrition according to the indicators analyzed. Children at nutritional risk and malnourished children who were identified during the investigation were sent to the local healthcare service for the attendance needed.

Data analysis

The data collected were entered into the Epi Info 6.02 software. Double data entry was done for 10% of the data. The prevalence and odds ratio (OR), respectively, were adopted as the statistical measurements of occurrence and association. The Mantel-Haenszel chi-squared test was used in the descriptive analysis, to test the statistical significance between proportions. Logistic regression was utilized for simultaneous analysis of the variables of interest, with the calculation of adjusted measurements. Statistical significance of the associations analyzed was established on the basis of p-values <0.05. The SPSS for Windows 8.0 software was utilized for statistical calculations, while anthropometric data was analyzed using the Epinut module of the Epi Info 6.02 software.

The ethical aspects of the present study were approved by the Ministry of Health, Unicef and the Ethics Committee of the Regional Medical Council of Sergipe.

RESULTS

It was observed that 22.5% of the preschool children presented serum retinol levels that were considered low (0.35 to 0.69 µmol/l), while levels considered deficient (<0.35 µmol/l) were detected in 9.6% of the cases. In total, a 32.1% prevalence of vitamin A deficiency was seen (Table 1). A mean serum retinol level of 0.87 µmol/l was found (SD = 0.38) among the children investigated. Classifying the children into age groups, the mean serum retinol for children aged 6 to 24 months was 0.85 µmol/l (SD=0.39) and for those aged 25 to 60 months was 0.89 µmol/l (SD=0.37). These mean values are lower than those defined by WHO (=1.05 µmol/l) to characterize a normal nutritional state with regard to vitamin A.

During the four months preceding the survey, 9.3% of the children had been utilizing medications containing vitamin A. Nevertheless, no statistically significant difference was observed between the serum retinol levels of these children and those who had not been taking such medications (χ^2=0.344; p=0.558), thus indicating that this did not interfere in the prevalence found.

The distribution of the serum retinol levels according to age group did not reach statistical significance. Nonetheless, the children aged 6 to 24 months presented a higher proportion (34.8%) of low and deficient serum retinol levels (defined as <0.70 µmol/l) than among the children aged 25 months or over (30.5%) (Table 1).

It was seen that the distribution of low and deficient serum retinol levels according to the mother's schooling diminished as the schooling increased. However, no statistical significance was detected between these variables (Table 1); a similar condition was observed in relation to the mother's age.

Severe and moderate anthropometric deficits (<-2 z-scores) were identified in 10.0 and 11.5%, respectively, of the preschool children investigated, when evaluated according to the weight-for-age and height-for-age indicators. Among the children with a deficit in relation to the weight-for-age indicator, 49.2% presented vitamin A deficiency. Among eutrophic children, this prevalence dropped to 30.2% (Table 1). Deficits in the weight-for-age indicator (OR=2.235; 95% CI: 1.31-3.81) were shown to be associated with deficient serum retinol levels in the bivariate analysis (Table 1). Although no statistically significant association was observed between the height-for-age indicator and serum retinol levels, it was noted that children with a deficit in this indicator presented a greater chance of having inadequate serum retinol levels than did eutrophic children (OR=1.477; 95% CI: 0.88-2.46).

When the per capita family income was taken into

Table 1 - Distribution of retinol levels and raw odds ratio (OR) for the association between hypovitaminosis A and the biological, nutritional and social variables among preschool children. Sergipe, 1998.

Variables	N	%	Serum vitamin A level (<70 µmol/l) Raw OR	95% C.I.		p-value
Age (in months)						
6 to 24	78	(34.8)	1	-	-	
25 to 60	117	(30.5)	0.823	0.580	1.169	0.2769
6 to 60	195	(32.1)				
Total (N=607)						
Child's gender						
Male	107	(34.2)	1	-	-	
Female	88	(29.9)	1.216	0.864	1.711	0.2623
Total (N=607)						
Height-for-age anthropometric indicator						
≥-2 (z score)	167	(31.1)	1	-	-	
<-2 (z score)	28	(40.0)	1.477	0.885	2.464	0.1353
Total (N=607)						
Weight-for-age anthropometric indicator						
≥-2 (z score)	165	(30.2)	1	-	-	
<-2 (z score)	30	(49.2)	2.235	1.310	3.812	0.0032
Total (N=607)						
Mother's age (in years)						
20 to 29	103	(31.1)	1	-	-	
≥30	69	(32.7)	1.242	0.709	2.176	0.4494
<20	23	(35.9)	1.068	0.738	1.546	0.7269
Total (N=606)						
Mother's schooling (years of study completed)						
≥5 years	78	(28.6)	1	-	-	
1 to 4 years	90	(35.3)	1.144	0.525	2.492	0.7349
Never studied	26	(33.8)	1.268	0.678	2.369	0.4572
Total (N=605)						
Per capita family income (minimum salaries)						
≥0.50	27	(21.6)	1			
0.50 to 0.25	47	(32.4)	1.741	1.004	3.017	0.0482
<0.25	77	(34.2)	1.888	1.137	3.136	0.0140
Total (N=495)						

consideration, a higher prevalence of serum retinol deficiency was observed among the children who were classified in the lower family income categories (Table 1). Bivariate logistic regression analysis indicated that per capita family income situated both in the range of 0.50-0.25 of a minimum salary (OR=1.741; 95% CI: 1.004-3.017) and the range below 0.25 of a minimum salary (OR=1.888; 95% CI: 1.137-3.136) were associated with a deficit in serum retinol levels (Table 1).

After adjusting the model to include only the variables for which the p-value was less than 30 in the bivariate analysis, the weight-for age anthropometric indicator and per capita family income remained included. Although the category of the mother's schooling presented a p-value greater than this, it was kept in the model because of the known association between the mother's schooling and the child's nutritional state. In fact, this procedure provided better adjustment and statistical significance for the model. Thus, after the adjustment procedures, it was observed that a deficit in the weight-for-age anthropometric indicator (defined as <-2 z-scores) raised the risk that the child would present inadequate vitamin A levels, in comparison with eutrophic children, by a factor of 2.22 (95% CI: 1.035-4.761) (Table 2).

It was also noted that the chance that the child would present inadequate vitamin A levels was 1.87 times greater (95% CI: 1.086-3.208) when the per capita family income was situated below 0.25 of a minimum salary, in comparison with children whose families had per capita incomes greater than or equal to 0.50 of a minimum salary (Table 2).

Table 2 - Adjusted* odds ratio (OR) for the association between hypovitaminosis A and the biological, nutritional and social variables among preschool children. Sergipe, 1998.

Variables	Serum vitamin A level (<70 µmol/l) Adjusted* OR	95% C.I.		p-value
Weight-for-age anthropometric indicator				
≥-2 (z score)	1	-	-	-
<-2 (z score)	2.22	1.035	4.761	0.041
Per capita family income**				
≥0.50	1	-	-	
0.50 to 0.25	1.76	0.098	3.125	0.051
<0.25	1.87	1.086	3.208	0.024

*Adjusted for mother's schooling, child's gender and age, and height-for-age indicator
**In minimum salaries

DISCUSSION

Taking into consideration the revised WHO criteria[15] (1996), the prevalence of inadequate vitamin A levels detected in this population (32.1%) implies that vitamin A deficiency is an important health problem in the State of Sergipe.

The results obtained provide evidence that vitamin

A deficiency is also a public health problem for yet another state in the northeast of Brazil, of dimensions that were, until now, unknown. For other states in this region, vitamin A deficiency has already been mapped out in some geographical areas. From a study selecting a representative sample of the under-five population in the State of Pernambuco, it could be seen that 19.3% of these children had serum retinol levels of less than 0.70 µmol/l, and that 3% presented levels of less than 0.35 µmol/l (INAN/MS-IMIP,[7] 1998). This is therefore a public health problem for that state. In the State of Bahia, Santos et al[11] (1996), in a study carried out in the semi-arid zone among children aged zero to 72 months, concluded that the lack of vitamin A could be considered an important health problem in infancy, both because of the prevalence of inadequate retinol levels (54.7%), and because of the magnitude of dietary insufficiency. Assis et al[1] (1997), investigating children aged 6 to 72 months in localities within the same region of the state, found similar prevalences: 40.4% of the children had serum retinol levels that were considered low (0.35-0.69 µmol/l), and 4.3% had levels considered deficient (<0.35 µmol/l). Only the results obtained by Diniz[4] (1997), in a study using a representative sample of children aged less than five years in the State of Paraíba, have shown that vitamin A deficiency could be classified within the threshold of endemicity (prevalence of 16.0%). The author attributed this lower prevalence to the periodic campaigns for administering massive doses of vitamin A in that state.

The present results indicate that the occurrence of vitamin A deficiency among preschool children in the State of Sergipe is similar to what is observed in other states in the northeastern region. The results reinforce the argument that this deficiency constitutes an important public health problem in the northeast of Brazil. They put forward evidence that this group of children is exposed to higher risks of morbidity-mortality during infancy, given the protective role that vitamin A plays in the survival of preschool children (Beaton et al,[3] 1993).

Family income is an indicator of structural processes in society and constitutes a determining factor for the health and nutrition conditions of children and their families. Thus, conditions of poverty represent risk factors for a series of nutritional deficiencies, including vitamin A deficiency (ACC/SCN,[10] 1997). In the present study, the per capita family income showed an inverse association with the serum retinol levels, thus indicating that, as the per capita family income decreases, the risk of vitamin A deficiency among preschool children increases. In particular, income of less than 0.25 of a minimum salary, even when adjusted for the other variables in the model, remained as a predictor for such deficiency.

In addition to the economic and structural factors of the society in which the child and its family live, other factors connected with conditions of morbidity also contribute towards the depletion of serum retinol levels. Prominent among these are infections that increase the requirement for or stimulate the endogenous loss of this micronutrient, and also protein energy malnutrition, which affects the synthesis of retinol binding protein (RBP). This protein has a short half-life (Lee et al,[8] 1993), thus diminishing the availability of retinol. In the present study, a statistically significant association was observed between serum retinol levels and anthropometric state when evaluated using the weight-for-age indicator. This indicated that low weight increased the chance that the child would present depleted serum retinol levels by a factor of 2.22.

Over recent decades, a significant reduction in the mortality rate and malnutrition prevalence during infancy has been observed in Brazil. Nonetheless, the conditions of life, health and nutrition among children in the northeastern region continue to be precarious (Unicef,[13] 1995) and these conditions have been manifested in the high rates of micronutrient deficiency, particularly in relation to vitamin A and iron.

It must furthermore be taken into consideration that children who present a specific deficiency in one micronutrient normally have multiple deficiencies. Malnutrition may also be associated with other socioeconomic factors that contribute towards increasing the weight-height deficit of such children.

These results provide strong evidence of the need for strengthening and organizing healthcare actions so as to make them more effective, through the systematization of prevention and treatment measures, in order to reduce the prevalence of vitamin A deficiency.

ACKNOWLEDGEMENTS

To the Health Department of the State of Sergipe, for its institutional support and collaboration.

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