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Vitamin A Deficiency in Children with Acute Diarrhoea: A Community-based Study in Bangladesh

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ABSTRACT

The prevalences of nightblindness and xerophthalmia were assessed in 400 children, aged 6-59 months, with acute diarrhoea in a rural community in Bangladesh. The prevalences of nightblindness, conjunctival xerosis, and Bitot's spot were 7.8%, 9.5%, and 2.7% respectively. Fifty-two percent of the children who complained of nightblindness had ocular signs of vitamin A deficiency compared to 9% of those without nightblindness ($p<0.000$). The nightblindness was significantly higher among the male children, aged 24-59 months, who were dysenteric and undernourished, did not consume vitamin A-containing foods daily, and were not breastfed. The coverage of periodic administration of vitamin A capsule was inversely related to the prevalence of nightblindness. This finding was determined by logistic regression analysis of data indicating that a combination of male sex, history of dysentery, absence of periodic administration of vitamin A treatment, and daily intake of vitamin A-containing foods gave the best-fitted model with an overall prediction of 92.5% of being nightblind. The findings of the study suggest that mothers should be educated to observe their diarrhoeal children about development of nightblindness and to seek treatment for it. The locally-relevant nutrition education should also be offered to them.

Key words: Vitamin A deficiency; Xerophthalmia; Nightblindness; Diarrhoea, Acute; Diarrhoea, Infantile; Vitamin A; Infant nutrition

INTRODUCTION

In 1974, WHO stated, "one of the greatest scandals of our time is that young children go permanently blind because of the lack of minute amounts of retinol in their diet" (1). This statement is particularly important in the case of Bangladesh where the prevalence of nightblindness among children, aged 6 months-6 years, is 0.62% (2), i.e. about 5,000 preschool children are becoming blind each year. In Bangladesh, the national programme for periodic distribution of high-potency vitamin A capsule was initiated in 1972.

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Globally, more than 124 million children are vitamin A-deficient, and improved vitamin A nutriture alone could prevent 1.3-2.5 million deaths in older infants and preschool children per year. Population of India, Indonesia, the Philippines, and Bangladesh are exposed to the highest risk of nightblindness (3).

There is ample evidence of the association between vitamin A deficiency and diarrhoea (4). Decreased intestinal absorption of vitamin A is associated with various infections, especially diarrhoea, helminthiasis, and respiratory infections (5). Cohen *et al.* and Khan *et al.* found that in Bangladesh all children with xerophthalmia or eye-signs of vitamin A deficiency had diarrhoea in the preceding month (6-7). In studies conducted in urban hospitals of Bangladesh, Stoll *et al.* and Stanton *et al.* also found an association of prolonged

and dysenteric diarrhoea and protracted diarrhoea with vitamin A deficiency (8-9).

The present investigation was carried out to assess the prevalence of vitamin A deficiency and risk factors of nightblindness among 400 rural Bangladeshi children suffering from acute diarrhoea.

METHODS AND MATERIALS

As part of a community-based study on diarrhoea, carried out in rural areas of Chittagong district of Bangladesh, a questionnaire was used for collecting data. In total, 400 mother-child pairs were investigated in the present study. The index children were aged 6-59 months with acute diarrhoea having no signs of severe dehydration. A sample size of 400 children seems to be adequate to have the estimate of the prevalence rate within ±2% with 95% confidence interval (CI), and to identify a relative risk of 3 with 5% level of significance and 80% power. During the interview, the interviewer asked the mothers of the index children about the nightblindness, using the specific Bangla term '*ratkana*' (nightblindness) which is a well-known and widely-used term in the community. The index children were examined by a physician specially trained for identification of eye-signs of vitamin A deficiency. Anthropometric measurements and an in-depth medical history of each child were recorded.

Poor socioeconomic status of a child was defined as the one who was unable to have basic needs, e.g. food, clothing, and shelter. The nutritional status of the children was classified according to the Waterlow criteria. The dietary practices regarding vitamin A-containing foods (dark green-leafy vegetables, yellow fruits, cowmilk, and egg) were inquired, using a food-frequency table. Information on breast-feeding was also recorded.

The differences between "nightblind" and "not nightblind" groups against predicting variables were analyzed using chi-square statistics. The prevalence, rate ratio, and confidence intervals were computed. Bivariate analysis was done to determine the association of a total of 15 factors with nightblindness of the children. The factors were: (1) age, (2) gender, (3) nutritional status, (4) breast-feeding status, (5) coverage of vitamin A capsule, (6) intake of vitamin A-containing foods, (7) frequency of intake of vitamin A-containing foods, (8) education of mothers, (9) knowledge about preventive and curative action of vitamin A capsule, (10) total number of children, (11) socioeconomic condition, (12) type of diarrhoea, (13) duration of diarrhoea, (14) status of dehydration, and (15) associated acute respiratory infection (ARI). Stepwise logistic regression analysis was done to identify the influencing variables associated with nightblindness. Data were analyzed using the SPSS-Win and Epi Info software.

RESULTS

In total, 369 (92.25%) children suffered from acute watery diarrhoea, and the rest 31 (7.75%) suffered from dysentery. Ninety-four percent and 6% of the children had 'no signs of dehydration' and 'some dehydration' respectively. Of the 400 children (aged 6-59 months), 31 had the history of nightblindness, i.e. a 7.8% (95% CI 5.2-10.4) prevalence rate of nightblindness. Forty-nine (12.3%; 95% CI 9.1-15.5) of the children had ocular signs of vitamin A deficiency, and of them, 38 (9.5%; 95% CI 6.7-12.3) had conjunctival xerosis, and 11 (2.7%; 95% CI 1.2-4.2) had Bitot's spot. Fifty-two percent of the children who complained of nightblindness had ocular signs of vitamin A deficiency compared to 9.0% of those without nightblindness ($p<0.000$).

The characteristics of the children with and without nightblindness were compared with the 15 factors, and the characteristics found to be significantly associated with nightblindness are shown in Table 1.

The nightblind children were more likely to be undernourished boys (wasted, stunted, and both), aged 24-59 months, with dysenteric illness. They were also more likely to have a less coverage of high-potency vitamin A capsule, less likely to consume vitamin A-containing foods daily, and less likely to be breastfed. No significant association of nightblindness with education of mothers, knowledge of mothers about vitamin A capsule, total number of children, socioeconomic status, duration of diarrhoea, dehydration status, associated ARI, and intake of vitamin A-containing foods was found, although a higher proportion of the nightblind children had poor socioeconomic status and some dehydration, and were not consuming vitamin A-containing foods. No significant difference was also found between the socioeconomic classes in consuming vitamin A-containing foods.

Three hundred ten children (77.5%) received the high-potency vitamin A capsules during the preceding 6 months. Twenty-two (71%) of the nightblind children did not receive any prophylactic vitamin A capsules, while 9 (29%) received vitamin A capsules. Nine (2.9%) children, who received vitamin A capsules, complained of nightblindness compared to 22 (24.4%) children who did not receive any vitamin A capsules, and the difference was highly significant ($p<0.000$).

Seven factors (Table 1) showed a significant association with nightblindness, and these factors were subjected to stepwise logistic regression, taking the status of nightblindness (nightblind-0, not nightblind-1) as a dependent variable. A combination of factors, such as sex of children, type of diarrhoea, coverage status of vitamin A capsule during the preceding 6 months, and frequency of intake of vitamin A-containing foods (Table 2), was found to be the best-fitted model with an overall predictive value of 92.5%.

Table 1. Characteristics of children with and without a history of nightblindness

Characteristics	Nightblind (n=31)		Not nightblind (n=369)		Rate ratio (95% CI)	p value
	No.	%	No.	%		
Age (months)						
06-23	6	19	148	40	2.61	0.0225
24-59	25	81	221	60	(1.10-6.21)	
Sex						
Male	22	71	182	49	2.35	0.0205
Female	9	29	187	51	(1.11-4.97)	
Nutrition (Waterlow criteria)						
Normal	5	16	123	33	2.45	0.0185
Malnutrition	26	84	246	67	(0.96-6.23)	
Type of diarrhoea						
Watery	25	81	344	93	2.86	0.0118
Dysentery	6	19	25	07	(1.27-6.44)	
Coverage of VAC						
Yes	9	29	301	82	8.42	0.0000
No	22	71	68	18	(4.02-17.63)	
Frequency of intake of vitamin A-containing foods						
Daily	05	16.7	125	34.9	2.49	0.0419
Not daily	25	83.3	233	65.1	(0.99-6.43)	
Breast-feeding (age <24 months)						
Yes	04	66.6	135	91.2	4.63	0.0467
No	02	33.4	013	08.8	(0.92-23.22)	

VAC=Vitamin A capsule; CI=Confidence interval

Table 2. Results of stepwise logistic regression analysis showing the best-fitted model (last step)

Factor	Regression coefficient	df	p value	Odds ratio
Sex (male-0, female-1)	0.9709	1	0.0194	2.6402
Type of diarrhoea (dysentery-0, acute watery diarrhoea-1)	1.1247	1	0.0413	3.0794
Coverage of VAC (yes-1, no-0)	0.7375	1	0.0890	2.0906
Frequency of intake of vitamin A-containing foods (daily-1, not daily-0)	1.0477	1	0.0399	2.8512
Constant	0.2802			

Model chi-square=15.668, df-4, p<.001

DISCUSSION

The prevalences of nightblindness, conjunctival xerosis, and Bitot's spot were 7.8%, 9.5%, and 2.7% respectively among the study children who were at risk of developing vitamin A deficiency at the rural community in Bangladesh. The rates were many times higher than the rates quoted by WHO for identification of vitamin A deficiency (10) and higher than that of the national prevalence rate of 0.62% in Bangladesh (2). Fifty-two percent of the children who complained of nightblindness also had ocular signs of vitamin A deficiency, and were at risk of becoming blind in the absence of vitamin A therapy. As diarrhoea precipitates vitamin A deficiency, WHO recommends vitamin A treatment schedule (10) for children aged above 12 months as follows: Immediately on diagnosis: 110 mg retinol palmitate or 66 mg retinol acetate (200,000 IU) orally, or 55 mg water miscible retinol palmitate (100,000 IU) by intramuscular injection; the following day: 110 mg retinol palmitate or 66 mg retinol acetate (200,000 IU) orally; and prior to discharge or if clinical deterioration occurs or 2-4 weeks later: 110 mg retinol palmitate or 66 mg retinol acetate (200,000 IU) orally. The prophylaxis schedule of children aged above 12 months is: 110 mg retinol palmitate or 66 mg retinol acetate (200,000 IU) in oil miscible form as standard capsule or as liquid at an interval of 4-6 months.

Our findings suggest a strong association between diarrhoea and vitamin A deficiency, although it is not clear whether diarrhoea precipitates vitamin A deficiency or vitamin A deficiency predisposes diarrhoea or other infections in marginally-nourished children (4,11,12). The diarrhoeal children, who were male, were aged 24-59 months, were undernourished, and had dysentery

were at a higher risk of developing nightblindness. These findings are consistent with those of Stoll *et al*. (8). Our findings indicate no significant association between poor socioeconomic conditions of the children and nightblindness, although higher proportions of poor children were suffering from nightblindness. This might be due to the fact that now-a-days either the rural children in Bangladesh have been consuming vitamin A-containing foods irrespective of their social class, or the poor class has been consuming more dark green-leafy vegetables as an effect of nutrition education. However, the quantity consumed is very important, and it was observed that those who consumed vitamin A-containing foods daily were significantly less likely to suffer from nightblindness. It was also observed that breast-feeding practices reduced the risk of vitamin A deficiency. The finding is consistent with that of Mahalanabis who reported 74% reduction of vitamin A deficiency among breastfed children (13).

The coverage of vitamin A capsule distribution was 77.5%, and its impact was evident from our findings that nightblindness was inversely related to the coverage of vitamin A capsule, which confirms the findings of Cohen *et al*. (6). Besides, the results of logistic regression analysis indicate that sex of children, type of diarrhoea, coverage of vitamin A capsule, and frequency of intake of vitamin A-containing foods are the predictive factors and all the factors, except age, could be modified by intervention.

Diarrhoea is a public health problem of high magnitude in Bangladesh (14), and children with diarrhoea are at risk of developing vitamin A deficiency and becoming blind. Besides, mothers remain the first and most important agent for healthcare of their children, particularly for diarrhoea (15,16). The mothers should, therefore, be educated to observe their diarrhoeal children about development of nightblindness and to seek treatment for it. The health workers should be advised to provide vitamin A treatment to the sick children, particularly those who have prolonged diarrhoea or dysentery, are not breastfed, and are undernourished. While treatment will help some individual cases, the long-term aim should be to prevent vitamin A deficiency through various approaches where locally-relevant nutrition education to mothers is essential (17). The total care of children rather than specific intervention is favoured to aim at "healthy eyes in a healthy child" (18).

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