Determinants of Vitamin A Deficiency amongst Children in Aligarh District, Uttar Pradesh

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Objectives: To determine the prevalence and determinants of xerophthalmia among children aged 0-60 months .

Methods: This cross-sectional study included 3571 children under 5 years of age from six villages and four periurban areas. Children with xerophthalmia were identified and severity graded using the WHO classification. The main outcome measures were socio-demographic, nutritional and comorbidity related risk factors of xerophthalmia. A pretested questionnaire carrying information on the above factors was administered to the caregivers. Univariate and multivariate binary logistic regression analyses were performed to examine the association of each of these factors with xerophthalmia.

Results: The overall prevalence of xerophthalmia was of serious public health importance at 9.1%. Prevalence of both mild (night blindness, and Bitot's spots) and severe forms (corneal changes) of xerophthalmia increased with age. Bitot's spots and night blindness were the commonest manifestations. Rural dwelling, lower social class, maternal illiteracy and occupation outside home were significant antecedent socio-demographic risk factors on univariate analysis. Multivariate analysis revealed low intake of proteins and vitamin A containing foods as well as predominant maize diet to be significant dietary factors. Nutritional wasting and a preceding history of measles were significant comorbid determinants ($P<0.05$). None of the socio-demographic variables emerged significant on multivariate analysis.

Conclusions: Vitamin A deficiency remains a significant public health problem in Aligarh district.The proximal factors in a child's mileu *viz* nutrition and comorbidities were more significantly associated with xerophthalmia than the distal socio-demographic factors, thereby making a case for their cost effective prevention.The high magnitude of the problem calls for intensification of existing prophylactic measures in these areas.

Key words: *Determinants, Deficiency, India, Prevalence, Vitamin A.*

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Vitamin A deficiency (VAD) is an important cause of preventable blindness among children and a major public health problem in developing countries like India. It has also been established that VAD increases the risk of childhood morbidity and mortality [1,2]. India remains home to more than a quarter of the world's preschool children suffering from subclinical VAD and a third of the preschool children with xerophthalmia [3]. Existence of focal pockets of xerophthalmia in several areas makes it important to assess the true magnitude of the problem in these areas so as to prioritize interventions. We estimated the prevalence of xerophthalmia among rural and urban preschool children, and analyzed the antecedent risk factors in 6 villages and 4 peri-urban areas in Western Uttar Pradesh.

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METHODS

The present cross-sectional descriptive study was undertaken between January and July 2009. The study population comprised all the under-five children (0-60 months) residing in these areas (n=3679). Of these, 108 could not be included because of various reasons; 3571 children formed the study subjects. Ethical clearance was obtained from the Institutional ethics committee.

A house-to-house survey was carried out and information was obtained as per a predesigned proforma that included the identification data, and sociodemographic and environmental profile of the child's family. The social class of the child's family was determined using the Modified Prasad Scale [4]. Social classes I, II and III of the modified Prasad's classification are categorized as upper class and IV and V as lower classes. A precise history of dietary intake and vitamin A containing foods was elicited from the mother (recall of food items consumed in last 24 hours). Appropriate breastfeeding was defined as exclusive breastfeeding for six months of age and continued up to two years along with semi solids. Complementary feeds given in recommended amount and frequency as per WHO guidelines [5] was labelled as appropriate feeding. Second part of the proforma consisted of anthropometry and general physical examination of the child including signs of xerophthalmia. One pediatrician and eight post-graduate students from the Departments of community medicine and ophthalmology comprised of the field unit. All children with positive clinical findings and a systematic sample of 1 in 50 of those with a negative clinical finding were examined by a senior pediatrician. If any positives were detected from the negatives, then all the negatives of that day were re-examined by the senior pediatrician. The first four questions of the WHO algorithm listed below [6] for assessment of night blindness were enquired from mothers of children above two years of age, *viz* (*i*) Do you/does your child have any problem seeing in the daytime? (*ii*) Do you/does your child have any problem seeing in the evening or in low levels of light?, (*iii*) If (2)=yes: Is this problem different from most other children/women in your community?, (*iv*) Do you/Does your child have '*Rataundhi*'? (The local term for XN).

Proxy reports from mothers were used for children. All participants (including mothers) who complained of having a problem seeing in low levels of light but no problem seeing during the day; and which were different from most other children/ women in their community were considered to be having night blindness. They were asked to give examples of the problem (spontaneous complaints). If no spontaneous complaints were reported, they were asked whether, in low levels of light, they were able to see something (eg food) that had been put in front of them, were able to play or work, or were prone to walk into or to trip over objects (prompted complaints). Standard methods and procedures for ophthalmic examination were used to detect signs of xerophthalmia [7]. Ocular examination was done with the help of a bright illuminant torch. WHO classification [8] was adopted to grade the severity of xerophthalmia. Conjunctival xerosis in isolation was not included as a marker but was considered when accompanied with Bitot's spots or a positive *Kajal sign* [9]. *Kajal* is a formulation of lamp black mixed with oil used as an ocular cosmetic. It stains the xerotic areas in the eye black which makes XIA and XIB lesions stand out. Nutritional assessment was done using CDC 2000 reference standards. Age and sex specific –2 *Z*-scores were followed to define wasting and stunting. Statistical analysis was carried out by chi-square test and odds ratio with its 95% confidence interval. Binary logistic regression was used to do the multivariate analysis.

RESULTS

Age and sex distribution of the study population is shown in ***Table* I**. Mean age of the participants was 36±21 months. The urban and rural sex ratios were 0.83 each. Prevalence of xerophthalmia in the present study was 9.1%. There was a rising trend in the prevalence and severity of xerophthalmia with increasing age (***Table* II**). The difference in xerophthalmia prevalence among under two and over two years age groups was statistically significant ($P<0.001$). ***Table* III** depicts the socio demographic and maternal factors in relation with xerophthalmia. Univariate analysis revealed lower socioeconomic status, rural status, illiterate or working mother, incomplete immunization and inappropriate care seeking behavior to be significantly associated with xerophthalmia. A large number of children were underweight (32%), stunted (65%) and wasted (72%) but xerophthalmia was significantly associated with wasting alone (***Table* IV**). Other risk factors associated with xerophthalmia are also depicted in ***Table* IV.** Multivariate binary logistic analysis obviated the

TABLE I AGE AND SEX DISTRIBUTION OF THE STUDY POPULATION

Age group	Rural(61)		Urban(39)	
(months)	Males (%)	Females (%)	Males (%)	Females (%)
0-12	265 (22.7)	221 (22.3)	141(18.4)	162 (25.2)
13-24	219 (18.7)	213 (21.5)	159 (20.7)	151 (23.5)
25-36	198 (16.9)	192 (19.4)	167 (21.7)	109 (16.9)
37-48	264 (22.6)	215 (21.6)	162 (21.2)	121 (18.8)
49-60	221 (18.9)	152 (15.3)	138 (17.9)	101 (15.7)
Total (*n*=3571)	1167 (100)	993 (100)	767 (100)	644 (100)

TABLE II PREVALENCE OF XEROPHTHALMIA IN DIFFERENT AGE GROUPS

Age-group (months)	Number	Only night blindness (XN only)	Only Bitot's spots (XIB only)	Corneal xerosis X2	Corneal ulceration X3A	Kerato-malacia X3B	Corneal scarring XS	Total number with xerophthalmia
0-12	789	–	6 (0.7)	0 (0)	0 (0)	0(0)	2 (0.3)	8(1.1)
13-24	742	–	44 (5.9)	1 (0.1)	1 (0.2)	0(0)	1 (0.2)	47(6.3)
25-36	666	23 (3.5)	47 (6.9)	3 (0.4)	1 (0.2)	0(0)	3 (0.4)	77(11.6)
37-48	762	43 (5.6)	42 (5.5)	3 (0.4)	2 (0.2)	0(0)	6 (0.8)	96(12.6)
49-60	612	35 (5.7)	54 (8.8)	2 (0.3)	1 (0.2)	0(0)	5 (0.8)	97(15.8)
Total	3571	101 (2.8)	193 (5.4)	9 (0.3)	5 (0.2)	0(0)	17 (0.5)	325(9.1)

Figures in parentheses indicate percentages.

potential confounding factors that were statistically significant on univariate analysis. An inadequate intake of proteins and vitamin A containing foods as well as predominant maize diet emerged significant dietary factors.

Similarly, nutritional wasting and a preceding history of measles were significant comorbid determinants.

DISCUSSION

The prevalence of xerophthalmia in the present study (9.1%) was far above the WHO threshold for classifying xerophthalmia as a serious public health problem [10]. Nearly similar prevalence of 8.7% was also observed among preschool children in urban slums of Nagpur [11]. A remarkably wide range of prevalence (1.1% to 22.3%) noted in earlier studies [12,13] could be a result of distinct study parameters and the fact that they were carried out among different population groups with varying epidemiologic characteristics. Similarly, the results of the NNMB micronutrient survey indicate a far low prevalence of Bitot's spots and night blindness in preschool children. (0.7% and 0.5%, respectively) [3]. This vast disparity in prevalence again reflects the 'focal and local' nature of the disease. Indeed, the prevalence of all stages of xerophthalmia including corneal signs was alarmingly higher than acceptable in the present study. Prevalence rates increased with age with peak at 4-5 years. This trend has been confirmed by Curtale, *et al*. [14] in their large scale community surveys. This is because of low dietary intake of vitamin A foods and frequent exposure to intercurrent infections. Also, prolonged breast feeding practice in the Indian scenario may have sufficient prophylactic effect for vitamin A deficiency for preschool-age children upto age 2 years. Corneal ulceration and keratomalacia are known to be associated with high mortality and were

TABLE III SOCIO DEMOGRAPHIC AND MATERNAL FACTORS IN RELATION WITH XEROPHTHALMIA

Variable	Xerophthalmia		
	Yes	No	OR (95%CI)
Gender			
Male	182	1752	0.9
Female	143	1637	(0.7 to 1.2)
Religion			
Hindus	131	1460	0.8
Muslims	194	1786	(0.6 to 1.1)
Social class			
Upper	9	277	0.3
Lower	316	2969	(0.2 to 0.6)
Family			
Nuclear	49	542	0.8
Joint	276	2704	(0.6 to 1.2)
Dwellings			
Rural	247	1913	2.2
Urban	78	1333	(1.7 to 2.8)
Working mother			
Yes	319	136	3.9
No	1160	1950	(3.2 to 4.8)
Mother			
Literate	23	354	0.05
Illiterate	23	2912	(0.01 to 0.2)
Immunization			
Complete	32	1217	0.2
Incomplete	293	2029	(0.12 to 0.3)
Care seeking behavior*			
Appropriate	4	291	0.2
Inappropriate	321	2955	(0.04 to 0.4)
Maternal xerophthalmia			
Present	19	159	1.2
Absent	306	3087	(0.7 to 1.9)

Appropriate care was care sought from qualified medical professionals in government health facilities and private hospitals/ clinics. Purchasing medicines from pharmacy, home remedies, visiting pharmacies, temples and traditional healers was defined as inappropriate care.

TABLE IV NUTRITIONAL AND COMORBID FACTORS IN RELATION WITH XEROPHTHALMIA

Variable	Xerophthalmia		
	Yes	No	OR(95%CI)
Breastfeeding			
Adequate	134	2010	0.4
Inadequate	191	1236	(0.3 to 0.5)
Calories			
Adequate	14	1057	0.09
Inadequate	311	2189	(0.05 to 0.2)
Proteins			
Adequate	152	1847	0.6
Inadequate	173	1399	(0.5 to 0.8)
Staple			
Maize	140	600	3.3
Wheat	185	2646	(2.6 to 4.3)
Vitamin A rich foods			
Adequate	48	916	0.4
Inadequate	277	2330	(0.3 to 0.6)
Weight for Age			
Normal	149	997	1.9
Underweight	176	2249	(1.5 to 2.4)
Height for Age			
Normal	136	2186	0.3
Stunted	189	1060	(0.2 to 0.4)
Weight for height			
Normal	210	2370	0.7
Wasted	115	876	(0.5 to 0.8)
Pallor			
Present	242	2471	0.9
Absent	83	775	(0.7 to 1.2)
Vitamin D deficiency			
Present	10	265	0.5
Absent	315	2981	(0.3 to 0.9)
Measles			
Yes	69	95	8.9
No	256	3151	(6.4 to 12.5)
Diarrhoea			
Yes	14	161	0.8
No	311	3088	(0.5 to 1.5)
Worms			
Present	176	1216	1.9
Absent	149	2030	(1.6 to 2.5)
Development			
Normal	8	236	0.3
Delayed	317	3010	(0.2 to 0.6)

WHAT IS ALREADY KNOWN?

- Vitamin A deficiency is an important cause of preventable blindness due to xerophthalmia and high mortality rates among under-five children in India.

WHAT THIS STUDY ADDS?

- Prevalence of xerophthalmia among children in Aligarh district of Western UP region is considerably high to warrant extra efforts to combat the same.

less common than other signs as observed by other Indian investigators [15]. Other variables like maternal illiteracy, rural dwellings, poverty, poor care seeking behavior, etc. observed significant in the present study were similar to those reported earlier [15-19]. The present study, however, did not reveal any significant association of maternal xerophthalmia with xerophthalmia in children. Semba, *et al*. [20] had reported a relative risk of 9.08 for maternal xerophthalmia if her child had xerophthalmia. This is probably because subclinical hypovitaminosis A is more common in adults and also that females are reluctant to share their health concerns out of hesitation and family pressures.

In a sub-economic society as in our study, a child is likely to become deficient of protein and also not to retain an adequate intake of carotenoids than to be deficient in either of the two alone. This can be expected as the dietary questionnaire admininistered revealed less than the recommended allowances of green leafy vegetables, yellow fruits and animal proteins in a majority of the subjects. The second repeat survey of the National Nutritional Monitoring Bureau (NNMB) also revealed that the consumption of micronutrients was woefully inadequate among individuals from all age groups including children. As many as 50-70% of individuals consumed less than 30% of RDI for vitamin A; especially the pre-school children having higher deficits in their diets. Schémann, *et al*. [21] also observed that weekly consumption of vitamin A rich food was rare among xerophthalmic preschool children in Mali. Association of wasting, measles, and worm infestation with xerophthalmia has also been observed earlier [16,20,22]. An interesting observation made in the present study was a significantly higher occurrence of xerophthalmia among children whose families consumed maize as the staple cereal. The majority of maize consumed was white maize, which is essentially devoid of yellow carotenoid pigments, including those that serve as a source of provitamin A. In three of the villages surveyed, maize was the most important staple food and supplied more than 50% of the energy in local diets.Similar observation was made by Harjes, *et al*. [23]. This could probably account for the reason behind clustering of xerophthalmia cases in these villages.

We conclude that the undisputed long-term solution to prevent this nutrition-related, avoidable blindness lies in changing the dietary habits of the rural Indian population through behavior change communication by nutritional education, nutritional supplementation, and nutritional rehabilitation. Fortification of staple cereals like maize through innovative food engineering technologies can go a long way towards alleviation of the problem. Routine screening of 'at risk' children for signs of xerophthalmia by peripheral health workers will help in early detection and treatment. Prompt prophylaxis of contacts of affected children would address the potential subclinical cases. Research is required into factors responsible for clustering of cases in specific areas.

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