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An Investigation into the Relationship between Children's Feeding Habits and Their Nutritional Status (6–23 Months) In Rajasthan

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Abstract

Malnutrition remains a critical public health issue in this region, with improper feeding practices contributing significantly to the problem. The study's broad objectives were to identify gaps in nutrient intake among children aged 6-23 months in three districts of Rajasthan, India, to describe the feeding practices adopted by these children's mothers, and to determine the variables significantly associated with insufficient nutrient intake. Based on the prevalence, a sample size of 720 from each of the studied districts, for a total of 2160, was selected using population-proportionate to sample (PPS) methods.

Insufficient food energy intake and a rising prevalence were detected in children aged 12 months and older. Male children were more likely than female children to experience energy shortages. Calcium deficiency is most prevalent in children aged 18-20 months. Regarding iron, there was a significant prevalence of insufficiency in all children compared with the RDA recommendations. Children who were breastfed after a gap of more than 6 hours were at 4.5 times higher risk of inadequate nutrition. Overall, the study indicated a substantial connection between children's immunization status, mothers' socioeconomic position, breastfeeding practices, household sanitation, and personal hygiene practices, and the child's insufficient nutrient intake.

To improve proper feeding practices, health education for mothers on breastfeeding and complementary feeding practices needs to be strengthened, and simple, understandable nutritional messages delivered through behavioural change communication by public health staff and health care providers to the community. MNP should not replace the feeding recommendations but should be promoted alongside these Food-Based Dietary Recommendations (FBDRs) and breastfeeding on demand during the first two years of a child's life. The implementation of the Integrated Child Development Scheme (ICDS), Poshan Abhiyan, and other programs to address malnutrition should be expedited.

Keywords: Child nutrition, feeding practices, recommended dietary allowance, food-based dietary recommendations.

Introduction

India is home to an estimated 200 million malnourished people, suggesting widespread food insecurity (McKay, F. H., Sims, A., & van der Pligt, P., 2023). Multiple forms of childhood malnutrition-chronic hunger, undernutrition, micronutrient malnutrition, and overweight/obesity-affect millions of Indian children. Globally in 2022, 149 million children under 5 were estimated to be stunted (too short for age), 45 million were estimated to be wasted (too thin for height), and 37 million were overweight or living with obesity. Nearly half of the deaths among children under 5 years of age are linked to undernutrition. (Carolin, A., Balakrishnan, S., & Senthil, R.,2022). These mostly occur in low-and middle-income countries. The developmental, economic, social, and medical impacts of the global burden of malnutrition are profound and lasting, affecting individuals, families, communities, and countries.

One of the significant causes of malnutrition is economic inequality; their diet often lacks both quality and quantity. Women who are malnourished are less likely to have healthy babies. Nutrition deficiencies inflict long-term damage to both individuals and society. Compared with their better-fed peers, nutrition-deficient individuals are more likely to have infectious diseases such as pneumonia and tuberculosis, which lead to a higher mortality rate.

Nutrient deficiencies in vitamin A, iron, iodine, and zinc are widespread among children in India and other developing countries. A 2021 meta-analysis of studies from various age groups found that the most prevalent micronutrient deficiencies in India were vitamin D deficiency (VDD) at 61%, iron deficiency at 54%, vitamin B12 deficiency at 53%, and iodine deficiency disorder (IDD) at 17%. Children under 5 years old have higher rates of anemia (32–63%), VAD (15–35%), and zinc deficiency (35–63%) (Harika R, Faber M, Samuel F, Mulugeta A, Kimiywe J, Eilander A, 2017).

Enriquez, J., & Archila-Godinez, J. (2021) stated that socio-cultural factors, such as cultural capital, social stratification, and inequality, can trigger consumers' FC. Factors such as foodscapes, social environments, tastes, and even nutritional information have led consumers to choose a product under pressure or make uninformed choices that are generally unhealthy. Restricting food accessibility triggers a reactive, unaware response, so it is necessary to build a sustainable food culture, with consumers as the first step toward self-awareness of their current FC.

Objectives of the Study

The broad objectives of the study were to identify gaps in nutrient intake among children aged 6-23 months in three districts of Rajasthan, to describe the feeding practices adopted by the mothers of these children, and to determine the variables significantly associated with insufficient nutrient intake.

Material and Methods

The study was conducted after selecting three districts from three different agro-climatic zones. A random sampling procedure was used to select zones and districts.

Study Design and Participant Selection

The study focuses on the dietary patterns of children aged 6-23 months. Initially, multiple-stage sampling methods were adopted. The children were subdivided into the age groups 6-11 and 12-23 months within the selected areas of four rural blocks/urban slums in each district, based on systematic random sampling. For each selected block, ten villages/urban slums (PSU) have been selected. Further, from each PSU, 6 children aged 6-11 months and 12 children aged 12-23 months have been selected through systematic random sampling from the lists available to ASHA/ Anganwadi workers in the respective PSU. Hence, in every district, a random sample of 720 respondents, comprising 2 groups of infant mothers, has been interviewed using a 24-hour recall. A similar approach has been replicated in the second and third districts. Henceforth, the total sample size for the study was 2160 for all three selected districts. To determine the sample size, the single population proportion formula was used. The sample size of the study was determined based on a 95% confidence interval, a 5% margin of error, and a 27.6% prevalence of nutritional status among children in Rajasthan from NFHS-5. Based on the prevalence, sample size calculation has been done, and an estimated 716=720 (Say) has been considered for the present study from each studied district. The participants were selected using multi-stage sampling methods, including random and population-proportional-to-sample (PPS) sampling.

Respondents Profile

Religion and Caste Profile

The religious composition of the respondents is given in Table 1. The majority of households (92 per cent) in the sampled population were followers of Hinduism, whereas 6 per cent were followers of the Muslim religion, and the remaining 2 per cent were from other religions. Regarding religious belief, the study suggests that among the interviewed households, a majority (95 per cent) were Hindus in the third district, followed by the 2nd and 1st districts, respectively. The Muslim population was found to be the highest (10 per cent) in the second Udaipur district and the lowest (less than 4 per cent) in the third district. The average household size in the 3 districts was 5.3. The average family size was found to be lowest (5.1) in the second Udaipur district and highest (5.5) in the third ~~Baran~~ District. The study's information on caste/tribe shows that more than two-fifths (68 per cent) of households were from other backward castes. Further, the analysis suggests that around 11 per cent of households belonged to the general category, 16 per cent to the scheduled caste group, and the remaining one-third (28 per cent) to the scheduled tribe group (Table 1).

Table 1: Respondents' Religion and Caste Profile

District		Religion			Caste				
		Hindu	Muslim	Other	SC	ST	OBC	Gen	Total Population
Ist Bhilwara (n=720)	Count	633	70	17	136	53	430	102	3749
	%	87.8	9.7	2.5	18.9	7.4	59.6	14.1	

2nd Udaipur (n=720	Count	676	32	12	82	382	177	78	3674
	%	94	4.5	1.5	11.4	53.1	24.6	10.8	
3rd Baran (n=720	Count	684	28	8	132	159	375	55	3975
	%	94.9	3.9	1.2	18.3	22.1	52	7.6	
Rajasthan (N=2160)	Count	1993	130	37	350	594	195	40	11398
	%	92.2	6.0	1.8	16.2	27.5	45.4	10.9	

Family Structure

More than half (52 percent) of the families were nuclear families, 45 percent were joint families, and the remaining 3 percent were extended nuclear families. The nuclear family was found at its highest (64%) in the second district and at its lowest (43%) in the third District. Further, it emerged from the analysis that the number of nuclear families was higher in the Hindu community than in their Muslim counterparts (Table 1).

In the family type category, the extended joint family (OR=1.996, CI=1.066-3.739) was statistically significant for insufficient intake of food energy. It was also observed that the kind of area and gender were correlated with insufficient protein intake in children. Children living in urban areas had a 1.514 times higher risk of inadequate protein intake than those living in rural areas, and, by gender, females had a 1.20 times higher risk of protein insufficiency than males.

Findings and Discussion

Using SPSS statistical software (version 21), firstly, average intakes of thirteen nutrients, namely food energy, protein, fat, calcium, iron, zinc, vitamin C, thiamin, riboflavin, vitamin B6, folate, vitamin B12, and vitamin A RAE were computed, and compared with corresponding RDAs recommended by ICMR (2020 guidelines). Descriptive analysis included proportions (age, gender, ethnicity, and district-wise), mean values, and standard deviations for each nutrient.

A one-way analysis of variance (ANOVA) was performed to assess group-wise variation in nutrient intake. Fisher's least significant difference post hoc test was used for the multi-group comparison in the ANOVA test, and the significance level was set at 0.05.

To identify the variables significantly associated with insufficient nutrient intake across the three study districts, a statistical analysis was conducted. A total of 34 independent variables were considered, for which information was collected via the questionnaire during household visits, and were selected to measure the association with the 13 outcomes (dependent variables). For each of the independent variables, using descriptive statistics, frequencies and proportions were determined and presented in tables. Thereafter, multivariable binary logistic regression analysis was performed, and a backward stepwise elimination method was used to identify the determinants of insufficient nutrient intake. The results were presented by Odds Ratios (ORs) with 95% Confidence Interval (CI). The statistical association was declared significant if the p-value was less than 0.05.

The prevalence of insufficient dietary intake of all 13 nutrients assessed in this study exceeded 60% in all study districts. Of the thirteen nutrients assessed, seven (Food energy, Calcium, Iron, Zinc, Thiamin, Riboflavin, and Vitamin B6) had insufficient intake prevalence greater than 70% and were identified as problem nutrients. Table 2 below presents the combined and gender-specific prevalence of inadequate dietary intake of the assessed nutrients. Detailed tables of the prevalence of insufficient intake of all the nutrients (combined, gender, and age category-wise prevalence).

Table 2: Summary of Insufficient Nutrient Intakes (total and gender-wise percentage prevalence, problem nutrient highlighted)

S. No.	Nutrient	Category	District			Rajasthan
			ist District	2nd District	3rd District	

1.	Food Energy	Total	71.9%	72.2%	74.0%	72.7%
		Females	65.3%	72.8%	70.3%	69.5%
		Males	77.7%	71.7%	77.5%	75.7%
2.	Protein	Total	48.6%	60.8%	59.4%	56.3%
		Females	41.6%	62.1%	57.4%	54.0%
		Males	54.7%	59.5%	61.3%	58.4%
3.	Fat	Total	36.5%	41.3%	34.3%	37.4%
		Females	33.2%	43.3%	32.1%	36.4%
		Males	39.4%	39.1%	36.3%	38.3%
4.	Calcium	Total	89.9%	94.7%	95.6%	93.4%
		Females	89.8%	94.3%	94.5%	92.9%
		Males	89.9%	95.2%	96.6%	93.8%
5.	Iron	Total	100.0%	99.7%	99.9%	99.9%
		Females	100.0%	99.7%	100%	99.9%
		Males	100.0%	99.7%	99.7%	99.8%
6.	Zinc	Total	100.0%	99.8%	99.4%	99.7%
		Females	100.0%	100.0%	99.1%	99.7%
		Males	100.0%	99.5%	99.6%	99.7%
7.	Ascorbic Acid	Total	66.8%	65.3%	66.3%	66.1%
		Females	61.7%	66.5%	65%	64.5%
		Males	71.2%	64.0%	67.4%	67.7%
8.	Thiamin	Total	97.4%	98.9%	98.6%	98.3%
		Females	97.6%	98.9%	98.3%	98.3%
		Males	97.2%	98.9%	98.9%	98.3%
9.	Riboflavin	Total	76.3%	80.1%	82.9%	79.8%
		Females	73.4%	83.1%	82.8%	79.9%
		Males	78.8%	77.1%	83.0%	79.7%
10.	Vitamin B6	Total	94.2%	98.9%	97.1%	96.7%

		Females	93.7%	98.9%	96.8%	96.6%
		Males	94.6%	98.9%	97.3%	96.9%
11.	Folate	Total	63.5%	63.8%	63.3%	63.5%
		Females	58.7%	65.9%	61.8%	62.3%
		Males	67.6%	61.5%	64.7%	64.7%
12.	RAE	Total	71.9%		Total	71.9%
		Females	67.1%	68.7%	67.3%	67.7%
		Males	76.2%	65.7%	72.7%	71.7%
13.	Vitamin B12	Total	64.9%	66.4%	66.5%	65.9%
		Females	59.3%	67.3%	65.9%	64.3%
		Males	69.7%	65.4%	67.1%	67.5%

In the first district, 71.9% of children had insufficient energy intake, and the prevalence increased among children aged 12 months and above. The prevalence of energy insufficiency was higher among males (77.7%) than among females (65.3%). The prevalence of Calcium insufficiency was 89.9%, with the highest prevalence (98.1%) in children aged 18-20 months. In terms of Iron, a noticeable prevalence of 100% insufficiency was presented, indicating that all the children (n=720) consumed iron well below the RDA. Similarly, all children aged 12 months and above had insufficient Zinc intake, with 100% prevalence. The overall prevalence of Thiamin insufficiency was reported as 97.4%, with similar prevalence across all age categories. Prevalence of Riboflavin insufficiency was 76.3%, with the highest prevalence (96.2%) in the age group of 18-20 months. For Vitamin B6, the overall prevalence was 94.2%, with similar prevalence across all age groups and both genders.

In the second district, the prevalence of food energy insufficiency was 72.2%, with similar gender-wise prevalence, and the highest prevalence (99.1%) was observed in children aged 18-20 months. The prevalence of Calcium insufficiency in the second Udaipur district was 94.7%, with a similar prevalence across all age groups and genders. In the case of Iron and Zinc insufficiency, with a high prevalence in the first Bhilwara district, the prevalence in the second Udaipur district was 99.7% and 99.8% for the two micronutrients, respectively. The overall prevalence of Thiamin insufficiency was reported at 98.9%, with prevalences varying by age and gender. Regarding Riboflavin insufficiency, the second Udaipur district had a prevalence of 80.1%, with a higher prevalence in children aged 12 months or older. Gender-wise, prevalence was higher in females (83.1%) than in males (77.1%). The overall prevalence of Vitamin B6 was 98.9%, with similar prevalence across all age groups and both genders.

In the third Baran district, the overall prevalence of insufficient food energy intake was 74%, with a higher prevalence in males (77.5%) than in females (70.1%). The prevalence of Calcium insufficiency was reported as 95.6%, with similar prevalence across all age groups and both genders. Identical to the second and third Bhilwara and Udaipur districts, the prevalence of Iron and Zinc insufficiency in Baran was again high at 99.9% and 99.4%, respectively. The overall prevalence of Thiamin was reported at 98.6%, with a similar approximate prevalence across all age groups and genders. The prevalence of Riboflavin insufficiency was 82.9%, with a higher prevalence in children aged 12 months or older.

Considering all three districts together (n=2160), the highest levels of insufficient dietary intake were observed for Iron (99.9%) and Zinc (99.7%), followed by Thiamin (98.3%), Vitamin B6 (96.7%), and Calcium (93.4%). The average daily intake of net food energy for all children (n=2160) was 643.95 +/- 269.34 Kcal, which was 72.36% of the estimated RDA (Table 3). However, significantly very low average daily intakes of Iron (1.41+/- 0.91 mg), Vitamin B6 (0.25 +/- 0.13 mg), and Zinc (2.00 +/- 0.76 mg) were presented, with their respective mean intake values being as low as 18.63%, 34.72% and 40.0% of the estimated RDA levels for each. Similarly, the average daily intakes of Calcium, Thiamin, and Vitamin B12 were well below 60% of their respective RDA estimated levels. On average, only the daily intakes of Protein (15.35 +/- 7.57 g) and Fat (33.71 +/- 17.53 g) met their respective estimated RDA levels. Table 3 presents district-wise averages for daily nutrient intake.

Table 3: Average dietary intake per day of nutrients for the total children population (n=2160)

Nutrient	Average Nutrient Intake (Mean +/- Standard Deviation)		Estimated Mean RDA	Intake as Percentage of RDA
	Mean	SD		
Food Energy	643.95	269.34	889.88	72.36
Protein	15.35	7.57	15.14	101.39
Fat	33.71	17.53	24.14	139.64
Calcium	280.44	153.75	564.26	49.70
Iron	1.41	0.91	7.57	18.63
Zinc	2.00	0.76	5.00	40.00
Vitamin C	32.61	20.76	34.64	94.14
Thiamin	0.21	0.09	0.43	48.84
Riboflavin	0.34	0.16	0.53	64.15
VitaminB6	0.25	0.13	0.72	34.72
Folate	46.88	21.06	60.34	77.69
VitaminB12	0.3897	0.22	0.71	54.89
Vitamin A RAE	356.83	267.07	382.12	93.38

The age-wise multi-comparison ANOVA test results of nutrient intakes revealed that the average food energy intake decreased significantly (p<0.005) as the age of the child progressed from 6-8 months to 9-11 months (Mean Difference C1-C2 = 80.63 Kcal/ day), followed by progression to age group of 12-14 months (MD C2-C3= 144.51 Kcal/day). However, no significant difference (p>0.05) in mean food energy intake was observed among those aged 14 months or older. Similarly, fat intake decreased significantly (p<0.005) as the age progressed from 6-8 months to 9-11 months (MD C1-C2 = 6.40 g/ day), followed by progression to the age group of 12-14 months (MD C2-C3 10.90 g/day), beyond which no significant decrease in fat intake was noted. Notably, the same pattern of variation in intakes was also observed for intakes of calcium, iron, zinc, vitamin C, riboflavin, folate, vitamin B12, and vitamin A RAE, where the significant decrement in their intake was observed as the age progressed from 6- 8 months to 12- 14 months, beyond which there was no significant decrease in their respective intakes. However, no significant differences in the mean intakes of dietary protein, vitamin B12, and thiamin were observed across age groups.

Table 4: District-wise average dietary intake of nutrients per day

Nutrient	Average Nutrient Intake (Mean +/- Standard Deviation)							
	Ist District		~~2nd~~-District		3rd District		Rajasthan	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD

Food Energy	671.86	264.93	616.85	261.47	643.17	278.87	643.95	269.34
Protein	17.29	9.87	13.94	5.67	14.83	6.05	15.35	7.57
Fat	34.76	17.13	32.87	17.32	33.52	18.12	33.71	17.53
Calcium	309.88	170.85	264.96	139.61	266.50	144.95	280.44	153.75
Iron	1.55	0.90	1.28	0.87	1.42	0.96	1.41	0.91
Zinc	2.10	0.78	1.91	0.72	2.01	0.79	2.00	0.76
Vitamin C	32.41	20.02	32.58	20.78	32.85	21.48	32.61	20.76
Thiamin	0.23	0.09	0.20	0.09	0.22	0.09	0.21	0.09
Riboflavin	0.38	0.17	0.32	0.15	0.33	0.15	0.34	0.16
VitaminB6	0.29	0.15	0.23	0.11	0.24	0.13	0.25	0.13
Folate	49.34	20.36	44.99	20.90	46.31	21.71	46.88	21.06
VitaminB12	0.42	0.24	0.38	0.21	0.38	0.22	0.3897	0.22
Vitamin A RAE	338.43	262.50	367.53	264.28	364.55	273.73	356.83	267.07

The study by Payne, Anne, and Belton, Neville. (2008), nutrient intake and growth in preschool children's data were grouped by age and gender. The study found that despite low group means for energy intake at 80–85% of the current Estimated Average Requirement, the children were apparently growing normally. Considerable variation in diet composition was observed. A highly significant negative correlation was found between the % energy from fat and the % energy from sugars, and a significant positive correlation between total energy intake and fiber intake. However, as no relationship was found between energy intake and % energy from fat, sugars, or starch, the diet's composition did not appear to influence total energy intake.

Table 5: Age-wise nutrient intake of all children (n=2160)

Nutrient	**Age Category**	**Average Nutrient Intake (Mean +/- Standard Deviation)**		**Mean Difference (MD) between age categories [*significant values with p<0.05]**		**p-value**
		Mean	**SD**			
Food Energy	C1	837.11	320.86	MD C1- C2	80.63*	.000
	C2	756.48	308.27	MD C2-C3	144.51*	.000
	C3	611.96	245.20	MD C3-C4	47.91*	.009
	C4	564.05	225.38	MD C4-C5	-2.69	.889
	C5	566.73	192.32	MD C5-C6	-11.69	.528
	C6	578.42	203.62	MD C6-C1	258.68964*	.000

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Protein	C1	15.66	5.97	MD C1- C2	.41798	.491
	C2	15.24	6.06	MD C2-C3	.23726	.659
	C3	15.00	8.12	MD C3-C4	.15389	.780
	C4	14.85	8.53	MD C4-C5	-.36685	.528
	C5	15.21	6.95	MD C5-C6	-.92459	.098
	C6	16.14	8.66	MD C6-C1	.48231	.420
Fat	C1	48.96	21.31	MD C1- C2	6.40103*	.000
	C2	42.56	19.66	MD C2-C3	10.90092*	.000
	C3	31.65	15.30	MD C3-C4	3.62675*	.002
	C4	28.03	13.96	MD C4-C5	.39666	.742
	C5	27.63	11.48	MD C5-C6	-.00545	.996
	C6	27.64	11.65	MD C6-C1	-21.31991*	.000
Calcium	C1	389.14	171.30	MD C1- C2	48.30458*	.000
	C2	340.84	166.36	MD C2-C3	75.07309*	.000
	C3	265.77	133.76	MD C3-C4	28.23917*	.007
	C4	237.53	131.34	MD C4-C5	1.75888	.873
	C5	235.77	126.01	MD C5-C6	-6.65972	.530
	C6	242.43	134.40	MD C6-C1	146.71600*	.000
Iron	C1	0.97	0.72	MD C1- C2	-.19868*	.005
	C2	1.17	0.88	MD C2-C3	-.24853*	.000
	C3	1.41	0.90	MD C3-C4	-.06859	.287
	C4	1.48	0.87	MD C4-C5	-.15546*	.022
	C5	1.64	0.98	MD C5-C6	-.05068	.437
	C6	1.69	0.90	MD C6-C1	.72194*	.000
Zinc	C1	2.29	0.78	MD C1- C2	.11708	.052
	C2	2.17	0.84	MD C2-C3	.22623*	.000
	C3	1.95	0.76	MD C3-C4	.09620	.080
	C4	1.85	0.72	MD C4-C5	-.06870	.235

	C5	1.92	0.72	MD C5-C6	-.02642	.635
	C6	1.94	0.70	MD C6-C1	-.34439*	.000
Vitamin C	C1	51.99	25.70	MD C1- C2	8.14038*	.000
	C2	43.85	23.06	MD C2-C3	13.62623*	.000
	C3	30.22	17.70	MD C3-C4	4.14744*	.002
	C4	26.07	16.00	MD C4-C5	1.41613	.312
	C5	24.66	12.87	MD C5-C6	.39514	.769
	C6	24.26	12.59	MD C6-C1	-27.72532*	.000
Thiamin	C1	0.22	0.08	MD C1- C2	-.00095	.896
	C2	0.22	0.09	MD C2-C3	.00500	.438
	C3	0.21	0.09	MD C3-C4	.00369	.578
	C4	0.21	0.09	MD C4-C5	-.01294	.064
	C5	0.22	0.10	MD C5-C6	-.00431	.520
	C6	0.23	0.09	MD C6-C1	.00950	.185
Riboflavin	C1	0.45	0.18	MD C1- C2	.04497*	.000
	C2	0.40	0.17	MD C2-C3	.07508*	.000
	C3	0.33	0.15	MD C3-C4	.02577*	.020
	C4	0.30	0.14	MD C4-C5	.00124	.915
	C5	0.30	0.13	MD C5-C6	-.01090	.331
	C6	0.31	0.14	MD C6-C1	-.13618*	.000
VitaminB6	C1	0.22	0.11	MD C1- C2	-.01669	.111
	C2	0.23	0.12	MD C2-C3	-.00824	.374
	C3	0.24	0.12	MD C3-C4	-.01287	.177
	C4	0.25	0.13	MD C4-C5	-.01735	.084
	C5	0.27	0.14	MD C5-C6	-.01699	.078
	C6	0.29	0.15	MD C6-C1	.07214*	.000
Folate	C1	59.88	22.87	MD C1- C2	5.50618*	.001
	C2	54.38	23.84	MD C2-C3	9.86075*	.000

	C3	44.52	19.66	MD C3-C4	3.20532*	.028
	C4	41.31	18.98	MD C4-C5	-1.13230	.461
	C5	42.44	17.69	MD C5-C6	0.11852	.936
	C6	42.32	16.92	MD C6-C1	-17.55846*	.000
VitaminB12	C1	0.58	0.26	MD C1- C2	.08184*	.000
	C2	0.49	0.25	MD C2-C3	.12743*	.000
	C3	0.37	0.19	MD C3-C4	.04778*	.001
	C4	0.32	0.18	MD C4-C5	.00681	.665
	C5	0.31	0.17	MD C5-C6	-.00511	.735
	C6	0.32	0.17	MD C6-C1	-.25875*	.000
Vitamin A RAE	C1	612.90	327.61	MD C1- C2	106.56580*	.000
	C2	506.34	291.44	MD C2-C3	174.37944*	.000
	C3	331.96	224.47	MD C3-C4	61.98436*	.000
	C4	269.97	203.35	MD C4-C5	18.95312	.287
	C5	251.02	167.10	MD C5-C6	10.83979	.526
	C6	240.18	161.11	MD C6-C1	372.72250*	.000

The most notable finding was an association between the child's immunization status (partial, ongoing, or none) and nutrient insufficiency. The statistical analysis revealed that children who were partially (OR=3.017, CI=1.669-5.453), continuing (OR=5.280, CI=4-124-6.760), or not fully immunized (OR=2.969, CI=1.125-7.832) had a statistically significant association with insufficient food energy intake compared with fully vaccinated children. Similarly, partially immunized children (OR=8.954, CI=3.714-21.590), continuing immunization (OR=6.005, CI=3.644-9.895), and not all immunized (OR=8.265, CI=2.078-32.875) were significantly associated with insufficient Calcium intake. It was also recognized that, compared with children with complete immunization, those with partial immunization, continuing immunization, or no immunization had a higher risk of insufficient Vitamin C, Riboflavin, Folate, and Vitamin A RAE. In contrast, children who were still receiving vaccinations had a higher risk of inadequate intake of Protein, Fat, and Vitamin B12.

Shinsugi, Chisa & Mizumoto, Ann. (2021) also examined the associations between nutrition status with complete immunization coverage, and water, sanitation, and hygiene status among children aged 0-23 months in the 2015–2016 Thailand Multiple Indicator Cluster Survey (n= 9060). When adjusted for confounding factors, it was found that children with incomplete immunization status were more likely to be stunted (adjusted odds ratio (aOR) 1.47; 95% confidence interval (CI): 1.24–1.75, $p < 0.001$), wasted (aOR 1.67, 95% CI: 1.31–2.12, $p < 0.001$), and overweight (aOR 1.24, 95% CI: 1.01–1.51, $p < 0.05$), whereas children used unimproved water sources were more likely to be overweight (aOR 2.43, 95% CI: 1.27–4.64, $p < 0.01$).

The study also observed that mothers with no knowledge of nutrition had a significant association with insufficient nutrient intake. Children of mothers with no understanding of nutrition had a 1.263 times higher risk of inadequate food energy intake than children of mothers with knowledge of nutrition. Similarly, children of mothers with no understanding of nutrition were at 1.237 times higher risk of insufficient fat intake. Mother's knowledge of nutrition (OR=1.440, CI =1.419-1.805) was also statistically significant in children with inadequate Vitamin C intake. Furthermore, mothers' lack of knowledge of nutrition was significantly correlated with lower intake of folate and Vitamin A RAE than among mothers who were knowledgeable about nutrition. Parental education also impacted diet and nutrition. This finding from the present study is also similar to that of a study that found that children whose parents had higher educational levels had higher energy and protein adequacy (Chitra & Reddy, 2007; Mathad et al., 2011; Sultan, 2014). Seasonality was observed to be an important influencing variable affecting diet adequacy in a study in rural Karnataka: The findings revealed that while dietary intake of all the nutrients was inadequate among children regardless of the season, the extent of inadequacy varied between the seasons; the average adequacy of calorie and protein was higher in monsoon and winter seasons, because of greater consumption of groundnut harvested in these seasons (A, Jyothi lakshmi & Begum; Khyrunnisa et al., 2005). Although this is the lone study, it highlights the importance of the types of food available for dietary patterns.

The present study showed a significant association between mothers' working status and children's insufficient nutrient intake. Children of non-working mothers were at higher risk of inadequate Vitamin C, Riboflavin, Folate, Vitamin B12, and Vitamin A RAE compared to children of working mothers. Children of uneducated mothers (OR=2.409, CI=1.31-4.424) were at higher risk of Vitamin A RAE insufficiency compared to children of educated mothers. The same has been found in the study by Crepinsek, M. K., and Burstein, N. R. (2004), which also shows that nutritional differences between children of part-time working mothers and children of nonworking mothers were more sensitive to maternal and family characteristics, with no clear pattern of nutritional differences emerging. This study analyzed differences in nutrition outcomes among children whose mothers work full time, part time, or not at all, and the role of the Child and Adult Care Food Program (CACFP) in meeting the nutrition needs of participating children, especially those whose mothers work.

The study also revealed another noteworthy factor associated with insufficient nutrient intake: WASH practices (Water, Sanitation, and Hygiene). Hand washing practices were significantly associated with inadequate intake of Food Energy, Protein, Calcium, Vitamin C, Thiamin, Riboflavin, Vitamin B6, Folate, and Vitamin A RAE. Children of mothers who did not wash their hands before cooking and handling food had 1.464, 1.235, and 1.648 times the risk of insufficient Food Energy, Protein, and Calcium intake, respectively, compared to the children of mothers who washed their hands before cooking and handling food. Not washing hands before cooking and handling food was also statistically significant, along with insufficient intake of Vitamin C, Folate, and Vitamin A RAE in children. Also, not washing hands before feeding the child was significantly associated with inadequate intake of food energy, Vitamin C, Riboflavin, Folate, and Vitamin A RAE in children.

In assessing household sanitation practices and nutrient intake in children, the present study revealed a significant association between the method of stool disposal and insufficient intake of Vitamin C, Riboflavin, Folate, and Vitamin A RAE. Those adopting methods of stool disposal, such as putting stool in ditches/drains and throwing it in garbage, were at higher risk of insufficient intake of Vitamin C, Riboflavin, Folate, and Vitamin A RAE compared to those using a toilet/latrine. Likewise, children using shared toilet facilities were at higher risk of insufficient intake of Vitamin C, Folate, and Vitamin B12 than those with their own toilet/latrine. In contrast, no toilet facility was significantly associated with inadequate Vitamin A RAE intake.

Conclusion and Recommendations

Nutritional status of the selected children of 6-23 months of age

1. In children aged 12 months and above, insufficient food energy intake and increasing prevalence were observed. The prevalence of energy insufficiency was higher among male children than among female children. Prevalence of Calcium insufficiency, with the highest prevalence in children aged between 18 and 20 months. Regarding Iron, a noticeable prevalence of insufficiency was observed, indicating that all the children consumed iron well below the RDA.
2. Similarly, all the children aged 12 months and above were presented with insufficient Zinc intake, with 100% prevalence. The overall prevalence of Thiamin insufficiency was similar across all age categories.
3. Prevalence of Riboflavin insufficiency was observed with the highest prevalence in the age group of 18-20 months. For Vitamin B6, the overall prevalence, along with approximate prevalence by age and gender, is provided.
4. The age-wise multi-comparison ANOVA test results of nutrient intakes revealed that the average food energy intake decreased significantly ($p<0.005$) as the age of the child progressed from 6-8 months to 9-11 months (Mean Difference C1-C2 = 80.63 Kcal/ day), followed by progression to age group of 12-14 months (MD C2-C3= 144.51 Kcal/day). However, no significant difference ($p>0.05$) in mean food energy intake was observed among those aged 14 months or older. Similarly, fat intake decreased significantly ($p<0.005$) as the age progressed from 6-8 months to 9-11 months (MD C1-C2 = 6.40 g/

day), followed by progression to the age group of 12-14 months (MD C2-C3 10.90 g/day), beyond which no significant decrease in fat intake was noted.

5. Notably, the same pattern of variation in intakes was also observed for intakes of calcium, iron, zinc, vitamin C, riboflavin, folate, vitamin B12, and vitamin A RAE, where the significant decrement in their intake was observed as the age progressed from 6- 8 months to 12- 14 months, beyond which there was no significant decrease in their respective intakes. However, no significant differences in the mean intakes of dietary protein, vitamin B12, and thiamin were observed across age groups.
6. The prevalence of insufficient dietary intake of all thirteen nutrients assessed in this study was found to be greater than in all the study districts. Of the thirteen nutrients assessed, seven (Food energy, Calcium, Iron, Zinc, Thiamin, Riboflavin, and Vitamin B6) had insufficient intake prevalence and were identified as problem nutrients.
7. Children with complete immunization had a higher risk of insufficient Vitamin C, Riboflavin, Folate, and Vitamin A RAE. In contrast, children who were still receiving vaccinations had a higher risk of inadequate intake of Protein, Fat, and Vitamin B12.
8. Children of mothers with no knowledge of nutrition were at 1.263 times higher risk of insufficient food energy intake compared to the children with mothers who knew about nutrition. Similarly, children of mothers with no understanding of nutrition were at 1.237 times higher risk of insufficient fat intake. Mother's knowledge of nutrition (OR=1.440, CI =1.419-1.805) was also statistically significant in children with inadequate Vitamin C intake. Mother's lack of knowledge of nutrition was also significantly associated with lower intake of folate and Vitamin A RAE than among mothers who were knowledgeable about nutrition.
9. Children who were breast-fed after a gap of more than 6 hours were at 4.5 times higher risk of insufficient Calcium intake compared to those who were fed on demand. Likewise, children who were breast-fed after a gap of more than 6 hours (OR=2.042, CI =1.282 -3.252) showed a statistically significant association with insufficient Riboflavin intake. Factors such as exclusive breastfeeding and the age of initiation of complementary feeding were not associated with inadequate nutrient intake.
10. Factors about WASH practices were also notably found to be associated with insufficient dietary intake of various nutrients assessed. Children of mothers who did not wash their hands before cooking or handling food and before feeding the child, or who followed poor practices of stool disposal, were found to be significantly associated with insufficient intake of several nutrients. Consuming water from untreated sources such as hand pumps, tankers, and wells also posed a higher risk of inadequate intake of several nutrients.
11. Minimum dietary diversity was observed in three-fifths of the children between 6 and 23 months. MMF was observed in about one-half of children aged 6–23 months. Minimum acceptable diet (MAD) indicator (proportion of children aged 6–23 months who receive at least the MDD as well as at least the MMF) was found to be adequate only in one-fourth of the 6-23-month-old children.
12. Family type extended joint family (OR=1.996, CI=1.066- 3.739) was statistically significant with insufficient intake of food energy. The kind of area and gender correlated with inadequate protein intake in children. Children living in urban areas had a 1.514 times higher risk of insufficient protein intake than those living in rural areas, and, by gender, females had a 1.206 times higher risk of protein insufficiency than males.

The study revealed significant associations between the child's immunization status, the mother's socioeconomic status, breastfeeding practices, and household sanitation and personal hygiene (WASH) with the child's insufficient nutrient intake.

Recommendations

1. To improve the proper feeding practices, health education of mothers on breastfeeding and complementary feeding practices needs to be strengthened, and simple, understandable, proper nutritional messages through public health staff and health care providers should be provided to the community. Behavioral change communication might be more useful than the information, education, and communication method, as caregivers' behavior and attitudes affect their feeding practices.
2. The further implementation of simple and cost-effective health promotion activities and practices at the household level may be critical interventions for healthy child growth and development.
3. Successive governments' nutrition programmes over the years, such as the Integrated Child Development Services (ICDS), mid-day meals, Poshan Abhiyaan, Take Home Ration (THR), Pradhan Mantri Matru Vandana Yojana, Anganwadi Services, and Scheme for Adolescent Girls under the umbrella of the Integrated Child Development Services Scheme as direct targeted interventions to

address the problem of malnutrition in the country, including the State of Rajasthan, should be strengthened.

4. ASHA, ANM should be trained enough to create awareness about the proper food habits with required food diversification and to convince the community and at individual houses on the ill effects of restriction of food during pregnancy and lactation.
5. Beyond the age of 6 months, more than 90% of the iron requirements of a breast-fed infant must be met by complementary food rich in bioavailable iron. Dietary diversification must be encouraged. (Kazal LA, 2021)
6. Cooking soups containing vegetables of low pH by simmering (heating for a long time below the boiling point) in cast iron vessels helps in increasing iron intake. This practice should be encouraged. Frying in iron vessels does not usually have a similar effect. (Geerligs PDP, Brabin BJ, Omari AAA, 2003)
7. It is difficult to meet complete iron requirements in young children through diet without fortifying complementary feeds or iron supplements. As a public health measure, food fortification can significantly reduce the prevalence of iron deficiency. Except for wheat flour or rice in some state government distribution systems, iron-fortified foods are uncommon in India. (Samuel, Aregash, Saskia J. M. Osendarp, Elaine Ferguson, Karin Borgonjen, Brenda M. Alvarado, Lynnette M. Neufeld, Abdulaziz Adish, Amha Kebede, and Inge D. Brouwer. 2019.)
8. It is important to emphasize that Multiple Micronutrient Powder (MNP) should not replace the feeding recommendations but should be promoted in addition to these FBDRs together with breastfeeding on demand during the first two years of the child's age. Multiple Micronutrient Powder (MMNP) fortification should be considered in high-risk settings where the above interventions are challenging to implement. Combining fortification and supplementation might exceed the tolerable upper limit (TUL) for iron intake; however, the clinical significance of this is unclear.
   a. In infants >6-month age (Public health measure WHO guidelines 2016), Iron supplementation should be given to children aged 6-24 months in the dose of 10-12 mg /day, three months a year, wherever the prevalence of anemia is >20% [Strong recommendation, moderate quality evidence]. This comes to about 1-2 mg/kg/day, as most of India has anemia prevalence>40%.
   b. National Health Mission (NHM) guidelines recommend bi-weekly 100 doses/year of 20 mg Fe + 100 mcg FA supplementation in children aged 6-24 months as syrup. Iron should be withheld in acute illness (fever, acute diarrhea, pneumonia, etc.), severe acute malnutrition (SAM), and hemoglobinopathy or history of repeated blood transfusion. In malaria-endemic areas, public health measures to manage malaria must be in place. Folic acid should not be used in malaria-endemic areas where antifolate malaria medications are used (WHO, 2018). In infants under <6-month of age (Individual case-based supplementation)
   c. Low birth weight (LBW) babies should be supplemented with iron 2-3 mg/kg/day, beginning from 2 weeks for babies with birthweight <1500 g, and 6-8 weeks for babies with birthweight >1500 g [Shenoi A, Nair SI, Prasad V., 2010], till toddlerhood when diet meets the iron requirements. Babies who received multiple transfusions during neonatal care should be clinically and biochemically assessed for the need for supplementation at 6-8 weeks.
   d. Since large number of term babies (21.4% at 4 months and 36.4% at 5 months) (Krishnaswamy S, Bhattarai D, Bharti B, Bhatia P, Das R, Bansal D, 2017) suffer from iron deficiency, it is recommended that iron supplementation be started at 4 months in exclusively breastfed babies, especially where there is high risk of low iron transfer from mothers suffering from malnutrition, anemia, hypertension (with growth retardation) and diabetes.

Informed Consent Statement: Informed consent was obtained from all the respondents and stakeholders involved in the study. Literate respondents provided written informed consent, while third-party witnesses were present for verbal consent from those who could not read or write.

Conflict of interest: None

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