Public Health Nutrition: 6(5), 447–452 DOI: 10.1079/PHN2002454

Vitamin A deficiency in poor, urban, lactating women in Bangladesh: factors influencing vitamin A status

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Submitted 9 September 2002: Accepted 5 December 2002

Abstract

Aims: To investigate the prevalence of vitamin A deficiency among lactating women in a poor urban population of Bangladesh, and to examine the relationship between various factors and vitamin A status.
Design: Cross-sectional study.
Setting: Maternal and child health clinic in Dhaka City, Bangladesh.
Subjects and methods: A total of 120 lactating women aged 17–37 years were randomly selected from women who attended a local maternal and child health clinic in Dhaka City for immunisation of their children. Various socio-economic, personal characteristics, dietary intakes of vitamin A and anthropometric data were collected. Serum retinol (vitamin A) concentration was determined as a measure of vitamin A status.
Results: Of the subjects, 37% had low serum vitamin A levels ($<30\,\mu g\,dl^{-1}$), with 13.3% having sub-clinical vitamin A deficiency ($<20\,\mu g\,dl^{-1}$). Eighty-seven per cent had vitamin A intakes below the recommended dietary allowance. The lactating women who were either illiterate or received only informal education had significantly ($P = 0.002$) lower serum vitamin A levels compared with those who received formal education. The women whose husbands received formal education had significantly ($P = 0.05$) higher serum vitamin A levels than those whose husbands were either illiterate or received only informal education. The serum vitamin A levels of women in households with poor sanitation/latrine practice were significantly ($P = 0.03$) lower than those of women in households with good sanitation/latrine practice. The women with one child had significantly ($P = 0.015$) lower serum vitamin A levels than those with two or more children. Women with a lactation period of 6 months or more had significantly ($P = 0.034$) lower serum vitamin A levels than women with a lactation period of less than 6 months. The women who consumed less than the median vitamin A intake ($274.8\,\mu g\,day^{-1}$) had significantly ($P = 0.01$) lower serum vitamin A levels than those who consumed more than the median vitamin A intake. By multiple regression analysis, education level of the women, number of living children, duration of lactation and dietary intake of vitamin A were found to have significant independent relationships with serum vitamin A. The overall *F*-ratio (6.8) was highly significant ($P = 0.000$), the adjusted R^2 was 0.16 (multiple $R = 0.44$).
Conclusion: A significant proportion of poor, urban, lactating women in Bangladesh have vitamin A deficiency. Among the various factors, education level of the women, number of living children, duration of lactation and dietary intake of vitamin A appear to be important in influencing the vitamin A status of these women.

Keywords
Vitamin A deficiency
Lactating women
Serum retinol
Urban poor
Bangladesh

Vitamin A deficiency (VAD) is a public health problem around the world, with the highest number of clinical cases occurring in South-East Asia[1]. VAD has been found to be associated with increased morbidity and mortality among pre-school children and evidence now confirms that improving the vitamin A status of deficient children can increase their chance of survival by over 23%[2,3]. VAD is also known to influence the growth of children and precipitates anaemia[4–6]. Studies have shown that VAD is also prevalent among women of reproductive age[7,8], and it has now become evident that VAD in women has negative consequences on their health status as well as that of their infants[8–11].

In Bangladesh, VAD has been recognised as a public health problem for more than a decade[12]. However, most vitamin A research has focused on infants and children.

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More than 85% of Bangladeshi infants continue to be breast-fed through the first year of life and some continue partial breast-feeding until more than 2 years of age[13,14]. Infants who are born with low vitamin A stores mostly rely on their mother's breast milk vitamin A concentration to meet their needs. The breast milk vitamin A concentration is related to maternal vitamin A status and has direct implications on infants' health and survival[9,10,15]. Therefore, adequate vitamin A status of lactating mothers is important for sustaining adequate breast milk vitamin A concentration and hence the vitamin A status of infants and young children. The most recent, national vitamin A deficiency survey in 1997–98 indicated that nearly half of lactating women in rural Bangladesh had low serum vitamin A levels ($30\,\mu g\,dl^{-1}$)[16]. However, very little is known about the vitamin A status of lactating women in poor urban populations. Against this background, the aim of the present study was to describe the extent of VAD in lactating women of the poor urban population in Dhaka, Bangladesh. We also examined the relationship between vitamin A status and various social, personal and nutritional factors.

Subjects and methods

Subject identification and selection

The study group comprised 120 lactating women, aged 17–37 years, of poor urban communities who attended a local maternal and child health centre in Dhaka City, Bangladesh, for immunisation of their children between October and December 1999. Women whose babies had any consumption of breast milk were considered to be lactating. The health centre was selected purposely as a sizeable number (15–20) of mothers attend this clinic every day. On each immunisation day (twice weekly), every third woman who came to the centre for immunisation of her child was randomly selected. The purpose of the study was explained to each of the participants, who was asked to give consent for their participation in the study.

Questionnaire and sample collection

A questionnaire was developed to obtain information on the socio-economic characteristics, personal history including duration of lactation and diet in relation to vitamin A intake of the participants. The intake of vitamin A was assessed using a semi-quantitative, 24-hour dietary questionnaire[17]. Anthropometric data and blood samples were collected following the interview. Two millilitres of blood were drawn from the subject's arm. The 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 retinol (vitamin A) analysis was done within three months of blood collection.

Anthropometric and biochemical measurements

The body weight of each participant was taken to the nearest 100 g. Mothers were measured barefoot, with clothes on. The average weight (0.5 kg) of the clothes was later subtracted from the measured weight. Height was measured to the nearest 0.1 cm. Weight and height were measured in a combined height–weight scale (Detecto-Medic; Detecto Scales Inc., Webb City, MO). Body mass index (BMI) was calculated to assess the subject's nutritional status. Serum retinol (vitamin A) was determined by high-performance liquid chromatography as described elsewhere[18].

Statistical analysis

Data were analysed with the SPSS version 10.0 statistical package[19]. Univariate analysis comprised determination of the simple frequency distribution of selected variables. For each variable, a normality test for distribution of the data was performed by means of the Kolmogorov–Smirnov goodness-of-fit test. Mean, standard deviation and median were calculated for all parameters. The data were divided into groups, either on the basis of *a priori* logical categories or to produce equal numbers of subjects in each group for various social, personal 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 between serum vitamin A and social, personal and nutritional factors. Backward stepwise multiple regression analysis was carried out to examine the independent relationship of serum vitamin A with selected variables.

Results

More than two-thirds of the lactating women in this study were either illiterate or received only some level of education (up to Grade 10). About 93% were housewives. Nearly half of their husbands were either illiterate or received education only up to Grade 10. Forty per cent of the husbands were day labourers, 29.2% were petty businessmen and the rest were office workers. Nearly half of the lactating women came from families with five or more members, and with a per capita income below the poverty line (849 Taka/month; US$1 = 57.5 Taka). Selected personal characteristics of the lactating women who participated in the study are presented in Table 1.

Mean BMI of the lactating women was within the normal range and nearly 21% had BMI $<18.5\,kg\,m^{-2}$ (Table 2). Median vitamin A intake was only $274.8\,\mu g\,day^{-1}$, and 87% had intakes of vitamin A below the recommended dietary allowance (RDA) ($950\,\mu g\,day^{-1}$). Mean serum vitamin A (retinol) level was within the normal range (Table 2). Nearly 37% of the lactating women had low serum vitamin A levels ($<30\,\mu g\,dl^{-1}$), with 13.3% having sub-clinical VAD ($<20\,\mu g\,dl^{-1}$).

Table 1 Selected personal characteristics of the poor, urban, lactating Bangladeshi women who participated in the study

Variable	Number	Percentage
Age (years)		
17–19	17	14.0
20–29	79	65.8
30–35	24	20.0
Number of living children		
1	51	42.5
≥ 2	69	57.5
Duration of lactation (months)		
< 6	64	53.3
≥ 6	56	46.7
Pregnancy status		
Pregnant	9	7.5
Not pregnant	111	92.5

Table 2 Body mass index (BMI), dietary intake of vitamin A and serum vitamin A level in the poor, urban, lactating Bangladeshi women

Variable	Mean ± SD	Median
BMI ($kg\,m^{-2}$)	21.7 ± 3.9	20.9
Vitamin A intake ($\mu g\,day^{-1}$)	443.8 ± 388.8	274.8
Serum retinol (vitamin A) ($\mu g\,dl^{-1}$)	34.7 ± 12.1	33.3

SD – standard deviation.

The relationship between serum vitamin A level and various socio-economic characteristics of the lactating women is presented in Table 3. The women who were either illiterate or received education of up to Grade 10 had significantly ($P = 0.002$) lower serum vitamin A levels than those who received formal education (Secondary School Certificate or above). The women whose husbands received formal education had significantly ($P = 0.05$) higher serum vitamin A levels than those whose husbands were either illiterate or received education of up to Grade 10. The women in households with poor sanitation/latrine practice had significantly ($P = 0.03$) lower serum vitamin A levels compared with women in households with good sanitation/latrine practice.

Table 3 Relationship between various socio-economic characteristics and serum vitamin A level in the poor, urban, lactating Bangladeshi women

Variable	*n*	Mean ± SD	*P*-value
Participant's education			
Illiterate/informal education*	83	32.0 ± 11.5	0.002
Formal education†	37	40.0 ± 14.1	
Husband's education			
Illiterate/informal education	59	32.0 ± 11.4	0.05
Formal education	61	36.0 ± 13.8	
Per capita income			
≤ 849 Taka‡/month	56	34.0 ± 13.4	0.60
≥ 850 Taka/month	64	35.3 ± 12.5	
Sanitation/latrine practice			
Poor	12	27.2 ± 12.7	0.03
Good	108	35.5 ± 12.7	

SD – standard deviation.
* Up to Grade 10.
† Received at least Secondary School Certificate.
‡ US$1 = 57.5 Taka.

Mean serum vitamin A level of younger lactating women was lower than that of the older lactating women; however, the difference between groups did not reach the level of statistical significance ($P = 0.067$) (Table 4). Women with one child had significantly ($P = 0.015$) lower mean serum vitamin A level than women with two or more children (Table 4). The women with a lactation period of 6 months or more were found to have significantly ($P = 0.034$) lower mean serum vitamin A level than women with a lactation period of less than 6 months.

Mean serum vitamin A level was lower among lactating women with BMI $< 18.5\,kg\,m^{-2}$ than among those with BMI of $18.5\,kg\,m^{-2}$ or above, although the difference between groups was not statistically significant ($P = 0.067$) (Table 5). Women who consumed less than the median vitamin A intake ($274.8\,\mu g\,day^{-1}$) had significantly ($P = 0.018$) lower mean serum vitamin A level than women who consumed more than the median vitamin A intake (Table 5).

There were statistically significant positive associations between the level of serum vitamin A and age ($r = 0.19$; $P = 0.03$), BMI ($r = 0.22$; $P = 0.02$), level of education ($r = 0.27$; $P = 0.002$) and total vitamin A intake ($r = 0.23$; $P = 0.01$) of the women. Factors influencing the level of serum vitamin A were explored in more detail using backward stepwise multiple regression analysis (Table 6). When age, lactating women's and their husbands'

Table 4 Relationship between selected personal factors and serum vitamin A level in the poor, urban, lactating Bangladeshi women

Variable	*n*	Mean ± SD	*P*-value
Age (years)			
17–19	17	30.4 ± 8.7	0.067
20–29	79	34.1 ± 13.0	
30–37	24	39.5 ± 13.7	
Number of living children			
1	51	31.4 ± 11.1	0.015
≥ 2	69	37.1 ± 13.6	
Duration of lactation (months)			
< 6	64	37.0 ± 13.2	0.034
≥ 6	56	32.0 ± 12.0	

SD – standard deviation.

Table 5 Relationship between serum vitamin A level and body mass index (BMI) and dietary intake of vitamin A in poor, urban, lactating Bangladeshi women

Variable	*n*	Mean ± SD	*P*-value
BMI (kgm^{-2})			
< 18.5	25	30.6 ± 13.0	0.067
≥ 18.5	95	35.8 ± 12.7	
Dietary intake of vitamin A ($\mu g\,day^{-1}$)			
≤ 274.8	60	31.9 ± 12.4	0.018
> 274.8	60	37.5 ± 12.8	

SD – standard deviation.

Table 6 Backward multiple regression analysis* for serum vitamin A in poor, urban, lactating Bangladeshi women

Dependent variable: serum retinol (vitamin A)
Multiple $R = 0.438$
$R^2 = 0.192$
Adjusted $R^2 = 0.164$
F-ratio = 6.8; df = 4; Sig. $F = 0.000$

Variable in the equation	B	SE B	β	T	Sig. T
Participant's education	0.637	0.216	0.258	2.95	0.004
Number of living children	2.268	1.016	0.191	2.23	0.028
Duration of lactation (months)	−0.226	0.109	−0.175	−2.08	0.039
Dietary intake of vitamin A	0.0077	0.003	0.233	2.71	0.008

*B – ordinary least-squares regression coefficient; SE B – standard error of B; β – standardised β-coefficient; t – test statistic used for determining the significance of B and β: Sig. t – P-value for significance of B and β.

education level, number of living children, duration of lactation, sanitation practice, BMI and dietary intake of vitamin A were included in the analysis and using a P-value of 0.10 for exclusion, age, husbands' education, BMI and sanitation practice dropped out of the equation. Among the variables remaining in the equation, education level of the women, number of living children, duration of lactation and dietary intake of vitamin A were found to be significantly independently related to serum vitamin A level of these women, while the education level of the lactating women bore a stronger relationship with serum vitamin A level than the other variables, as judged by comparable beta coefficients. The overall F-ratio was 6.8 (df = 4) and was highly significant ($P = 0.000$). The adjusted R^2 was 0.16 (multiple $R = 0.44$), suggesting that the variables in the equation accounted for 16% of the variance in serum vitamin A level.

Discussion

In Bangladesh, nutritional studies in the past have focused on the rural population. An increasing proportion of the population now lives in urban areas, and thus there is a need to identify the critical healthcare requirements of this group. Considering the close relationship between maternal vitamin A status and breast milk vitamin A concentration, and its implications for infants' health and survival[9,10,15], it is important to evaluate the extent of VAD in lactating women of the poor urban population. By and large, the lactating women in the present study were mostly illiterate and came from families with poor socio-economic background of the urban population.

In this study we used serum retinol (vitamin A) as the indicator of vitamin A status. It has been suggested that serum vitamin A concentration can be highly valuable in quantifying the extent of sub-clinical VAD in populations[20]. The prevalence of VAD in the present study appears as high as in rural lactating women[16], indicating that poor, urban, lactating women are equally vulnerable and thus carry a significant public health risk.

Nearly 21% of the lactating women had BMI $< 18.5\,kg\,m^{-2}$, indicating that a sizeable proportion of these women had chronic energy deficiency. Poor nutritional status of mothers has been found to be associated with poor lactation performance and breast milk of lower nutritive values, including vitamin A[21]. Although the median vitamin A intake ($275\,\mu g\,day^{-1}$) of the lactating women in the present study appeared to be more than double that of their rural counterparts[16], about 87% of these women had vitamin A intake below the RDA. The habitual intakes of vitamin A among women in developing countries are generally poor.

Bivariate analysis revealed that serum vitamin A level of the lactating women was significantly related to their level of education, similar to the findings in the rural population[16]. Furthermore, husbands' education level also appeared to have a significant relationship with the serum vitamin A level of these women. In this society, the husband's education level usually reflects the economic condition of the family. However, in the present study we failed to demonstrate any relationship of serum vitamin A level with per capita. It has been reported that women in households with poor sanitation/latrine practice are more likely to suffer from VAD than women in households with good sanitation/latrine practice[16], as was found in our study. Poor sanitation may be associated with higher risk of infection including worm infestation. It has been suggested that infections also predispose to the development of VAD[3]. However, in the present study, we do not have any information regarding sub-clinical infection.

The women with one child had significantly lower serum vitamin A levels than those women with two or more children. A previous report has shown that the risk of VAD is about 1.7 times higher among younger women compared with older women[16]. It is likely that the women with one child belonged to the younger age group and the differences between groups could be attributable to age rather than number of children. Although the younger women in the present study had lower serum vitamin A level than the older lactating women, it reached only a marginally statistically significant ($P = 0.067$) difference. The women with a lactation period of 6 months or more had significantly lower mean serum vitamin A level than the women with a lactation period of less than 6 months. There is evidence that if the vitamin A intake during lactation is not sufficient to replace the amount transferred to the infant via breast milk, maternal vitamin A stores become depleted[22].

A study in Nepal showed that night-blind pregnant women were more malnourished than pregnant women without night blindness, as judged by all anthropometric indices[8]. In the present study, malnourished (BMI $< 18.5\,kg\,m^{-2}$) lactating women were found to have marginally significantly lower mean serum vitamin A

levels than well-nourished lactating women. As reported elsewhere[16], in this study we also observed a significant relationship between dietary intake of vitamin A and serum vitamin A levels of the lactating women.

It is possible that, by using bivariate analysis, the serum vitamin A level of these women was confounded by the effects of various social, personal and dietary factors. Therefore, multiple regression analysis was carried out to identify the independent factors that are related to serum vitamin A. The results indicate that the serum vitamin A level in poor, urban, lactating Bangladeshi women is significantly influenced by a number of independent factors such as education level of the women, number of living children, duration of lactation and dietary intake of vitamin A. However, the study did not include lactating women who were not attending the maternal and child health centre for immunisation of their children. The women who attend the health centre for immunisation of their children may represent relatively better educated and motivated subjects than those who do not seek immunisation service from the health centre. Therefore, it is unlikely that the subjects were representative of the wider population, and some caution should be exercised in the generalisation of these findings.

To improve the vitamin A status of lactating women and their breast-feeding infants living in endemic areas of VAD, the World Health Organization recommends supplementation with a single dose of 200 000 IU of vitamin A within 8 weeks postpartum. However, studies have indicated that one-time high-dose vitamin A supplementation may only be able to maintain adequate vitamin A status and breast milk retinol for a short period, which then decline as soon the available vitamin A is utilised[10,15]. In Bangladesh, mothers in poor urban societies continue to breast-feed their children for a long period of time[14]. Although the majority of 6-month-old infants start to receive complementary foods, these foods are generally carbohydrate-rich and low in vitamin A. Thus these women would need to improve their vitamin A intake in order to maintain their own vitamin A status and as well as to supply adequate vitamin A to their infants through breast milk. In the context of the present study population, increasing vitamin A intake through diet seems to have little prospect. On the other hand, frequent high-dose vitamin A supplementation may carry a risk of teratogenicity in the event of concurrent pregnancy. Recently we have demonstrated in a group of adolescent factory workers, who belonged to similar socio-economic conditions, that a low-dose weekly supplement of vitamin A could improve vitamin A status[23]. Thus, low-dose intermittent supplementation of vitamin A to the lactating women would result in a benefit to their own health and that of their breast-fed infants and children. In addition, effort should be made to improve their dietary vitamin A intakes, perhaps through nutrition education.

Acknowledgement

The authors express their sincere thanks to the participants of this study.

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