Vitamin-D Levels in Infants and Young Children in the Era of Routine Supplementation

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ABSTRACT

BACKGROUND

Vitamin D deficiency has been found to be very prevalent in India with a prevalence of 50 - 90 % in many parts of India. The Indian Academy of Paediatrics (IAP) has hence recommended routine administration of vitamin D in infants. In this study, we aim to find the prevalence of vitamin D deficiency in a random population and the efficacy of routine vitamin D administration in preventing vitamin D deficiency.

METHODS

48 children ranging from 2 months to 5 years who attended a medical camp were selected and their 25-OH vitamin D levels were determined. A detailed history regarding their diet and routine vitamin D supplementation was taken.

RESULTS

In the sample studied, only 8.3 % of children were vitamin D deficient and 10.4 % of children were vitamin D insufficient. Of the 9 children who were on supplements for more than 6 months, none developed vitamin D deficiency or insufficiency. Children born to multipara were more prone to develop vitamin D insufficiency (p value of 0.046).

CONCLUSIONS

The prevalence of vitamin D deficiency was found to be 8.3 % only, very low when compared with other studies in the infants and preschool children age group and there was no significant difference with supplementation of vitamin D. A follow up of these children to find out if the incidence increases with increasing age will be ideal.

KEY WORDS

Vitamin D, Vitamin D Deficiency, Vitamin D Insufficiency, Infants, Children

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DOI: 10.14260/jemds/2021/27

How to Cite This Article:
Lukose R, Jose J, Subramanian AT. Vitamin - D levels in infants and young children in the era of routine supplementation. J Evolution Med Dent Sci 2021;10(03):127-131, DOI: 10.14260/jemds/2021/27

Submission 22-09-2020,
Peer Review 19-11-2020,
Acceptance 26-11-2020,
Published 18-01-2021.

BACKGROUND

Vitamin D is an important hormone regulating the calcium homeostasis in the body, in addition to the bone health its deficiency is purported to be the causative factor in many endocrine, immune diseases and it also affects neurophysiological functioning.[1] In infants and young children Vitamin D plays an important role in bone mineralization hence its deficiency leads to rickets, hypocalcaemia symptoms and osteomalacia in older adolescents and adults. As many studies in India have proved that the prevalence of vitamin D deficiency in India ranges from 50 % to 90 %.[2] recommendations have been put forward for regular supplementation of vitamin D in infants and children.

According to the recommendations put forward by the IAP all children have been advised regular intake of 400 IU of Vitamin D till 6 months or till 1 year whenever an adequate dietary goal has been reached. In this study, we have measured the vitamin D levels in a group of children whose mothers had been advised routine vitamin D supplementation from the new-born period.

Objectives

1. To study the prevalence of vitamin D deficiency / insufficiency in a group of infants and children who were advised routine vitamin D supplementation.
2. To estimate the vitamin D levels in normal infants and children.
3. To compare the vitamin D levels of infants who have been on and routine supplementation and those who have not been regularly supplemented.
4. To compare the vitamin D levels of infants and children with respect to their diet and sunlight exposure.
5. To estimate the prevalence of vitamin D deficiency / insufficiency in these children.

METHODS

48 infants and children (2 months to 5 years) who were exclusively breastfed were selected. According to the IAP recommendation, all babies born in our institution are advised daily administration of vitamin D 400 IU till 6 months of age.

Inclusion Criteria

Infants and children who are exclusively breastfed born in our hospital in a year.

Exclusion Criteria

1. Preterm infants already on supplements.
2. Those with chronic infections on various medications.
3. Children with acute infections.

Sample size was calculated using the formula

$$N = \frac{(Z1 - \text{alpha}/2\ pq)}{d^2}$$

P = Prevalence of vitamin D deficiency (77 %)[3]
Q = 1-p
Alpha = significance level 5 % (1.96)
d = relative precision 20 % of p
Therefore n = 29 (minimum sample size)

Statistical significance was assessed by Fisher's exact test. All calculations were done using Statistical Package for the Social Sciences (SPSS) 23 software.

Health camp was conducted by the department of Pediatrics of Amala Institute of Medical Sciences, project in Amala Institute of Medical Sciences. A questionnaire was prepared, and mothers were asked about their educational status, parity, mode of delivery, antenatal check-ups and whether routine iron and calcium supplementations were taken or not. Questions were also asked regarding the dietary habits of the children, whether vegetarian or non-vegetarian, intake of milk and eggs. Their daily sunlight exposure in terms of duration per day was asked. The children were examined, for any rachitic features and their nutritional status was noted. Their period of gestation, birth weight was also noted and also whether they were being supplemented with the recommended dose of vitamin D (they were advised 0.5 ml of Zincovit drops (400 IU / ml of vitamin D) twice daily and calcium and if so for how long. 48 children were evaluated after taking informed consent. The study was conducted after taking the approval by the institutional ethics committee. Babies underwent venipuncture for 25 (OH) vitamin D estimation after taking informed consent.

25 (OH) vitamin was assessed using chemiluminescent bioassay and levels below 50 nmol / L were considered deficient; 50 – 75 nmol / L were insufficient; > 75 nmol / L were considered normal (US Endocrine Society Guideline)[4].

RESULTS

The children were grouped into 3 groups having deficient, insufficient and sufficient vitamin D levels. The first two groups were compared with those children having sufficient vitamin D levels.

Vitamin-D	Number of Patients	Percentage (%)
Deficient (< 50 nmol / L)	4	8.3
Insufficient (50 - 75 nmol/L)	5	10.4
Sufficient (> 75 nmol / L)	39	81.3
Total	**48**	**100**

Table 1. Vitamin D Levels of Children in the Study Population

Age in Months	Vitamin D Deficiency	Vitamin D Insufficiency	Vitamin D Sufficiency	Total	P Value (Fisher Exact Test)
< 12 months	0	4	15	**19**	0.043
12 - 24 months	3	1	10	**14**	
24 - 36 months	0	0	14	**14**	
36 - 60 months	0	0	1	**1**	
total	3	5	45	**48**	

Table 2. Age Distribution and Relation with Vitamin D Levels

The mean Vitamin D concentration of the population was 96.97 nmol / L. The mean age of the study group was 18.54 months. Of the 48 children 21 were females and 28 were

males, 6 males were having low vitamin D levels but only 2 females were having low vitamin D levels. (p = 0.446)

Duration of Vit - D Supplementation	Number	% Age	Vitamin D Deficient	Vitamin D Insufficient	Vitamin D Sufficient	Total	P Value
< 3 months	8	16.7	1	1	6	**8**	0.319
3 - 6 months	26	54.2	3	4	19	**26**	
> 6 months	9	18.8	0	0	9	**9**	
Not given	5	10.7	0	0	5	**5**	
Total			**4**	**5**	**39**	**48**	

Table 3. Vitamin D Levels and the Relation with the Duration of Routine Supplementation

Of those supplemented for more than 6 months, none developed hypovitaminosis, 2 of the 8 children supplemented for less than 3 months developed hypovitaminosis D and 7 of the 26 children who were supplemented for 3 - 6 months developed hypovitaminosis D.

Sunlight/ Day	Number	Percentage	Vitamin D Deficient	Vitamin D Insufficient	Vitamin D Sufficient	Total	P Value (Fishers exact Test)
< 15 minutes / day	4	8.3	0	0	4	**4**	0.222
15 - 30 minutes / day	34	70.8	2	2	30	**34**	
> 30 min / day	10	20.8	1	3	6	**10**	
Total	**48**	**100**	**3**	**5**	**40**	**48**	

Table 4. Vitamin D Levels and Sunlight Exposure

37 children were having no malnutrition according to the IAP classification, 8 (16.6 %) were having grade 1 protein energy malnutrition (PEM), 1 (0.02 %) was having grade 2 PEM and one had grade 3 protein energy malnutrition, one child was obese with a body mass index (BMI) of 20.2. Similarly, 37 (77.1 %) had no stunting, 8 (16.6 %) had first degree stunting according to Waterlow classification, 1 child had second degree stunting. Of the children studied, 41 had no features of rickets, and the remaining 7 children had Harrison's sulcus but no other evident features of rickets.

On considering the dietetic history of these children, the weaning food in 35 of the 48 children was banana powder which though has good calorific value is a poor source of calcium. Only 10 children were given ragi and 2 had rice and 1 was given amrutham powder as weaning food. 47 of the 48 children had a non-vegetarian diet so there was no significant association.

Regarding the intake of eggs in the diet, of the 34 children who had < 2 eggs / week, 2 had vitamin D deficiency and 5 had vitamin D insufficiency. Of the 13 children who had > 2 eggs / week, only one developed vitamin D deficiency (p value = 0.159)

Of the mothers, 39.6 % were primigravida, 60.4 % were multigravida. 50 % of the mothers had normal BMI, 27.1 % were underweight, 20.8 % were overweight and only 2.1 % were obese. Regarding the educational status of the mothers, 58.3 % were graduates and 41.7 % were high school pass outs. 52.1 % of mothers had normal delivery and 47.9 % underwent caesarean section. Only 2 children born to underweight mothers were having low vitamin D levels, 4 children born to mothers with normal nutrition had low levels of vitamin D, 3 born to overweight mothers had low levels. There was no significant correlation (p value = 0.858).

Parity	No. of Children	% Age	Vit D Deficient	Vitamin D Insufficient	Vitamin D Normal	Total	P = 0.046
Primi	19	39.6	0	1	19	**20**	
Multigravida	29	60.4	4	4	20	**28**	
	48	100	4	5	39	**48**	

Table 5. Vitamin D levels in Children Born to Primi Mothers and Multigravida

DISCUSSION

Vitamin D deficiency with a resurgence of rickets is increasingly being reported in infants and toddlers from various parts of the world despite food fortification policies in many countries. The prevalence of vitamin D deficiency is 50 - 90 %[2] in the Indian subcontinent in spite of being in the equatorial region. The prevalence of hypovitaminosis D ranged from 84.9 to 100 % among school going children, 42 to 74 % among pregnant women, 44.3 to 66.7 % among infants 70 to 81.1 % among lactating mothers and 30 to 91.2 % among adults.[5]

Risk factors for Vitamin D deficiency and rickets in early life include breastfeeding without Vitamin D supplementation, dark skin pigmentation, sunlight exposure, season, latitude and maternal vitamin D deficiency.[6] The definitions of vitamin D insufficient have been taken as levels below 30 ng / mL (72.5 nmol / L) and deficient levels as below 20 ng / mL (50 nmol / L), according to US Endocrine Society Guidelines[1]. According to Institute of Medicine (IOM), only Vitamin D levels above 20 ng / mL need to be taken as sufficient as 25 (OH) vitamin D of 20 ng / mL meets the needs for 97.5 % of the population, and only < 15 ng / mL of vitamin D is deficient.[7] Thus IAP guidelines also adopts similar criteria: vitamin D > 20 ng / mL (50 nmol / L) is sufficient, 12 – 20 ng / mL (30 - 50 nmol / L) as insufficient and < 12 ng / mL (< 30 nmol / L) as deficient.[8] But, many studies done in India and abroad have still taken the US Endocrine Society Guidline[4] recommendation of vitamin deficiency levels, we have also taken the same criteria for classification in our study so that comparisons can be made with other similar studies.

There is evidence that the current supplementation recommendations, particularly for pregnant and lactating women, are inadequate to ensure vitamin D sufficiency in these groups, thus infants who are exclusively breastfed by such un-supplemented mothers are at increased risk of developing vitamin D deficiency and or rickets.[9]

The IAP hence has recommended 400 IU of vitamin D and 250 – 500 mg / day of calcium up to one year of age and from 1 - 18 years 600 IU and 600 - 800 mg of calcium / day to all babies born term and preterm[6] newborns both exclusively breastfed and formula fed babies[10] and mothers should continue their intake of vitamin D to the tune of 600 IU daily.

In view of the high prevalence of vitamin D deficiency in India, questions have been raised whether this dose may suffice to treat the deficiency.[11]

Several studies have been done in various parts of India and even in Kerala, Anitha A et al. had done a cross-sectional study among healthy school children in central Kerala during the months of March and April ; though none had any rachitic features, 60.92 % had vitamin D deficiency and 30.46 % had insufficiency.[12] Bindusha S et al. assessed the Vitamin D status of 6 - 14 year old children and found that 52.2 % had normal vitamin D status, 47.9 % had insufficient levels, of which 20.7 % was deficient and 3.3 % had severe deficiency with significant association with stunting.[13] Basu et al. in 2015 conducted a study on 310 children and adolescents in eastern India and found that the deficiency was most prevalent in adolescents (86.1 %) followed by school children (61 %) and lowest in preschool children and the levels were lower in winter months.[14] Ekbote et al.[3] studied the importance of sunlight exposure in toddlers and showed a vitamin D deficiency prevalence of 77 % in those exposed to > 30 minutes / day.[3] Khan et al. did a study on 140 children 3 - 6 years in a rural, tribal population in Kerala and found the prevalence of vitamin deficiency to be 47.1 %, insufficiency in 35 % and only 17.9 % had adequate levels.[15] But another similar study done in northern district of Kerala by Vijayakumar et al. showed a prevalence of vitamin D deficiency to be 11.1 %, and children who ate fish daily had significantly higher values of 25 (OH) Vitamin D and also those who were examined in the summer months of March - May had higher values.[16] Our study has been conducted in Thrissur (10.5276^0 N and 76.2144^0 E) which has an annual average solar irradiation of 5 kWh / sqm, with maximum exposure being during November to March.

In our study, 81.3 % of children (39) had normal levels of vitamin D, 10.4 % (5) children had vitamin D insufficiency and only 8.3 % (4) had vitamin D deficiency. These values are significantly lower than the prevalence of vitamin D deficiency in other parts of the country. The prevalence in 1 - 5 year old children was 74.6 % in a study conducted in Pune where they also concluded that the functional cut offs of Vitamin D deficiency may be lower.[17,18] As vitamin D levels are affected by a number of factors like geographical location, sunlight exposure and individual characteristics, a study regarding the prevalence has to take these factors into account. Though such an extensive study was beyond our capabilities, we tried to study a few of the extrinsic factors.

In our study, there were 19 infants of whom 4 had insufficient vitamin D levels, 3 among the 1 - 2 years had vitamin D deficiency, so vitamin D insufficiency was more in less than 2 years and is significant (p value = 0.043). Sex did not have any statistical significance in the incidence of vitamin deficiency unlike other previous studies which showed a female preponderance.[19,20]

No significant association was found with grades of malnutrition or stunting with vitamin D levels unlike the studies in older children by Bindusha et al.[13] Though children with milk intake of more than 500 ml daily had adequate vitamin D levels, there was no significant association On considering the type of weaning food, 6 children who were given banana powder as weaning food developed hypovitaminosis D when compared to other weaning foods, though no statistical significance could be found. (P value = 0.066)

Regarding sunlight exposure of children, 20.8 % of the children were exposed to less than 15 minutes of sunlight 70.8 % of children were exposed to more than 30 minutes per day of sunlight; 8.3 % had 15 - 30 minutes of sun exposure. But, even in those exposed to sunlight, they were not subjected to 10 am to 3 pm sunlight. The recommended minimum sunlight exposure for Indians with Fitzpatrick skin type V is > 45 minutes.[21] So, even though the vitamin D levels may be near normal in young children they need to be well exposed to sunlight as they grow up. There was no statistical significant association between sunlight exposure and vitamin D levels. (p = 0.773)

Of the children who were supplemented for more than 6 months none developed insufficiency or deficiency. Of the children supplemented for 3 - 6 months with multivitamin only 3 developed vitamin D insufficiency, and 4 developed vitamin D deficiency. Of the 8 children who were supplemented for less than 3 months, one each developed vitamin D insufficiency and deficiency. The p value being 0.319. On evaluating maternal factors into consideration, 8 children who were born to multipara mothers developed vitamin D insufficiency, whereas only one child born to a primi developed vitamin D insufficiency and there is statistical significance (p = 0.046). There is no significant relation between the vitamin D levels and the BMI of the mother or mode of delivery (p value = 0.588). The educational status of the mother had no bearing on vitamin D deficiency in children (p value = 0.756) unlike studies which showed increased prevalence of vitamin D deficiency in illiterate population.

Though, many studies have been done to find the prevalence of hypovitaminosis D not much have been done in India to assess the efficacy of giving the recommended vitamin D for breastfed infants.

As the prevalence of vitamin D deficiency in the studied age group was found to be lower than the previous studies, there is a need to confirm the results in a larger population, probably, we would have got significant associations with many factors. But again, vitamin D deficiency prevalence increases with age, so a follow up study of the same population will give us an idea how other extraneous factors come into play in vitamin D metabolism. The importance of vitamin D supplementation should be explained to the mothers, as many of them though advised to take supplementation do not do so and think that breast milk is adequate in all aspects, and again, the importance of continuing supplementation is not ensured by clinicians and mothers are reluctant if the baby vomits or does not tolerate the multivitamins. Adequate nutritional advice and education is also to be taught to mothers who are lax in continuing their own calcium supplements after delivery. There is no proper knowledge regarding vitamin D rich foods which can be made easily available, among mothers. The need for regular sunlight exposure of at least > 45 minutes / day during the period of 10 am to 3 pm is also to be stressed during parental education.

CONCLUSIONS

Though no significant association was seen between lack of supplementation and vitamin deficiency, the incidence of hypovitaminosis was definitely more in the un-supplemented group. A follow up of these children to find out if the incidence increases with increasing age will be ideal.

Data sharing statement provided by the authors is available with the full text of this article at jemds.com.
Financial or other competing interests: None.
Disclosure forms provided by the authors are available with the full text of this article at jemds.com.

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