Original Article

Anaemia and vitamin A deficiency in poor urban pregnant women of Bangladesh

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This cross-sectional study investigated the prevalence of anaemia and vitamin A deficiency (VAD) among pregnant women in a poor urban population of Bangladesh. It also examined the association of various socio-economic and dietary factors with anaemia and vitamin A status. A maternal and child health clinic in Dhaka city, Bangladesh was used to obtain the sample. Three hundred and eighty three pregnant women, aged 20-30 years, of 20-30 weeks gestation were randomly selected from women on their first presentation for antenatal care. Socio-economic, pregnancy related information, usual dietary pattern and anthropometric data were collected. Blood haemoglobin and serum retinol (vitamin A) concentrations were determined. About 40% of the pregnant women were anaemic (haemoglobin <11.0 g/dl) and 45% had low serum vitamin A levels (<30 μg/dl); with 8.6% having sub-clinical VAD (serum retinol <20 μg/dl). The women with low serum vitamin A levels had 1.8 times greater risk of being anaemic than did the women with normal vitamin A status. Food frequency data revealed that a large proportion of these women did not consume egg (49%), milk (25%), meat (31%), liver (83%), large fish (32%), small fish (39%) and sweet pumpkin (52%) at all; while about 25% of the women reported consuming dark green leafy vegetables (DGLV) and 64% reported an intake of fruit at least four servings a week. The pregnant women who were either illiterate or received only informal education (up to grade ten) had significantly lower haemoglobin and serum vitamin A levels compared to those who completed at least a secondary school certificate. The women whose husbands were illiterate or received only informal education had significantly (*P*=0.01) lower serum vitamin A levels than those whose husbands had received at least a secondary school certificate. The women who came from families with a per-capita income below the poverty line had significantly lower haemoglobin and serum vitamin A levels compared to those who came from families with a per-capita income above the poverty line. The women who consumed three servings or less of DGLV and fruit per week had significantly lower haemoglobin and serum vitamin A levels than those who consumed four or more servings a week. The women who never consumed large fish had significantly lower haemoglobin compared to those who reported at least one serving a week. Furthermore, the women who never consumed sweet pumpkin had significantly lower serum vitamin A than the women who ate at least one serving a week. By multiple regression analysis, intake of meat, DGLV and fruit, and serum vitamin A levels were found to have a significant independent relationship with haemoglobin. The overall F-ratio (9.9) was highly significant (*P*=0.000), the adjusted R-square was 0.086 (multiple R =0.309). Multiple regression analysis for serum vitamin A also revealed a significant independent relationship with per capita income, haemoglobin levels, intakes of DGLV and sweet pumpkin. The overall F-ratio (10.2) was highly significant (*P*=0.000), the adjusted R-square was 0.10 (multiple R =0.312). In conclusion, anaemia and vitamin A deficiency were highly prevalent among poor urban pregnant women in Bangladesh. Various socio-economic and dietary factors may influence the anaemia and vitamin A status of these women. The present study emphasizes the need for a comprehensive intervention strategy, which include both nutritional and environmental factors, to improve the nutritional status of this population.

Key Words: vitamin A deficiency, anaemia, pregnant women, serum retinol, haemoglobin, urban poor, Bangladesh

Introduction

Anaemia, particularly iron deficiency anaemia (IDA), is recognized as the world's most prevalent nutritional disorder, affecting more than 2 billion people in both developed and developing countries.[1] Pregnant women are at particularly high risk of IDA, with a highest prevalence in South-East Asia.[1] Anaemia has been reported to contribute significantly to maternal morbidity[2] and mortality.[3-4] IDA during pregnancy is also found to be associated with ahigher risk of low birth weight and preterm delivery.[5-6] There is evidence that iron deficiency during pregnancy reduces fetal iron stores, which may lead to iron deficiency and adversely affect infant development.[6] Vitamin A deficiency (VAD) is also a major public health problem in

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the world[1] and it is increasingly recognized that pregnant women in developing countries are one of the most vulnerable groups.[7-8] It has recently become evident that VAD has important consequences on maternal morbidity and mortality[8-9] and may contribute to poor pregnancy and lactating outcomes.[10] VAD is also known to precipitate anaemia[11-13] and studies have shown that VAD may cause abnormalities in iron metabolism.[11,12]

In Bangladesh, there is a high prevalence of low birth weight, and high morbidity and mortality in infancy and early childhood. The roots of all these problems lie during pregnancy and in the nutritional preparation of mothers for pregnancy. Although the availability of food, energy and macronutrients may play a part in influencing fetal growth and development, there is increasing evidence that micronutrient status may also play an important critical role.[6,10,14] Nutritional anaemia and VAD have long been identified as serious public health problems in Bangladesh.[15-16] The most recent national vitamin A survey in 1997-98 revealed that nearly half of pregnant women in rural Bangladesh had anaemia[17] and marginal VAD.[18] However, these studies have been carried out only in rural populations and inadequate attention has been paid among women living in urban areas. As a consequence, there have been no systematic studies that characterized the extent of anaemia and VAD in pregnant women in poor urban communities. Therefore, the present study was designed to examine the extent of anaemia and VAD among pregnant women in a poor urban population of Dhaka, Bangladesh. We also assessed the relationship of various socio-economic and dietary factors with haemoglobin and serum vitamin A concentrations among these women.

Subjects and methods

Subject identification and selection

The study was conducted among 383 pregnant women, aged 20-30 years, of 20-30 weeks gestation who came from poor urban communities. The women were assessed at their first presentation for antenatal care at a local maternal and child health centre in Dhaka city, Bangladesh between March and June 1998. The subjects were selected using simple random sampling technique. The purpose of the study was explained to each participant and each were asked to give consent to participate in the study. The study was approved by the Institute of Nutrition and Food Science, University of Dhaka, Bangladesh.

Questionnaire and sample collection

A questionnaire was developed to obtain information on the socio-economic conditions, pregnancy status, and usual dietary pattern in relation to vitamin A and iron rich foods, and pre-tested before finalization. The dietary pattern was assessed by interview using a 7-day food frequency questionnaire (FFQ) on selected food items. Anthropometric measurements and blood samples were collected following the interview. Two millilitres of blood was drawn by venipuncture from the subject's arm. An aliquot of this blood was put in a heparinized tube for determination of haemoglobin concentration. The remaining blood was placed in a glass centrifuge tube and immediately wrapped in foil to protect against degradation of vitamin A by light. After centrifugation, serum samples were separated and kept frozen at –20 °C until further analysis. Serum vitamin A analysis was done within four months of blood collection.

Anthropometric and biochemical measurement

Body weight of each participant was taken to the nearest 100g. The mothers were weighted barefoot, with cloths on. The average weight (0.5 kg) of the clothes was later subtracted from the measured weight. The height was measured to the nearest 1.0 mm. Weight and height were measured using a combined height-weight scale (Detecto-Medic; Detecto Scales Inc, Webb City, MO). Body mass index (BMI) was calculated to assess nutritional status. Mid upper arm circumference (MUAC) was measured on the subject's left arm with a tailoring tape to the nearest 1.0 mm. Haemoglobin concentration was determined by the cyanomet-haemoglobin method, using commercial kit (Boehringer Mannheim, Germany). Serum retinol (vitamin A) was determined by HPLC according to Bieri *et al.*,[19] with modifications, as described elsewhere.[20]

Statistical analysis

Data were analysed with the SPSS/version 10.0 statistical Package.[21] Univariate analysis comprised simple frequency distribution of selected variables. For each variable, normality test for distribution of data was performed by Kolmogorov-Smirnov goodness of fit test. Mean, standard deviation and medians for all parameters were calculated. For socio-economic conditions (participants and their husbands' education, per-capita income) and frequency of intake of each of the selected foods, the data were divided into two groups based on a priori logical categories to examine the relationship of haemoglobin and serum vitamin A with various social and dietary factors. The means and differences between groups were assessed using one-way analysis of variance. Pearson's correlation test was performed to examine the association of various social and nutritional factors with haemoglobin and serum vitamin A concentrations. Stepwise multiple regression analysis was carried out to examine the independent relationship of various factors on haemoglobin and serum vitamin A concentrations.

Results

Of the participants, 56% were between 20 and 24 years, and the remaining 44% were from 25 to 30 years old. Sixty five per cent of the pregnant women were in late second trimester (20-24 weeks of gestation) and 35% were in early third trimester (25-30 weeks of gestation). Nearly 80% of the women and 60% of their husbands were either illiterate or received only some level of informal education (up to grade ten). Twenty five percent of the women came from families with a per-capita income below the poverty line (Taka 849/month). A large majority (67%) of the participants lived in thatch/mud houses.

Table 1 provides the anthropometric and biochemical measures of nutritional status. Fifteen per cent of the pregnant women had BMIs <18.5 kg/m^2 and 66% had MUAC <22.5 cm. Both blood haemoglobin and serum vitamin A (retinol) levels were normally distributed. Mean haemoglobin was 11.3 g/dl, ranging from 7.6-14.3 g/dl. Using a cut off point of <11.0 g/dl for haemoglobin, 39.7% of the pregnant women were found anaemic. The mean serum vitamin A concentration was 31.4 μg/dl, ranging from 8.0-76.0 μg/dl. Of the participants, 45% had low serum vitamin A levels (<30 μg/dl), with 8.6% having sub-clinical VAD (serum retinol <20 μg/dl).

Table 1. Anthropometric and biochemical measures of nutritional status of poor urban pregnant women in Bangladesh

Variable	Mean	± SD	Median
Anthropometry			
Body weight (kg)	48.5	8.3	46.0
Height (cm)	150.1	6.2	150.0
Body mass index (kg/m^2)	21.5	3.3	20.8
Mid upper arm circumference (mm)	21.9	2.3	21.5
Biochemistry			
Haemoglobin (g/dl)	11.3	1.1	11.4
Serum vitamin A (μg/dl)	31.4	9.2	31.1

There was a significant positive correlation between serum vitamin A and haemoglobin levels (r=0.17; *P*=0.001). The pregnant women with low serum vitamin A levels (<30 μg/dl) were found to have significantly (*P*=0.004) lower haemoglobin levels compared with those who had adequate (≥30 μg/dl) serum vitamin A. Further, the pregnant women with low serum vitamin A levels had a greater risk (odds ratio: 1.8; 95% CI: 1.2 - 2.8) of also being anaemic than did the pregnant women with adequate serum vitamin A levels. Mean frequency of intake of egg, milk, meat, large fish, small fish, dark green leafy vegetables (DGLV) and fruit were 1.5, 2.4, 1.3, 1.6, 1.3, 2.6 and 6.3 servings per week, respectively; while the consumption of liver and sweet pumpkin were 0.3 and 0.9 servings per week, respectively. Distribution of the participants by frequency of intake of selected food items is shown in Table 2. A good percentage of the women reported not eating egg (49%), liver (83%) and sweet pumpkin (52%) in the previous week.

Table 2. Distribution of the pregnant women by frequency of intake of selected iron and vitamin A rich foods

	Frequency/week		
	0	1-3	≥4
Food items	%	%	%
Egg	49.1	35.0	15.9
Milk	25.3	48.9	25.8
Liver	83.0	16.5	0.5
Meat	31.3	61.7	7.0
Large fish	32.1	54.8	13.1
Small fish	39.4	53.0	8.6
DGLV	11.0	64.5	24.5
Sweet pumpkin	52.0	43.0	5.0
Fruit	12.5	23.8	63.7

A sizable proportion did not report consuming milk (25%), meat (31%), large fish (32%) and small fish (39%). About 64% of the women reported consuming fruit and 25% ate DGLV at least 4 servings during the previous week.

The relationship of selected socio-economic conditions with haemoglobin and serum vitamin A levels are presented in Table 3. The women who were either illiterate or received only some level of informal education (up to grade ten) had significantly lower haemoglobin (*P*=0.02) and serum vitamin A (*P*=0.01) levels than those who received at least a secondary school certificate. The women whose husbands received at least a secondary school certificate had significantly (*P*=0.01) higher mean serum vitamin A level compared to those whose husbands were either illiterate or received only some level of informal education (up to grade ten). No significant difference was observed in the haemoglobin level between groups by husbands' education level. The women in households with per-capita income below the poverty line had significantly (*P*=0.04) lower haemoglobin and serum vitamin A levels than the women in households with per-capita income above the cut-off for poverty line.

The relationship of the frequency of intake of selected foods with haemoglobin and serum vitamin A levels are shown in Table 4. The data were divided into two groups based on the frequency distribution of intake of egg, milk, liver, meat, large and small fish, and sweet pumpkin, using a cut off point of one serving per week. For DGLV and fruit, a cut off point of four servings per week was used. Mean values of haemoglobin and serum vitamin A were calculated for each group. Both haemoglobin and serum vitamin A levels were significantly lower in the women who consumed less than four servings of DGLV and/orf fruit per week than in the women who consumed four servings or more of each. The women who consumed one serving or more of large fish per week had significantly (*P*=0.01) higher haemoglobin levels compared to the women who did not consume any large fish. The women who consumed one serving or more of sweet pumpkin per week had significantly (*P*=0.04) higher serum vitamin A levels compared to the women who did not consume any sweet pumpkin.

The association between various socio-economic conditions and the frequency of intake of selected foods and haemoglobin and serum vitamin A levels of the pregnant women were tested using Pearson's correlation. There were statistically significant positive correlations between haemoglobin level and frequency of intake of egg (r=0.14; *P*=0.007), meat (r=0.13; *P*=0.01), large fish (r=0.14; *P*=0.007), DGLV (r=0.14; *P*=0.005) and fruit (r=0.21; *P*=0.000). Statistically significant positive correlations were also observed between the level of serum vitamin A and frequency of intake of DGLV (r=0.22; *P*=0.000) and sweet pumpkin (r=0.23; *P*=0.01). Serum vitamin A level and age were also correlated (r=0.10; *P* =0.05).

Factors influencing haemoglobin concentration of the pregnant women were evaluated using stepwise multiple regression analysis (Table 5). When education level of the

Table 3. Mean concentration of haemoglobin and serum vitamin A by selected socio-economic conditions of the poor urban pregnant women in Bangladesh

Variable	*N*	Haemoglobin (g/dl)			Serum vitamin A (μg/dl)		
		Mean	± SD	*P* value	Mean	± SD	*P* value
Participants' education							
Illiterate/ informal[a]	302	11.2	1.1	0.02	30.8	8.9	0.01
SSC[b] or more	81	11.5	0.9		33.6	9.6	
Husbands' education							
Illiterate/ informal	232	11.3	1.2	NS	30.4	8.6	0.01
SSC or more	151	11.3	1.0		32.8	9.8	
Per-capita income							
Taka ≤849/month#	98	11.2	1.1	0.04	29.7	9.2	0.04
Taka ≥850/month	285	11.5	1.1		31.9	9.1	

[a]Up to grade ten; [b]Secondary school certificate; # Cut-off for poverty line; NS= not significant.

Table 4. Mean concentration of haemoglobin and serum vitamin A by frequency of intake of various foods of the poor urban pregnant women in Bangladesh

Variable	Frequency /week (*N*)	Haemoglobin (g/dl)			Serum vitamin A (μg/dl)		
		Mean	± SD	*P* value	Mean	± SD	*P* value
Egg	0 (188)	11.2	1.1	NS	31.1	8.7	NS
	≥1 (195)	11.4	1.1		31.7	9.6	
Milk	0 (97)	11.2	1.2	NS	30.3	8.8	NS
	≥1 (286)	11.3	1.1		31.8	9.3	
Liver	0 (317)	11.2	1.1	NS	31.3	9.0	NS
	>1 (66)	11.5	1.0		32.1	9.9	
Meat	0 (120)	11.2	1.1	NS	31.6	9.9	NS
	>1 (263)	11.3	1.1		31.3	8.8	
Large fish	0 (123)	11.1	1.1	0.01	31.0	9.0	NS
	>1 (260)	11.4	1.1		31.5	9.2	
Small fish	0 (151)	11.3	1.2	NS	31.2	9.0	NS
	≥1 (232)	11.3	1.0		31.5	9.3	
DGLV	≤3 (289)	11.2	1.1	0.01	30.4	8.9	0.000
	≥4 (94)	11.5	1.0		34.4	9.3	
Sweet pumpkin	0 (199)	11.2	1.2	NS	30.5	9.5	0.04
	>1 (184)	11.4	1.0		32.4	8.6	
Fruit	≤3 (139)	11.1	1.1	0.05	30.2	7.9	0.05
	≥4 (244)	11.4	1.1		32.1	9.7	

NS=not significant

Table 5. Determinants of haemoglobin and serum vitamin A (retinol) concentrations in poor urban pregnant women of Bangladesh, by stepwise multiple regression analysis

	B	Std Error	Beta	*P* value
Haemoglobin (g/dl)				
Intake of fruit	0.046	0.012	0.193	0.000
Serum vitamin A	0.017	0.006	0.142	0.005
Intake of DGLV	0.065	0.029	0.11	0.028
Intake of meat	0.077	0.038	0.10	0.044
Serum vitamin A (μg/dl)				
Intake of DGLV	0.943	0.240	0.194	0.000
Intake of sweet pumpkin	0.978	0.352	0.136	0.006
Haemoglobin	1.225	0.411	0.147	0.003
Per-capita income	0.001	0.001	0.098	0.045

For haemoglobin: R^2=0.095; adjusted R^2=0.086; F=9.9 (df. 4); *P* value = 0.000
For serum vitamin A: R^2=0.10; adjusted R^2=0.09; F=10.2 (df.=4); *P* value = 0.000

pregnant women, per-capita income, serum vitamin A level, frequency of intake of egg, meat, large fish, DGLV and fruit were included in the analysis and using a *P* value of 0.10 for exclusion, education level, per-capita income, and frequency of intake of egg and large fish dropped out of the equation. Among the variables remaining in the equation, serum vitamin A, frequency of intake of meat, DGLV and fruit were found significantly independently related to haemoglobin level of these women. The frequency of intake of fruit bore a stronger relationship with haemoglobin level compared to other variables judged by comparable beta coefficients. The overall F ratio was 9.9 (df =4) and was highly significant (*P*=0.000). The adjusted R^2 was 0.086 (multiple R = 0.309), suggesting that the variables in the equation accounted for 8.6% of the variance in haemoglobin level.

A similar analysis was done for serum vitamin A (Table 5). When age, women's and their husbands' education level, per-capita income, haemoglobin level, frequency of intake of DGLV, sweet pumpkin and fruit were included in the analysis and using a *P* value of 0.10 for exclusion, age, women's and their husbands' education level and frequency of intake of fruit dropped out of the equation. Among the variables remaining in the equation, per-capita income, haemoglobin level, frequency of intake of DGLV and sweet pumpkin were found significantly independently related to serum vitamin A levels of these women. The frequency of intake of DGLV bore a stronger relationship with serum vitamin A level compared to other variables judged by comparable beta coefficients. The overall F ratio was 10.2 (df =4) and was highly significant (P=0.000). The adjusted R^2 was 0.09 (multiple R =0.312), suggesting that the variables in the equation accounted for 9% of the variance in serum vitamin A level.

Discussion

Both anaemia and VAD are highly prevalent and continue to be significant problems in Bangladesh. In the past, nutritional studies in Bangladesh have placed emphasis on rural populations only. An increasing proportion of the population now live in urban areas, and it is important to recognize the critical health care requirements of people in urban settings. Considering the important consequences of anaemia and VAD during pregnancy on maternal health and fetal development,[4-6] and their implications for infant health and survival,[6] it is essential to determine the prevalence of anaemia and VAD among pregnant women in poor urban populations.

The present study reports the extent of anaemia and VAD among poor urban pregnant women in Bangladesh. This study also explores the relationship of various socio-economic and dietary factors with anaemia and vitamin A status in this population. Largely, these pregnant women are illiterate and come from families with poor socio-economic background. Since this study included only pregnant women who attended a maternity clinic for antenatal care, the participants in the present study may not be truly representative of the wider population from which they were drawn. The result therefore can not be taken as representative of all poor pregnant women in Dhaka city, but it is likely that for most pregnant women in this population the situation is no better, on the whole, than that reported here.

The World Health Organization defines pregnant women with a haemoglobin level below 11.0 g/dl as anaemic.[22] In the present study, nearly 40% of the women were found anaemic by this criterion, and this compares with a prevalence of anaemia among rural Bangladeshi pregnant women of 49%.[17] A study among pregnant women at 12-16 weeks of gestation from urban slums in Dhaka also reported a prevalence of 34.6% for anaemia.[23] In that study, however, the samples were not randomly selected. Although the causes of anaemia are multiple, and include malaria and hemoglobinopathy, nutritional deficiency especially iron deficiency is considered to be the most common cause of anaemia in non-malaria endemic areas, such as Bangladesh.[17] In the present study, we collected information on the intake of iron and vitamin A rich foods using a 7-day FFQ. Since the usual dietary pattern of this population is highly monotonous, with very limited choice of food items and mostly cereals based, the 7-day FFQ method on selected food items rich in iron and vitamin A is considered adequate to represent their usual iron and vitamin A intake pattern. The food frequency data indicate that a large proportion of the pregnant women do not take liver, meat and fish - rich sources of heme-iron in the diet. In the poor communities of Bangladesh, most dietary iron comes from plant sources.[24] We observed that nearly 64% of the women reported consuming fruit and 25% of the women reported eating DGLV at least four times a week. Fruit, especially citrus fruit (vitamin C containing fruits), may enhance iron absorption.

We used serum retinol (vitamin A) as an indicator of vitamin A status as it has been suggested that serum vitamin A concentration can be highly valuable in quantifying the extent of sub-clinical VAD in populations.[25] The results of the present study showed that about 45% of the pregnant women had low serum vitamin A level (<30 μg/dl), with 8.6% having sub-clinical VAD (serum retinol <20 μg/dl). The most recent Bangladesh national vitamin A survey in the rural population showed a significant prevalence (49.2%) of low serum vitamin A levels (<30 μg/dl) with 23.7% having sub-clinical VAD (<20 μg/dl) among pregnant women.[18] The overall prevalence of VAD in the present study appears to be similar to that in rural pregnant women, although the severity of the deficiency is more evident in rural areas. Nevertheless, with respect to vitamin A status these poor urban pregnant women are equally vulnerable and thus constitute a serious public health risk. In the poor communities of Bangladesh, as in most of the other developing countries, approximately 90% of the total vitamin A intake comes largely from plant foods (carotene rich foods).[24] In the present study we found that only 11% of the women did not consume DGLV at all. Sweet pumpkin is also a rich source of provitamin A carotenoids, however, over 50% of the women do not report eating sweet pumpkin. During the time of the study, vitamin A rich fruit such as mango and jackfruits were not available. Among the vitamin A rich fruit available, mainly ripe papaya and orange were eaten. Although we do not have any quantitative information, the food frequency data suggest that a large proportion of the women might have low vitamin A intake. A recent study in a similar population has shown that 87% of the lactating women had vitamin A intake below RDA[26], and thus support our contention.

A study conducted among lactating women and their infants in a rural village in West Java, Indonesia showed that vitamin A deficient mothers had a 2-3 fold higher risk of being deficient in iron or zinc when compared to mothers with normal vitamin A status, emphasizing the co-existence of multiple micronutrient deficiencies in this population.[27] The present study also indicated that the pregnant women with low serum vitamin A status were almost twice as likely to be at risk of being anaemic (most likely iron deficient). Although we did not have information about other micronutrients status, it is likely that these women may also have concurrent deficiencies of many other nutrients. Nearly two thirds of the pregnant women had MUAC less than 22.5 cm, indicating that a sizeable proportion of these women were chronically malnourished. Poor nutritional status of the pregnant women has been found to be associated with poor pregnancy outcome.[14]

Bivariate analysis revealed that both haemoglobin and serum vitamin A levels of poor urban pregnant women were significantly related to their level of education. A similar finding was also reported among non-pregnant rural women in Bangladesh, that illiterate women were more likely to be night blind (vitamin A deficient) and had greater risk of being anaemic.[18] Husbands' education level was also found to be significantly related to serum vitamin A levels of these women. This was similar to that reported in a study of poor urban lactating women in Bangladesh.[26] In this society, husbands' education level usually determines the economic condition of the family. In this study, we also found a significant relationship between haemoglobin and serum vitamin A levels of the women and per-capita income of their family. Studies of rural non-pregnant women in Bangladesh also indicated that both anaemia and VAD were associated with proverty.[17-18]

In the present study, we also investigated whether the dietary pattern of these women is associated with their haemoglobin and serum vitamin A levels. Our findings revealed that the women who had relatively high intake of large fish (at least one serving a week), DGLV and fruit (four or more servings a week) had significantly higher haemoglobin levels. Fish contains heme iron, and its intake can also enhance the non-heme iron absorption; such as iron from DGLV.[28] Further, large fish intake is considered to be an important source of dietary protein in this population,[29] and protein status is related to haemoglobin synthesis. Fruit especially citrus fruit are also known to influence non-heme iron absorption.[28] Higher frequency of intake of DGLV, fruit and sweet pumpkins by the pregnant women were found to be associated with higher serum vitamin A levels. A study of rural Bangladeshi women of reproductive age reported that the relatively high intake of vitamin A, from DGLV, was found to be associated with decreased maternal night blindness[30] and thus support our findings. The data suggest that despite low bioavailability of beta-carotene in fruit and vegetables, promotion of consumption of fruit and vegetables seems to be an effective measure to improve vitamin A status of this population, who have little access to foods containing preformed vitamin A.

It might be possible that using bivariate analysis, the levels of haemoglobin and serum vitamin A of these women were confounded by the effect of various socio-economic and dietary factors. Therefore, multiple regression analysis was carried out to identify independent factors that are related to haemoglobin and serum vitamin A levels separately. We found that haemoglobin levels of these women are significantly influenced by a number of independent factors such as intake of DGLV, fruit and meat, and serum vitamin A level. Further, the results showed that for every unit change in serum vitamin A there was a 0.017 unit change in haemoglobin while all other factors in the equation were taken into account. An association of lower haemoglobin with lower serum retinol concentrations has also been reported in different age groups in several countries.[13, 31- 32] It has been suggested that vitamin A exerts an influence on the metabolic availability of iron, and hence haemoglobin formation.[33]

Multiple regression analysis of our data also revealed that per-capita income, haemoglobin level, intake of DGLV and sweet pumpkin are significantly independently related to serum vitamin A levels of these women. Further, the data indicate that for every unit change in haemoglobin level there was a 1.2 unit change in serum vitamin A while all other factors in the equation were taken into account. Previously we have shown a similar relationship in urban schoolchildren[34] and adolescent females[20] in Bangladesh. A recent study among Mexican preschool children indicated that iron supplementation could improve plasma vitamin A and transport protein of vitamin A and the authors suggested an interaction between iron and vitamin A metabolism.[35]

In conclusion, this study shows that a significant proportion of poor urban pregnant women in Bangladesh have anaemia and VAD. Further, various socio-economic and dietary factors may influence the anaemia and vitamin A status of these women but accounted for only about 9% of the variance. The present study, therefore, emphasizing the need for a comprehensive intervention strategy, which include both nutritional and environmental factors, to improve the nutritional status of this population.

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