PERSPECTIVE

Vitamin A supplementation policy: A shift from universal to geographical targeted approach in India considered detrimental to health and nutritional status of under 5 years children

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EVOLVEMENT OF VITAMIN A SUPPLEMENTATION (VAS) PROGRAMME IN INDIA: UNIVERSAL COVERAGE OF CHILDREN 6–59 MONTHS

Vitamin A is an essential fat-soluble micronutrient required for normal growth and development, maintenance of healthy mucosal membranes, reproductive health, immunity, and vision, especially for dark adaptation. Vitamin A deficiency (VAD) continues to be a major nutritional problem of public health concern in India, despite the implementation of a programme for vitamin A supplementation for over four decades. Although the incidence of clinical VAD in India has declined significantly over the period of time, the highest proportion of the world's VAD children still lives in India [1, 2]. The proportion of rural preschool children in India with Bitot's spots, an objective clinical sign of VAD is reported to be over 0.5%, making VAD a public health problem [3–13]. A similar pattern of prevalence of sub-clinical VAD (serum retinol ≤ 0.70 µmol/L or ≤ 20 µg/dL) is also observed and confirms VAD to be a severe public health problem (≥ 20%) in India [4–9, 11, 14] Table 1.

Taking into consideration the grave public health problem of VAD and nutritional blindness in India, the National Institute of Nutrition (NIN) carried out a series of clinical, biochemical, and field intervention studies in the 1960s [15]. Following this, a countrywide high dose (200000 IU) six-monthly Vitamin A Supplementation (VAS) program was recommended [16, 17]. In 1970, the Government of India launched the "National program for prophylaxis against blindness in children due to vitamin A deficiency" targeting children 1–5 years [18]. Subsequently, the VAS programme was revisited in 1991 by the Indian experts in the context of emerging evidence of the impact of VAS on child mortality [19] and an India study on seroconversion of measles vaccine by the NIN [20]. The revised VAS programme included infants 6–11 months and was renamed as "Management of Vitamin A deficiency Programme". In the early period of implementation, taking into consideration the supply of vitamin A solution and cost, the policy accorded a higher priority to administer VAS to the most vulnerable children aged 9–36 months.

However, in 2006, with increased prevalence of VAD in 36–59 months children and no constraint on the supply of vitamin A solution, the Government of India expanded the target age group to meet the 1991 policy guidelines to 6–59 months [21]. The VAS is in operation in India as well as in more than 70 countries around the world and is recognised to be one of the most effective public health interventions ever undertaken [22, 23]. Taking into consideration, the need for improving the coverage of six monthly administration of VAS In India, a biannual VAS strategy was piloted and scaled up in India [21].

PROPOSED POLICY SHIFT FROM UNIVERSAL VAS COVERAGE TO TARGETING TO THE SELECTED STATES: QUESTIONING THE RATIONALE

Some studies carried out in India during the last two decades have reported a considerable decrease in the prevalence of Bitot's Spots [24–26] and these findings have led to a constant opposition to the continuation of the universal VAS programme in India. The recommendation to discontinue the VAS programme by a selected group of experts has been persistent for over a decade despite the lack of state or nationally representative database that confirms substantial improvement in clinical, sub-clinical VAD or dietary vitamin A consumption among children under 5 years. In fact, after the NNMB-2003-05 rural survey in 8 states in India, no large-scale study has been carried out to measure sub-clinical vitamin A status in children [27]. Moreover, the dietary survey findings of the National Nutrition Monitoring Bureau (NNMB) surveys that were available also do not support discontinuation of VAS since the diets of children under 5 were reported to be extremely poor in vitamin A [25, 26].

The argument by a select group of experts to discontinue universal Vitamin A Supplementation (VAS) for children 6–59 months under the national programme gained momentum following the release of the Comprehensive National Nutrition Survey (CNNS) report 2019 on micronutrients, including vitamin A status of young children and adolescents [28]. The Expert Group constituted by the Ministry of Health, Government of India recommended modification in the existing national programme and shifting the focus of VAS from universal coverage of children to a geographical targeted approach. This recommendation was primarily based on the CNNS findings of a low prevalence of sub-clinical VAD of 17.6% among children aged 1–4 years as assessed

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by the measure of serum retinol levels below 20 µg/dl and VAD as a severe public health problem (prevalence of ≥ 20%) only in 10 of the 30 states/union territories that were surveyed. An examination of the CNNS methodology, however, raises a number of questions on the prevalence of sub-clinical VAD among children reported by the CNNS, since there is a substantial gap in the design and the actual execution. Similarly, a substantial difference is noted in the CNNS methodology that prescribed the representative sample of children to be covered in various states and at the national level for estimation of various micronutrients including vitamin A and the actual number of children that were covered for estimation of serum retinol [28]. The CNN survey covered only 6694 children aged 1–4 years as against the 20,350 children proposed in the study methodology. Likewise, none of the 30 states/union territories surveyed met the target sample of children that was prescribed in the survey design. In about half of the states, the coverage was only around one-third of the proposed sample size, while the coverage was more than 75% of the proposed sample in only two of the 30 states- Odisha (80.5%) and Sikkim (76%) (Table 2). In such a situation of coverage of grossly inadequate sample size, valid estimation and inference on the prevalence of VAD are scientifically not correct. Such an inadequate sample could result in unduly large standard errors; inadequate power with the resulting inferences drawn being misleading. Moreover, the report on VAD situation does not represent the entire country and is limited to 28 states and two union territories (UTs). Similarly, the CNNS report has excluded serum retinol data of two states i.e. Rajasthan and Nagaland and the survey did not cover the six union territories. Therefore, the findings of the CNNS were derived from the grossly inadequate and non-representative sample for the country. Despite such apparent limitations in the CNNS survey, the Expert Committee recommends to discontinue the VAS programme in all the states and union territories except for 3 states with a high prevalence of VAD [24]. The rationale for zeroing on 3 states from the 10 states reported having VAD as a severe public health problem remains an enigma. On that account, the evidence is not sufficient to indicate a low prevalence of sub-clinical VAD to argue for modification of the existing VAS policy in India.

ASSUMPTION OF VITAMIN A INADEQUACY IS NOT CONVINCING

In addition to the CNNS findings on VAD, the Expert Committee also substantiated their recommendation for change in vitamin A policy on the basis of dietary intake of vitamin A and fortification of oil and milk with vitamin A. These inferences on dietary vitamin A consumption were based on secondary data collected at two different time periods, a decade ago by the NNMB [25] and the National Sample Survey Office (NSSO) [29]. Likewise, it was also projected by the Expert Committee that the dietary inadequacy (≤ 70% of Recommended Dietary Allowances) of vitamin A will reduce substantially with the ongoing efforts by the country to fortify oil and milk with vitamin A [24]. There was no scientific data presented to support this assumption. Moreover, consumption of oil and milk used as food vehicles for fortification is rather low and the consumption of these food items differ widely in the various socio- economic groups. In fact, even if the fortification is 100%, the deficit intake will continue to be high as most rural, tribal, and peri-urban households in India purchase milk and oil from local vendors. As per the NNMB surveys, the intakes of oil and milk among the rural, tribal, and urban children in India are extremely poor [25, 26, 30] with the inadequacy (≤70% of Recommended Dietary Intakes) of intakes ranging from a low of 86.2 to a high of 100%. Likewise, the dietary inadequacy (≤ 70% of RDA) of vitamin A is also very high ranging from a low of 86.3% in rural children 4–6 years age to a high of 93.4% in urban children 1–3 years [25, 26, 30] Table 3. The total available vitamin A gets further reduced due to the fact that the dietary source of vitamin A in the Indian diet is primarily from vegetarian source and the availability of vitamin A is rather low as compared with animal source of vitamin A. Provitamin A carotenoids from plant sources have lower relative absorption efficiency ranging from only 5% to 26% [31] and the ratio of conversion of provitamin A carotenoids to retinol in humans varies from 2:1 to 24:1 on a µg:µg basis [32, 33]. While in contrast, pre-formed vitamin A (retinol) found only in animal-sourced foods is an active form of vitamin A with 70–90% bio-availability [34, 35].

Therefore, it is scientifically inappropriate to argue for the modification of the existing vitamin A policy based on dietary data collected more than a decade ago. Moreover, the Expert Committee conveniently ignored the latest dietary data collected by the CNN survey (2016–18) that indicated extremely poor intake of dietary source of vitamin A, where only 5% of Indian children of 2–4 years reportedly consumed vitamin A-rich fruits and vegetables and the negligible proportion of them consumed animal source foods rich in vitamin A [24, 28].

Table 1. Prevalence (%) of clinical and sub-clinical vitamin A deficiency among children 1–4 years in India by States.

Study	Study setting (State)	Prevalence (%) of VAD
Panda et al. [10]	Odisha s	Bitot's Spot: 3.5; Corneal scarring: 0.06
Aswasthi et al. [11]	Uttar Pradesh	Bitot's Spot: 3.5 & Sub-clinical VAD: 49–65
Sachdeva et al. [12]	Aligarh Dist, Uttar Pradesh	Bitot's Spot: 5.4; Corneal scarring: 0.5; Sub-clinical VAD: 64.8
Laxmaiah et al. [13]	8 NNMB€ states	Bitot's Spot: 0.8 & Sub-clinical VAD: 62
Arlappa et al. [14]	South India	Bitot's Spot: 0.6 & Sub-clinical VAD: 59.3
Arlappa et al. [15]	North India	Bitot's Spot: 0.9 & Sub-clinical VAD: 64
Arlappa et al. [16]	Madhya Pradesh	Bitot's Spot: 1.4 & Sub-clinical VAD: 88
Arlappa et al. [17]	Drought affected	Bitot's Spot: 2.4
Arlappa et al. [18]	West Bengal	Bitot's Spot: 0.6 & Sub-clinical VAD: 61
Arlappa et al. [19]	Maharashtra	Bitot's Spot: 1.3
Toteja et al. [20]	Bihar	Bitot's Spot: 4.7
Meshram et al. [21]	Nagaland	Sub-clinical VAD: 36.6
CNNS□[28]	All India	Sub-clinical VAD: 2.4–43.2

Figures in parenthesis are reference numbers. €National Nutrition Monitoring Bureau
□Comprehensive National Nutrition Survey

Table 2. Details of sample covered and prevalence of sub-clinical vitamin A deficiency among 1–4 year children by State – CNN Survey[€] (2016–18).

State	Proposed Sample to be covered (*N*)	Actual sample covered (*N*)	Deficit in Coverage (N)	Coverage against Target (%)	Deficit of Coverage (%)	VAD[µ] (%)
Andhra Pradesh	600	211	389	35.2	64.8	20.8
Arunachal Pradesh	650	360	290	55.4	44.6	14.8
Assam	700	193	507	27.6	72.4	21.4
Bihar	700	336	364	48.0	52.0	23.5
Chhattisgarh	650	446	204	68.6	31.4	26.6
Delhi	1000	424	576	42.4	57.6	17.8
Goa	550	144	406	26.2	73.8	2.4
Gujarat	550	143	407	26.0	74.0	14.6
Haryana	600	127	473	21.2	78.8	26.1
Himachal Pradesh	700	194	506	27.7	72.3	5.9
Jammu & Kashmir	600	226	374	37.7	62.3	8.7
Jharkhand	650	163	487	25.1	74.9	43.2
Karnataka	550	272	278	49.5	50.5	9.6
Kerala	500	202	298	40.4	59.6	17.1
Madhya Pradesh	600	37	563	6.2	93.8	27.1
Maharashtra	1000	134	866	13.4	86.6	9.4
Manipur	600	226	374	37.7	62.3	17.1
Meghalaya	650	204	446	31.4	68.6	6.3
Mizoram	500	160	340	32.0	68.0	39.2
Nagaland*	600	*	-	-	-	*
Odisha	650	523	127	80.5	19.5	19.8
Punjab	550	280	270	50.9	49.1	17.2
Rajasthan*	650	*	-	-	-	*
Sikkim	600	456	144	76.0	24.0	2.7
Tamil Nadu	1000	349	651	34.9	65.1	13.1
Telangana	600	270	330	45.0	55.0	26.5
Tripura	600	252	348	42.0	58.0	20.6
Uttar Pradesh	1050	226	824	21.5	78.5	17.1
Uttarakhand	600	243	357	40.5	59.5	14.3
West Bengal	1100	586	514	53.3	46.7	5.0
India	20,350	6694	13,656	32.9	67.1	17.6

[€]Comprehensive National Nutrition Survey (https://nhm.gov.in/WriteReadData/l892s/1405796031571201348.pdf).
[µ]VAD = Vitamin A deficiency
*Sample size coverage and data on prevalence of VAD were not available for Nagaland and Rajasthan.

PRESUMPTION OF VITAMIN A HYPERVITAMINOSIS HAS NO BASIS

Besides the arguments stressing vitamin A deficiency is not a public health problem in the country and the dietary inadequacy of vitamin A is low, the Expert Committee has presented an additional viewpoint for the discontinuation of VAS programme. This argument pertains to the speculation and concerns that introduction of fortification of oils and milk with vitamin A combined with continuation of VAS would lead to hypervitaminosis among young children. No evidence is presented to support this rationale. Reports of acute toxicity have been reported only in case when erroneously an extremely high dose of VAS has been administered in a short period of time [36]. On the other hand, chronic toxicity has been reported only on long-term ingestion of vitamin A when the intake is higher than 10 times the recommended daily allowance [34]. Except for few reports of toxic effects in infants below six months, side effects of VAS are usually rare in children aged six months or older [37–39]. Penniston & Tanumihardjo substantiate that hypervitaminosis is not at all relevant to the age beyond 9 months with the recommended massive dose VAS for public health programmes or combination of interventions i.e., diet, fortified foods, and supplements [40]. In India, as indicated earlier, dietary intake of vitamin A, as well as the consumption of food vehicle selected for vitamin A fortification, is rather low and the issue of vitamin A toxicity remains totally hypothetical. Having a scientific basis is imperative for drawing such a conclusion and would require the use of an appropriate method such as application of sensitive biomarkers to assess the adverse impact of vitamin A supplement when combined with food fortification, the condition of hypervitaminosis cannot be detected by the mere measure of serum retinol concentrations [41].

Table 3. Intakes of fats & oils, milk & milk products and dietary vitamin A by Age group and percent of RDI */RDA †.

	1–3 Yrs Children			4–6 Yrs Children		
	Fats & Oils	MMP ‡	Vitamin A (% of RDA)	Fats & Oils	MMP	Vitamin A (% of RDA)
NNMB URBAN SURVEY-2017 (NNMB-2017)						
< 50% of RDI	75.7	58.7	89.0	47.8	58.5	80.9
≤ 70% of RDI	86.2	68.9	93.4	66.3	66.1	88.1
≥ 70% of RDI	13.8	31.1	6.6	33.7	33.9	11.9
NNMB RURAL SURVEY-2011-12 (NNMB-2012)						
< 50% of RDI	96.8	75.9	81.5	87.3	81.2	80.0
≤ 70% of RDI	100	85.2	88.2	96.7	86.2	86.3
≥ 70% of RDI	0.0	14.8	11.8	3.3	13.8	13.7
NNMB TRIBAL SURVEY-2008-09 (NNMB-2009)						
< 50% of RDI	96.0	97.3	86.6	91.0	97.8	84.1
≤ 70% of RDI	99.0	98.6	89.0	97.7	99.1	86.8
≥ 70% of RDI	1.0	1.4	11.0	2.3	0.9	13.2

Source National Nutrition Monitoring Bureau (NNMB) Surveys
**RDI* Recommended Dietary Intakes
†*RDA* Recommended Dietary Allowances, ‡*MMP* Milk & Milk Products

REFLECTING ON IMPACT OF VAS PROGRAMMES IN INDIA: IMPERATIVE TO ENSURE EACH AND EVERY CHILD IS PROTECTED FROM VITAMIN A DEFICIENCY

In public health programmes, the provision of micronutrient supplements such as vitamin A, iodine, and iron are viewed as a short-term strategy to reinforce dietary approaches to mitigate micronutrient deficiencies [42]. Administration of VAS is also recommended to be progressively phased out as soon as micronutrient-rich food-based interventions enable adequate consumption [43, 44], and therefore, administration of VAS is not viewed to be a long-term strategy for prevention of VAD [45]. Several studies have supported a dietary modification (food-based) approach as a sustainable model for the prevention and control of multiple micronutrient deficiencies, particularly the VAD [46–49]. However, Sommer and Davidson have proposed that, based on dietary data and kinetic modelling, it is virtually impossible to correct widespread VAD by diet alone in developing countries, where populations remain dependent on conventional plant-based foods [50]. In Western societies, preformed vitamin A provides > 70% of daily vitamin A requirement [51] while people in developing countries meet 80–85% of their daily requirement of vitamin A from plant sources of foods [52]. Paradoxically VAD is common even in Indian children of affluent households when the source of vitamin A is predominantly from vegetarian diets [30, 53]. If we consider this scientific evidence, it is impractical to assume children in India consume such amounts of fruits and vegetables, considering not only the access and cost but, the bioavailability and the rate of conversion of carotenoids to retinol.

Since the 1970s, food-based approaches have been an integral part of vitamin A deficiency control programme in India; but despite this, the dietary intakes of vitamin A have remained persistently low and have not changed much at all in the past four decades [49]. Thus, improving dietary intake of vitamin A through dietary diversification remains a challenge in India. Chronic poverty and ignorance, deep-rooted cultural and religious factors, as well as seasonal accessibility to micronutrient-rich foods, have longstanding impact on dietary intakes of vitamin A by Indian population. The unique requirements of caste and religion in India have further contributed to extreme variations in the diet; even among individuals living in geographic proximity [15].

In India, the introduction of the biannual fixed months VAS programme since mid 2000 has positively impacted VAS with coverage of children under 5 years for massive dose VAS reported to have increased from 25% in 2003–05 [27] to 60.2% in 2015–16 [54]. Recent NFHS-5 (2019–21) data also indicates a significant improvement in the percentage of children 9–36 months who received VAS in the preceding six months to be 71.2 % [55]. Such an improvement in coverage of children 6–59 months with VAS administration is possibly the reason for the low prevalence of sub-clinical VAD (17.6%) [34] and Bitot's spots (0.3%) [25] in contrast to a high prevalence of Bitot's spots (1.4%) [25] and sub-clinical VAD (21.5%) [28] in children aged 5–10years. Hence, the lower prevalence of VAD in children under 5 years as compared to that of 5–10 years old could definitely be attributed to the coverage under VAS. On the other hand, discontinuation of VAS when not replaced with adequate intake of vitamin A rich foods would possibly worsen the vitamin A status. Therefore, suspending the VAS programme prior to an improvement in dietary vitamin A intakes solely on the basis of nationally non-representative CNNS findings may reverse the progress in vitamin A status and lead to the re-emergence of blinding xerophthalmia [56]. This is also evident from an Indian study that reported corneal xerosis (0.3%) and corneal scars (0.5%) among children of Uttar Pradesh in 2011 [5]. Global Alliance for Vitamin A (GAVA) advocated that before scaling-back the existing VAS policy, countries should ascertain that the dietary intakes of vitamin A are adequate, the sub-clinical vitamin A status of children is optimal, and the prevalence of sub-clinical VAD among children 6–59 months is less than 10% [57]. Therefore, considering these recommendations of the GAVA, it is pertinent to judge the ground realities of vitamin A status in the country. From the available recent data, it is obvious that the diets of children are extremely poor in vitamin A and the prevalence of sub-clinical VAD among children is 17.6%, which cannot be considered low enough to revise the existing VAS policy in India [58–60].

CHANGE OF VAS POLICY IN INDIA IN THE CURRENT SITUATION IS NOT CONDUCIVE

It is imperative that prior to taking any decision on revision of India's existing vitamin supplementation A policy, the Ministry of Health and Family Welfare (MoHFW) should appraise the ground realities of vitamin A status among children under 5 years in rural, tribal, urban and urban slums within the various states in India by undertaking a well-designed study with adequate state and nationally representative sample size using various parameters

comprising serum retinol, Bitot's spots and dietary vitamin A intake. Additionally, study with more sensitive biomarkers like relative dose response tests [58] is required to be undertaken in a sub-sample of children. In absence of such valid information, discontinuation of VAS programme in India implies denying children's right to receive VAS until their vitamin A intake has improved optimally. Deprivation of vitamin A during formative years is detrimental to the growth and development of a child, resulting in morbidity and mortality [61]. In the Pandemic situation of Covid-19, we need to provide support in building immunity of children who are yet to receive vaccination against Covid-19 infection and may have lower intake of dietary vitamin A due to possible interruptions in the world's largest ongoing supplementary feeding programme under the Integrated Child Development Services (ICDS) for children or poor food purchasing power. In such a grave situation, the significance of continuing the VAS policy of six monthly administration of vitamin A supplement to young children cannot be ignored.Universal coverage of all children 6–59 months with VAS in the current Covid-19 Pandemic situation needs high priority. The implications of the recommendation of Expert Committee to shift the existing universal coverage of VAS approach to a targeted geographical approach, with coverage limited to less than one tenth of the country could be devastating to the health of children, particularly those from poor and marginalised households. There is a need for substantial supportive scientific evidence. In absence of convincing rationale, the recommendation by selected experts to make changes in the existing VAS policy in India appears to be very similar to the well documented initial resistance by few scientists and experts who had strong opinions but not sufficient scientific basis to their claims for opposing the public health intervention of introduction of Bacille Calmette-Guerin (BCG) and many other novel vaccines across the globe [22].

DATA AVAILABILITY

National Nutrition Monitoring Bureau published Technical Reports
https://www.nin.res.in/downloads.html
Comprehensive National Nutrition Survey (CNNS) National Report 2016-18
https://nhm.gov.in/WriteReadData/l892s/1405796031571201348.pdf

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NA conceptualised and prepared the perspective.

COMPETING INTERESTS

The author declares no competing interests.

ADDITIONAL INFORMATION

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