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PREVALENCE OF VITAMIN A DEFICIENCY AMONG PRE-SCHOOL AND SCHOOL-AGED CHILDREN IN ARSSI ZONE, ETHIOPIA
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Y.T. ASRAT, A.M. OMWEGA and J.W.G. MUITA

ABSTRACT

Objective: **To investigate vitamin A status of pre-school and school aged children in the study area.**
Design: **Cross-sectional.**
Setting: **Arssi, Ethiopia.**
Subjects: **Four hundred and two children.**
Results: **Night blindness, Bitots spot, corneal xerosis, corneal ulceration and corneal scar were observed in 7.2%, 2.2 %, 0.2%, 0.5%, and 0.5% of the children respectively. The prevalence of xerophthalmia was higher in school aged children than pre-school children (P< 0.0001). Based on the WHO recommended cut-off level, serum retinol levels were in the "low" range (<20µl/dl) in 51% of the children.**
Conclusion: **The results indicate that vitamin A deficiency (VAD) is a public health problem in Arssi, with higher prevalence among school aged children than pre-school children.**

INTRODUCTION

Pre-school children are the most susceptible group to vitamin A deficiency because of their higher requirements per body weight and higher incidence of infections and infestation(1). Mclaren and Frigg(2) indicate that school aged children are also vulnerable to vitamin A deficiency due to increased requirement to growth, especially during the adolescent growth spurt. Although mortality rates in school aged children is low compared to pre-school children, frequent morbidity occurs among school-aged children, notably, upper respiratory tract and febrile parasitism, and diarrhoea. Studies conducted in two African countries showed that VAD is a significant public health problem in school aged children(3). In Ethiopia, Studies conducted among pre-school children have demonstrated that the prevalence of xerophthalmia increases with age(4,5). Furthermore, other studies have shown that corneal ulceration reaches its maximum in the fifth and sixth year of life(6) and xerophthalmia reaches its peak in children aged 60 to 72 months(7). These findings suggest that vitamin A deficiency could be a public health problem among the school aged children in Ethiopia. Yet, information on vitamin A status of school aged children in Ethiopia is rather scarce. Lack of such data may have lead to the current situation whereby the on-going VAD control program in Ethiopia focuses only on under six years old children. This study was therefore designed to investigate the vitamin A status of both pre-school and school aged children in order to meet this need. The study was conducted in Tedecha Guracha and Badosa Betela farmers associations, Dodotana Sire weeda, Arssi zone, central Ethiopia.

MATERIALS AND METHODS

Study design: In this cross sectional study a total of 402 children between the age of six months and fifteen years were studied.

Sampling: The Multistage, cluster sampling technique was used in selecting the study population. Of the 20 districts of Arssi zone Dodotana Sire district was selected at random for this study. The district has three towns and 43 farmers associations. The three towns of the district were purposely excluded from the sampling frame in order to get homogeneous group. Of the 43 farmers associations two farmers associations were selected randomly. Census was carried out in the selected two farmers associations. Households with at least one under fifteen years old child were identified and grouped into clusters based on their geographical proximity. A total of 15 clusters were formed. Of these four clusters were randomly selected and a maximum of three children aged between six months to fifteen years per household were included in the study until the required sample size was achieved.

Data collection: Information on the children's age, sex, history of breastfeeding, time of introduction and type of supplementary foods was collected by administering a pre-tested questionnaire to mothers or care-givers (for children under six years old) and to the children and their mothers or care-givers in case of children older than the age of six years.

Ophthalmological examination: House to house ophthalmological examination for signs and symptoms of xerophthalmia was conducted on all the sampled (402) children. The assessment was carried out using different stages of xerophthalmia. All clinical examinations were done by the principal investigator (though not an ophthalmologist, he has been trained on the use of standard diagnostic criteria of xerophthalmia and has got extensive field experience in diagnosis of xerophthalmia through working with ophthalmologists and conducting field survey for a number of years). After the completion of the study therapeutic dose of vitamin A capsules were given to all clinically positive children.

Serum retinol Measurement: Effort was made to perform blood analysis on all children with clinical signs of VAD and in every 20th child. However, the analysis was not possible on 14 subjects due to refusal to give blood, haemolysis or recovery of inadequate quantities of serum.

Venous blood (5-10ml) was collected by venous puncture without anticoagulant using vacutainer system (venoject; Terumo, Belgium). The blood sample collected in a venoject wrapped in aluminum foil (to protect vitamin A from light) and stored in cool box and transported to the field laboratory established at Dera Health Center and centrifuged within three hours. The serum samples were collected into cryo vials covered with aluminium foil and frozen using the refrigerator at the Health Center and transported to the Ethiopian Health and Nutrition Research Institute (EHNRI) in a cool box containing dry ice. The serum samples were stored in the dark at 20°c until analysis.

The serum retinol was determined by high pressure liquid chromatography (HPLC) using the method of Bieri *et al*(8). 100 μl serum was transferred to 10 x 75 mm glass test tubes. A known concentration of internal standard (retinyl acetate) and 90μl of absolute ethanol were added to each sample and mixed gently on vortex mixer. After that about 500μl hexane (HPLC grade) was added and mixed with vortex mixer for one minute. It was then centrifuged for 5 min at 3000 rpm to separate the phases. The hexane layer was taken out very carefully and transferred into another tube and evaporated under a gentle stream of nitrogen gas. It was then reconstituted in 55μl of MeOH (HPLC grade) and 50 μl was injected on HPLC. The mobile phase was MeHO: H2o (95:5), flow rate 1.5 ml/minute and the column was reverse phase C18. After each injection of samples or standards the loop was cleaned three or more times with MeOH A series of retinol standards (prepared by serial dilution) and a known concentration of internal standard (which was constant) were prepared and 50 μl of each were injected three times. Retinol, which was eluted as a sharp peak within one to six minutes, was detected by a sensitive UV detector set at 325-328nm. Retinol was quantified by use of a peak area ration relative to an internal standard.

Data Processing: The SPSS for Windows version 7.5 was used for all data entry and analysis.

Appropriate statistical methods were used to assess the level of significance between and among variables used in the analysis. Chi-square was used to assess level of significance between proportion. Unpaired t-test was used to compare mean serum retinol values between boys and girls, and pre-school and school aged children.

RESULTS

Demographic Characteristics: A total of 402 children were investigated in the study. Age and sex distribution of the study population is presented in Figure 1. The ratio of male to female was about 1:1. The mean age of male and female children were 6.3 ± 4 and 6.8 ± 4 years respectively. However, for the under-six years old children, the mean age was 2.9 ± 1.5 years while 3.0 ± 1.5 years for males and females, respectively. The mean age of school children was 9.7 ± 2.5 years while the average household size for the study villages was 5.7 persons.

Clinical examination of xerophthalmia: A total of 188 pre-school children and 214 school aged children were examined for ocular manifestations of vitamin A deficiency. The overall prevalence of xerophthalmia was 10.7%. The occurrence of acute and long-standing xerophthalmia in relation to age and sex is presented in Table 1, which presents the most severe signs.

Night blindness (XN), without other signs of xerophthalmia was reported in 7.3 % of the boys and 7.1% of the girls. A further 1.9 % of boys and 1.5 % of the girls reported night blindness together with other more severe signs of xerophthalmia. The prevalence of Bitot's spot (X1B) was 2.4% in males and 2.0 % in girls. The Bitot's spot was bilateral in eight children and unilateral in one child. In addition, and though not specific for xerophthalmia, conjunctival xerosis (X1 A) was observed in 3.2 % of the children.

The two severe signs of active xerophthalmia (corneal xerosis and corneal ulceration) were exhibited together by 0.9% of the boys and 0.5% of girls. The corneal ulceration was unilateral in the boy and bilateral in the girl while the ulceration in both cases covered less than one third of the corneal surface (X3A). Corneal scar (XS) was seen in 0.48% in boys and 0.51% in girls. Both of the children with the scar were reported not to have a history of trauma or any other events which could have contributed to the scaring of the cornea. The corneal scaring was observed in one eye in the girl while it occurred in both eyes in the boy and involved more than one-third of the corneal, which meant the boy, was blind. Overall, a higher prevalence rate of xerophthalmia was observed in boys (11.1%) than girls (10.2%), however, this difference was not significant. Of the children who had the ocular symptoms and/or signs, only 16 % were below the age of six years. This difference is statistically significant ($p<0.0001$). In addition all the severe forms of xerophthalmia were observed in school aged children. No xerophthalmic child was observed below the age of two years.

Figure 1

Study subjects by age and sex

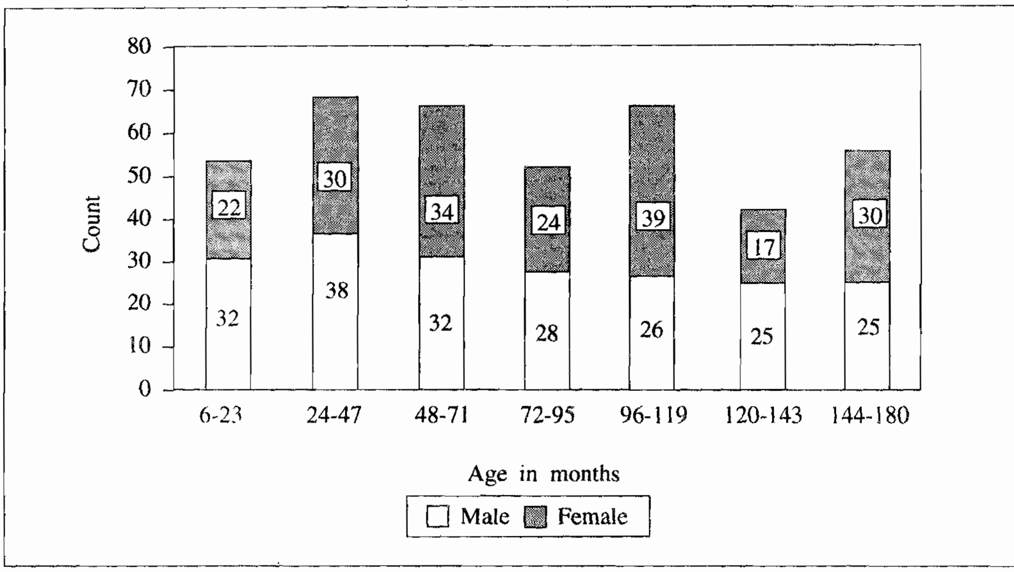

Table 1

Distribution of clinical symptoms and signs of xerophthalmia by age and sex

Symptom /Sign	Sex	Age (months) <24	24-47	48-71	72-95	96-119	120-143	144-180	Total
Night blindness	M	0	2	2	3	2	1	5	15
	F	0	1	1	1	4	4	3	14
	M+F	0	3	3	4	6	5	8	29
Bitot's Spot	M	0/0[a]	0/0	0/1	0/1	0/1	0/0	1/1	1/4
	F	0/0	0/0	0/0	0/1	0/1	0/0	0/2	0/4
	M+F	0/0	0/0	0/1	0/2	0/2	0/0	1/3	1/8
Corneal xerosis	M	0/0	0/0	0/0	0/0	0/0	0/1	0/0	0/1
	F	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0
	M+F	0/0	0/0	0/0	0/0	0/0	0/1	0/0	0/1
Corneal ulceration	M	0/0	0/0	0/0	1/0	0/0	0/0	0/0	1/0
	F	0/0	0/0	0/0	0/0	0/0	0/0	0/1	0/1
	M+F	0/0	0/0	0/0	1/0	0/0	0/0	0/1	1/1
Corneal Scar	M	0/0	0/0	0/0	0/0	0/0	0/1	0/0	0/1
	F	0/0	0/0	0/0	0/1	0/0	0/0	0/0	0/1
	M+F	0/0	0/0	0/0	0/1	0/0	0/1	0/0	0/2
Total eye symptoms & signs	M	0	2	3	5	3	3	7	23
	F	0	1	1	3	5	4	6	20
	M+F	0	3	4	8	8	7	13	43
Total examined	M	32	38	32	28	26	25	25	206
	F	22	30	34	24	39	17	30	196
	M+F	54	68	66	52	65	42	55	402

[a]Monocular/binocular respectively

Biochemical Assessment: Serum retinol level was deficient (<10μg/dl) in 8.2 %, low (10μg/dl-20μg/dI) in 42% and normal (>20μg/dl) in 49% of the children. This is based on the previous WHO classification. However, recent WHO report recommends that a cut-off level of <20μg/dl for serum retinol be used and that the prevalence value below the cut-off be ranked to indicate the degree of public health significance(9). According to this cut-off value 51 % of the children had low serum retinol level.

The mean serum retinol level of the children was 22.15 (SD 10.7). The serum mean retinol level by age group and sex is presented on Table 2. There was no statistically significant difference between the sexes in the mean serum retinol levels (p>0.05). However, the mean serum retinol level of pre-school children was found to be significantly higher than school aged children (p<0.05).

Table 2

Mean serum retinol level of the children by sex and age group

Sex	Serum retinol level				
	Mean	SD	T	df	p
M	22.11	(11.19)			
F	22.20	(10.50)	-0.31	47	0.97
Age group					
Pre-school	29.34	(11.53)			
School-age	20.31	(9.80)	2.51	47	0.016

SD= Standard deviation
t = t-value
df=degrees of freedom
p = 2-tailed probability

Breastfeeding and Weaning Practice: Data on breastfeeding and weaning practice were collected from all children under three years. Of the mother's of these children 68.5% were breastfeeding their children. Further break down of the data by age group showed that all children below the age of one year and 91.7% of children between the age of 12 and 24 months were found to be breastfed at the time of this study. Even amongst the older children 28.6% of them were being breastfed. Of the mothers who were breastfeeding their children, 98.4% started giving their breast to the baby immediately after birth while the remaining 1.6% started one to three days later. No clinical symptoms and signs of xerophthalmia were recorded among the breastfed children.

The average age at which foods other than breast milk were introduced was 6.1 months. The main weaning foods were cows milk and porridge made from wheat or barley floor.

DISCUSSION

Prevalence of Vitamin A Deficiency: The threshold criteria developed IVACG(10) for determining vitamin A deficiency as a problem of public health significance are a prevalence of night blindness (XN), Bitot's spots (X1B), active corneal lesion (X2/X3A/X3B), and corneal scar (XS) exceeding 1%, 0.5%, 0.01% and 0.05%, respectively. The findings of the present study compared to the criteria is 7.2-fold for night blindness, 4-fold for Bitot's spots, 25- fold for corneal xerosis, 50-fold for corneal ulceration and 10-fold for corneal scar. These proportions signify the problem as being of public health significance in the area.

Studies conducted among pre-school children in Arssi zone in general and Dodotana Sire district in particular (the district where this study was carried out) reported considerably high prevalence rate of xerophthalmia. For example, in a community survey in the district bordering Arssi and Bale zones, Bitot's spots were seen in 5% of children aged between six months and six years, corneal xerosis and ulceration with keratomalacia in 0.8% and corneal scar in 0.5%(4). Tezera and Yonas (personal communications) found out an overall xerophthalmia prevalence of 9.2 % among children aged under six years in Dodota district. In the same period, an alarmingly high prevalence rate of xerophthalmia was recorded among the same age group in another village in the same district i.e a prevalence of night blindness, Bitot's spots, corneal ulceration and corneal scar at 17%, 26.5%, 2.7% and 0.7% respectively(7). It is therefore clear that unlike the previous studies, considerably lower prevalence rates of xerophthalmia were found in the present study among children aged between six months and six years which suggests that the VAD problem has substantially decreased in the area in this age group.

It has been stated that administration of mega dose of vitamin A has a 90% prophylactic efficacy for 4-6 months among recipient children against developing mild xerophthalmia and corneal disease and a more than four fold reduction in the prevalence of Bitot's spot(11). There is also evidence suggesting reduction of the prevalence of xerophthalmia(12). Hence, the observed encouraging results in decreasing VAD in the area can be attributed primarily to the universal vitamin A capsule distribution in the area in conjunction with polio eradication campaign.

On the other hand, although a number of studies have intimated that vitamin A deficiency may also be a public health problem among school aged children(7,13) no campaign has been mounted to supplement mega doses of vitamin A to this age group. This study clearly demonstrated that VAD is a significant public health problem among school-aged children in the study area. The high prevalence rate of xerophthalmia reported in the present study might be due to a chronic shortage of vitamin A rich foods in the area.

The prevalence of night blindness and Bitot's spots is almost equal in the two sexes, which is in accordance with the observations reported earlier in Ethiopia and elsewhere(6,7,14). Furthermore, no major difference in the relative effectiveness of vitamin A between the sexes was also demonstrated in supplementary trials(15). These observations are in direct contrast to reports which suggest greater vulnerability of boys to mild xerophthalmia than girls(4,16,17). However, there is no readily available explanation for the contrast, since the issue of male preponderance to mild xerophthalmia is not yet well understood and study findings on this line are inconsistent. In the literature, it has been indicated that in most societies children of both sexes are equally affected by active xerophthalmia (X2/X3A/X3B)(18). Although a similar finding was recorded in the current study, the numbers of children in the present study with these severe signs of vitamin A deficiency was too small for a definite conclusion to be made.

The extent of vitamin A deficiency in the study area is confirmed by the finding that 8.2 % of the children had serum retinol levels less than 10µg/dl which is higher than the threshold value (5% with less than 10µg/dl) set by WHO(19) in determining the public health significance of vitamin A deficiency. Even according to the recent WHO(19) recommended cut-off value of $\geq$ 20% for the population proportion low serum retinol levels (< 20µg/dl), the study population is severely vitamin A deficient, since 51% of the children had serum vitamin A concentration below 20µg/dl.

No statistically significant difference was observed in the mean serum retinol level of the sexes, which is well in agreement with the clinical findings. Comparison of mean serum retinol level by age groups, however, revealed that pre-school children had a significantly higher mean serum retinol level than that of school aged children ($p < 0.05$). This is not surprising, since pre-school children have been periodically supplemented with a mega dose of the vitamin.

Breastfeeding: Studies have shown that breastfed infants are protected from vitamin A deficiency(20). This might be partly due to the regular supply of preformed vitamin A in the milk. It may also be due to lower rate of infection compared with artificial fed children. Breast milk provides sufficient vitamin A to prevent clinical manifestation of vitamin A deficiency throughout the first year of life even in poorly-nourished populations(16). Such protection of breast milk against vitamin A deficiency in under-one year children was also reported from Ethiopia(4,7) and the Sudan(17). Similarly, in the present study, no xerophthalmic child was found below the age of two. The data shows that more than 94% of the under-two children were breastfed at the time of the study. This suggests that breastfeeding is protective against vitamin A deficiency.

Of the children who manifested clinical symptoms and/or signs, only 2.3% were below the age of three years while the remaining were above three. The difference is statistically significant ($P < 0.001$) which is in accordance with the observations reported earlier in Ethiopia(6,7). However, this proportion is much lower than the observation in Asia(21,22). The contrast may possibly be explained by the extended breastfeeding practice of the rural Ethiopian women. Interestingly, prolonged breast-feeding is generally a norm and considered as a natural phenomenon in the study area. As mentioned earlier, more than 94% under two children were found to be breastfed. Furthermore, amongst the older children almost 29 % of them were breastfed. Presumably breast-milk is a major source of vitamin A which grants considerable protection against vitamin A deficiency for children of this age group in the study area.

In summary, the data from this study reveals that vitamin A is a public health problem in the area. Furthermore, the results indicate that school aged children are more affected than pre-school children attributable to the vitamin A supplementation to pre-school children. The findings of this study, therefore, lead to a recommendation that the on-going vitamin A intervention program in the study area should also give due attention to school aged children.

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