Short Communication

Dietary Vitamin A Intake, Coverage of Vitamin A Megadose Supplementation, and Prevalence of Vitamin A Deficiency among Marginalized Children 6–59 Months in Anganwadis of Chandigarh: A Multistage Cluster Sampling Survey

Rohit Yadav, Ajay Patial, Bhavneet Bharti, Savita Verma Attri, Prateek Bhatia

Department of Pediatrics, Advanced Pediatrics Center, Postgraduate Institute of Medical Education and Research, Chandigarh, India

Abstract

Background: Lack of recent local data regarding Vitamin A deficiency, dietary intake, and coverage of biannual high-dose Vitamin A prophylaxis among marginalized children poses challenges for policy change. **Objective:** Our study aimed to evaluate the burden of serum Vitamin A deficiency, dietary Vitamin A intake, and current Vitamin A supplementation coverage. **Methodology:** We enrolled 216 children aged 6–60 months from 30 Anganwadis of Chandigarh using two-stage cluster sampling. **Results:** Dietary intake of Vitamin A-rich foods and vegetables in the last 24 h was observed only in 20% of enrolled children. Although 79.21% (160/202) of children aged ≥9 months reported receiving Vitamin A supplementation, only 38.52% had documented record of age-appropriate complete supplementation. None of the children showed ocular manifestations of Vitamin A deficiency. For the subjects in which C-reactive protein levels were ≤5 mg/l (n = 148), 35.14% (52/148) had serum retinol ≤0.7 μmol/L and 2.03% (3/148) had serum retinol ≤0.3 μmol/L. The multivariate odds ratios (ORs) of Vitamin A deficiency (serum retinol <0.7) were 2.23 times higher in subjects with inappropriate complementary feeding (OR: 2.23; 95% confidence interval [CI]: 1.07–4.80; P = 0.035) whereas odds were significantly lower for middle (OR: 0.27; 95% CI: 0.09–0.76; P = 0.015) and higher income (OR: 0.14; 95% CI: 0.03–0.53; P = 0.005) families in reference to low-income group. **Conclusions:** Subclinical Vitamin A deficiency is still a public health crisis with suboptimal dietary intake of Vitamin A-rich foods and compromised food diversity necessitating targeted approach for marginalized children.

Keywords: Children, deficiency, dietary intake, prevalence, retinol, Vitamin A

Introduction

Vitamin A deficiency has been recognized as one of the key childhood micronutrient deficiencies, especially among low- and middle-income countries.[1-5] Although over the years, the burden of hypovitaminosis A leading to blindness has declined, less severe form of Vitamin A deficiency (mainly biochemical) is still widely reported.[6-8] At the policy level, Vitamin A deficiency has emerged as a challenge with regard to need for universal Vitamin A megadose biannual supplementation due to lack of updated surveillance data.[9,10] Before dietary fortification and diversification are promoted as standalone measures for eradicating the Vitamin A deficiency, the availability of local data is vital.[11-14] Although larger aggregate population-level data have recently become available, these may mask certain marginalized subpopulations.[1,5,6,15,16] Therefore, a targeted approach based on topical *disaggregated data* regarding Vitamin A deficiency is *imperative* to reveal patterns that can assist the policymakers where the nutrition-sensitive and nutrition-specific interventions are most needed and can

Access this article online

Quick Response Code:

Website: www.ijcm.org.in

DOI: 10.4103/ijcm.IJCM_650_20

Address for correspondence: Dr. Bhavneet Bharti, Department of Pediatrics, Advanced Pediatrics Center, Postgraduate Institute of Medical Education and Research, Chandigarh - 160 012, India. E-mail: bhavneetsahul@gmail.com

How to cite this article: Yadav R, Patial A, Bharti B, Attri SV, Bhatia P. Dietary vitamin a intake, coverage of vitamin a megadose supplementation, and prevalence of vitamin a deficiency among marginalized children 6–59 months in anganwadis of Chandigarh: A multistage cluster sampling survey. Indian J Community Med 2021;46:692-6.

Received: 26-07-20, **Accepted:** 26-08-21, **Published:** 08-12-21

have the biggest impact. One such niche population includes resettlement colonies, villages, and slums of Chandigarh population (5.5 lakh) which is covered by 450 Anganwadi centers with most families migrating from the poorest states of India, and the prevalence of Vitamin A deficiency has not been evaluated earlier in this marginalized section. Hence, our study was aimed to find out the prevalence and predictors of Vitamin A deficiency among children (aged 6 months–5 years) along with their dietary Vitamin A intake as well as coverage of Vitamin A supplementation in a cross-sectional sample from the Anganwadis of Chandigarh.

Methodology

The study was conducted as a community-based cross-sectional survey of children across the Anganwadi centers in Chandigarh covering 450 Anganwadis (our sampling frame) in three Integrated Childhood Development Scheme (ICDS) projects of Chandigarh from January 2018 to June 2019. From all the three ICDS projects, we randomly selected 30 clusters (10 Anganwadis from each ICDS project area). Children in the age group of 6 months–5 years were enrolled. At least 6 children were enrolled from each Anganwadi center (6–12 months – 2 children, 1–3 years – 2 children, and 3–5 years – 2 children). The children in each category were selected by simple randomization from the list provided. In case of nonavailability of the particular child, nonbiased replacement of the candidate was done from the randomization list.

Informed consent from either the parent or legally acceptable representative/guardian was taken. Children documented to suffer from chronic systemic illness (congenital or acquired heart disease, chronic renal disease, chronic liver disease, malabsorption state, and immune deficiency) were excluded from the survey. The permission for the study was granted by the institutional ethics committee.

The basic demographic details, history, and clinical examination were taken for all children. A 24-h dietary recall on 3 nonconsecutive days was taken in as many as children as possible, which was not possible in some cases due to nonwillingness, loss to follow-up, migration, nonavailability of parents, and limitations in time and resources. Infant and Young Child Feeding (IYCF) indicators were calculated in the study cohort. Children were classified as having appropriate or inappropriate complementary feeding (CF) based on the timeliness of initiation of CF, dietary diversity, meal frequency, and amount of meals and snacks consumed. We estimated a daily dietary intake of Vitamin A by entering the 24-h dietary intake for every child into DietCal version 9.0 (Profound Tech Solutions; http://dietcal.in/), which is based on values from the Indian Food Composition Tables 2017.

For sample size estimation for population survey, we assumed a 30% prevalence (based on pilot data) of Vitamin A deficiency, acceptable margin of 7.5%, 30 clusters, and design effect of 1.5. Using StatCalc in Epi Info version 7, a total sample size of 180 children was calculated. To account for refusal and difficulty in obtaining blood samples, problems in transport, and storage of blood samples, we increased the total number of enrolled children to 216.

All measurements were done by the investigator (first author) who was well trained in growth laboratory during his postgraduate training in pediatrics. The weighing scale and stadiometer used were from Seca Company. The authors ensured the quality of anthropometric data by randomly cross-checking the measurements, and there was low digit preference. The Z-score values for height for age, weight for age, weight for height, mid-upper arm circumference (MUAC), and body mass index (BMI) for age relative to the WHO 2007 growth charts and IAP growth charts 2015 were calculated using WHO AnthroCal software. Nearly all z-scores were biologically plausible and their standard deviations (SDs) were around 1.

The Z-score values for height for age, weight for age, weight for height, MUAC, and BMI for age relative to the WHO 2007 growth charts and IAP growth charts 2015 were calculated using WHO AnthroCal software.[17] For estimating serum retinol levels, LCMS/MS-based method was used. Quantitations were performed using a Qtrap 4500 triple-stage quadrupole mass spectrometer instrument (Sciex) equipped with electron spray ionization coupled with Shimadzu Nexera X2 chromatographic instrument. Data processing and quantitation was done using Sciex Analyst® 1.6.2 software. The stock solutions of all-trans-retinol were prepared in methanol with butylated hydroxytoluene (1 g/L) and stored at −80°C until use.[18] Vials were wrapped with aluminum foil prior to sampling and were immediately kept on ice and carried in the cold chain for transport to the laboratory. Limit of detection (defined as signal-to-noise ratio >5) was found to be 0.48 μM/L. The quantification limit for all-trans-retinol was 1.9 μM/L. The testing methodology was checked, tested, and verified by the Centers for Disease Control and Prevention standards using test samples for serum ferritin, C-reactive protein (CRP), and serum retinol under the Vitamin A Laboratory – External Quality Assurance Program. Furthermore, eight healthy age-matched controls and three healthy age unmatched controls were taken for conducting the whole questionnaire for the enrollment as well as quality testing and cross-verification of laboratory results.

Results

We enrolled 216 children from 30 Anganwadis of Chandigarh during the study period using two-stage cluster sampling [Figure 1 for the study flowchart]. Out of 216 subjects enrolled in our study period, 109 (50.4%) were male and 106 (49.6%) were female (male-to-female ratio almost 1:1). The mean age of enrollment was 30.8 months (±15.3 months).

The prevalence of underweight, stunting, and wasting in the study cohort is 19.4%, 22%, and 16.1%, respectively. A 24-h dietary recall (24 h) captured detailed information about all foods and beverages consumed by the children in the

past 24 h. It was recorded in 216 children. Although planned for 3 nonconsecutive days, it could not be done in all the children due to several logistic reasons such as nonavailability of parents on follow-up, lack of confidence in recalling the diet with accuracy, and migratory population characteristics of the study cohort. Only 43% of children (n = 93) had 1 dietary recall, 18% (n = 39) had 2 recalls, and 22.7% of children (n = 49) had 3 dietary recalls. Given the recommended dietary allowance for dietary retinol (μg/day) and beta-carotene of 400 and 3200/day, respectively, for Indian children <5 years (Indian Council of Medical Research [ICMR] 2010), there was a grossly inadequate intake of dietary retinol (mean: 228.3; SD: 152.7) and β-carotene (mean: 672.7; SD: 695.24) [Table 1].[19] The dietary retinol intake was significantly higher in infants and children <24 months when compared to older children (P < 0.001). Consumption of Vitamin A-rich foods and vegetables in the last 24 h was observed only in 20% of the enrolled children. Evaluation of dietary diversity in our study cohort revealed that only 56.1% of children had consumed ≥4 food groups, while in the remaining 43.9% of children, food groups consumed were 3 or less which signifies lack of food diversity. The study cohort has high milk consumption (93.5%), whereas consumption of eggs and flesh foods was very low (3.7% and 2.8%, respectively). The nature of CF was found to be inappropriate in 60.8% of children (n = 130/214). The reason for delayed weaning was found to be unawareness of the proper method in 62% of children (n = 80/129) followed by social and cultural beliefs in the remaining 38% of cases (n = 49/129).

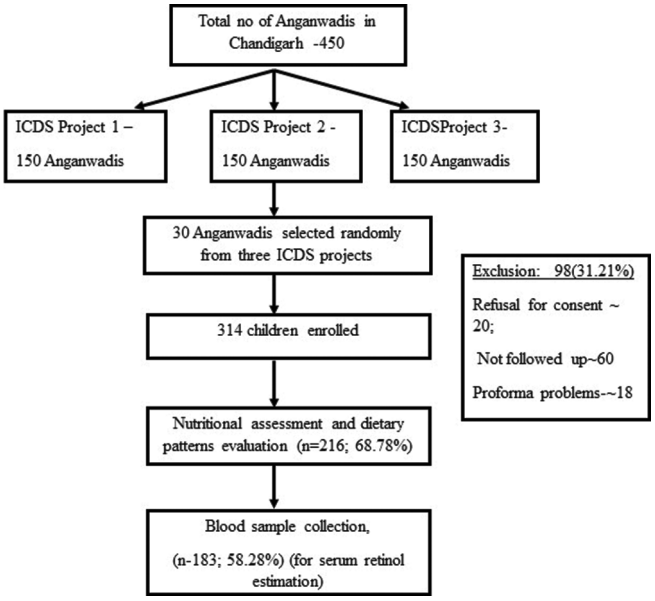

Figure 1: Flowchart showing study flow

Prevalence of Vitamin A deficiency based on ocular manifestations of VAD (WHO staging) was not present in any of the children examined clinically (n = 216). Serum retinol estimation was done in 183 children. The serum retinol concentration of 183 children tested was 0.82 ± 0.31 μmol/L (mean ± SD). Retinol is an acute-phase reactant, and levels may fall during the time of acute infection, so children with CRP >5 mg/L were excluded from the study as they may have low values during the acute episode. The serum retinol levels remained nearly same (mean: 0.82; SD: 0.30). For the subjects in which CRP levels were ≤5 mg/l (n = 148), 35.14% (52/148) had serum retinol ≤0.7 μmol/L, 12.16% (18/148) had serum retinol ≤0.5 μmol/L, 2.7% (4/148) had serum retinol ≤0.35 μmol/L, and 2.03% (3/148) had serum retinol ≤0.3 μmol/L.

As far as Vitamin A supplementation was concerned, 79.21% (160/202) of children aged 9 months or above reported receiving Vitamin A supplementation. However, records could be procured for only 135 children, out of which only 52 (38.52%) had age-appropriate complete Vitamin A supplementation.

Serum retinol levels were positively correlated with income (r = 0.24; P = 0.001), total socioeconomic score (r = 0.25; P = 0.001), weight for age z-score (r = 0.18; P = 0.01), height of age (r = 0.13; P = 0.08), weight for height z-score (r = 0.14; P = 0.07), BMI z-score (r = 0.15; P = 0.06), and MUAC z-score (r = 0.15; P = 0.046).

The unadjusted univariate and adjusted multivariate odds ratios (ORs) were computed for the predictors of Vitamin A deficiency (serum retinol <0.7). The odds of Vitamin A deficiency were 2.52 times higher in subjects with inappropriate CF (unadjusted OR: 2.52; 95% confidence interval [CI]: 1.29–5.12, P = 0.008), and this predictor of inappropriate CF retained its statistical significance when adjusted for other confounding variables on multivariate logistic regression (adjusted OR: 2.23; 95% CI: 1.07–4.80; P = 0.035).

The odds of Vitamin A deficiency were 75% and 86% lower in subjects with middle (Rs. 3907-11907) (unadjusted OR: 0.25; 95% CI: 0.09–0.64; P = 0.005) and higher family income

Table 1: Daily mean dietary intake (using DietCal nutrient software) of retinol stratified by age

Age groups	Mean daily retinol intake±SD	95% CI for mean		Minimum	Maximum
		Lower bound	Upper bound		
≤12 months	412.24±114.368	368.74	455.74	225	645
≤24 months	253.02±104.447	221.64	284.40	10	595
>24 months	129.14±106.262	102.81	155.47	6	501
Total	228.31±152.675	202.70	253.91	6	645

CI: Confidence interval, SD: Standard deviation

(>Rs. 11,907) (unadjusted OR: 0.14; 95% CI: 0.04–0.44; P = 0.001), respectively, when compared to lower family income of <Rs. 3907, and the predictor of income retained its statistical significance when adjusted for other confounding variables on multivariate logistic regression [Table 2].

Discussion

The prevalence of Vitamin A deficiency based on predefined criteria of serum retinol level <0.7 µmol/L was found to be 35.14% (n = 52/148) in our study cohort. This high prevalence of subclinical Vitamin A deficiency would qualify as a severe public health problem (WHO 2009 guidelines).[5] None of the children in our study had ocular manifestations of VAD.[5] Overall, sharp decline in prevalence of clinical Vitamin A deficiency has been reported in India over the last few decades.[6] In a nationwide study conducted by the ICMR in 2001, only 3 districts out of 16 had a prevalence of Bitot's spots of 0.5%.[6] In the absence of clinical marker, several studies carried out worldwide use serum retinol as a biochemical marker for Vitamin A deficiency with heterogeneous prevalence rates ranging from 10% to 88%. Fortunately, national-level representative data regarding the micronutrients including Vitamin A is now available to make recent valid comparisons of subclinical Vitamin A deficiency across different states of India.[16] This Comprehensive National Nutrition Survey (CNNS) among 112,316 children and adolescents in the age group of 0–19 years were surveyed to collect comprehensive information on nutritional status and micronutrient deficiencies among Indian children in the year 2016–2018.[16] Since majority of the families enrolled in our study had migrated from the states of Uttar Pradesh, Bihar, Chhattisgarh, and Jharkhand to escape poverty, food insecurity, and lack of employment opportunities in their respective states, we compared our study estimates with the Vitamin A deficiency rates reported from states outsourcing these migrant populations in Chandigarh. Only Jharkhand state (44%) exceeded our study. Other states such as Bihar (23.5%), Chhattisgarh (26.6%), and Haryana (26.1%) have a severe public health problem and Punjab (17.2%) and Uttar Pradesh (17.1%) have a moderate public health problem of Vitamin A deficiency.

When compared to the results of the NNMB covering 3934 preschool children from 8 states with median serum retinol level of 0.60 µmol/L (range: 0.32–0.71 µmol/L), analysis of our blood samples revealed that the overall median (interquartile range) serum retinol level was 0.80 (0.34) µmol/L with range between 0.35 and 1.99 µmol/L.[20] Although more than 3/4th of children aged 9 months or above in our study cohort reported having received Vitamin A supplementation doses, complete coverage from available records was only 38.52%. This figure is below the NFHS-4 survey, conducted in 2015–2016 where 60% of the preschoolers aged 9–59 months received a Vitamin A dose in the past 6 months. Furthermore, estimated compliance with 6-monthly megadose Vitamin A in North Indian population reported by DEVTA trial was also higher (86%).[21]

The odds of Vitamin A deficiency were lower in subjects with middle (Rs. 3907–11,907/month) and higher family income (>Rs. 11,907/month), respectively, when compared to lower family income of <Rs. 3907 when adjusted for other confounding variables on multivariate logistic regression (adjusted OR: 0.27; 95% CI: 0.09–0.76; P = 0.015 for middle-income group and adjusted OR: 0.14; 95% CI: 0.03–0.53; P = 0.005 for high-income group). Disadvantaged urban populations face constraints depending on their income, therefore, they require tailored interventions that fit their circumstances. The results are in agreement with results of CNNS where the prevalence of Vitamin A deficiency ranged between 26.6% in the poorest wealth quintile and 10.9% in the richest.[16]

Table 2: Univariate and multivariate predictors of Vitamin A deficiency (serum retinol <0.7)

Dependent: Vitamin A deficiency (<0.7)	No	Yes	OR (univariable)	OR (multivariable)
Nature of CF				
Appropriate	52 (44.1)	15 (23.8)	Reference group	Reference group
Inappropriate	66 (55.9)	48 (76.2)	2.52 (1.29-5.12, P=0.008)	2.23 (1.07-4.80, P=0.035)
Monthly income groups				
<3907	7 (5.9)	14 (22.6)	Reference group	Reference group
<11,907	79 (66.9)	39 (62.9)	0.25 (0.09-0.64, P=0.005)	0.27 (0.09-0.76, P=0.015)
>11,907	32 (27.1)	9 (14.5)	0.14 (0.04-0.44, P=0.001)	0.14 (0.03-0.53, P=0.005)
SES categories				
≥UM	9 (7.6)	2 (3.2)	Reference group	Reference group
LM	40 (33.9)	20 (32.3)	2.25 (0.52-15.68, P=0.328)	1.56 (0.33-11.38, P=0.606)
Lower	69 (58.5)	40 (64.5)	2.61 (0.63-17.67, P=0.235)	1.01 (0.20-7.58, P=0.987)
National program supplementation				
Yes	92 (77.3)	51 (81.0)	Reference group	Reference group
No	27 (22.7)	12 (19.0)	0.80 (0.36-1.69, P=0.569)	0.66 (0.28-1.48, P=0.329)

OR: Odds ratio, CF: Complementary feeding, SES: Socioeconomic status, UM-Upper middle, LM- Lower middle

Conclusions

To conclude, although clinical Vitamin A deficiency over the years has declined and continuation of biannual megadose Vitamin A supplementation is being questioned, our community survey has unmasked the alarmingly high subclinical Vitamin A deficiency and poor Vitamin A dietary intake among marginalized children aged 6–60 months who are beneficiaries of the ICDS program. Therefore, a targeted approach involving updated surveillance of susceptible populations is critical to optimize the existing nutrition programs like Poshan Abhiyaan besides exploring the option of food fortification with Vitamin A in the supplementary food supplied under the ICDS program.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. WHO. Global prevalence of vitamin A deficiency in populations at risk 1995–2005. WHO Global Database on Vitamin A Deficiency. Geneva, World Health Organization, 2009.
2. 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.
3. Kapil U, Sachdev HP. Prevalence estimates of Vitamin A deficiency in India by NNMB surveys. Indian Pediatr 2011;48:655-6.
4. Roos N, Ponce MC, Doak CM, Dijkhuizen M, Polman K, Chamnan C, *et al.* Micronutrient status of populations and preventive nutrition interventions in South East Asia. Matern Child Health J 2019;23:29-45.
5. WHO. Global Prevalence of Vitamin A Deficiency in Populations at Risk 1995-2005. WHO Global Database on Vitamin A Deficiency. Geneva: World Health Organization; 2009.
6. Toteja GS, Singh P, Dhillon BS, Saxena BN. Vitamin A deficiency disorders in 16 districts of India. Indian J Pediatr 2002;69:603-5.
7. Vijayaraghavan K. National control programme against nutritional blindness due to vitamin A deficiency: Current status and future strategy. Indian J Med Res 2018;148:496-502.
8. Agrawal D, Sahu A, Agrawal D. Prevalence of ocular morbidities among school children in Raipur district, India. Indian J Ophthalmol 2020;68:340-4.
9. Coutsoudis A, Sanders D, Dhansay MA, Van Stuijvenberg ME, Benn CS. Is it time for South Africa to end the routine high-dose vitamin A supplementation programme? S Afr Med J 2019;109:907-10.
10. Mason J, Greiner T, Shrimpton R, Sanders D, Yukich J. Vitamin A policies need rethinking. Int J Epidemiol 2015;44:283-92.
11. Hombali AS, Solon JA, Venkatesh BT, Nair NS, Pena-Rosas JP. Fortification of staple foods with vitamin A for vitamin A deficiency. Cochrane Database Syst Rev 2019;5:CD010068.
12. Wirth JP, Petry N, Tanumihardjo SA, Rogers LM, McLean E, Greig A, *et al.* Vitamin A supplementation programs and country-level evidence of vitamin A deficiency. Nutrients 2017;9:E190.
13. Campos Ponce M, Polman K, Roos N, Wieringa FT, Berger J, Doak CM. What approaches are most effective at addressing micronutrient deficiency in children 0-5 years? A review of systematic reviews. Matern Child Health J 2019;23:4-17.
14. Gupta P, Indrayan A. Effect of vitamin A supplementation on childhood morbidity and mortality: Critical review of Indian studies. Indian Pediatr 2002;39:1099-118.
15. Gonmei Z, Toteja GS. Micronutrient status of Indian population. Indian J Med Res 2018;148:511-21.
16. Ministry of Health and Family Welfare (MOFHW), Government of India, UNICEF, Council P. Comprehensive National Nutrition Survey (CNNS). National Report. New Delhi; 2019.
17. WHO. WHO AnthroPlus for personal computers manual: Software for assessing growth of the world's children and adolescents. Geneva: WHO; 2009.
18. Midttun Ø, Ueland PM. Determination of Vitamins A, D and E in a small volume of human plasma by a high-throughput method based on liquid chromatography/tandem mass spectrometry. Rapid Commun Mass Spectrom 2011;25:1942-8.
19. Indian Council of Medical Research. Nutrient Requirements and Recommended Dietary Allowances for Indians. A Report of the Expert Group of the Indian Council of Medical Research. Hyderabad: National Institute of Nutrition; 2010.
20. National Institute of Nutrition Indian Council of Medical Research. NNMB Technical Report No.: 24. National Institute of Nutrition, Hyderabad, Indian Council of Medical Research; 2006.
21. Awasthi S, Peto R, Read S, Clark S, Pande V, Bundy D, *et al.* Vitamin A supplementation every 6 months with retinol in 1 million pre-school children in north India: DEVTA, a cluster-randomised trial. Lancet 2013;381:1469-77.