

Approaches to Intervention Among Children and Adolescents

B. S. Narasinga Rao, Ph.D.

An analysis of current dietary intakes of preschool and school children and adolescents belonging to poor income groups in India indicate that they suffer from deficiencies of several nutrients with associated clinical and functional consequences. The observed deficiencies include energy, calcium, iron, zinc, vitamin A, riboflavin, ascorbic acid, and folate. Some degree of protein deficiency is also present. The best strategy to correct the deficiencies of these nutrients is the food-based approach where nutrient-rich food supplements are formulated with nutrient-rich familiar foods and given to children at the household level. Another strategy for helping mothers and preschool children to achieve the recommended daily intakes is to fortify with micronutrients the supplementary foods currently targeted to them for improving their energy and protein intake. This can be achieved by expanding the current supplementary feeding program to school children and adolescents.

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Introduction

Preschool and school children and adolescents account for nearly 50% of our population and constitute important vulnerable groups from a nutrition point of view. Their nutrition requirements are generally higher than that of adults. Preschool children, school children, and adolescents belonging to the low-income groups in the rural and urban areas of India generally consume ill-balanced diets deficient in several nutrients including protein, energy, and calcium and in several micronutrients, particularly vitamin A, riboflavin, folic acid, iron, zinc, and perhaps in other essential trace elements and B vitamins. Nutrition surveys among these groups have identified clinical and subclinical deficiencies of energy, protein (PEM), vitamin A (Bitot's spot), iron and folate

(anemia) and riboflavin (angular stomatitis). Subclinical deficiencies of these nutrients are associated with several functional abnormalities such as growth retardation, impaired immune and cognitive functions, and lowered work capacity. The degree of nutrition deficiencies and their functional and health consequences are relatively more severe among preschool children than among school children or adolescents. The observed functional deficiencies are caused by several nutrient deficiencies acting synergistically and the interactions among them. Infective morbidity, prevalent among poor children, is known to aggravate PEM and other micronutrient deficiencies. Malnourished and undernourished children and adolescents, therefore, require appropriate nutrition intervention, besides proper health care, to improve their health and nutrition status.

There are several nutrition intervention strategies available to improve the nutrition and health status of children and adolescents, each with its own advantages and limitations.

Dietary Nutrient Intake Status of Children and Adolescents

The essential nutrients derived through diet to maintain good nutrition status of humans subjects are listed in Table 1. Several of these nutrients are considered to be essential for humans and their daily requirements have been well established. These include energy, protein, fat, calcium, iron, iodine, zinc, B-complex vitamins, vitamin A, and ascorbic acid. Deficiencies of these nutrients are encountered particularly among children and pregnant and nonpregnant women. Dietary deficiencies of other micronutrients, vitamins, and minerals are generally not encountered, either because the diet contains enough of them to meet human needs or their deficiencies, if present, cannot be recognized in the presence of deficiencies of other well-known nutrients.

Dietary intake of nutrients by preschool children, school children, and adolescents as reported by NNMB¹ survey, expressed as per cent of their RDI² are given in Tables 2, 3, and 4 respectively. In these tables are also

Dr. Rao is Former Director, NIN, Hyderabad, 11/4 (1-2-62/3), Kakateyanagar, Habsiguda, Hyderabad-500 007, India.

Table 1. Micronutrients Essential for Humans and Animals

Vitamins		Trace Minerals	
A. Micronutrients known to be essential for humans and animals			
Vitamin A*	Thiamin*	Iron*	Selenium*
Vitamin D*	Riboflavin	Iodine*	Manganese
Vitamin K	Nicotinic acid	Zinc*	Chromium*
Vitamin E	Pyridoxine	Copper	Cobalt
Essential fatty acid*	Folic acid*		
	Vitamin B ₁₂		
	Ascorbic acid		
B. Micronutrients essential for animals and not yet established as essential for humans			
Biotin	Choline	Silicon	Molybdenum
Pantothenic acid	Para amino Benzoic acid	Fluoride	Arsenic Nickel

* Dietary deficiency of these nutrients is well recognized to lead to widespread deficiency diseases (i.e., vitamin A deficiency, iodine deficiency disorders, iron-deficient anemia.).

given daily supplements of nutrients required to meet the RDI of these groups.

The current dietary intakes by preschool children (Tables 1 and 2) indicate inadequacies with respect to several nutrients—energy, fat, calcium, iron, zinc, vitamin A, thiamine, riboflavin, and ascorbic acid. While iodine intake is satisfactory, intakes of protein and folic acid are marginally adequate. The deficit in intake of the above nutrients ranges from 40–50%. In the case of

school children (Table 3) dietary intake of several nutrients also falls short of RDI by 30–60% for energy, fat, iron, zinc, vitamin A, riboflavin, and ascorbic acid. There are, however, marginal inadequacies with respect to protein, particularly in 10–12-year-olds, and the actual deficiency may be of a larger order in view of the 25% energy deficiency. Folic acid intake also falls short of RDI by 15%.

Dietary intakes of adolescents (Table 4) also show a 20–50% deficit of several nutrients, including protein. As in the case of the other age groups, the other deficient nutrients are fat, energy, calcium, iron, zinc, vitamin A, riboflavin, and folate, while rates of dietary deficiencies of iron, vitamin A, and riboflavin among the adolescents are as high as among preschool and school children. However, protein inadequacy is greater while deficiencies of fat, energy, calcium, and zinc are somewhat lower. This may be due to a larger intake of cereals by the adolescents.

It is thus seen from the dietary intake data of the children of the three age groups that deficiencies of energy, calcium, iron, zinc, vitamin A, and riboflavin are common among all the age groups. There is also conditioned deficiency of protein due to concomitant energy deficiency. Surprisingly, the extent of protein inadequacy increases with age. Although folate intake seems adequate compared with ICMR RDI, the deficit may be larger if we consider the recently reported higher requirement of folate of 100–200 µg/day for children and adolescents as compared with corresponding figures of 30–100 µg/day recommended by the ICMR.

It must also be pointed out that dietary intake of iodine among these children in the nonendemic goiter

Table 2. Daily Intake of Nutrients by Preschool Children as % of Reference Dietary Intakes (RDI) and Daily Supplement Needed to Meet RDI

Nutrients	Daily intake as % of RDI		Daily supplement to meet RDI		RDI (ICMR) ²	
	1–3 years	4–6 years	1–3 years	4–6 years	1–3 years	4–6 years
Protein, g	96	104	1.2	—	22	30
Total fat, g	50	66	15.8	10.7	35	31
Energy, kcal	63	69	461	524	1240	1690
Calcium, mg	61	80	155	81	400	400
Iron, mg	50	54	6.0	8.2	12	18
Zinc, mg	46	53	4.3	5.2	8	11
Iodine, µg	105	127	—	—	70	90
Vitamin A, µg	35	42	259	232	400 (1600) ^b	400 (1600) ^b
Thiamine, µg	59	77	0.3	0.4	0.6	0.9
Riboflavin, mg	51	48	0.3	0.5	0.7	1.0
Niacin, mg equivalents	114 ^a	106 ^a	—	—	8	11
Ascorbic acid, mg	48	53	15	19	40	40
Free folic acid, µg	96	108	?	?	30	40

Source: reference 1.

^a Includes contribution from tryptophan.

^b β-carotene.

Table 3. Daily Intake of Nutrients by School Children as % of Reference Dietary Intake (RDI) and Daily Supplement Needed to Meet RDI*

Nutrients	Daily intake as % of RDI		Daily supplement to meet RDI		RDI (ICMR) ²	
	7-9 years	10-12 years	7-9 years	10-12 years	7-9 years	10-12 years
Protein, g	91	77	3.8	13	41	56
Total fat, g	74	56	9.6	16	28	25
Energy, Kcal	72	78	600	478	1950	2080
Calcium, mg	93	65	44	210	400	600
Iron, mg	47	44	13.7	18	26	27
Zinc, mg	56	62	5.7	5.2	13	14
Iodine, μ g	157	109	—	—	90	150
Vitamin A, μ g	35	37	391	381	600	600
Thiamine, μ g	82	91	0.2	0.1	1.0	1.1
Riboflavin, mg	47	50	0.5	0.6	1.2	1.3
Niacin equivalents, mg	123	121	—	—	13	14
Ascorbic acid, mg	66	68	13	13	40	40
Free folic acid, μ g	89	86	6.4	10	60	70

Source: reference 1.

area is more than adequate, without taking into account the iodine intake derived from water, which is around 30 μ g/L. This raises the question whether there is any need for iodine supplementation through iodized salt to the population groups living in the nonendemic area.

Dietary intake data confirm that preschool and school children and adolescents have inadequate intake of energy, fat, calcium, iron, zinc, vitamin A, riboflavin, ascorbic acid, folic acid, and also, perhaps to a lesser extent, of protein. Emphasis used to be placed on inadequacy of dietary intake of nutrients only in preschool children, and strategies to correct dietary deficiency were targeted to this group. The foregoing analysis indicates that all age groups from 1-18 years suffer from all nutrition deficiencies previously considered to be preva-

lent only among preschool children. The future intervention strategy with macro- as well as micronutrients should cover preschool children, school children, and adolescents.

In view of multinutrient deficiencies in these groups, any proposed intervention strategy should cover all the concerned nutrient deficiencies among them. There is a well-known synergistic interaction between nutrients in their metabolism requirements and development of their deficiency as illustrated in Table 5. In view of such an interaction between nutrients, the children have to be supplemented with all of the deficient nutrients to derive maximal benefit for improving their health and nutrition status.

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Table 4. Daily Intake of Nutrients by Adolescents as % of Reference Dietary Intake (RDI) and Daily Supplement Needed to Meet RDI

Nutrients	Daily intake as % of RDI		Daily supplement to meet RDI		RDI (ICMR) ²	
	13-15 years	16-18 years	13-15 years	16-18 years	13-15 years	16-18 years
Protein, g	74	80	18	15	68	71
Total fat, g	69	83	12	12	22	21
Energy, Kcal	87	91	313	262	2255	2350
Calcium, mg	69	95	187	48	600	500
Iron, mg	48	48	18	22	35	40
Zinc, mg	68	75	5	4	15	15
Iodine, μ g	131	150	—	—	150	150
Vitamin A, μ g	43	48	343	342	600	600
Thiamine, μ g	94	100	—	—	1.1	1.2
Riboflavin, mg	53	57	0.7	0.6	1.4	1.4
Niacin equivalents, mg	144	154	—	—	15	16
Ascorbic acid, mg	83	91	6	6	40	40
Free folic acid, μ g	72	82	29	18	100	100

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Source: reference 1.

Table 5. Some Examples of Micronutrient Interaction in Their Metabolism and in the Development of Their Deficiency

Metabolism	Promoters	Inhibitors
1. Absorption of dietary iron carotenase	ascorbic acid (calcium, zinc)	phytate, tannin protein deficiency
2. Carotene → retinol		
3. Vitamin A absorption and metabolism	vitamin E	low fat intake, iron
4. Tryptophan → niacin	pyridoxine, riboflavin	leucine
5. Absorption and storage of vitamin B ₁₂	pyridoxine	
6. Folate → polyglutamate coenzyme	vitamin B ₁₂	
7. B vitamins → coenzyme	riboflavin coenzyme	
8. Pyridoxine → coenzyme	riboflavin coenzyme	
9. Absorption of thiamine		folate deficiency
10. Riboflavin absorption and conversion to its coenzyme FNM		hypothyroidism (iodine deficiency)

tional and international agencies to place emphasis only on micronutrient supplementation to the exclusion of macronutrients like energy, fat, and protein. Although such an approach may be relevant to population groups in the developed countries who have adequate intake of energy and protein, it would be futile to supplement only with micronutrients without correcting the energy and protein deficiencies that prevail among children and mothers in the developing countries like India. Such an intervention with only micronutrients will be only partially effective in correcting some of the specific manifestations of a particular nutrient deficiency, but will not allow these undernourished children to fully achieve growth potential and adequate nutrition and health.

The dietary deficiency of nutrients as observed among children and adolescents has been shown to result in growth stunting and development of subclinical and clinical deficiencies as reported in nutrition surveys carried out by NNMB among these groups.¹ In Table 6, nutrition status of children according to weight for age (Gomez classification) is depicted. It is seen that only 3–10% of children have normal weight for age, and this percentage increases as age increases, while severe grades increase from 8% to 19%. The moderate grade of malnutrition is nearly 50%, ranging from 43% among preschool children to 63% among adolescents. It is

interesting to note that nutrition status is equally unsatisfactory among children of all age groups, 1–18 years. Adolescents and school children in this respect are worse off than preschool children. As a matter of fact, the nutrition grades among preschool children have improved (Table 7) over the past twenty years, which may be partly attributable to various nutrition programs targeted to preschool children.

Nutrition Deficiencies Among Children and Adolescents

The inadequacy of the current dietary intakes of nutrients of all three groups of children is confirmed by the presence of nutrition deficiency signs as observed in the nutrition surveys carried out by NNMB. These data are given in Table 8. The data presented in this table confirm the existence of deficiencies of vitamin A and B-complex vitamins. Anemia is also widespread, as indicated by the anemia survey carried out by NIN and other institutions (Table 9). Although the prevalence of deficiency signs is 1–5%, they are only the tip of the iceberg and suggest that a large percentage of children suffer from subclinical malnutrition. Similarly, subclinical malnutrition forms of vitamin C, folate, vitamin B₁₂, calcium, and vitamin D₃ may be prevalent without any clinical signs. Besides

Table 6. Percent Distribution of Children According to Nutrition Status (Weight for Age)—Gomez Classification

Group	Age	Nutrition Grades			
		>90 Normal	75–90 Mild	60–75 Moderate	<60 Severe
Preschool children	1–3	9.7	38.9	43.3	8.1
	3–5	8.3	42.3	44.8	4.6
School children	6–9	5.5	31.4	54.7	8.4
	10–13	2.7	16.6	52.0	28.8
Adolescents	14–17	3.0	25.5	52.7	18.9

National Center for Health Stat standards used.
Source: reference 1.

Table 7. Nutrition Status of Preschool Children (Gomez Classification): Time Trends

Year	Nutrition Grades			
	Normal ≥90	Mild 75-90	Moderate 60-75	Severe <60
1975-1979	5.9	31.6	47.5	15.0
1988-1990	9.9	37.6	43.8	8.7
1996-1997	8.9	40.6	44.3	6.2

National Center for Health Stat standards
Source: reference 1.

contributing to a high prevalence of anemia primarily caused by iron deficiency, folate and B₁₂ inadequacy may be contributing to CVD. Similarly, lack of other micronutrients such as calcium, zinc, vitamin A, and B vitamins may be contributing to observed growth retardation (Table 4) primarily caused by energy and protein deficiencies. Although scurvy is not seen, subclinical vitamin C deficiency may be present in the form of low antioxidant capacity and poor absorption of dietary iron. The above analysis of diet and nutrition survey data indicates that preschool children, school children, and adolescents in our country suffer from deficiencies in protein, energy, fat, calcium, iron, zinc, vitamin A, riboflavin, ascorbic acid, and folic acid. There are several strategies to correct these dietary deficiencies of nutrients, collectively or individually. It is recommended that all the prevailing nutrient deficiencies be concurrently corrected to obtain maximal health and nutrition benefits for our children aged 1-18 years.

Strategies for Combating Dietary Deficiencies of Nutrients Among Children and Adolescents

There are generally three strategies to improve the health and nutrition status of malnourished populations (Table 10).

Improve Diets of Families

One of the long-term strategies is to improve people's diets and render them more balanced by promoting

Table 8. Percent Prevalence of Nutrition Deficiency Signs Among Children and Adolescents

Deficiency Signs	1-5 Years	5-12 Years	12-18 Years	
			Boys	Girls
NAD	88.6	72.9	80.1	82.8
Edema	0.2	—	—	—
Marasmus	0.4	—	—	—
Bitot's spots	1.1	2.8	2.4	0.9
Angular stomatitis	1.7	4.5	2.9	1.5
Dental fluorosis	—	1.5	1.7	0.8

Source: reference 1.

Table 9. Prevalence of Anemia in Rural Population of India According to Severity

Age (Years)	Sex	Percent prevalence of anemia		
		Per WHO criteria	Moderate Hb <10 g/dL	Severe Hb <7 g/dL
1-6	Boys	75.5	56.3	10.9
	Girls	77.1	57.5	7.6
6-15	Boys	56.8	15.8	1.6
	Girls	68.8	18.3	2.4
>15	Men	42.0	5.1	0.5
Average	All sexes	58.1	20.7	2.6

Source: reference 3.

consumption of protective foods such as milk, eggs, flesh foods, legumes, oil, and fruits and vegetables, particularly green leafy vegetables. The diet of a poor preschool child has been compared with a low-cost balanced diet in Table 11. It is evident that to make the diets of the preschool children balanced, the daily intake of almost all the components of the diets has to be increased. This is perhaps equally true of school children and adolescents and women. There is a need for an all-round improvement of the family diet of the poor.

This calls for a long-term strategy involving socio-economic development and increasing the purchasing power of these poor families. Also, the current production of several of the country's protective foods is not adequate to meet the per capita requirement for a well-balanced diet (Table 12). There is considerable shortage in the availability of vegetables, particularly green leafy vegetables, fruits, and animal foods. Their production and availability have to be considerably augmented, requiring much input from agriculture and food storage and distribution sectors.

As an immediate measure to improve the diets of low-income families, the possibility of providing some of these foods besides cereals, such as oils, pulses, milk, and vegetables, at subsidized prices through the public

Table 10. Strategies to Improve Nutrient Intakes of Malnourished Children and Adolescents

1. To improve diets of the families (long-term approach).
2. To provide micronutrient-rich supplementary food prepared at home from locally available micronutrient-rich foods to provide all the deficient nutrients.
3. To fortify a universal vehicle like salt with minerals such calcium, iron, zinc, and iodine to overcome deficiencies in the diets of the population.
4. To fortify supplementary foods with micronutrients, calcium, iron, zinc, vitamin A, riboflavin, ascorbic acid, folate, and iodine in the goiter-endemic area.

Table 11. Food Supplements to Poor Preschool Children to Upgrade Their Current Diets to a Balanced Diet

Foodstuffs	Daily intake (g)		
	Balanced diet	Current intakes	Daily supplement
Cereals (rice)	200	141	59
Pulses/legumes	35	12	23
Milk	300*	130	170
Fats and oils	25	5	20
Sugar and jaggery	35	11	24
Green leafy vegetables	50	10	40
Other vegetables including roots and tubers	50	27	23
Fruits	50	13	37

* 30 g of flesh foods can be substituted for 100 g of milk. Average flesh food intake is 15 g/day. Supplement can be 70 mL milk and 15 g flesh foods.

distribution system (PDS) may be considered. Currently, only cereals, wheat and rice, and edible oil, to a limited extent, are distributed. The present PDS needs to be upgraded and targeted only to those families below the poverty line. Also, these families, particularly the women, have to be properly educated to use the subsidized food commodities distributed through PDS effectively to improve the nutrition of their children. The present PDS also need reorganization to achieve this goal.

Promote Home Preparation of Micronutrient-rich Supplements

The second strategy is to promote consumption of micronutrient-rich supplements formulated and prepared at home from locally available low-cost foods with which

the population groups in different regions of the country are familiar. A list of such foods, including cereals and pulses rich in calcium, iron, zinc, β -carotene, ascorbic acid, and folic acid are given in Table 13. A supplement based on these foods will also provide some energy and protein. Such a food-based approach will supply other bioactive compounds with antioxidant potency naturally present in these foods, which will protect the population against degenerative diseases like cancer, cardiovascular disease, and diabetes.

Multiple micronutrient supplements based on synthetic nutrients are currently advocated by international agencies and NGOs. Such supplements may be more effective in correcting the marginal deficiencies of these micronutrients among population groups in the developed countries whose diets are otherwise satisfactory with respect to energy and protein. In these countries, large supplements of micronutrients are also advocated to protect against degenerative diseases widely prevalent among the population in these countries. However, such pure micronutrient supplementation with synthetic nutrients will be far less effective among low-income populations in developing countries like India whose diets are deficient in macronutrients like protein, energy, and fat, besides several of the micronutrients. Advocacy of synthetic micronutrient supplementation in developing countries therefore requires reconsideration.

Fortification of a Universal Vehicle

Fortification is another strategy to improve the intake of the micronutrients that are most deficient in diets, such as iron and iodine leading to iron deficiency anemia (IDA) and iodine deficiency disorders (IDD). For a successful fortification program to cover the entire population, selection of a universal vehicle is a critical step. In India and several other developing countries, salt appears to be the most appropriate universal vehicle to carry nutrients

Table 12. Per Capita Requirement and Availability of Foodstuffs in India

Foodstuffs	Requirement per capita/day (g)	Availability per capita/day	Percent adequacy
Cereal/millet	420	410	98
Pulses/legumes	40	38	95
Roots and tubers	75	52	69
Green leafy vegetables	50	—	—
Other vegetables	75	87.6	117
Fruits	50	72	140
Milk	150	128	85
Fats and oils	25	16.0	64
Sugar	30	27.3	91
Egg	45	13.4	30
Meat	25	—	—
Fish	25	57.3	115

Source: reference 2.

Table 13. Micronutrient-rich^a Plant Foods Commonly Consumed in India

Cereals and Millets	Pulses ^b and Legumes	Nuts and Oilseeds	Vegetables			
			Green leafy	Others	Fruits	Spices
Ragi	Blackgram	Gingelly	Amaranth	Cluster beans	Amla	Raisins
Bajra	Bengalgram	Mustard/Rape	Agathi	Dondakari	Lime	Turmeric
Jowar	Cowpea	Niger	Corriander leaves	Ladies fingers	Tomato	Fenugreek seeds
	Greengram	Coconut (dry)	Curry leaves	Colocacia	Papaya	Coriander
	Red gram	Groundnut	Mint	Carrots	Mango	Poppy seeds
	Horse gram		Mustard/rape leaves	Green chillies	Guava (country)	
	Rajma		Ponna-ganni	Yam (wild)	Lemon	
	Soyabean		Fenugreek leaves		Coconut fresh	
			Drumstick leaves			

^a Micronutrient content per 100 g food: calcium 150–1500 mg; iron 5–50 mg; zinc 3–6 mg; β -carotene 1500–7500 μ g, vitamin C 50–600 mg; folic acid (total) 100–185 μ g.

^b Sprouting of legumes will increase ascorbic acid content and iron and zinc bioavailability. (Suitable combination of above foods will provide micronutrient-rich supplement.)

to cover the entire population, particularly the poor population groups among whom nutrient deficiencies are most widespread.

Iodization of salt is already in operation in India and several other countries to combat IDD. A technology was developed⁴ for the fortification of salt with iron and successfully field tested.⁵ Subsequently, a technology for double fortification of salt with iron and iodine has been developed at NIN⁶ and field tested. The formulas for fortification of salt with iron and iron plus iodine are shown in Tables 14 and 15, respectively. Both these technologies are awaiting implementation to combat IDA and IDA plus IDD among our population. There is a possibility of adding calcium, zinc, and other trace elements to the double-fortified salt to combat all the mineral deficiencies in the diets of the poor population groups in India.

Fortification of processed foods is often advocated as a strategy to deliver nutrients to the malnourished

populations. It must be recognized that there are serious limitations to this strategy in developing countries like India. This strategy may work in developed countries where most of the foods are processed and consumed by a majority of the population. In a developing country like India, however, only a limited quantity of foods consumed are processed and most of the processed food reach only the well-to-do segment of the population, and not the poor population who really need nutrient supplementation. However, processed foods, which represent only a small proportion of food trade in a developing country, can be fortified with nutrients to restore nutrients lost in processing or to improve their overall nutrition quality if the raw food itself is deficient in certain nutrients (e.g., lysine in wheat).

Fortification of Supplementary Foods

An alternate effective strategy for delivering extra nutrients to the vulnerable groups is to fortify the supplement-

Table 14. Micronutrient-fortified Supplementary Foods for Undernourished Preschool Children

Composition of Supplementary Foods (g/child/day)		Nutrient	Content in the Daily Supplement
Cereals	80	Energy, kcal	500
Sugar/jaggery	10	Carbohydrate, en% ^a	60–70
Legumes/defatted oilseed	20	Fat, en% ^a	22
Fat	12	Protein, en% ^a	12
Vitamins and mineral fortification		Calcium, mg	200
		Iron, mg	15
		Riboflavin, μ g	850
		Ascorbic acid, mg	20
		Zinc, mg	10
		Folate, μ g	50
		Retinol, μ g or β -carotene, μ g	1000

^a Energy derived from carbohydrate, fat, and protein content of the supplementary food expressed as percentage of total energy content of the supplementary food.

Table 15. Formula for Iron-fortified Salt

Ferrous Sulphate	3500 ppm ^a
Orthophosphoric acid or sodium hydrogen phosphate	3200 ppm
Sodium acid sulphate	5000 ppm

^a Provide 1 mg iron per g of salt.

tary foods that are currently targeted to these groups. The supplementary foods can be fortified with other nutrient-rich foods, such as red palm oil, leaf powder, or leaf protein concentrate, which are rich in beta-carotene, or with synthetic nutrients. The supplementary foods that are currently targeted to children and mothers are intended to provide extra energy and some protein. The supplements that are the source of energy and protein can be fortified with calcium and other micronutrients such as iron, zinc, vitamin A, riboflavin, ascorbic acid, and folate to improve the intake of these nutrients by the target groups. The level of the nutrient to be added to the supplementary foods should be enough to increase the daily intake of these micronutrients by the target groups to meet their daily requirement (RDI) fully. An example of such a fortification in the case of preschool children is given in Table 16. Also, in view of the fact that the diets of school children and adolescents, as well as those of preschool children, are deficient in all the nutrients (calcium, iron, zinc, vitamin A, riboflavin, ascorbic acid, and folate), the current supplementary feeding program with the fortified supplementary foods should also be extended to school children and adolescents. The current supplementary feeding program, which suffers from several operational bottlenecks, requires much improvement and reorganization to serve as an efficient and effective

strategy to deliver macro- as well as micronutrients to all children from 1-18 years of age.

Need for an Area-specific Strategy For India

In a large country like India, with much regional diversity in food habits, food availability, and in the prevalence of nutrient deficiencies, a decentralized, area-specific strategy for providing nutrients, as well as health care, to malnourished children and adolescents is essential for promoting health and nutrition status of children of all age groups. Each state in the country can evolve its own strategy to be implemented by its own health and social welfare authorities. A single global strategy of nutrition intervention often advocated by international agencies and NGOs may not be relevant or fully effective in a large country like India.

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Table 16. Formula for the Double Fortification of Edible Salt with Iron and Iodine

Additive	Ingredients	Double-fortified salt	Iron-fortified salt	Iodized salt
Iron 1 mg/g	Ferrous sulphate	3.2 g/g	3.2 g/g	—
Iodine 40 ppm	Potassium iodide (KI) (or potassium iodate (KIO ₃))	52 µg/g 67 µg/g	—	52 µg/g 67 µg/g
Stabilizer 1%	Sodium hexameta-phosphate	1%	1%	—