Original Article

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

I. I. Meshram, G. Neeraja, T. Longvah[1]

Division of Public Health Nutrition, National Institute of Nutrition, [1]Division of Food Chemistry, National Institute of Nutrition, Hyderabad, Telangana, India

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 cyanmethemoglobin 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.

Access this article online

Quick Response Code:

Website: www.ijcm.org.in

DOI: 10.4103/ijcm.IJCM_62_21

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

Address for correspondence: Dr. I.I. Meshram, Division of Public Health Nutrition, ICMR-National Institute of Nutrition, Jamai-Osmania (PO), Tarnaka, Hyderabad - 500 007, Telangana, India.
E-mail: indrapal2405@gmail.com

How to cite this article: Meshram II, Neeraja G, Longvah T. Vitamin A deficiency, anemia, and nutritional status of under 5-year children from Northeast India. Indian J Community Med 2021;46:673-9.

Received: 28-01-21, **Accepted:** 02-08-21, **Published:** 08-12-21

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 km^2, 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, VAD, 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%,[11] 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 contiguously. 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].

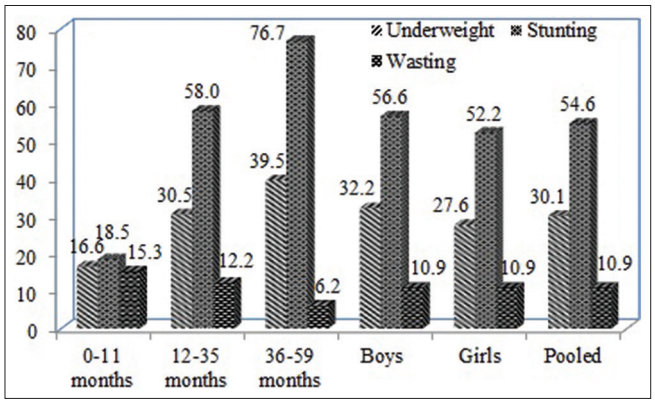

Figure 1: Age and gender wise distribution (%) of nutritional status of 0–5 year children

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

Table 1: Mean (standard deviation) haemoglobin value and prevalence of anaemia for each physiological group

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	9.89±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

Table 2: Prevalence (%) of Vitamin A deficiency, anemia and nutritional status according to sociodemographic particulars

HH socioeconomic particulars	0-5 years children			1-5 years children	
	Under-weight	Stunting	Wasting	Anaemia	Vitamin A deficiency
Type of house					
Pucca/semi-pucca	29.9	57.6	11.7	72.2	56.5
Kutcha	30.3	49.6	9.7	59.8	61.5
P	NS	0.04	NS	0.03	NS
Type of family					
Nuclear	30.0	54.4	11.4	68.2	56.7
Extranuclear	25.6	61.5	5.1	60.0	85.7
Joint	39.1	47.8	8.7	80.0	-
P	NS	NS	NS	NS	0.03
Family size					
1-4	28.1	51.9	12.9	74.4	58.2
5-8	31.8	57.2	9.3	63.1	57.3
≥9	30.8	53.8	7.7	63.6	66.7
P	NS	NS	NS	NS	NS
Literacy status of father					
Illiterate	27.5	53.4	9.2	73.6	64.3
1st-8th class	30.4	58.3	10.1	64.3	52.5
>9th class	31.5	46.6	14.4	72.3	64.2
P	NS	NS	NS	NS	NS
Literacy status of mother					
Labour	45.2	87.1	9.7	76.5	55.6
Cultivator	34.7	54.7	14.7	51.7	35.3
Others	39.1	65.2	0.0	60.0	50.0
Housewife	28.0	52.1	11.0	70.6	61.4
P	NS	0.01	NS	NS	NS
Per capita income (monthly)					
1st tertile	36.7	61.5	10.6	63.2	52.2
2nd tertile	26.0	52.4	12.5	67.0	54.8
3rd tertile	26.8	49.0	9.6	76.8	67.2
P	0.02	0.02	NS	NS	NS
Sanitary latrine					
Present and in use	27.2	52.4	11.2	70.9	57.8
Absent	39.9	62.2	9.8	58.2	60.0
P	0.01	0.03	NS	0.07	NS

NS: Nonsignificant, HH: Household

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%).[2] Study carried out by NIN reported low prevalence of anemia among preschool children (27%).[24] 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%).[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 *et al*. in their study observed 37% prevalence of VAD among preschool children which is lower

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		
ANC care		Underweight	Stunting	Wasting
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

than the present study.[24] 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.[25]

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.[6]

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.

Acknowledgment

We are thankful to Director, and technical staff of division of Public Health Nutrition NIN Hyderabad for support during the study. We are thankful to Dr. Naveen Kumar for his help in the analysis of data.

Financial support and sponsorship

Nil.

Table 4: Average consumption of food stuffs (g/day) and nutrient intakes of 1-6 year children

Food Articles	1-3 years children		4-6 years children	
	Mean±SD	RDI	Mean±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	-	26.8±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±56.0	30	23.0±37.4	40
Nutrients	**1-3 years children**		**4-6 years children**	
	Mean	**Median**	**RDA**	**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
VitaminA (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
VitaminC (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)*
Cultivator		0.73 (0.4-21.28)
Others		2.08 (0.77-5.61)
Housewife		1
Per capita income (monthly)		
1st tertile		2.12 (1.35-3.33)**
2nd tertile		1.15 (0.73-1.80)
3rd tertile		1
Sanitary latrine		
Present and in use	1	
Absent	1.79 (1.20-2.67)	
For <12 month children	**Underweight**	**Wasting**
Exclusive BF		
Yes	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.

References

1. Stevens GA, Finucane MM, De-Regil LM, Paciorek CJ, Flaxman SR, Branca F, *et al.* Global, regional, and national trends in haemoglobin concentration and prevalence of total and severe anaemia in children and pregnant and non-pregnant women for 1995-2011: A systematic analysis of population-representative data. Lancet Glob Health 2013;1:e16-25.
2. International Institute for Population Sciences (IIPS) and ICF. National Family Health Survey (NFHS-4), 2015-16. India. Mumbai: IIPS; 2017.
3. Cusick SE, Georgieff MK. The role of nutrition in brain development: The golden opportunity of the "first 1000 days". J Pediatr 2016;175:16-21.
4. Carter RC, Jacobson JL, Burden MJ, Armony-Sivan R, Dodge NC, Angelilli ML, *et al.* Iron deficiency anemia and cognitive function in infancy. Pediatrics 2010;126:e427-34.
5. Victora CG, Adair L, Fall C. Maternal and child under-nutrition: Consequences for adult health and human capital. Lancet 2008;371:340-57.
6. Stevens GA, Bennett JE, Hennocq Q, Lu Y, De-Regil LM, Rogers L, *et al.* Trends and mortality effects of Vitamin A deficiency in children in 138 low - income and middle - income countries between 1991 and 2013: A pooled analysis of population - based surveys. Lancet Glob Health 2015;3:e528-36.
7. World Health Organization (WHO, 2019). Malnutrition. Available from: https://www.who.int/news-room/fact-sheets/detail/malnutrition. [Last accessed on 2020 Sep 25].
8. India State-Level Disease Burden Initiative Child Mortality Collaborators. Subnational mapping of under-5 and neonatal mortality trends in India: The Global Burden of Disease Study 2000-17. Lancet 2020;395:1640-58.
9. United Nations General Assembly. Resolution Adopted by the General Assembly on 25 September 2015: Transforming Our World: The 2030 Agenda for Sustainable Development. Resolution no. A/RES/70/1; 2015. https://documents-dds-ny.un.org/doc/UNDOC/

GEN/N15/291/89/PDF/N1529189.pdf?OpenElement [Last accessed on 2020 Jul 29].
10. Ministry of Women and Child Development, Government of India. POSHAN Abhiyaan (National Nutrition Mission). Ministry of Women and Child Development, Government of India; 2019. Available from: https://icds-wcd.nic.in/nnm/home.htm. [Last accessed on 2020 Jul 29].
11. International Institute for Population Sciences (IIPS) and Macro International. National Family Health Survey (NFHS-3), 2005–06: India. Vol. 1. Mumbai: IIPS; 2007.
12. Thimmayamma BV, Rao DH. A comparative study of oral questionnaire method with actual observation of the dietary intake of preschool children. J Nutr Dietet 1969;6:177-81.
13. Gopalan C, Ramaswamy BV, Balasubramanyam SC, Rao BS, Deosthale YG, Pant KV. Nutritive Value of Indian Foods. Hyderabad-500007, India: National Institute of Nutrition, Indian Council of Medical Research (ICMR); 1989.
14. Expert Group of Indian Council of Medical Research. Recommended Dietary Intakes for Indians. New Delhi: ICMR 1981.
15. Expert Group of the Indian Council of Medical Research. Nutrient Requirements and Recommended Dietary Allowances for Indians. New Delhi: ICMR; 2011.
16. Sari M, de Pee S, Martini E, Herman S, Sugiatmi, Bloem MW, *et al.* Estimating the prevalence of anaemia: A comparison of three methods. Bull World Health Organ 2001;79:506-11.
17. WHO. Iron deficiency anaemia. Assessment, prevention and control. In: A Guide for Progamme Managers. Geneva: World Health Organization; 2001.
18. Craft NE, Haitema T, Brindle LK, Yamini S, Humphrey JH, West KP Jr. Retinol analysis in dried blood spot by HPLC. J Nutr 2000;130:882-5.
19. World Health Organization (WHO). Serum Retinol Concentrations for Determining the Prevalence of Vitamin A Deficiency in Populations. Geneva: World Health Organization; 2011.
20. WHO Multicentre Growth Reference Study Group. WHO Child Growth Standards based on length/height, weight and age. Acta Paediatr Suppl 2006;450:76-85.
21. International Institute for Population Sciences (IIPS) and ICF. National Family Health Survey (NFHS-4), India, 2015-16. District Fact Sheet, East Khasi Hills, Meghalaya. Mumbai: IIPS; 2017.
22. Longvah T, Khutsoh B, Meshram II, Krishna S, Kodali V, Roy P, *et al.* Mother and child nutrition among the Chakhesang tribe in the state of Nagaland, North-East India. Matern Child Nutr 2017;13 Suppl 3:e12558.
23. Ghosh S, Varerkar SA. Undernutrition among tribal children in Palghar district, Maharashtra, India. PLoS One 2019;14:e0212560.
24. Meshram II, Kumar BN, Venkaiah K, Longvah T. Subclinical Vitamin A deficiency and anemia among women and preschool children from Northeast India. Indian J Community Med 2020;45:371-4.
25. Muliyil DE, Rose A, Senthamizh SV, Chatterjee T, Helan J, Kang G, *et al.* Prevalence and risk factors of Vitamin A deficiency in children and women of childbearing age in a southern Indian tribal population: A cross-sectional study. Indian J Community Med 2019;44:162-5.