Epidemiology of Vitamin A Deficiency in Selected Vulnerable Population Groups of Bangladesh

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Abstract

A prospective study was carried out among the population groups 'at-risk' in four different agro-ecological regions and two urban slums of Bangladesh. Following multistage sampling technique, sixty households having at least one child from 2-5 years were selected purposively from among the landless or marginally landholding groups in each location. Data on food intake (24 hour recall and food frequency questionnaire) and clinical examinations were collected in two different seasons, namely rainy season (June-July) and winter (December-January). Poor intake of energy and nutrients were observed among the studied population. Almost all vitamin A was provided by vegetable sources. Total intake of vitamin A was significantly higher ($p < 0.05$) in the rainy season in all the locations excepting the Lower Ganges Flood Plain, where a higher but statistically non significant intake was observed in winter ($p > 0.05$). Mean usual pattern of food (UPF) score of the observed children was significantly higher in the rainy season in all rural locations ($p < 0.05$). Such seasonal differences were not found in the urban locations. A shift in UPF score distribution toward high-risk category in the winter was observed in the rural locations and also in slum in Dhaka. Children with xerophthalmia were detected in 3 rural locations and in the slum in Chittagong, and it was higher in the rainy season. No cases of xerophthalmia were found in the coastal district of Patuakhali and slum in Dhaka. Prevalence of infectious diseases was higher in the rainy season, and most of the xerophthalmia affected children were found to have suffered from diarrhoea, dysentery, or measles before developing ocular signs. Seasonality and geographical variation in availability and intake of vitamin A rich food sources and prevalence of xeropthalmia were markedly observed. Children in the coastal region did not manifest any sign of vitamin A deficiency probably due to easy availability of small fishes.

Key words : Vitamin A Deficiency, Xerophthalmia Prevalence, Pre-school Age Children, UPF score

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Introduction

Vitamin A deficiency is a well-documented nutritional problem of significant public health importance in Bangladesh[1-4]. Behind the cases of overt avitaminosis A, there are many who sustain various degrees of sub-clinical vitamin A deficiency[5-8]. Studies have shown that dietary intake of vitamin A is rather higher among the poor households. Overcrowded housing and a contaminated environment associated with poor living conditions often precipitate vitamin A deficiency[9]. Moreover, during the last three decades, a number of intervention programmes aimed at addressing the vitamin A deficiency have been implemented in the country. Although the conditions seem to have improved as a result of the programmes, vitamin A capsule distribution has to be continued to contain the problem. To address vitamin A deficiency problem effectively, potential non-dietary factors should also be identified along with the dietary studies. This study was undertaken to delineate socioeconomic, environmental, ecological and seasonal attributes of vitamin A malnutrition.

Materials and Methods

Selection of locations

Since the objective of the study was to delineate the ecological attributes of vitamin A deficiency, representation of various agro-ecological areas of the country was necessary. After consulting the Report on Land Resources Appraisal of Bangladesh, the whole country was divided in to 4 broad agro-ecological zones, namely Tista Meander Flood Plain, Lower Ganges Flood Plain, Southern Coastal Belt and Active Young Brahmaputra Jamuna Flood Plain. One union from a district in each of the agro-ecological area was selected. The districts were Gaibandha (Tista Meander Flood Plain), Madaripur (Lower Ganges Flood Plain), Patuakhali (Southern Coastal Belt) and Jamalpur (Active Young Brahmaputra Jamuna Flood Plain). Two urban slums in each of the two major metropolises of the country were also selected. One was on the Mohammadpur flood protection embankment in Dhaka and the other was the Jhautala slum under Double Mooring thana in Chittagong.

Selection of households

Union council tax categories 'A' and 'B' households with at least one child between 2-5 years of age were listed. Sixty households from the list or each location were selected by simple unrestricted random sampling technique.

Dietary survey

Household dietary intake was assessed by 24-hour recall method. Food consumption data were converted into nutrient intake using food composition table[10]. To account for seasonal variability in intake, dietary surveys were conducted in two different seasons. Rainy season (June-July) is characterized by plentiful carotene rich food while winter season is moderately lean period for carotene rich foods. Besides household dietary intake, data on habitual intake of food sources of vitamin A by the target children (2-5 years old) were obtained using the simplified method proposed by the IVACG[11,12]. Proportion of the target population at risk for vitamin A deficiency was calculated using the usual pattern of food (UPF) score according to simplified method recommended by the IVACG. UPF score is computed by using a weighting factor for usual consumption pattern (daily, weekly and monthly) of foods rich in vitamin A and it's precursor. Risk categories are classified into high (<120), moderate (120 to 210) and low (>210) based on the score.

Clinical investigation

Clinical investigation and classification of ocular signs were done according to WHO[13].

Statistical analysis

Statistical analysis was done by SPSS release 8.0 (SPSS Inc., Chicago, Illinois, U.S.A.). Means were tested by Student's 't' test or ANOVA with post-hoc Bonferroni test. Distributions were tested by χ^2 test.

Results

The socio-economic and quality of living conditions data are presented in Table1. Monthly income ranged from 1127 Takas for the slum dwellers in Chittagong to 2030 Takas for the households in Patuakhali. By occupation, about two fifths were peasant farmers and nearly an equal proportion were day labourers in all rural locations except Madaripur, where only 19 % were peasant farmers while 64% were day labourers.

Table 1. Socioeconomic and quality of living conditions of the households by region

	Gaibandha	Madaripur	Patuakhali	Jamalpur	Dhaka	Chittagong
Income of the house hold (Taka·Mo^{-1})*	1719 (1066)	1621 (1034)	2030 (1084)	1282 (641)	1463 (1304)	1127 (792)
Occupation of the house hold head¶						
Peasant farmer	38	19	36	38	0	0
Day labourer	38	64	39	44	89	93
Petty business	10	14	13	10	7	7
Office job	12	0	2	5	0	0
Fishing	0	3	12	3	0	0
Housing condition¶						
Thatch	65	40	85	67	34	48
Earthen-C.I. sheet	12	29	14	20	12	0
Bamboo wicker-C.I. sheet	23	28	01	13	15	0
Bamboo wicker	0	3	0	0	39	51
Source of household water¶						
Municipal supply/tube well	98	29	2	97	43	41
Open well	2	0	0	0	0	22
River/canal/pond	0	71	98	3	57	37
Human excreta disposal facility¶						
Hygienic	17	0	1	0	0	0
Unhygienic	83	100	99	100	100	100

*Mean (SD)
¶Percent distribution of the households

About 10 % ran petty businesses. A small percentage held subordinate office jobs. Another small group in three rural locations was engaged in fishing. Among them largest was 12 % in Patuakhali. Of the urban slum dwellers, most were day labourers or rickshaw pullers. Only 7 % ran petty business. The remaining did odd jobs. Majority in all rural locations except Madaripur lived in houses built of thatch. Among the other building materials, bamboo wickerwork wall and corrugated iron sheet roofing was observed. In urban locations, use of corrugated iron sheets was less common. Thatch and bamboo wicker inter-spaced with polythene sheet was most used building materials. In Gaibandha and Jamalpur all most all used tube well water for domestic purposes, while in Madaripur it was observed in only in 29% of the households. In Patuakhali, 98% used river or canal water for domestic purposes. In the urban locations, more than 40% used water from the municipal supply or tube well. Overall human excreta disposal practices was unhygienic in all locations. Energy and nutrient intake are presented in Table 2.

Table 2. Energy and nutrient intake by region and season*

	Gaibandha		Madaripur		Patuakhali		Jamalpur		Dhaka		Chittagong	
	Rainy	Winter	Rainy	Winter	Rainy	Winter	Rainy	Winter	Rainy	Winter	Rainy	Winter
Energy (MJ)	7.63 (2.01)	8.09 (2.52)	7.30 (1.61)	6.76 (1.50)	7.06 (2.17)	7.11 (1.66)	7.76 (1.66)	7.16 (1.79)	7.01 (1.84)	6.43 (2.06)	6.24 (1.60)	6.60 (2.57)
Carbohydrate (g)	391(108)	406(127)	370(82)	339(73)	339(104)	355(82)	390(91)	357(92)	340(94)	325(99)	308(83)	329(126)
Protein (g)	42.6 (12.5)	48.3 (15.7)	42.7 (12.5)	42.8 (13.1)	48.4 (17.0)	46.8 (22.3)	47.6 (12.9)	46.1 (12.9)	44.9 (15.1)	35.3 (15.7)	38.6 (12.9)	42.6 (22.9)
Fat (g)	9.6 (6.2)	13.8 (10.:	10.5 (5.6)	9.7 (9.8)	14.8 (17.3;	9.9 (5.5)	9.6 (4.5;	11.1 (4.7)	14.9 (11.1)	10.7 (10.:	10.4 (7.5	10.4 (8.8)
Iron (mg)	30.6 (12.7)	27.1 (11.3)	23.8 (7.4)	28.9 (9.8)	24.7 (11.7)	23.3 (8.6)	29.5 (11.8)	32.8 (11.3)	26.8 (14.6)	25.9 (18.'	28.8 (21.ı	25.8 (17.4;
Calcium (mg)	391(265)	290(254)	274(199)	346(204)	470(342)	289(245)	388(324)	381(260)	359(431)	188(200)	400(417)	279(247)
Pre-formed vitamin A (μg RE)	32.11^{ac} (73.7)	43.44 (114.5)	27.93^{c} (54.7)	13.94 (49.1)	42.78^{cd} (65.1)	40.60 (85.4)	15.12 (28.	7.22 (17.4)	1.24^{b} (4.7)	24.57 (84.6)	4.68^{bc} (18.7)	19.57 (74.:
Total vitamin A (μg RE)	2126^{a} (1730)	765 (1154	645^{b} (1160)	743 (818)	1169 (2062)	536 (616)	1159 (1958)	469 (518)	1159 (2064)	571 (984)	1022^{b} (1624)	737 (1139)
Thiamin (mg)	1.3 (0.4)	1.5 (0.5	1.2 (0.3)	1.0 (0.2	1.1 (0.4)	1.1 (0.3	1.5 (0.4)	1.5 (0.5)	1.1 (0.4)	1.1 (0.4	1.1 (0.4	1.2 (0.6)
Riboflavin (mg)	0.7 (0.4)	0.6 (0.3	0.5 (0.2)	0.4 (0.2	0.6 (0.5)	0.4 (0.2	0.7 (0.4)	0.7 (0.3)	0.5 (0.4)	0.4 (0.3	0.4 (0.2	0.5 (0.4)
Niacin (mg)	19.0 (5.1)	21.0 (6.5	18.5 (4.4)	16.6 (3.3	18.4 (5.7)	17.3 (4.1	19.7 (4.4)	18.7 (4.9)	17.6 (4.7)	15.9 (5.1	15.7 (4.3	17.4 (7.5)
Vitamin C (mg)	49 (40)	41 (23)	32 (30)	54 (41)	25 (42)	28 (29)	28 (41)	59 (49)	26 (22)	25 (25)	25 (290	29 (23)

*Mean (SD)
[abc]Means for each season with unlike superscript letters were significantly different at $p < 0.05$ in ANOVA

No noticeable inter-location variation in energy and nutrient intake was observed. Mean energy intake was 7.14 MJ (± SD 1.96) per person per day. There was no significant seasonal variation in energy intake. Intake pattern of protein, fat, minerals were similar in all locations. Low intake of calcium and riboflavin were seen in both seasons. Low fat intake was observed in all locations. Contribution of visible fat to total fat intake was very low. Per capita cooking oil consumption was only between 3 and 4 g (data not presented). Most of vitamin A was supplied by carotenes. Very low intake of preformed vitamin A was observed in all locations in both seasons. In rainy season, intake of preformed vitamin A for the two urban locations was significantly lower than the intake for the rural locations ($p < 0.05$). There was no seasonal difference in preformed vitamin A intake in the rural locations. Of the two urban locations, preformed vitamin A intake was significantly lower in the rainy season ($p < 0.05$) in Dhaka. Although lower intake of preformed vitamin A was also observed in rainy season in Chittagong, the difference was not statistically significant. Most commonly consumed vegetables were jute leaves, *Cucorbitaceae* leaves and *Amaranth*. Total intake of retinol equivalents was significantly lower ($p < 0.05$) in winter in the slums of the cities and in all rural locations except Madaripur. Total intake was higher in winter in Madaripur due to availability of *Lathyrus sativus* leaves in the season. However, this was not statistically significant. Table 3 shows the mean UPF score of the pre school age children.

Table 3. Usual pattern of food (UPF) scoring of the preschool age children*

Region	Season		*p* value
	Rainy	Winter	
Gaibandha	394 (274)	97 (51)	0.000
Madaripur	345 (310)	141 (74)	0.000
Patuakhali	250 (158)	111 (64)	0.000
Jamalpur	260 (137)	134 (60)	0.000
Dhaka	203 (142)	193 (127)	0.731
Chittagong	200 (130)	242 (138)	0.811

* Mean (SD)

The mean scores in the rainy season were higher for all rural locations than for the urban locations. On the other hand, in the winter, mean UPF scores for the urban locations were higher than that for rural locations. The winter scores for all rural locations were significantly ($p < 0.05$) lower than the rainy season scores. Scores in both seasons in Dhaka were close, while it was higher in winter in Chittagong. However, the difference was not statistically significant. Percent distribution of children into different vitamin A deficiency risk categories based on UPF score is presented in Table 4.

Table 4. Distribution of preschool age children by risk category by region and season*

Risk category¶	Gaibandha		Madaripur		Patuakhali		Jamalpur		Dhaka		Chittagong	
	Rainy (*n* =57)	Winter (*n* =49)	Rainy (*n* =58)	Winter (*n* =53)	Rainy (*n* =52)	Winter (*n* =48)	Rainy (*n* =59)	Winter (*n* =51)	Rainy (*n* =60)	Winter (*n* =52)	Rainy (*n* =59)	Winter (*n* =55)
High	10	61	21	49	29	60	20	43	28	38	27	23
Moderate	19	37	27	32	33	32	22	45	21	24	13	23
Low	71	2	52	19	58	8	58	12	51	38	60	54

*Percent distribution
¶High, UPF < 150; moderate, UPF 150 - 210; low, UPF > 21

Marked increase in proportion at high risk for vitamin A deficiency with a concomitant decrease in low risk group was observed in winter season in all rural locations. Of the two urban locations, increase in high risk population was observed in winter in Dhaka. However, it was smaller in magnitude than that was observed in the rural locations. In Chittagong, distribution into various risk categories was essentially the same in both seasons. Clinical findings on vitamin A deficiency are presented in Table 5. Xerophthalmia cases were detected in 3 rural locations in both seasons.

Table 5. Children with clinical signs of vitamin A deficiency by region and season*¶

Ocular sign	Gaibandha		Madaripur		Patuakhali		Jamalpur		Dhaka		Chittagong	
	Rainy (*n* =57)	Winter (*n* =49)	Rainy (*n* =58)	Winter (*n* =53)	Rainy (*n* =52)	Winter (*n* =48)	Rainy (*n* =59)	Winter (*n* =51)	Rainy (*n* =60)	Winter (*n* =52)	Rainy (*n* =59)	Winter (*n* =55)
XN	7.0	2.0	6.9	3.8	0.0	0.0	10.2	3.9	0.0	0.0	0.0	1.8
	(4)	(1)	(4)	(2)	(0)	(0)	(6)	(2)	(0)	(0)	(0)	(1)
X1B	0.0	2.0	1.8	1.9	0.0	0.0	1.7	0.19	0.0	0.0	0.0	0.0
	(0)	(1)	(1)	(1)	0	0	(1)	(1)	0	0	0	0

*Percent distribution
¶Figures in parentheses are number of cases
XN, night blindness; X1B, Bitot's spot

Incidence of xerophthalmia (XN and X1B) cases was higher in rainy season in these locations. Highest incidence of xerophthalmia was observed in Jamalpur in rainy season. In winter, the xerophthalmia cases were found to have improved. Of the two urban locations, one case was found in Cittagong in winter. No cases of xerophthalmia were found in Patuakhali and Dhaka. Prevalence of diseases is shown in Figure 1.

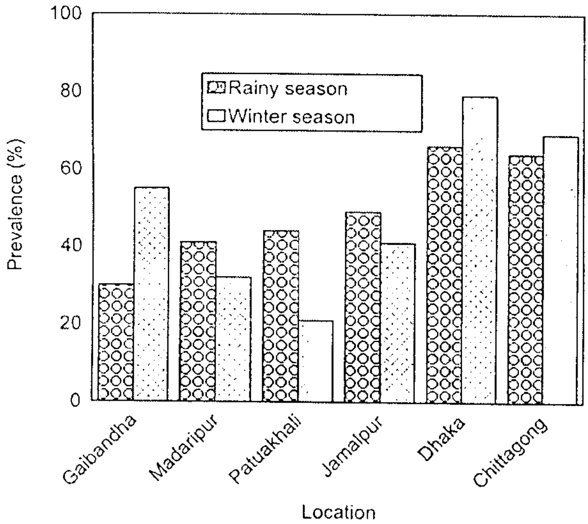

Fig 1. Prevalence of disease among children

No regular trend in prevalence was observed across the seasons. Prevalence of the diseases was significantly higher in the urban slum ($p < 0.05$) in both seasons. Of the rural locations, prevalence in winter was higher in Gaibandha, and lower in Patuakhali. However, this was not statistically significant. Table 6 shows the morbidity pattern of the preschool age children.

Table 6. Pattern of morbidity among the preschool age children by region and season*

	Gaibandha		Madaripur		Patuakhali		Jamalpur		Dhaka		Chittagong	
	Rainy	Winter	Rainy	Winter	Rainy	Winter	Rainy	Winter	Rainy	Winter	Rainy	Winter
Diarrhoea	47	37	37	56	27	40	52	46	60	9	39	10
RTI	24	26	42	6	5	10	3	18	15	43	20	40
Measles	0	4	4	0	0	0	3	0	0	4	0	0
Others¶	29	33	17	38	68	50	42	36	25	44	41	50

*Percent distribution
RTI, respiratory tract infection
¶Infectious diseases non contributory to vitamin A deficiency

On average about 40% suffered from diarrhoea. Highest incidence of diarrheoa was observed in Dhaka in the rainy season. Second most commons was respiratory tract infection. There were cases of other infectious diseases such as measles, jaundice, dysentery, scabies etc. Higher incidence of infectious diseases contributed in developing increase in the number of xerophthalmic cases during the rainy season.

Discussion

Vitamin A deficiency disorders continue to be a serious public health problem in Bangladesh. Considering geographical and seasonal variation in prevalence of xerophthalmia, this study was carried out in population at risk in six locations in four agro-ecological regions and two urban locations of Bangladesh in two different seasons[4]. Over all nutrition situation of the population studied was poor (data not presented). Mean monthly family income ranged from 1127 to 2030 Takas (1US$ = 50 Takas). Mean per capita energy intake of 7.14 MJ, which was below the requirement. Foods from animal sources contributed very small amount of vitamin A to the diet. Carotenes provided almost all of the dietary vitamin A.

Seasonal variation in per capita intake of vitamin A was evident in the study. In the rainy season, per capita daily intake of vitamin A was high, more than requirement. The picture was completely different in winter. Overall intake failed to meet daily requirement. Intake was lower in winter in most locations except in the lower Ganges flood plain. In Madaripur, intake was slightly higher in winter. In most of the locations intake in winter failed to meet the daily requirement. Seasonal variation in vitamin A intake was due mainly to seasonality of the green leafy vegetables consumed by this population. The rural people are mainly dependent on a limited number of vegetables suited to the agro-ecology of that area, and that are traditionally grown by the people.

One common food item in rainy season was jute leaves, which they could collect from fields for free. Consumption of jute leaves was particularly high in Gaibandha. Among the other vegetables consumed by this population were *Cucorbitaceae* climbers and *amaranth* grown on homesteads. Among the fruits, jackfruit was found to be popular in all locations in the rainy season. The winter vegetables are less common on rural homesteads nor could they be collected from fields. One exception was Madaripur, where considerable consumption of *Lathyrus sativus* leaves collected from fields was observed in winter. Urban slum dwellers seldom have land to grow vegetables on homesteads. Not surprisingly, only 13 % of the urban households selected in Dhaka grew *Cucorbitaceae* climbers on roof top. None in the Chittagong slum was found to grow vegetables. The urban population therefore had to buy vegetables from the markets for consumption in both seasons. Although vegetables are more plentiful in winter, the popular ones are poor in β carotene.

Average intake values may not reveal the important difference in intake between different age groups. It is not possible to classify individuals in different risk categories using the data. Considering this, it may not be fare to say that the children surveyed got an equal share of vitamin A and carotene rich foods with the adults. Besides, intake of a single day may not reflect the subject's habitual intake. A single qualitative estimate done on subjects in a cross sectional survey does not identify individuals at risk of deficiency. To offset the shortcoming, an indirect method based on usual pattern of intake (UPF scoring) was suggested by the IVACG[11]. This study concentrated more on the age group considered most vulnerable to vitamin A deficiency, *i.e.*, pre-school age children. Quantitative information based on the UPF scoring showed that the overall condition with respect to vitamin A intake was better in rainy season than in winter. Substantial shifts toward the high and moderate risk populations were observed in the winter in all rural locations.

Point prevalence of xerophthalmia was high in rainy season. Number of positive cases was highest in Jamalpur. Next largest number of cases was detected in Gaibandha and Madaripur. The xerophthalmia cases were found to have improved in winter. This improvement was due to higher dietary vitamin A intake during the rainy season. The higher vitamin A intake rainy season not only improved clinical conditions, but also offered protection for some length of period by storing the nutrient in the body. No cases were detected in Patuakhali and Dhaka. Lower incindence of xeropthalmia in the urban areas was probably due to better coverage by vitamin A capsule distribution programmes. Patuakhali is a coastal region. Although only 12 % of the household heads in Patuakhali took fishing as occupation, many other occasionally fished in the rivers and canals. Habitual intake of small fish may be therefore higher there. This population consumes the small fish that are not accepted by the local purchase centres. Moreover, vitamin A_1 contained in marine fish has biological activity 2.5 times that of A_2 present in fresh water species[14].

Poor environmental hygiene and sanitary practices seem to precipitate vitamin A deficiency in this population. Use of water from ponds and rivers for domestic purposes is substantial in poor communities. Combined with this, unhygienic toilet practice expose them to communicable diseases. Not surprisingly, incidence of communicable disease in them was high in both seasons. It was found that most of the children with night blindness and Bitot's spot had attacks of diarrhoea or dysentery before developing the condition. One reported to have suffered from measles. Diarrhoea, respiratory tract diseases, and measles often precipitate vitamin

A deficiency[12]. Frequency, duration and severity of infection contribute directly or indirectly to vulnerability[15]. Parasite infestation may interfere with uptake of vitamin A[16].

In summary, vitamin A deficiency disorders cannot be eradicated in isolation because of its complex nature. There is no easy way or short cut approach to solve the problem. Vitamin A intake of the subjects in Gaibandha was highest, yet several cases of xerophthalmia were detected there. It is noteworthy that all most all vitamin A of this population come from leafy vegetables. Recent findings suggest lower bioavailabilty of vitamin A from vegetable sources than hitherto thought[17-20]. Composition of diet is also important for availability of vitamin A from food. Intake of fat was very low in the population studied. dietary fat has been shown to increase vitamin A absorption[21]. As the mucosal cells absorb β carotene incorporated in lipid micelles a diet low in fat may contribute to vitamin A deficiency. Moreover, carotene absorption requires not only sufficient fat in diet but also sufficient protein and zinc[22-23], while large amount of dietary fibre has been shown to reduce bioavailablity of carotenes[24]. Besides food, hygiene practices also need to be improved. Otherwise, repeated attack of infectious diseases due to fecal contamination and poor personal hygiene with only negate the situation.

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