Prevalence and factors associated to vitamin A deficiency in children attending public day care centers in the Southwest of Bahia

Taiane Gonçalves Novaes [1]
Andressa Tavares Gomes [2]
Karine Chagas Silveira [3]
Cláudio Lima Souza [4]
Joel Alves Lamounier [5]
Michele Pereira Netto [6]
Flávio Diniz Capanema [7]
Daniela da Silva Rocha [8]

[1,2,3,4,8] Universidade Federal da Bahia. Instituto Multidisciplinar em Saúde. Campus Anísio Teixeira. Rua Rio de Contas, 58. Quadra 17, Lote 58. Candeias. Vitória da Conquista, BA, Brasil. CEP: 45.029-094. E-mail: drochaufba@gmail.com
[5] Universidade Federal de São João del-Rei. São João del-Rei, MG, Brasil.
[6] Universidade Federal de Juiz de Fora. Instituto de Ciências Biológicas. Departamento de Nutrição. Juiz de Fora, MG, Brasil.
[7] Fundação Hospitalar do Estado de Minas Gerais. Belo Horizonte, MG, Brasil.

Abstract

Objectives : to determine the prevalence of vitamin A deficiency and factors associated to children attending public day care centers in the Southwest of Bahia.

Methods: a cross-sectional study involving 303 children aged 24 to 60 months attending public day care centers in the city of Vitória da Conquista, BA. A questionnaire was applied for the parents or legal guardians to answer and the children´s height and weight were measured. Blood samples were collected to analyze serum retinol taking in consideration the values below 0.70 µmol/L as inadequate. The vaccination card was verified in relation to the adequacy of vitamin A supplementation. Food weighting was done to evaluate the consuming of lipids and vitamin A. The association between the variables and vitamin A deficiency was verified by logistic regression.

Results: the prevalence of inadequate serum retinol levels was 13.1% (1.99 ± 1.17 µmol/L); 4.3% were low height and 1.2% of thinness. Most children (91.7%) had their vitamin A doses outdated on their vaccination cards. The variables associated to vitamin A deficiency were children aged less or equal to 34 months (OR: 2.66, 95% CI: 1.23 - 5.74) and maternal age was less than 26 years (OR: 2.39; 95% CI: 1.11 - 5.17).

Conclusions: vitamin A deficiency configures as a moderate public health problem in children attending public day care centers in the Southwest of Bahia.

Key words *Vitamin A deficiency, Preschool child, Nutritional status, Risk factors*

Introduction

Vitamin A is a nutrient that presents extreme importance functions associated to growth, immune system, differentiation processes and epithelial maintenance and integrity of the ocular globe.[1] The most vulnerable groups to vitamin A deficiency (DVA) are infants and preschool children, but its occurrence can extend from school age and to adulthood.[2] Among the changes occurred , there are those that affect the vision and may evolve to irreversible blindness; growth and development impairment and the reduction in resisting infections.[3]

Vitamin A deficiency can be triggered due to some factors, such as the early weaning or absence of breastfeeding, the insufficient consumption of food rich in vitamin A and/or insufficient intake of food rich in fat, the presence of frequent infections, socioeconomic conditions, the lack of sanitation and in addition to the accelerated growth and development in the phase of life.[4,5]

DVA is considered a public health problem due to the high prevalence and severity of consequences.[6] Review studies on vitamin A deficiency in children younger than six years old showed rates between 16 and 74%,[7] this may be a cause for concern[8] and is a severe public health problem in the North, Northeast and Southeast regions of Brazil, making the children form the Northeast the most vulnerable to endemic deficiencies.[9,10]

However, there are a few studies in Bahia and those that exist are dated back to more than 10 years ago. In addition, there were no studies conducted in the city of Vitória da Conquista, the third largest city in Bahia, characterized as an endemic area for hypovitaminosis A. Thus, this study aimed to assess the prevalence of hypovitaminosis A and factors associated in children aged from 24 to 60 months attended at day care centers in the city of Vitória da Conquista, Bahia.

Methods

This is a cross-sectional study with probabilistic sample representing all public day care centers in the urban area affiliated to the City Hall in the city of Vitória da Conquista, BA, in the period of February to November 2012.

Vitória da Conquista is the third largest city in the state of Bahia with an estimated population of 340,199 inhabitants. Located in the Southwest of Bahia, 503 km from the capital, Salvador, it has one of the fastest growing Gross Domestic Product (PIB) in the countryside of the State and a human development index (IDH) of 0.67812.[11]

The sample was calculated by taking the total number of children aged between 24 to 60 months regularly enrolled full-time at the 20 public day care centers in the city (n=3869). For the calculation of the sample, the prevalence of hypovitaminosis A (17.4%)[12] was taken into consideration; a precision of 5% and a 95% of confidence interval resulted in 206 children. Also, considering a possible loss of 20% in the samples, so therefore, totaling a minimum sample size of 250 children to be studied. The inclusion of the children was randomly drawn by the use of Microsoft Office Excel.

As the inclusion criterion considered children aged between 24 to 60 months and that continued to be full-time at the day care. The children who presented C Reactive protein (PCR) >10 mg/dL were excluded from the study because retinol binding protein reduces during the acute phase, and thus the inflammatory changes resulting in a decrease of the concentration of this protein and plasma retinol.[13]

All data were collected at the day care centers through the application of a structured questionnaire for the children´s parents or guardians to answer, containing information about the identification of the child, socioeconomic conditions and maternal variables. The children´s vaccine card was assessed in relation to the adequacy of vitamin A supplementation in the last six months prior to the survey.

The anthropometric measurements consisted the children´s weight and height with the help of Marte® an electronic scale (capacity to weigh someone up to 200 kg and its sensitivity of 50g) and a portable stadiometer, Alturexata® (35 to 213cm and 1mm of accuracy) using standardized norms, according to the procedures established by the World Health Organization.[14] The nutritional status was assessed according to the height/age (E/I) and weight/height ratio (P/E), expressed as Z score. To assess the inadequacy of the nutritional status, the -2 Z score was used as a cut-off point, classifying in low height for the E/I index and P/E for thinness; and as for population reference, the growth curves of the World Health Organization was adopted.[15] The anthropometric data analysis were performed with the help of the *WHO Anthro software* version 3.2.2.

To assess food intake was performed by direct dish weighing offered during three non-consecutive days in all the day care centers, using the Marte® food scale with a capacity for 3.200 grams and a precision of 0.01 grams. All the food preparation offered during the day was weighed before being served, in addition weighing leftovers and seconds of each dish to evaluate the real consumption of the

children. A total of 900 dishes was assessed (15 dishes/day care x 3 days x 20 day care centers). The assesses on centesimal composition of lipids and vitamin A was performed on the *Avanutri software* version 3.1.4. The adequacy of food intake was calculated on the basis of the Resolution/CD/FNDE number 26, dated June 17, 2013[16] which recommends a 70% of daily requirements of nutrients for children attending full-time basis; and the age groups used were 1 to 3 years old and 4 to 5 years to calculate the adjustments.

Blood samples were collected from children at the day care after fasting for 8 hours by an adequately trained team to evaluate retinol and PCR. The blood tubes were wrapped in aluminum foil to prevent the degradation of the retinol viewing its photosensitivity, and the analyzes were performed in the Clinical Analysis Laboratory in the city. The methods used to evaluate retinol and PCR levels were high performance liquid chromatography and nephelometry, respectively. The cut-off points for serum retinol levels were: poor: <0.35 µmol/L, low: 0.35 to 0.69 µmol/L, acceptable: 0.70 to 1.04 µmol/L and normal: ≥1.05 µmol/L. Retinol values less than 0.70µmol/Lwas considered as inadequate.[2]

The statistical analyzes were performed with the help of the *Statistical Package for Social Sciences software* (SPSS) version 17.0.[17] To compare the prevalence of vitamin A deficiency according to the characteristics of the studied population, it was applied the chi-square (χ^2) or Fisher's exact test. The magnitude of the association between the risk factors and the occurrence of hypovitaminosis A is expressed as *odds ratios* (OR) and its respective confidence intervals (95% CI). Initially it was considered as a dependent variable of the vitamin A deficiency (retinol inferior to 0,70µmol/L). In the univariate analysis, it was considered as independent variables related to the children: age (25th percentile), gender, length of time in the day care, height-for-age (E/I), receiving the appropriate mega dose of vitamin A (present on the vaccine card), vitamin A intake in food, intake of lipids provident of the food, exclusive breastfeeding, presence of disease and the occurrence of hospitalization. The variables regarding mothers and socioeconomic conditions and family were: mother's age (median), number of children, monthly income per capita (R$70.00), monthly family income in minimum salary during the period of the study (R$622.00), maternal schooling and paternal job.

The multivariate analysis came from the inclusion of variables with $p<0.20$ in the univariate analysis; right after the logistic regression of *backward* technique was used, and slowly the variables less significant was removed until a final model with all the significant variables stayed, finalizing a model to better explain independently the factors associated to vitamin A deficiency. To assess the adequacy of the multivariate model, the Hosmer and Lemeshow test was used. Considering a significant association between the variables with a *p value* <0.05.

This research project was approved by the Ethics Committee on Human Research, at Universidade Estadual do Sudoeste da Bahia, protocol number: 020/2011. The children´s parents or guardians signed the Informed Consent Form. The nominal data were kept in secrecy and the children´s parents or guardians had access to the results of exams.

Results

The data was collected from 303 children aged between 24 to 60 months attending public day care centers full time in the city of Vitória da Conquista. Of these, 44 children were excluded (14.5%),they presented PCR > 10 mg/dL, totaling 259 evaluated children and 53.7% were males, average age of 38.7±6.7 months. As for the monthly family income, 35% received less than the minimum wage and 48.2% had a family *per capita* income of less than 1/4 of the minimum wage. Almost half of the children (45.9%) went to day care center for a period less than three months and the median time at the day care is equivalent to 2.89 months. As to schooling, the average year for mothers to study (8.09 ± 3.2 years) was higher than the parents (7.17 ± 3.8 years).

Deficiency of serum retinol levels were found in 2.3% of preschool children (<0.35 µmol/L), 10.8% had levels were considered to be low (0.35 to 0.69 µmol/L), 17% were acceptable levels (0.70 to 1.04 µmol/L) and 69.9% were normal levels (≥1.05 µmol/L). Thus, the prevalence of inadequate levels of retinol (<0.70µmol/L) was 13.1% with an average of 1.99±1.17 µmol/L.

As for vitamin A supplementation in doses proposed by the Ministry of Health in the last six months, most of the children (91.7%) presented their vaccine card outdated and among these children, the prevalence of hypovitaminosis A was 14.2%.

The prevalence of nutritional deficits (<-2 Z score) in the studied population were 4.3% with low height and 1.2% of thinness.

As for food consumption in the day care center, 75.8% of the children consumed adequate amounts of vitamin A in relation to the National School Meal

Program (PNAE) recommendation and only 31.3% of the children consumed adequate amounts of lipids.

The prevalence of vitamin A deficiency was higher in children aged less than or equal to 34 months, enrolled at the day care center less than three months, low height for the age and who did not receive the mega dose of vitamin A, however these differences were significant only for the child´s age variable (Table 1).

In Table 2 the variables expressed are related to maternal characteristics, socioeconomic and family and found higher prevalence of DVA in children whose mothers were less than 26 years old and had three children or less.

Using the logistic regression analysis, the variables that remained significant in association to inadequate serum retinol levels were the child and mother's ages. It was observed that children with less than or equal to 34 months showed 2.66 (CI 95%: 1.23 - 5.74) times of having inadequate retinol levels when compared to children over the age of 34 months. In addition, children whose mothers were younger than 26 years of age presented 2.39 times (CI 95%: 1.11 - 5.17) of having inadequate retinol levels (Table 3).

Table 1

Prevalence of vitamin A deficiency, gross *odds ratio* and confidence interval (CI95%) according to the characteristics of children under five years of age attended in public day care centers in Vitória da Conquista, Bahia, 2013.

Variable/Category	Total (N)	Vitamin A deficiency (%)	*Odds ratio* (gross)	CI 95%	*P*
Age (months)	259			1,28-5.68	0.009
≤34		22.7	2.69		
>34		9.8	1		
Length of time at day care (months)	257			0,94-4,08	0.072
<3		17.5	1.96		
≥ 3		9.8	1		
Height-for-age (E/I)	258			0,66-10.38	0.164*
< -2.0 Z score		27.3	2.61		
≥ -2.0 Z score		12.6	1		
Mega dose of vitamin A updated	253			0,43-25,55	0.193*
No		14.2	3.32		
Yes		4.8	1		
Vitamin A from food	252			0,32-1,91	0.596
<100% recommendation		11.5	0.79		
≥100% recommendation		14.1	1		
Exclusive breastfeeding	255			0,48-2,89	0.728
No		14.9	1.17		
Yes		13.0	1		
Gender	259			0,54-2,29	0.781
Male		13.7	1.11		
Female		12.5	1		
Lipids from food	252			0,50-2.45	0.793
<100% recommendation		13.9	1.11		
≥100% recommendation		12.7	1		
Hospitalization	256			0,48-2.03	0.963
Yes		13.2	0.98		
No		13.4	1		

* Fisher's exact test.

Table 2

Prevalence of vitamin A deficiency, gross *odds ratio* and confidence interval (CI 95%) according to maternal characteristics, socioeconomic and family of children under five years of age attended at public day care centers in Vitória da Conquista, Bahia, 2013.

Variable/Category	Total (N)	Vitamin A deficiency (%)	*Odds ratio* (gross)	CI 95%	*P*
Mother's age (years)	243			1,18-5.40	0.017
<26		19.6	2.52		
≥26		8.8	1		
Number of children	256			0.52-0,98	0.019*
>3		4.0	0.23		
≤3		15.5	1		
Per capita income	245			0,49-3,94	0.535
<R$70.00		16.1	1.39		
≥ R$70.00		12.1	1		
Paternal Job	224			0,31-4,05	0.539*
No		13.6	1.12		
Yes		12.4	1		
Family income (minimum wage)	246			0,55-2,61	0.640
<1		14.0	1.20		
≥ 1		11.9	1		
Maternal schooling (years)	253			0,42-1.83	0.715
<8		12.5	0.87		
≥ 8		14.1	1		

* Fisher's exact test.

Table 3

Determinants factors of vitamin A deficiency in children under five years of age attended at public daycare centers in Vitória da Conquista, Bahia, 2013.

Variable/Category	Total (N)	Vitamin A deficiency (%)	*Odds ratio* (gross)	CI 95%	*P*
Child´s Age (months)	259			1,23-5,74	0.012
≤34		22.7	2.66		
>34		9.8	1		
Mother's age (years)	243			1,11-5,17	0.027
<26		19.6	2.39		
≥26		8.8	1		

Discussion

Vitamin A deficiency represents an is endemic problem in large parts of Brazil as in the Northeast, North and South and the infant population in the Northeast stands out as the most vulnerable to this deficiancy.[18] The prevalence of 13.1% of the inadequate retinol levels (<0.70 μmol/L) found in the present study characterizes moderate public health problem in the studied population, according to the World Health Organization criteria.[2] This result was similar to another study conducted with preschool children in the state of Piaui,[19] confirming the data of a literature review on micronutrient deficiency in Brazilian children attending day care found an average prevalence of 12.5% of vitamin A deficiency.[20] On the other hand, some studies have found the prevalence of superior hypovitaminosis[9,10,21,22] as well as the National Survey on Demographics and Child and Woman Health (PNDS) with a prevalence of 17.4% higher in the Northeast (19.0%) and the Southeast (21.6%) of Brazil.[12] The differences in prevalence rates may be associated to the children´s age range although studies that work with infants have greater prevalence in relation to preschool children.[21] It is important to highlight the influence of the infectious process in the nutritional status of vitamin A. Studies show an overestimation of 2.0 to 4.6% in the prevalence of hypovitaminosis A when infants have an infection.[22-24]

Due to the impact of vitamin A deficiency the National Program for Vitamin A Supplementation was established according to the number of the document: 729/2005 with the goal to prevent and controll this deficiency. The program distributes mega doses of vitamin A for children under five years of age and women in post partum immediately to those belonging in endemic areas of vitamin A deficiency which constitutes the Northeast Region, the Vale do Jequitinhonha in Minas Gerais and in the Vale do Ribeira in São Paulo.[25] The city of Vitória da Conquista is situated in an endemic area for hypovitaminosis A and should be distributed by the Vitamin A Program, but 91.7% of the children did not receive the supplementation for the past 6 months, indicating inadequate coverage of the program in the city. There was no association statistically significant differences found in the previous supplementation of vitamin A with inadequate levels of serum retinol according to another study,[21] however, other studies found benefits in the supplementation of vitamin A.[19,26] In this present study preschool children were assessed probably already received the preventive supplementation for a longer time, so the delay on the last dose could not interfere in the stocks of vitamin A. This study did not investigate the reason for high inadequacy in relation to the coverage of vitamin A supplementation, however many mothers reported lack of vitamin A in the health units.

Among the factors associated to vitamin A deficiency, what withstands is the child´s age that was associated to low levels of retinol. Given this corroborated by a study conducted with preschool children in Piaui[19] where it demonstrated an inverse relationship between the child's age and the prevalence of inadequate levels of retinol, on the other hand, the prevalence of vitamin A deficiency is reduced with the increase of the child´s age. Some authors explain this association to the increased susceptibility of young children to intestinal infections and respiratory diseases that affect the nutritional status of vitamin A, in addition to the dietary pattern that is affected by several factors, such as the family influence and the educational institution and the quality of diet tend to improve with age.[19,27]

The prevalence of teenage mothers was small in this study (8.6%), so the risk associated to the maternal age was present in mothers younger, a median of 26 years old and there was a significant association to maternal age with serum levels of retinol. A study conducted in the state of Pernambuco has also found significant association between maternal age and vitamin A deficiency.[28] The reasons for this are not established clearly in literature and this association is not a consensus, although some explanations are associated to the worst maternal nutrition and low socioeconomic status, in addition to the lack of experience of mothers in caring for their children.[29]

As well as other deficiencies problems, vitamin A deficiency is associated to socioeconomic factors and more prevalent in less fortunate regions.[10,19] However, no association was found on income with inadequate levels of retinol in this present study, similar found in other studies.[3,21,26,28] It is likely that the homogeneity displayed by the studied population has made it difficult to identify these statistical associations. In addition, one may speculate that these children remain most of the days in the week at the day care centers, where they receive food and care, the socioeconomic factors role has its influence reduced.

Vitamin A deficiency can result from a poor diet and which the hepatic reserve of vitamin A are maintained making it essential food consumption from its sources.[3] It is also necessary adequate intake of lipids, because vitamin A is a fat-soluble vitamin and requires the presence of lipids in its proper absorption. It would be expected that low intake of vitamin

A and lipids show association to low levels of serum retinol levels, but no significant association was identified in the studied children. The serum retinol levels suffer the influence of homeostatic control, reflects on the nutritional status of vitamin A only when the hepatic reserves are too high or too low.[30] It is worth knowing that in spite of children having most of the meals at daycare centers because they are there at full-time basis, it was not considered in this present study, food consumption at homes could interfere with the results. In addition, some criticisms have been made about the assessment of food intake, such as data limitation only on consumption without the information on absorption and the use of biological nutrient.[6]

Vitamin A deficiency is still a public health problem, given to the facts that the indices have presented moderate in endemic areas. Special attention should be devoted to children aged 6 to 59 months, who are more vulnerable to the problem, and then they are the target in the National Program of Vitamin A Supplementation. Therefore, it is important to emphasize a regular evaluation of the problem, the development of activities on nutritional education towards managers, parents and/or guardians of the children, as well as the maintenance of the program of supplementation of mega doses of vitamin held in the basic health services.

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