Original Article

Vitamin A Deficiency, Anemia, and Nutritional Status of under 5-Year Children from Northeast India

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Abstract

Background: Vitamin A deficiency (VAD) and Anemia are important public health nutritional problems in India. Objective: To assess nutritional status and prevalence and correlates of undernutrition, anemia, and VAD among children. Materials and Methods: A community-based cross-sectional study was carried out adopting systematic random sampling. Information on socio-demographic particulars was collected and 20 µL blood was collected for hemoglobin and free-flowing drop on Whatman filter paper for Vitamin A estimation. Hemoglobin was estimated using indirect cymnemethemoglobin and Vitamin A by high-pressure liquid chromatography. Nutritional status was assessed using the WHO Child Growth Standard. Results: The overall prevalence of anemia and VAD was 68% and 59%, respectively, while underweight, stunting, and wasting was 30%, 55%, and 11%, respectively, among under 5 year children. Stepwise logistic regression analysis revealed no significant association of anemia and VAD with any sociodemographic variables, while the odd of stunting was four times higher among children of mothers engaged in labor and two times among children from low-income group, while underweight was two times higher among children from households not having sanitary latrine. Exclusive breastfeeding was observed to be associated with undernutrition among infants. Conclusions: Anemia, VAD, and stunting were high among children. Low intakes of green leafy vegetables and milk and milk product may be the reasons for the higher prevalence of anemia and VAD. There is a need to strengthen supplementation of iron and folic acid tablets and Vitamin A and also public distribution system.

Keywords: Anemia, preschool children, undernutrition, Vitamin A deficiency

INTRODUCTION

Micronutrient malnutrition, especially Vitamin A and iron deficiency resulting in anemia are the important health problems among children, adolescents, and women in reproductive age groups. Globally anemia affects about 43% of 6–59 months children.[1] As per the National Family Health Survey (NFHS 4), 59% of children of 6–59 months age had any form of anemia, while 2% had severe anemia.[2]

The important reasons for anemia among preschool children are improper nutrition, infections such as malaria and infestations.

Nutritional causes of anemia include inadequate dietary intake, especially poor complementary feeding (CF) practices or malabsorption of iron, an increased iron demand during rapid growth, and chronic blood loss due to blood disorders, in addition to folate and Vitamin B12 deficiencies.

Anemia during childhood adversely affects the mental, physical, and social development of the children in short- and long-term outcome; it causes abnormalities of immune function, poor motor, and cognitive development,[3,4] poor school performance, and reduced work productivity in later life,[5] thereby decreasing earning potentials and negatively affect national economic growth.

Vitamin A deficiency (VAD) is the leading cause of preventable blindness among young children in low-income countries. It impairs growth, weaken the immune system and thus increase susceptibility to infection, morbidity, and mortality. VAD is attributable to deaths due to diarrhea and

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measles, about 2% of death among under 5 children are due to VAD.\[6\]

Undernutrition among children is another important health problem in India, affecting about one-third of children.\[2\] About 45% of death among under 5 children are directly or indirectly related to undernutrition in developing countries.\[7\] Global burden disease study\[8\] reported that child and maternal malnutrition contribute to 68-2% of all child deaths in India in 2017. To achieve sustainable development goals\[9\] by 2030, it is important to improve child and maternal nutritional status in the country. Under National Nutrition Mission,\[10\] target has been fixed to reduce undernutrition and low-birth-weight by 2% per annum.

Northeast India is mostly inhabited by tribal living in forest and hilly areas. Meghalaya is situated at high altitudes (150–1941 m), the Khasi district is located at the highest altitude. Meghalaya covers an area of approximately 22,430 km², and is bounded by Bangladesh in west and south, Assam in North and east. The state has seven districts and received the highest rainfall. The economy is based on mostly agriculture, forestry, and tourism.

Although several studies have been carried out in India on the prevalence of anemia, very few studies are available for the North-Eastern region. The present study was carried out in the Khasi district of Meghalaya to assess nutritional status, V AD, and anemia among preschool children.

**Materials and Methods**

A community-based cross-sectional study was carried out in the West Khasi Hills district of Meghalaya by adopting systematic random sampling.

The sample size was calculated by assuming an overall prevalence of underweight (weight for age, < median-2 standard deviation [SD]) of 43%,\[13\] with 5% absolute precision and 95% confidence interval (CI), with design effect of 1.5, a sample size of 564 ≈ 600 children was required.

A total of 20 villages using systematic sampling procedure by arranging all villages according to population size and 30 households (HHs) having at least one under 5-year child were selected by selecting first HH randomly and then remaining HHs were covered contiguous. About 258 mothers of under 5-year children consented for blood drawing.

**Data collections**

Data were collected on predesigned and pretested pro forma by trained staff recruited locally, and standardized in survey methodologies. Information on household socio-economic and demographic particulars was collected from all the selected households. Food and nutrient intakes were collected by 24 h recall method of diet survey\[12\] as well as food frequency. Nutrient intakes were computed using Nutritive values of Indian Foods\[13\] and compared with the ‘Recommended Dietary Intakes (RDI) (1981)\[14\] and ‘Recommended Dietary Allowances for Indians (RDA)\[15\] suggested by the Indian Council of Medical Research.

**Haemoglobin and Vitamin A estimation**

Hemoglobin was estimated using the indirect cyanmethemoglobin method from dry blood spot samples at National Institute of Nutrition (NIN).\[16\] A cut-off level of <11 g/dL was considered for anemia among children and <7 g/dL as severe anemia.\[17\] Vitamin A was estimated by the high-pressure liquid chromatography method.\[18\] A cut-off value of <20 µg/dL was considered as VAD.\[19\]

**Infant and young child feeding practices**

Infant and young child feeding (IYCF) practices such as time of initiation of breastfeeding, colostrum feeding, exclusive breastfeeding, and initiation of CF were assessed for 0–11 month children.

**Data analysis**

Descriptive and appropriate statistical analyses were carried out using IBM SPSS Statistics for Windows, Version 19.0. (Armonk, New York: IBM Corp). Stepwise logistic regression analysis was carried with anemia, Vitamin A, undernutrition as dependant and socio-demographic variables, and IYCF practices as independent variables.

The nutritional status of children was assessed according to SD classification, using WHO standards.\[20\] Children who were below two SD of the reference median (<median-2SD) based on “weight-for-age,” “height-for-age” and “weight-for-height” indices were classified as underweight, stunting, and wasting, respectively.

**Results**

A total of 632 children (boys: 339; girls: 293) from 511 HHs were covered for the survey, of which 258 children of 1–5 years responded for blood drawings for hemoglobin, but for Vitamin A estimation only 198 samples could be collected as it requires some more blood. The mean age of the children was 26.6 ± 16.7 months.

Mean hemoglobin was 9.96 ± 1.40 among preschool children and was higher among boys compared to girls. The prevalence of anemia was 68%, while 2% had severe anemia and was similar among both the gender. Mean Vitamin A was 19.76 ± 7.47 and was higher among boys compared to girls. The prevalence of VAD was 59% and was higher among girls (60.4%) as compared to boys (56.7%) [Table 1].

**Prevalence of undernutrition, anemia, and Vitamin A deficiency according to socio-demographic particulars**

The prevalence of stunting was significantly higher among boys (56.6%) as compared to girls (52%). The prevalence of underweight and stunting was higher among 36–59 month children (39.5% and 76.7%, respectively) as compared to 0–11 month children (16.6% and 18.5%,
respectively) [Figure 1]. The prevalence of underweight and stunting was higher among children whose mothers were engaged in labor (45.2% and 87%, respectively), children from low socioeconomic groups (36.7% and 61.5%, respectively), and children from HHs not having sanitary latrine (39.9% and 62%, respectively) [Table 2].

No significant difference in the prevalence of anemia and VAD was observed with any sociodemographic variables.

Prevalence of underweight and wasting was observed high among anemic children (36.3% and 8.8% respectively) as compared to nonanemic children (27.8% and 1.3% respectively).

Association between undernutrition and antenatal care, delivery and infant and young child feeding practices

Ante-natal care practices such as availing antenatal care (ANC) during pregnancy, no. of ANCs, gestational age in the week at registration, and consumption of iron and folic acid (IFA) tablets during pregnancy were not associated with undernutrition. Place of delivery and birth weight was also not associated with undernutrition [Table 3]. Children who have received early initiation of breastfeeding (within 1 h of birth) had a lower prevalence of undernutrition (15.5%, 17%, and 14%, respectively) as compared to children who received breast milk after 3 h of birth (18%, 23%, and 18%, respectively), but was not significant. Exclusively breastfeeding up to 6 months had low prevalence of underweight and wasting (11% and 10%, respectively) as compared to those not exclusively breastfed (21% and 20%, respectively) [Table 3].

Food and nutrient intakes of children

Mean intakes of all the foods were below RDI except cereals and millets, other vegetables, root and tubers and nuts and oilseeds. The intake of green leafy vegetables (GLVs) and milk were grossly inadequate. The intakes of all the nutrients except proteins and calories were below RDA [Table 4].

Stepwise logistic regression analysis for undernutrition with sociodemographic variables and infant and young child feeding practices among infants

Underweight and wasting was 2–3 times higher among children who were not exclusively breastfed up to 6 months (for underweight, odds ratio (OR) 2.5; CI = 0.91–6.92) (for wasting OR 2.9; CI = 1.00–8.42) as compared to children who were exclusively breastfed.

Among sociodemographic variables, odds of underweight was two times higher for children from HHs not having facility of the sanitary latrine (OR 1.79; CI 1.20–2.67) as compared to children having facility of the sanitary latrine. Odds of stunting was four times higher among children whose mothers were engaged in labor (CI 1.51–11.89) as compared to those were housewife. Children belonging to lower socioeconomic status had two times higher risk of stunting (CI 1.35–3.33) as compared to children from high-income groups [Table 5].

None of the sociodemographic and economic variables were observed to be associated with anemia and VAD.

Discussion

West Khasi Hills district of Meghalaya is a hilly, forested area inhabited by the Khasi tribe. Although the area is rich in bio-diversity, the prevalence of anemia and VAD was observed high (68% and 59%, respectively) among preschool children. The prevalence of undernutrition such as underweight, stunting and wasting was 30%, 55%, and 11%, respectively, which is similar to NFHS 4 survey for the district (30%, 51%, and 17%, respectively).[21]

The study carried out by NIN in Phek district of Nagaland reported lower prevalence of undernutrition (14%, 22%, and 7%, respectively)[22] as compared to the present study. Ghosh and Varekar in their study among tribal children in Palaghar reported 53%, 59%, and 20% prevalence of underweight, stunting, and wasting, respectively.[23] The high prevalence of stunting in the present study may be attributed to sub-optimal

| Preschool children | Hb | Anaemia (%) | Vitamin A | Vitamin A deficiency (%) |
|-------------------|----|-------------| ----------|-------------------------|
|                   | n  | Mean±SD     | n         | Mean±SD                 |
| Boys              | 136| 9.95±1.30   | 68.9      | 97                      | 20.4±7.88 | 56.7 |
| Girls             | 122| 9.88±1.44   | 66.9      | 101                     | 19.1±7.05| 60.4 |
| Pooled            | 258| 9.96±1.40   | 68.0      | 198                     | 19.7±7.47| 58.6 |

SD: Standard deviation, Hb: Haemoglobin
feeding practices such as delayed initiation of CF, low dietary diversity, and high rates of infections.

The older children were at increased risk of stunting as compared to infants may be due to inappropriate feeding practices such as late initiation of CF, quality and quantity of complementary food in terms of diversity. Children from lower socioeconomic groups and mothers occupation as laborers were at higher risk of stunting indicating socioeconomic status plays an important role in undernutrition.

The prevalence of anemia observed in the present study was higher than that reported by NFHS 4 for the district (36.6%) and Meghalaya state (48%).\textsuperscript{[2]} Study carried out by NIN reported low prevalence of anemia among preschool children (27%).\textsuperscript{[3]} As per the NFHS-4 survey, the highest prevalence of anemia was observed in Sikkim and Arunachal Pradesh (54%–55%), while lowest in Mizoram and Manipur (19%–23%) from Northeastern states, while it was highest in Dadar and Nagar Haveli (85%), Daman and Diu (74%), and Chandigarh (73%).\textsuperscript{[2]} It was also observed that anemia was associated with mother literacy status, mother anemia status, and income.

High prevalence of anemia observed in the present study may be due to low consumption of GLV and other iron-rich food in the diet. Furthermore, IFA supplementation for children is not regular. Although the tribal are nonvegetarian, it was observed that the population was consuming nonvegetarian once in a fortnight or monthly. VAD was also observed high among the children, may be due to low consumption of milk and milk products as well as GLVs. Meshram \textit{et al.} in their study observed 37% prevalence of VAD among preschool children which is lower

\begin{table}[h]  
\centering  
\caption{Prevalence (%) of Vitamin A deficiency, anemia and nutritional status according to sociodemographic particulars}  
\hspace{1cm} HH socioeconomic particulars \hspace{2cm} 0-5 years children \hspace{2cm} 1-5 years children \hline  
Type of house & Under-weight & Stunting & Wasting & Anaemia & Vitamin A deficiency \hline  
Pucca/semi-pucca & 29.9 & 57.6 & 11.7 & 72.2 & 56.5 \hline  
Kutcha & 30.3 & 49.6 & 9.7 & 59.8 & 61.5 \hline  
P & NS & 0.04 & NS & 0.03 & NS \hline  
Type of family & Nuclear & 30.0 & 54.4 & 11.4 & 68.2 & 56.7 \hline  
Extranuclear & 25.6 & 61.5 & 5.1 & 60.0 & 85.7 \hline  
Joint & 39.1 & 47.8 & 8.7 & 80.0 & - \hline  
P & NS & NS & NS & NS & 0.03 \hline  
Family size & 1-4 & 28.1 & 51.9 & 12.9 & 74.4 & 58.2 \hline  
5-8 & 31.8 & 57.2 & 9.3 & 63.1 & 57.3 \hline  
≥9 & 30.8 & 53.8 & 7.7 & 63.6 & 66.7 \hline  
P & NS & NS & NS & NS & NS \hline  
Literacy status of father & Illiterate & 27.5 & 53.4 & 9.2 & 73.6 & 64.3 \hline  
1st-8th class & 30.4 & 58.3 & 10.1 & 64.3 & 52.5 \hline  
>9th class & 31.5 & 46.6 & 14.4 & 72.3 & 64.2 \hline  
P & NS & NS & NS & NS & NS \hline  
Literacy status of mother & Labour & 45.2 & 87.1 & 9.7 & 76.5 & 55.6 \hline  
Cultivator & 34.7 & 54.7 & 14.7 & 51.7 & 35.3 \hline  
Others & 39.1 & 65.2 & 0.0 & 60.0 & 50.0 \hline  
Housewife & 28.0 & 52.1 & 11.0 & 70.6 & 61.4 \hline  
P & NS & 0.01 & NS & NS & NS \hline  
Per capita income (monthly) & 1st tertile & 36.7 & 61.5 & 10.6 & 63.2 & 52.2 \hline  
2nd tertile & 26.0 & 52.4 & 12.5 & 67.0 & 54.8 \hline  
3rd tertile & 26.8 & 49.0 & 9.6 & 76.8 & 67.2 \hline  
P & 0.02 & 0.02 & NS & NS & NS \hline  
Sanitary latrine & Present and in use & 27.2 & 52.4 & 11.2 & 70.9 & 57.8 \hline  
Absent & 39.9 & 62.2 & 9.8 & 58.2 & 60.0 \hline  
P & 0.01 & 0.03 & NS & 0.07 & NS \hline  
\footnotesize{NS: Nonsignificant, HH: Household}  
\end{table}
Another study by Muliyil et al. in tribal children from southern India reported 10% prevalence of VAD among 1–8 years children which is lower than the present study.

Stevens et al. observed declined prevalence of VAD from 39% in 1991 to 29% in 2013 in low- and middle-income countries. In South Asia, the prevalence has declined from 47% to 44% during the same period.

**Conclusions and Recommendation**

The prevalence of anemia, VAD and stunting was high among children. Low intakes of GLV and milk and milk product may be the reasons for higher prevalence. There is a need to increase income-generating activities and regular food supply through public distribution system to meet food security as well as supply of IFA tablets/syrup and Vitamin A supplementation periodically to improve nutritional and micronutrient status. It is also important to impart health and nutrition education regarding the consumption of GLVs and other iron-rich foods to improve iron status.

**Limitation of the study**

As the Hb estimation was done using the indirect cyanmethemoglobin method, the correction was done while analyzing the data.

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**Table 3: Ante-natal check-up care delivery and infant and young child feeding practices among mothers of <12 months and its association with nutritional status of children (n=182)**

| Particulars                                | Percentage | Nutritional status |
|--------------------------------------------|------------|--------------------|
|                                           |            | Underweight | Stunting | Wasting |
| **ANC care**                               |            |            |          |         |
| Weeks of gestation at first ANC check-up   |            |            |          |         |
| <12 weeks                                  | 22.0       | 21.2       | 15.2     | 18.2    |
| 13-20 weeks                                | 65.4       | 13.2       | 14.0     | 14.4    |
| >20 weeks                                  | 4.4        | 12.5       | 37.5     | 12.5    |
| ANC not availed                            | 8.2        | 30.8       | 23.1     | 23.1    |
| P                                          |            | 3.41, NS   | 3.60, NS | 0.87, NS |
| Total number of ANCs                       |            |            |          |         |
| <4                                         | 63.2       | 16.2       | 17.8     | 16.5    |
| ≥4                                         | 28.6       | 12.5       | 10.4     | 12.5    |
| ANC not availed                            | 8.2        | 30.8       | 23.1     | 23.1    |
| P                                          |            | 2.51, NS   | 1.84, NS | 0.94, NS |
| Birth weight                               |            |            |          |         |
| <2.5                                       | 5.0        | 0.0        | 28.6     | 0.0     |
| ≥2.5                                       | 56.0       | 16.5       | 15.4     | 17.6    |
| Not available                              | 39.0       | 17.7       | 15.6     | 14.8    |
| P                                          |            | 1.46, NS   | 0.85, NS | 1.39, NS |
| Time of initiation of BF                   |            |            |          |         |
| Within 1 h                                 | 34.6       | 15.5       | 17.2     | 13.8    |
| 1-3 h                                      | 50.0       | 16.3       | 13.4     | 16.7    |
| >3 h                                       | 15.4       | 18.2       | 22.7     | 18.2    |
| P                                          |            | 0.08, NS   | 1.21, NS | 0.31, NS |
| Exclusive BF                               |            |            |          |         |
| Up to 6 months                             | 44.4       | 11.1       | 15.4     | 10.0    |
| No exclusive BF                            | 55.6       | 21.1       | 17.6     | 20.2    |
| P                                          |            | 2.88, 0.09 | 0.11, NS | 3.09, 0.07 |
| Type of feeding (6-11 months) n=98         |            |            |          |         |
| Only breast fed                            | 18.4       | 17.6       | 23.5     | 17.6    |
| Breast milk + water                        | 3.1        | 0          | 0        | 33.1    |
| Breast fed + CF                           | 78.6       | 21.1       | 22.5     | 18.5    |
| P                                          |            | 1.28, NS   | 4.48, NS | 0.86, NS |

BF: Breast feeding, CF: Complementary feeding, ANC: Ante-natal check-up
Table 4: Average consumption of food stuffs (g/day) and nutrient intakes of 1-6 year children

| Food Articles              | 1-3 years SD     | RDI | 4-6 years SD     | RDI |
|----------------------------|------------------|-----|------------------|-----|
| Cereals and Millets        | 225.8±94.8       | 175 | 257.0±99.6       | 270 |
| Pulses and Legumes         | 7.1±17.4         | 35  | 6.9±15.9         | 35  |
| Green leafy vegetables     | 20.0±33.4        | 40  | 17.1±29.9        | 50  |
| Other vegetables           | 34.1±49.4        | 20  | 36.4±55.3        | 30  |
| Roots and Tubers           | 57.0±41.7        | 10  | 67.1±45.7        | 20  |
| Nuts and oilseeds          | 225.8±94.8       | 175 | 257.0±99.6       | 270 |
| Other flesh foods          | 18.7±30.8        | 26  | 84.3±44.3        | -   |
| Milk and Milk products     | 7.2±25.0         | 300 | 5.8±23.3         | 250 |
| Fats and Oils              | 4.5±6.2          | 25  | 3.8±5.4          | 25  |
| Sugar and Jaggery          | 22.3±36.0        | 30  | 23.0±37.4        | 40  |

Nutrients

|                       | 1-3 years Mean | Median | RDA | 4-6 years Mean | Median | RDA |
|-----------------------|----------------|--------|-----|----------------|--------|-----|
| Protein (g)           | 29.8           | 26.3   | 17  | 32.7           | 27.3   | 20  |
| Total fat (g)         | 9.5            | 7.4    | 27  | 8.3            | 6.9    | 25  |
| Energy (Kcal)         | 1087           | 1040   | 1060| 1182           | 1115.8 | 1350|
| Calcium (mg)          | 202.3          | 117.7  | 600 | 182.5          | 126.2  | 600 |
| Iron (mg)             | 8.5            | 5.1    | 9   | 8.6            | 6.8    | 13  |
| Vitamin A (μg)        | 138            | 43     | 400 | 154.9          | 51.6   | 400 |
| Thiamine (mg)         | 0.4            | 0.4    | 0.5 | 0.5            | 0.4    | 0.7 |
| Riboflavin (mg)       | 0.2            | 0.2    | 0.6 | 0.3            | 0.2    | 0.8 |
| Niacin (mg)           | 6.9            | 6.6    | 8   | 8.3            | 7.3    | 11  |
| Vitamin C (mg)        | 26             | 16.6   | 40  | 22.2           | 20.8   | 40  |
| Dietary folate (μg)   | 40.6           | 33.8   | 80  | 45.9           | 34.7   | 100 |

RDA: Recommended dietary allowance, SD: Standard deviation, RDI: Recommended dietary intake

Table 5: Stepwise logistic regression analysis for under nutrition with socio-demographic particulars among under 5 year children and Infant & Young Child Feeding Practices among infants

| HH socioeconomic particulars | OR (CI) | Underweight | Stunting |
|-----------------------------|---------|-------------|----------|
| Major occupation of mother  |         |             |          |
| Labour                      | 4.24 (1.51-11.89)* | 1.76 | 2.12 (1.35-3.33)** |
| Cultivator                  | 0.73 (0.4-2.128)   | 1    | 1.15 (0.73-1.80)   |
| Others                      | 2.08 (0.77-5.61)   | 1    | 1                  |
| Housewife                   | 1        | 1           | 1        |
| Per capita income (monthly) |         |             |          |
| 1st tertile                 | 2.12 (1.35-3.33)** | 1    | 1.15 (0.73-1.80)   |
| 2nd tertile                 | 1.15 (0.73-1.80)   | 1    | 1                  |
| 3rd tertile                 | 1        | 1           | 1        |
| Sanitary latrine            |         |             |          |
| Present and in use          | 1        | 1           | 1        |
| Absent                      | 1.79 (1.20-2.67)   | 1    | 1                  |
| For <12 month children      |         |             |          |
| Exclusive BF                 |         |             |          |
| Yes                         | 1        | 1           | 1        |
| No                          | 2.51 (0.91-6.92)   | 2.91 (1.01-8.42) |

* P<0.05, ** P<0.001 HH: Household, OR: Odds ratio, CI: Confidence interval, BF: Breast feeding

Conflicts of interest
There are no conflicts of interest.

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