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Alarming levels of inadequate intake of B group vitamins in tribal lactating women from South India

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Abstract

Background: Micronutrients are necessary for proper growth and development of the human body, though required in small amounts. Dietary intake of these micronutrients by lactating women is essential for their own health as well as children's overall growth and development. objective of present study is to assess the adequacy of dietary B-group vitamins intake during lactation and to find out the factors associated with their inadequate intake.

Design and methods: It was a analysis of data from prospective cohort study for 10 months carried out among 340 Scheduled Tribes mothers in 10 clusters in Guntur district, Andhra Pradesh, India. Data collection was done using a 24 h dietary recall questionnaire. A *p*-value less than 0.05 was considered to be statistically significant.

Results: All the mothers ($n = 340$) were not having adequate intake of Thiamine, Riboflavin, Niacin, Pyridoxine, Pantothenic acid, Biotin and Folic acid. Methyl cobalamin intake was inadequate in 37.5% mothers ($n = 136$). The mean intake of Vitamin B12 was 40.98 + 42.8 (SD) µg/day. Age at marriage, location and parity were significantly associated with inadequate intake of Vitamin B12.

Conclusions: The current diet pattern of mothers of vulnerable groups might affect the growth and development of the infant. We strongly recommend for supplementation of B-group vitamins to pregnant and lactating women in India.

Keywords

Lactating mothers, micro-nutrients, B group vitamins, diet, deficiency

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Micronutrients are necessary for proper growth and development of the human body, though required in small amounts.[1] Micronutrient deficiencies also known as 'Hidden Hunger' affects the health, learning ability, productivity because of illness and disability from the vicious cycle of malnutrition, underdevelopment and poverty. It is estimated that around two billion people in the world are deficient in one or more micronutrients.[2] Dietary intake of these micronutrients by lactating women is essential for their own health as well as children's overall growth and development. Literature shows that maternal supplementation during pregnancy and early lactation with B-group vitamins significantly improved B group vitamin levels in the maternal plasma, breast milk and infant levels as well.[3] Studies have shown that nutrient rich foods during pregnancy and lactation is critical for child's optimal physical and mental growth throughout life.[4]

Micronutrients can be divided into two groups with respect to maternal intake during lactation, Group I micronutrients/priority micronutrients and Group II micronutrients. Group I micronutrients are the ones whose secretion

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in milk is dependent mainly on the maternal intake whereas Group II micronutrients secretion is relatively unaffected by maternal intake but mother becomes gradually depleted if the intake is insufficient. Most of the B-group vitamins comes under Group I micronutrients.[5,6]

To our knowledge, very few studies have been conducted across the world that assessed all the B group vitamins intake during lactation[6] and none were conducted in India and in vulnerable populations like Scheduled Tribes. Therefore, the objective of present study is to assess the adequacy of dietary B-group vitamins intake during lactation and to find out the factors associated with their inadequate intake.

Methodology

This is a analysis of data from community-based cohort study which was conducted in Guntur district, Andhra Pradesh, India from June 2021 to April 2022 among lactating mothers of infants less than 1 year of age. Mothers in selected households were eligible for participation if they fit the criteria defining a target group, such as; they reside in the study area for the last 6 months or more, they live in a selected household at the time of data collection, they belonged to a tribe of Andhra Pradesh and consent was given by the participant for participation. Mothers with symptoms suggestive of acute infection and those who deny consent were excluded. The sample size calculations used the assumptions of estimated incidence with 15% relative precision and 95% Confidence (1.96). A design effect of two was assumed and number of clusters were decided as 10. The sample size of the cohort came to 340 lactating mothers with infants. The sample size per cluster was 34 lactating mothers. All tribal pockets on the map of Guntur district were enumerated using the list of lactating mothers belonging to scheduled tribes with children less than 1 year of age received from ICDS, Guntur, Andhra Pradesh. There were 23 Project sites of ICDS in Guntur district, Andhra Pradesh. Each project site was divided into urban and rural areas catered by Anganwadi centres. Five clusters were randomly selected in the urban and rural areas each from the above list.[7] The project has been approved by All India Institute of Medical Sciences Mangalagiri ethics committee [AIIMS/MG/IEC/2021-22/105].

House to house survey was done in the selected cluster. The lactating mothers were interviewed according to the interview schedule and to assess the dietary intake of the mothers an interactive day 24-h recall method of diet survey was used. Three randomly selected non-consecutive days 24-h recall was done. To facilitate portion size estimates, the use of food pictures, bowls, plates and utensils familiar to the local area and samples of actual cooked or raw foods that are commonly consumed were used. For estimating all the B group vitamins intake in diet, DietCal (R) software was used.

All the data at baseline survey were entered using Microsoft Excel 2010. Quantitative data analysis was done using IBM SPSS Statistics Base v26.0 compatible with Windows. The results were expressed as means and standard deviations for quantitative variables or percentages for qualitative variables. Paired or unpaired *t*-tests were used to compare means as applicable. To find the association between deficient intake of methyl cobalamin (Vitamin B12) in mothers and other variables, we created a new categorical variable for Vitamin B12 (outcome variable) with binary responses, adequate and inadequate. Bivariable logistic regression analysis was done and the variables whose *p*-value were <0.2 were considered for multivariable logistic regression analysis. Correlation analysis was done with the B-group vitamins which were totally inadequate in the diet to find out whether there was any significant correlation between their intakes and the strength of the correlation. For all analyses, statistical significance was determined by a *p*-value of <0.05.

Results

A total 340 lactating mothers were studied with the mean age of the study participants being 23.51 ± 3.62 years. The mean age at marriage was 18.51 ± 2.19 years. Out of the 340 studied mothers, more than one-third (41.8%) were not literate or of less than primary education. Overall, almost 40% of husbands were illiterate. Three study participants were the widows. Of the total studied mothers, 84.7% were homemakers. Nearly three-fourth of the husbands were labourers. Nearly four-fifth of the study participants belonged to lower or lower-middle (80.3%) socio-economic strata using the modified B.G. Prasad scale of May 2021. Of the total, 27%, 24.7% and 30.9% of mothers belonged to Yerukula, Yenadis, Lambadi/Sugali tribes, respectively (Table 1).

Out of 338 mothers, 304 (89.9%) were able to quantify the consumption of iron-folic acid tablets during the last-child antenatal period. The consumption of iron-folic acid tablets during the last child's antenatal period among mothers was a minimum of 3 to a maximum of 185 tablets. The mean (SD) number of iron-folic acid tablets consumed by the mother during the last-child antenatal period was 110.6 ± 46.5. The median (IQR) number of iron-folic acid tablets consumed by the mother during the last-child antenatal period was 120 (80–150). Mothers who consumed 100 iron-folic acid tablets or more when they were pregnant was (*n*) 69.7%. Mothers who consumed 180 iron-folic acid tablets or more when they were pregnant were (*n*) 8.8% (Figure 1). Table 2 shows mean consumption of IFA Tablets in last antenatal period among mothers was more in rural based tribes that is, 135.64 (SD, 28.22). There was statistically significant difference between consumption of IFA tablets in last

Table 1. Distribution of selected characteristics among mothers with B group vitamin deficiency.

Variable	Category	All B group Vitamins except B12 ($N=340$)		Vitamin B12 ($N=136$)	
		n	%	*n*	%
Age in years (in years)	<=20	65	19.1	22	16.2
	>20	275	80.9	114	83.8
Type of Scheduled Tribe	Chenchu	34	10	13	9.6
	Yerukula	92	27.1	37	27.2
	Lambadi/Sugali	105	30.9	35	25.7
	Yanadi	84	24.7	38	27.9
	Others	25	7.4	13	9.6
Education of the participant	Illiterate	142	41.8	59	43.4
	Literate	198	58.2	77	56.6
Spouse's occupation[a,b,c]	Daily wage (Non-agricultural) labourer	229	68	96	71.1
	Other	108	32	39	28.9
Spouse's education[a,b]	Illiterate	134	39.5	56	41.5
	Literate	203	60.5	79	58.5
Type of marriage	Normal	201	59.1	88	64.7
	Consanguineous	139	40.9	48	35.3
Overcrowding	Yes	299	87.9	121	89
	No	41	12.1	15	11
Socio-economic status	Lower middle and lower	273	80.3	104	76.5
	Middle and above	67	19.7	32	23.5
Type of family	Nuclear	187	55	82	60.3
	Extended	153	45	54	39.7
Age at marriage (in years)	<18	76	22.4	24	17.6
	>=18	264	77.6	112	82.4
Age at menarche (in years)	<=13	116	34.2	44	32.4
	>13	223	65.8	92	67.6
Gravida	>=3	122	35.9	46	33.8
	<3	218	64.1	90	66.2
Parity	<=3	258	75.9	102	75
	>3	82	24.1	34	25
Age of the last child (in months)	0–6	124	36.5	60	44.1
	>6	216	63.5	76	55.9
IFA intake after delivery	Yes	229	67.4	85	62.5
	No	111	32.6	51	37.5
Location	Urban	170	50	63	46.3
	Rural	170	50	73	53.7

[a]$n=337$ for B – group vitamins except B12.
[b]$n=135$ for Vitamin B12.
[c]Spouse's occupation – cultivator, business/self-employed and job holder (government/private).

antenatal period among mothers by their tribe location with p value < 0.001. Mean consumption of IFA Tablets in last antenatal period among mothers was lower among illiterate mothers, women with illiterate husbands and lower socioeconomic status.

Intake of all B-group vitamins except methyl cobalamin (Vitamin B12) was calculated for all ($n=340$) mothers. Methyl cobalamin data was present only for 136 mothers. All the mothers ($n=340$) were not having adequate intake of Thiamine, Riboflavin, Niacin, Pyridoxine, Pantothenic acid, Biotin and Folic acid. Methyl cobalamin intake was inadequate in 37.5% mothers (here n is 136, not 340). The mean intake of Vitamin B12 was 40.98 ± 42.8 (SD) µg/day. The median dietary intake of Vitamin B12 was 35.15 (IQR 139.6) µg/day for studied mothers. Details regarding the summary statistics of the B-group vitamins of the study population and their comparison with recommended EAR, RDA and AI level are presented in Table 3 and Figure 2.

To find the factors associated with B12 inadequate intake, bivariate analysis followed by multivariable logistic regression analysis was done. Age at marriage, location and parity came out to be significantly associated with inadequate intake of Vitamin B12 (Table 4).

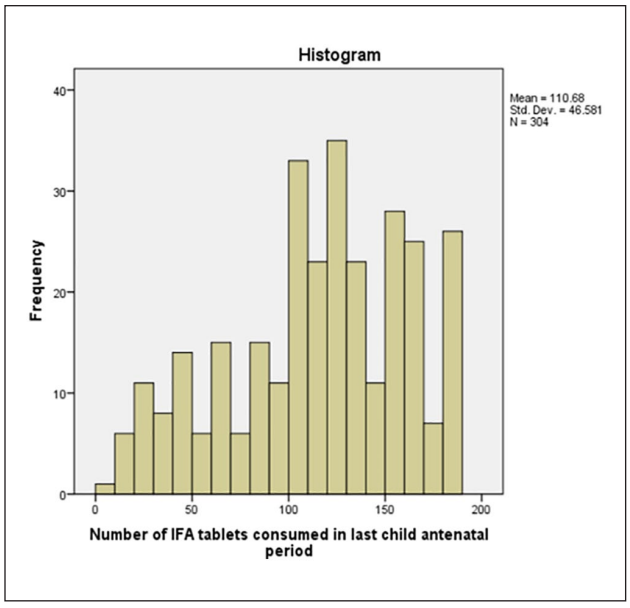

Figure 1. Distribution of consumption of iron-folic acid tablets by mothers during last-child antenatal period ($n = 304$).

Correlation analysis showed that the correlation between all the vitamins, except Vitamin B12 that is, Thiamine, Riboflavin, Niacin, Pyridoxine, Pantothenic acid, Biotin and Folate are significant and the strongest correlation exists between Pantothenic acid and Pyridoxine intake ($r = 0.85$) least correlation between Folate and Niacin ($r = 0.18$). Apart from the correlation between Folate and Niacin ($r = 0.18$), Biotin and Niacin ($r = 0.26$), Riboflavin and Niacin ($r = 0.38$) all were having strong correlation ($r > 0.5$). Correlation between Vitamin B12 and other vitamins is poor and not significant. Correlation coefficients between all the vitamins were presented in Table 5.

Discussion

It is first of its kind of study documenting dietary intake of vitamin B group among tribal lactating mothers. Our study showed that all the participants were having inadequate intake of all the B group vitamins except vitamin B12, with respect to both recommended estimated average requirement (EAR) and recommended dietary allowance

Table 2. Consumption of IFA Tablets in mothers during the previous ante-natal period by sociodemographic factors ($n = 340$).

Variable	Category	Consumption of IFA Tablets in last antenatal period among mothers			
		Mean	SD	*t*	*p* Value
Residence	Urban	135.64	28.22	133.41	<0.001
	Rural	83.81	48.03		
Mother occupation	Homemaker	110.28	46.368	0.001	0.97
	Other	110.57	50.730		
Mother education status	Not literate	104.96	51.237	2.705	0.101
	Literate	113.95	43.561		
Father occupation ($n = 337$)	Non-agricultural labour	110.37	49.46	0.18	0.83
	Others	109.84	42.21		
Father education status ($n = 337$)	Not literate	105.61	49.78	1.06	0.34
	Literate	112.99	45.21		
Socioeconomic status	Lower or lower middle	108.85	47.65	1.12	0.290
	Others	115.84	44.05		

Table 3. Summary statistics of the B group vitamin intake among mothers ($N = 340$).

Vitamin	Mean	Standard deviation	Median	Inter-quartile range
Thiamine (mg/day)	0.54	0.15	0.5	0.6
Riboflavin (mg/day)	0.47	0.16	0.4	0.8
Niacin (mg/day)	9.39	3.66	9	17
Pyridoxin (mg/day)	1	0.33	0.98	1.57
Pantothenic acid (mg/day)	3.12	0.81	3.1	3.5
Biotin (µg/day)	11.09	5.26	10.1	23.7
Folic acid (µg/day)	176.74	63.46	166	285

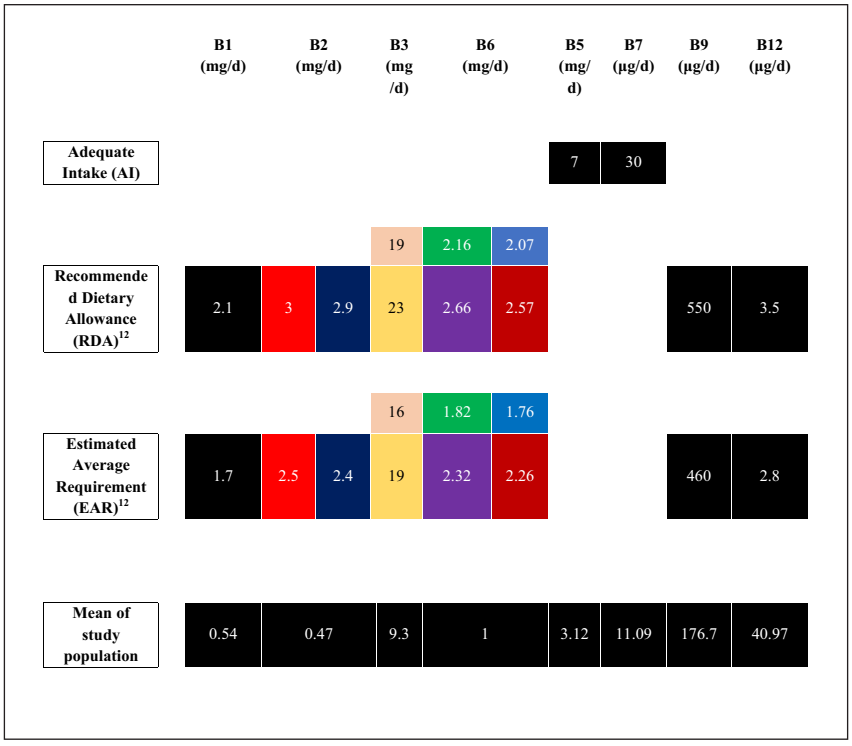

Figure 2. Comparison of population intake with standards of requirement for B group vitamins.
Legend to the figure:

	Mother with ≤6 months baby		Moderate work with ≤6 months baby
	Mother with >6 months baby		Moderate work with >6 months baby
	Mother of moderate work cat.		Heavy work with ≤6 months baby
	Mother of heavy work cat.		Heavy work with >6 months baby

(RDA) levels given by ICMR. Sample for vitamin B12 in our study is 136, among them around 38% were taking inadequate levels. Multi-variable logistic regression analysis showed that greater the age, rural households and greater the parity had lesser risk of inadequate intake.

We could find only a few studies that had assessed the dietary intake of micro-nutrients after pregnancy[8–10] and among them only one had assessed the adequacy of multiple B-group vitamins in Lactating mothers.[7] Study done by Aparicio et al. in Spain among lactating mothers showed that around 60% of participants had adequate intake of all the B group vitamins except Folic acid (39%).[8] This might be because Spain being a developed country and the participants don't belong to any vulnerable group. Literature shows that in India, even antenatal women are suffering from B-group vitamin inadequacy.[11] Lander et al. reported that ≥80% of antenatal woman in India had inadequate intake of multiple B-group vitamins (B1, B2, B6, B12 and Folate).[11]

The mean intake of Vitamin B12 among the participants in our study was 40.98 ± 42.8 (SD) µg/day and only 38% were having inadequate intake as per EAR and RDA requirements.[12] Distribution of the B12 data was positively skewed, because of which the mean was 40 µg/day. Though the tribal population was impoverished, main sources of food were animal sources as most of them rear cattle in their households for dietary purposes and this might be the reason for the positive skewness in the data. Poor correlation between B12 consumption and other Vitamin consumption levels supported the argument that main source of food might be animal source food. Study done by Patel and Lovelady among vegan Indian lactating mothers in USA showed that mean dietary intake is 2.6 µg/day (±0.2).[13] This is very low compared to our study and the reason might be that study was done in pure vegan mothers.

A crucial ongoing large-scale intervention under Anaemia Mukt Bharat is prophylactic Iron Folic Acid supplementation provided to children, adolescents, women of

Table 4. Association between inadequate intake of Vitamin B12 and selected variables ($n = 136$).

Variable	Inadequate intake of Vitamin B12						
	(*n*)	Yes *n* (%)	No *n* (%)	COR (95% CI)	*p*-Value	AOR (95% CI)	*p*-Value
Type of scheduled tribe	Chenchu (13)	2 (15.4)	11 (84.6)			REF	
	Yerukula (37)	15 (40.5)	22 (59.5)	3.75 (0.72–19.40)	0.12	4.53 (0.49–41.79)	0.18
	Lambadi/Sugali (35)	13 (37.1)	22 (62.9)	3.25 (0.62–17.01)	0.16	3.53 (0.36–34.38)	0.28
	Yanadi (38)	19 (50)	19 (50)	5.5 (1.07–28.22)	0.04	7.1 (0.81–62.06)	0.08
	Others (13)	2 (15.4)	11 (84.6)	1 (0.11–8.42)	1	9.74 (0.66–144.06)	0.09
Location	Urban (63)	29 (46)	34 (54)				REF
	Rural (73)	22 (30.1)	51 (69.9)	0.51 (0.25–1.02)	0.06	0.31 (0.11–0.83)	0.02
Spouse's occupation-($n = 135$)	Daily wage (Non-agricultural) labourer (96)	31 (32.3)	65 (67.7)			REF	
	Other (39)	20 (51.3)	19 (48.7)	2.21 (1.03–4.72)	0.04	2.67 (0.91–7.89)	0.08
Type of family	Nuclear (82)	27 (32.9)	55 (67.1)			REF	
	Extended (54)	24 (44.4)	30 (55.6)	1.63 (0.80–3.31)	0.18	1.35 (0.54–3.35)	0.52
Age at marriage	<18 (24)	14 (58.3)	10 (41.7)			REF	
	≥18 (112)	37 (33)	75 (67)	0.35 (0.14–0.87)	0.02	0.20 (0.06–0.65)	0.007
Gravida	≥3 (46)	13 (28.3)	33 (71.1)			REF	
	<3 (90)	38 (42.2)	52 (57.8)	1.86 (0.86–3.99)	0.11	0.41 (0.09–1.88)	0.25
Parity	<3 (102)	44 (43.1)	58 (56.9)			REF	
	≥3 (34)	7 (20.6)	27 (79.4)	0.34 (0.14–0.86)	0.02	0.14 (0.23–0.87)	0.04
Age of the last child (in months)	0–6 (60)	32 (53.3)	28 (46.7)			REF	
	>6 (76)	19 (25)	57 (75)	0.29 (0.14–0.60)	0.001	2.37 (INFINITE)	0.99

Table 5. Correlation analysis between the consumption pattern of B group vitamins ($N = 340$).

	Thiamine	Riboflavin	Niacin	Pantothenic acid	Pyridoxine	Biotin	Folate
Thiamine	1						
Riboflavin	0.7	1					
Niacin	0.59	0.39	1				
Pantothenic acid	0.76	0.63	0.75	1			
Pyridoxine	0.70	0.55	0.76	0.85	1		
Biotin	0.53	0.55	0.26	0.68	0.55	1	
Folates	0.72	0.58	0.19	0.60	0.59	0.59	1
Vitamin B12[a]	–0.13	0.02	0.01	0.03	0.03	0.1	–0.01

[a]$N = 136$.

reproductive age, and pregnant women, regardless of anaemia. In the present study, the mean (SD) number of iron-folic acid tablets consumed by a mother during the last-child antenatal period was 110.6 ± 46.5. The Median (IQR) number of iron-folic acid tablets consumed by the mother during the last-child antenatal period was 120 (80–150). Mothers who consumed 100 iron-folic acid tablets or more when they were pregnant were 69.7%. Similar were the findings according to NFHS 5 In Andhra Pradesh Mothers who consumed iron-folic acid for 100 days or more when they were pregnant were 70.3%.[14] As per data from the Health Management Information System, the Maternal IFA Supplementation Score Card which provide information on IFA coverage throughout pregnancy and breastfeeding from Andhra Pradesh 95% pregnant women had been provided 180 Iron Folic Acid (IFA) tablets.[15,16] Our results were similar to a study that documented that 90% of the women received iron and folic acid (IFA) tablets during pregnancy. However, only about 69% received more than 90 tablets.[17] Similarly a cross-sectional facility-based study conducted in Ballabgarh, Haryana in 2020 among a total of 484 pregnant women mentioned 77.1% were compliant with the IFA tablet supplement.[18] Another cross-sectional study from Haryana documented compliance among pregnant women, regarding iron supplementation was 80.47%.[19] A cross-sectional study of 239 from Gujrat revealed the overall compliance of 61.7% for IFA supplementation.[20]

Customised community-based counselling and skill development programmes can effectively tackle issues related to vitamin B deficiency, especially when combined with timely consumption of IFA supplements. Achieving the desired impact in service provider training and implementing successful behaviour change approaches are essential components of addressing these problems. More worrisome is IFA supplements provides only folic acid and remaining spectrum of Vitamin B group supplements and dietary intake both are lacking leading to unknown burden of morbidities among lactating mothers.

To enhance vitamin B12 intake among women, a multifaceted strategy can be recommended. Dietary counselling sessions can be implemented to educate women about the significance of B12 and highlight rich sources found in Animal Source Foods (ASF), such as lean meats, fish, eggs, and dairy products. Complementary to this, income generation programmes can empower women economically, enabling them to afford and access a diverse range of ASF. Community workshops can be conducted to raise awareness about the nutritional benefits of ASF, with the involvement of community leaders and influencers promoting the incorporation of these foods into daily meals. By combining these approaches, a holistic and sustainable initiative can be established to increase B12 intake in women, addressing economic, educational, and nutritional aspects simultaneously.

Strengths and limitations

In the current study, urban-rural bias had been taken care of by selecting equal number of participants from both urban and rural areas. Equal number of participants (34) had been selected from 10 different clusters of tribal population because of which the cluster differences would have been taken care of. In our study we used DietCal software, a professional dietary assessment tool which uses Indian Food Composition Tables (IFCT 2017) for calculating intake of various nutrients.

In the current study intake of the vitamins only through food is taken into consideration. Intake through supplements from pills, etc., is not taken into consideration while calculating the intake of respective vitamins. Dietary intake was captured using 24-h dietary recall method. Though in the current study, it was taken on three separate occasions, there might be a chance of improper representation of the long-term dietary habits of the patient. Only oral intake of the B-group vitamins were studied. If the study is coupled with serum levels of the vitamins in mother that would have made the study more rigorous. In the current study, Probability Proportional to Size sampling would have been the better sampling design to select the clusters but because of the operational reasons, five clusters each were randomly selected from rural and urban areas. Clustered analysis of the data couldn't be performed. Vitamin B12 levels were

reported for only 136 participants by the software used, where as for other micronutrients levels were reported for most of the participants. These can be considered as a limitation for the study.

Conclusion

Our study showed that dietary intake of the tribal lactating mothers is poor in all the B group vitamins. The current diet pattern of mothers might affect the growth and development of the infant. There is scope for further research to assess the effect of external B group vitamin supplementation in the form of tablets or fortification of food items with B group vitamins on the child outcomes in different types of Indian settings. As the source of B group vitamins are mainly plants and animal sources, promoting their availability through various social welfare programmes currently running in the country can be explored.

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Author contributions

All authors made a significant contribution to the work reported, in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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