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Original Article

Intervention with traditional food as a major source of energy, protein, iron, vitamin C and vitamin A for rural *Dalit* mothers and young children in Andhra Pradesh, South India

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Intakes of energy, protein, iron and vitamin A in India are usually reported as inadequate. Recognizing that traditional food systems are sustainable, high in species variety, and have rich nutrient sources, we compared dietary intakes and nutrient sources of *Dalit* mothers and their children living in villages with and without an intervention based on improved access to the traditional *Dalit* food system. 24-hour recalls were conducted with *Dalit* mothers and their children aged 6-39 months during summer and rainy seasons in 2003. We found that mothers from intervention villages had significantly higher intakes of energy (mean ± SD: 12,197 ± 3,515 kJ vs. 11,172 ± 3,352 kJ; $p= 0.02$) and protein (77.5 ± 25.1 g vs. 71.1 ± 25.2 g; $p= 0.05$) in summer, and higher intakes of energy (11,168 ± 3,335 kJ vs. 10,168 ± 3,730 kJ; $p= 0.04$), protein (68.9 ± 22.6 g vs. 60.4 ± 23.8 g; $p<0.01$) and iron (15.8 ± 6.6 mg vs. 13.7 ± 9.1 mg; $p<0.01$) during rainy season. There were no differences in children's intakes between intervention and control villages. In mothers, sorghum contributed 29% of energy, 33% of protein and 53% of iron, and green leafy vegetables contributed 21% of vitamin C and 38% of vitamin A. Our results indicate that traditional food such as sorghum, pulses and green leafy vegetables are major sources of energy, protein, iron, vitamin C and vitamin A, and that mothers from villages with the traditional food intervention had higher intakes of energy, protein and iron.

Key Words: food-based intervention, malnutrition, India, Indigenous Peoples, *Dalit*

Introduction

Nutritional disorders of public health concern in developing countries include protein energy malnutrition, iron deficiency anaemia, and vitamin A deficiency disorders.[1-3] Women of child bearing age and children <5 years of age are the most vulnerable groups, because of relatively high requirements.[4,5] In India, malnutrition among young children and women results from inadequate food intake, poverty, and deleterious caring practices such as delayed complementary feeding.[6] On average, 50% of Indian women and 53% of children are reported to be anaemic[7], and 5-7% of children are classified as vitamin A deficient.[8] Malnutrition is reported to be worst in children aged <3 years and among women living in rural areas, who are landless labourers or marginal farmers, and belonging to the scheduled caste.[6,8] The scheduled caste is the fifth group below the four distinct classes in the Hindu religion, representing the "untouchables" called *Dalit*.[9] Centuries of oppression have resulted in severe poverty; today the majority are illiterate, landless, and work as farm labourers.[10]

The diet of India's poor is predominantly based on cereals (rice, sorghum, millet), which provides 70-80% of total energy.[11-13] Extensive diet surveys showed that diets of low income groups are deficient in nutrients, including energy, iron and vitamin A. The staple diet relies primarily on plant based food items and is generally low in intakes of pulses, leafy and other vegetables, and animal source food.[12] Deficiencies of nutrients occur more frequently and to a greater extent among children, and among pregnant and /or lactating women.[12,14]

Of the three types of interventions (supplementation, fortification, dietary improvement) targeting malnutrition, food based strategies emphasizing dietary diversification based on traditional food systems are highlighted here. Although traditional food systems are sustainable, high in species variety and have rich nutrient sources, they have

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not been emphasized to date as a part of the solution to address malnutrition.[15,16]

The Indian government's Public Distribution System addresses energy inadequacy and provides subsidized rice to poor households. However, this results in a shift from eating locally grown food grains to rice, and in neglecting traditional agricultural practices, especially in dry-land areas such as the Medak District of Andhra Pradesh.[17]

The traditional food system in the Medak District is based on agriculture without pesticides or chemical fertilizers with a mixed cropping system producing sorghum, millet, pulses, green leafy vegetables, fruits, vegetables, roots and tubers. Various uncultivated green leafy vegetables and wild fruits are also gathered. These traditional food items are rich sources of energy, protein, minerals and vitamins, especially, iron, vitamin A and vitamin C.[18] Since the mid 1980s, *Dalit* women farmers in the Medak District organized themselves in volunteer women groups – called sanghams – supported by the Deccan Development Society (DDS), a local non-governmental organization, and created an Alternative Public Distribution System (APDS), a community based food security program based on their local food system. This research report compares dietary intakes (energy, protein, carbohydrate, fat, dietary fibre, iron, vitamin C, vitamin A) and their food sources in *Dalit* mothers and their young children living in intervention villages with the APDS and in control villages during the summer and rainy seasons in the Medak District in Andhra Pradesh, South India.

Subjects and methods

We followed guidelines of participatory health research with Indigenous Peoples to conduct this research.[19] Ethics approval was obtained from McGill University in Montreal, Canada. Informed consent from sangham leaders and each mother was obtained at the first contact. We chose a cross-sectional study design sampling villages with DDS sanghams: 19 intervention villages (implementing APDS since 1995) and 18 control villages without APDS from the same townships in the Medak District. One mother-child pair was recruited from each *Dalit* DDS sangham household which had at least one child aged 6-39 months. One mother-child pair was recruited per household. If the household had more than one mother with a child in this age group, we selected the one who was at home at the time of the survey. If the mother had more than one child in this age range, the older one was selected. We only recruited *Dalit* mothers, aged ≥ 15 years and who lived in a household with a sangham member.

Intervention

In 1995, the intervention (APDS) was designed and established through *Dalit* women farmers and the workers of the local non-governmental organisation DDS. The intervention is based on the principles of local production, local storage, and local distribution of sorghum.[17] Thirty three villages with DDS sanghams started the APDS in the Medak District, funded by the Indian Ministry of Rural Development, reclaiming fallow lands and reintroducing their traditional agriculture and food production to ensure household food security. Over 2,500 acres of fallow land have been cultivated and an additional amount of 800,000 kg of sorghum have been produced per year. Simultaneously, increased production of associated intercrops such as millet, pulses and green leafy vegetables naturally occurred within the traditional agricultural and dietary patterns. Sorghum was sold through sanghams for a low price to households in need during the rainy season, when food is scarce.[17]

Interviews

In 2003, trained Indian interviewers fluent in Telugu conducted 24-hour recalls during the summer (April) and rainy seasons (August). A repeat 24-hour recall was conducted in a 10% sub-sample on a non-consecutive day. We used a socio-cultural questionnaire during the rainy season to obtain socio-economic and physiological information on mothers and children. Height and weight of mothers were measured with a metallic height rod with accuracy of 1 mm (Galaxy Informatics, New Delhi) and a digital balance with accuracy of 100 g (SECA-840, Hamburg, Germany). Body mass index (BMI) was calculated (kg/m^2), excluding pregnant women.

Dietary recall

We adapted the 24-hour recall method used in Indian National Nutrition Monitoring Bureau's surveys. Mothers were asked to recall the exact food intake of herself and her child during the preceding day. Detailed descriptions of all food and beverages consumed, including cooking methods and brands were recorded. Quantities of food consumed were weighed with digital kitchen balances (ATCO Model No D2RS-02-W) to the nearest gram or estimated with household measures or standardized vessels. For cooked dishes, such as dhal and curries, all raw ingredients of the family preparation were weighed and the volume of the whole cooked family dish and the volume consumed by the mother and child were estimated. We used a standardized vessel set with 12 vessels to estimate volumes of cooked foods and liquids. The individual raw intake of each ingredient from a cooked dish was calculated according to the following established formula: raw amount of each ingredient cooked for the family dish in grams x the volume consumed by the individual ÷ the volume of the total cooked family dish. Standardized recipes and standard conversion factor for cooked rice were used for missing ingredients or volumes of cooked family dishes. For breastfed children standardized consumption of human milk was assumed: 500 ml human milk per day for 6 -12 months old children and 350 ml per day for 1-3 year old children.[20]

Nutrient database

We used nutrient values published by the Indian National Institute of Nutrition.[12] Missing nutrient values or food items and values of total dietary fiber were taken from ASEAN Food Composition Tables[21] or from European Food Composition and Nutrition Tables.[22] Food energy was calculated assuming protein, carbohydrate and fat yield 4, 4 and 9 kcal/gram. This was then converted to kilo joules (kJ) using the equivalent of 4.2 J per calorie. Provitamin A carotenoids were converted into retinol equivalents (RE) assuming 6 μg β-carotene equals 1 μg RE. In the absence of β-carotene values, we assumed that

6 μg total carotene equals 1 μg RE. We used β-carotene values determined by HPLC from recent publications whenever available.[23,24] Candat (Canadian Nutrient Data Analysis Toronto, Version 5.1, 1988, London, Ontario, Canada) was used as technical tool to calculate nutrient intakes. One repeat recall for 28 mothers and twelve children in summer (10%) in intervention and control villages) and 23 mothers and 22 children in rainy season (10% in intervention and 10% in control villages) were averaged within season.

Total nutrient intakes from intervention villages and control villages were determined as a group total for mothers and children using single 24-hour recalls. Within each group nutrients were pooled within nine food groups including other food grains (wheat, maize), nuts and oil seeds (8 species), pulses (9 species), animal foods (9 items), green leafy vegetables (9 species cultivated greens, 7 species wild greens), vegetables (20 species), fruits (7 species), drinks (3 items), and miscellaneous (11 items), separately for summer and rainy season. Nutrient contributions of total group nutrient intakes per season, expressed in percentages, from single food items (sorghum, rice, cooking oil) and these food groups were determined and ranked.

Statistical analysis

Data were analyzed separately for mothers and children, and summer and rainy seasons. Chi-Square was used for dichotomous and categorical characteristic variables. When the expected count of the Chi-Square was <5, Fisher's Exact Test was used. Non parametric test (Wilcoxon) was used for non-normally distributed data including all nutrient intakes of children, and fat, dietary fibre, iron, vitamin C and vitamin A intakes of mothers. Two sample Student's t-test was used to compare the means of normally distributed continuous variables between intervention and control villages. Paired Student's t-test and signed rank test was used to compare summer and rainy seasons within intervention and control villages. We tested for inter-village differences in the intervention and control group for each nutrient in each season and no significant nutrient intakes were observed. A two sided alternative hypothesis was tested with alpha at 0.05. Data from one child from a control village was missing during summer season. Statistical analysis was conducted with SAS version 8 (SAS Institute Inc, Cary NC, US).

The mean or median nutrient intakes of mothers from intervention and control villages were compared to the Indian recommended dietary allowances (RDA)[25] and the North American estimated average requirement (EAR)[26] for lactating, pregnant and non-lactating women. The mean or median nutrient intakes of young children were compared to the Indian RDA of preschool children aged 1-3 years.[25]

Results

Study participants

Mothers from intervention and control villages were similar in most of their characteristics as shown in table 1. A higher proportion (24%) of mothers from the intervention villages worked as daily labourers (assumed increased energy needs) during the rainy season compared to control villages. The average mother was in her early twenties, the majority had one or two children, ¼ was able to read and write a sentence, and most mothers and children participated during both the summer and rainy seasons. More mothers were pregnant during the summer than during the rainy season. In 2003, <50% of mothers consumed food nutritional supplements (enriched flour) at least once and <25% of mothers consumed five or more iron-folic tablets. Approximately half of all mothers consumed one or more iron-folic tablets during the pregnancy of the recruited child. Non-iodized salt was used in >80% of recruited households. BMI was similar in both intervention and control villages and the mean BMI in both groups was slightly below the recommended healthy range of BMI >18.5 kg/m².[27]

Table 2 demonstrates that children from intervention and control villages were similar in most characteristics. More children from the intervention villages consumed de-worming tablets at least once since birth. The majority of children were first or second born, and were complementary fed at the time of the survey. Between January and August 2003, 40% of all children consumed a food nutritional supplement at least once. Since birth 46% of all children received vitamin A drops at least once. Thirty seven percent of all children during summer and 24% during the rainy season (three months later) were aged 6 to 12 months. During the summer, more children were exclusively breastfed and less children were complementary fed and weaned than during the rainy season.

Nutrient intakes

Table 3 shows that mothers from intervention villages had higher intakes of energy (~1,000 kJ), protein (~8 g) and dietary fibre (~8 g) during both the summer and rainy seasons than mothers from control villages. The percentage of total energy from fat was approximately 10% in all mothers across seasons. The median iron intake in mothers from intervention villages was higher in both seasons (2.4 mg), but the intake during the rainy season was significantly higher. Vitamin C intakes were similar during the summer, but the median vitamin C intake in mothers from control villages was significantly higher (2.7 mg) during the rainy season. Fat and vitamin A intakes in mothers were found to be similar in intervention and control villages. All nutrient intakes, expect for vitamin C, were higher ($p \leq 0.05$) during the summer compared to the rainy season within both intervention and control villages.

As demonstrated in table 4, children from intervention and control villages consumed similar amounts of energy, protein, carbohydrate, fat, dietary fibre, iron, vitamin C and vitamin A during the summer and rainy seasons. Children had higher vitamin C and vitamin A intakes than their mothers. Approximately 23% of energy came from fat in all children across both seasons (not shown). Within the intervention group, intakes of protein ($p= 0.04$), dietary fibre ($p= 0.05$) and iron ($p= 0.05$) were higher during rainy season, and vitamin A intake ($p=0.02$) was higher during summer. Within the control group energy ($p< 0.01$), protein ($p< 0.01$), carbohydrate ($p< 0.01$), dietary fibre ($p< 0.01$) and iron ($p< 0.01$) were higher during rainy season.

Table 1. Characteristics of *Dalit* mothers in intervention and control villages[1]

Variable	Description	Intervention villages	Control villages	*p*
		n = 124	n = 96	0.30²
Age	Years (SD)	24.5 (4.1)	24.0 (3.5)	
Total children per mother	1 – 2	74 (60%)	67 (70%)	0.30
	3 – 4	43 (34%)	25 (26%)	
	> 4	7 (6%)	4 (4%)	
Illiterate	Yes	101 (81%)	72 (75%)	0.25
	No	23 (19%)	24 (25%)	
Nutrient supplement in 2003[4]	Yes	51 (41%)	42 (44%)	0.70
	No	73 (59%)	54 (56%)	
Iron-folic tablet in 2003	Yes	28 (23%)	18 (19%)	0.49
	No	96 (77%)	78 (81%)	
Iodized salt usage	Yes	19 (15%)	17 (18%)	0.64
	No	105 (85%)	79 (82%)	
		Summer Season		
		n = 125	n = 109	
Physiological status	Non-lactating, non-pregnant	13 (10%)	9 (8%)	0.30
	Lactating	96 (77%)	92 (85%)	
	Pregnant	6 (5%)	1 (1%)	
	Pregnant and lactating	10 (8%)	7 (6%)	
		Rainy Season		
		n = 124	n = 96	
Physiological status	Non-lactating, non-pregnant	13 (10%)	14 (15%)	0.19
	Lactating	100 (81%)	78 (81%)	
	Pregnant	7 (6%)	1 (1%)	
	Pregnant and lactating	3 (2%)	3 (3%)	
Work as daily laborer	Yes	100 (81%)	55 (57%)	<0.001*
	No	24 (19%)	41 (43%)	
Body Mass Index[5]	Body weight (kg) / height (m)²	18.2 (2.0)	18.3 (2.3)	0.71²
		Both Seasons		
		n = 140	n = 114	
Participated in both seasons	Yes	110 (79%)	91 (80%)	0.81
	No	30 (21%)	23 (20%)	

[1] Count (% of n) or mean (SD) and Chi-square test: * $p \leq 0.05$ statistically significant; [2] *p* from pooled two sample Student t-test; [3] *p*rom Fisher Exact Test; [4] Soya-corn blend and muruku (enriched chick pea four); [5] Pregnant women were excluded (experimental villages: n = 114, control villages: n = 91)

Dietary sources

Mother

Sorghum, rice and pulses were main sources of energy and protein for all mothers in both groups. Overall, sorghum, rice and pulses contributed 31, 48 and 9%, respectively, of total energy intake and 35, 36, and 22%, respectively, of total protein intake in intervention villages, which is similar in control villages. Millet was consumed by less than 1% of mothers in both groups.

Primary sources of iron were sorghum, rice, and pulses (Fig 1). Overall, sorghum, rice and pulses contributed 56, 16 and 15%, respectively, of total iron intake in intervention villages, which is similar to intake in control villages. Animal source food contributed less than 2% in both groups and cereals (sorghum, rice, wheat) contributed 79% in intervention villages compared to 68% in control villages. Cultivated and uncultivated green leafy vegetables contributed 2% of total iron intake and 11% of total vitamin C intake in intervention villages, which is three times lower than intakes in control villages.

Fruits and vegetables were the major sources of vitamin A (Fig 2). During the summer (mango season), fruits contributed 54% of vitamin A intake in intervention villages and 40% in control villages. In the rainy season, uncultivated green leafy vegetables contributed 43% of vitamin A in intervention villages and 36% in control villages. Vegetables, roots and tubers contributed 19% in intervention villages and 26% in control villages. Overall, sorghum and animal source food items contributed 9% and 8% of vitamin A intake in intervention villages, which is similar in control villages.

Children

Human milk and rice were primary sources of energy and

Table 2. Characteristics of *Dalit* children aged 6 to 39 months in intervention and control villages[1]

Variable	Description	Intervention villages	Control villages	*p*
		n = 124	n = 96	
Gender	Female	60 (48%)	50 (52%)	0.59
	Male	64 (52%)	46 (48%)	
Birth order	First	40 (32%)	36 (37%)	0.48
	Second	38 (31%)	34 (35%)	
	Third	25 (20%)	14 (15%)	
	≥ Fourth	21 (17%)	12 (13%)	
Nutrient supplement in 2003[2]	Yes	51 (39%)	41 (41%)	0.67
	No	80 (61%)	60 (59%)	
Vitamin A supplement since birth[3]	1 - 4 times	58 (44%)	53 (48%)	0.22
	No	73 (56%)	48 (52%)	
De-worming tablet since birth	Yes	12 (9%)	2 (2%)	0.03[2]
	No	119 (91%)	99 (98%)	
		Summer Season		
		n = 125	n = 108	
Age	6 - 12 months	47 (38%)	39 (36%)	0.57
	13 - 24 months	46 (37%)	46 (43%)	
	25 - 39 months	32 (27%)	23 (21%)	
Feeding status	Breastfed	27 (22%)	31 (28%)	0.25
	Complementary fed	70 (56%)	56 (52%)	
	Weaned	28 (22%)	21 (20%)	
		Rainy Season		
		n = 124	n = 96	
Age	6 - 12 months	30 (24%)	23 (24%)	0.20
	13 - 24 months	41 (33%)	42 (44%)	
	25 - 39 months	53 (43%)	31 (32%)	
Feeding status	Breastfed	12 (9%)	8 (8%)	0.62
	Complementary fed	74 (60%)	60 (63%)	
	Weaned	38 (31%)	28 (29%)	

[1] Count (% of n) and Chi-square test: * $p \leq 0.05$ statistically significant; [2] Soya-corn blend and muruku (enriched chick pea four); [3] Vitamin A Prophylaxis Programme for 6-36 months old children: six monthly dose of 100,000 International Units of vitamin A for infants and 200,000 International Units for young children

protein in both groups of children. Overall, human milk, rice and pulses contributed 34%, 33% and 5%, respectively, of total energy intake and 29%, 28% and 14%, respectively, of total protein intake in intervention villages, which is similar in control villages.

Sorghum, rice, and pulses were primary sources of iron (Fig 1). Overall, sorghum, rice, and pulses contributed 32, 17, and 14%, respectively, of iron intake in intervention villages. Miscellaneous food (including iron-fortified baby food) and animal source food items contributed 13% and 4% of iron intake in intervention villages, which is similar to the intake in control villages. During the rainy season, sorghum contributed 41% of iron intake in intervention villages and 34% in control villages. During the rainy season, cultivated and uncultivated green leafy vegetables contributed 6% of vitamin C in both groups. Human milk was the primary source of vitamin C and contributed ~70% in both groups.

Human milk, fruits and animal origin food items were the main vitamin A sources (Fig 2). Overall, human milk and animal food contributed 61% and 11% of vita-min A intake in intervention villages, which is similar in control villages. Sorghum contributed ~1% of vitamin A in both groups. During summer, fruits contributed 38% of vitamin A in intervention villages and 24% in control villages. During the rainy season, vegetables, roots and tubers contributed 5% of vitamin A in children from intervention villages.

Discussion

In India, it is well established that it is common practice to breasted children for a long time and delay the onset of complementary feeding. In our study, ¾ of all children aged 6-39 months were breastfed either predominately or in combination with complementary feeds. During summer, more than half of the children aged 6-12 months had not yet started to consume complementary food. Moreover, it is commonly known that supplementation programs are limited; the findings here confirm that the large scale programs including enriched flour, iron-folic tablets, iodized salt and vitamin A drops reached less than half of the rural *Dalit* study population.

Dietary intake in mothers

Mothers from intervention villages had higher energy and protein intakes during both seasons than mothers from control villages. Surprisingly, in both groups the energy intake was similarly higher during the summer and the rainy season, perhaps due to more mothers from the intervention villages being pregnant in both seasons. According to the 1993-94 data of the National Sample Survey about 80% of India’s rural population had energy intakes

Table 3. Nutrient intakes of *Dalit* mothers in intervention and control villages during summer and rainy seasons[1]

Nutrient	*Summer Season* Intervention villages n = 125	Control villages n = 109	*p*	*Rainy Season* Intervention villages n = 124	Control villages n = 96	*p*
Energy, *kJ*[3]	12,218 (3,511) 11,437 (9,941, 14,713)	11,155 (3,347) 11,117 (9,173, 13,663)	0.02[2]*	11,189 (3,335) 10,769 (8,623, 12,986)	10,193 (3,738) 10,038 (7,850, 12,432)	0.04[2]*
Protein, *g*[3]	77.5 (25.1) 74.8 (60.2, 98.6)	71.1 (25.2) 69.5 (50.5, 87.8)	0.05[2]*	68.9 (22.6) 66.4 (53.5,82.2)	60.4 (23.8) 61.8 (42.6, 75.2)	<0.01[2]*
Carbohydrates, *g*	578 (175) 549 (467, 705)	519 (170) 525 (416, 636)	0.01[2]*	535(162) 513 (425, 626)	490 (191) 479 (384, 606)	0.06[2]
Fat, *g*	31.6 (14.4) 27.6 (21.2, 37.6)	32.9 (15.5) 29.2 (22.7, 40.2)	0.54	27.1 (14.7) 24.2 (17.1, 33.9)	24.6 (11.7) 23.9 (17.9, 28.3)	0.36
Dietary fibre, *g*	48.5 (23.2) 46.8 (32.6, 60.1)	42.0 (23.1) 39.4 (22.5, 54.8)	0.03*	40.8 (19.6) 41.8 (25.9, 52.6)	32.5 (19.3) 33.6 (16.0, 46.3)	<0.01*
Iron, *mg*[3]	20.8 (12.0) 18.9 (13.0, 24.5)	18.8 (12.1) 16.5 (12.1, 22.4)	0.09	15.8 (6.6) 15.3 (10.8, 20.5)	13.7 (9.1) 13.0 (7.6, 18.2)	<0.01*
Vitamin C, *mg*[3]	26.4 (31.0) 15.4 (2.1, 38.9)	33.0 (66.4) 12.4 (2.3, 33.6)	0.91	19.7 (35.5) 8.3 (2.1, 22.1)	21.7 (26.1) 11.0 (4.2, 31.4)	0.04*
Vitamin A, *µg RE*[3,4]	354 (629) 110 (54, 423)	275 (503) 103 (53, 376)	0.42	155 (271) 73 (48, 137)	163 (250) 75 (49, 146)	0.65

[1] Mean (SD) and Median (1st and 3rd quartile): Nonparametric test (Wilcoxon): * $p \leq 0.05$ statistically significant, all nutrient intakes (expect vitamin C) are higher ($p \leq 0.05$) during summer season compared to rainy season (Experimental villages: Summer (17), rainy (11); Control villages: summer (11), rainy (12) repeated 24-h recall); [2] *p* from two-sided pooled Student t-test; [3] Recommended levels for pregnant and lactating women with moderate activity level, respectively (26): Energy: 10,517 kJ, 10,937 kJ; protein: 60 g, 63 g; iron: 37 mg, 30 mg; vitamin C: 40 mg, 80 mg; vitamin A: 600 µg RE, 950 *µg* RE, respectively; [4] RE indicates Retinol Equivalent (1*µg* Retinol = 1*µg* RE, 6 *µg* provitamin A carotenoids = 1µg RE)

<10,080 kJ recommended for adults in rural areas. Moreover, 30% of India's population consumed on average < 7,140 kJ per day and the poorest 10 % consumed < 5,460 kJ per day.[6] Mean energy intakes in this study in both seasons and groups were >10,000 kJ and our study population belonged to the poorest segment of the rural communities.

It is assumed that activity levels of mothers in all villages were sedentary during summer, when labor demand was low. But during rainy season mothers who were working as agricultural labourer were classified with a moderate activity level.[25] As calculated from the Indian RDA, energy requirement of a standardized Indian woman (45 kg, 18-30 years) is increased by approximately 1,500 kJ with a moderate (9,257 kJ) compared to a sedentary activity level (7,792 kJ).[25] Both requirements are below the mean intake of energy in both groups.

The Indian adult requirement of protein is 1.0 g per kg body weight. An additional 15 g protein for pregnancy and 18 g for lactation gives an average standard requirement of 60 g protein for pregnant and 63 g protein for lactating mothers.[25] Mean protein intakes in the intervention and control groups were >60 g in both seasons. It is well established that for the majority of Indians, 70-80% of daily energy and >50% of daily protein comes from cereals, being the highest among the low income families.[12] Marginal-farmer households in rural India were reported to have 72% of energy and 68% of protein from cereals, which is similar to this study, but 4% of energy- and 10% of protein from pulses, which is lower than in our study.[13]

In India, the iron RDA is 30 mg for lactating and non-lactating women and 37 mg for pregnant women, based on the average absorption rate of 3%.[25] The estimated average requirement (EAR) for women aged 19-30 years in North America is 8.1 mg for non-lactating women, 6.5 mg for lactating women and 22 mg for pregnant women, with an established absorption rate of 18%.[26] In this study, mothers from all villages had median intakes <20 mg iron during both seasons. Although cereals are not rich sources of iron, they contributed significantly due to large daily consumption. Mothers from intervention villages had a higher intake of iron as well as dietary fibre during the rainy season, which is likely due to frequent sorghum consumption. However, pulses, rice and grains are also rich in phytate and tannin and hence interfere with iron availability. Vitamin C may enhance availability; how ever, median intakes in our study were <15 mg vitamin C, much lower than the Indian RDA for individuals of 40 mg for non-lactating and pregnant women and 80 mg for lac-

Table 4. Nutrient intakes of *Dalit* children aged 6 to 39 months from intervention and control villages during sumer and rainy seasons[1]

	Summer Season			*Rainy Season*		
Nutrient	Intervention villages n = 125	Control villages n = 108	*p*	Intervention villages n = 124	Control villages n = 96	*p*
Energy, *kJ*[2]	3,003 (1,625) 2,780 (1,365, 4,166)	2,646 (1,449) 2,352 (1,365, 3,734)	0.17	3,356 (1,856) 2,881 (1,835, 4,670)	3,230 (1,491) 2,940* (1,953, 4,200)	0.90
Protein, *g*[2]	15.4 (10.8) 12.0 (5.5, 22.9)	13.9 (10.0) 10.1 (5.5, 21.6)	0.24	18.5 (12.4) 14.6* (7.8, 26.2)	17.2 (10.0) 15.5* (8.8, 22.5)	0.90
Carbohydrates, *g*	121 (84) 101 (37, 191)	99 (72) 78 (35, 154)	0.06	139 (95) 117 (58, 204)	131 (76) 117* (67, 189)	0.99
Fat, *g*	17.5 (6.7) 17.0 (14.6, 20.1)	17.7 (6.1) 17.0 (14.6, 20.0)	0.87	17.9 (7.2) 17.1 (13.7, 21.2)	17.9 (6.5) 17.8 (15.0, 21.0)	0.62
Dietary fibre, *g*	4.7 (6.5) 1.7 (0.1, 7.4)	4.0 (5.7) 0.8 (0, 6.5)	0.20	6.7 (8.7) 3.4* (0.4, 10.6)	5.6 (6.8) 2.7* (0.5, 10.2)	0.81
Iron, *mg*[2]	2.8 (3.4) 1.5 (0.3, 4.2)	2.5 (3.5) 1.0 (0.2, 3.9)	0.19	3.4 (3.4) 2.3* (0.7, 5.0)	3.3 (4.1) 2.2* (0.7, 4.7)	0.86
Vitamin C, *mg*[2]	22.8 (14.2) 25.0 (17.5, 25.0)	23.0 (14.1) 25.0 (15.5, 25.0)	0.82	21.4 (16.8) 20.0 (17.5, 25.0)	20.4 (11.8) 20.8 (17.0, 25.0)	0.97
Vitamin A, *µg RE*[23]	248 (229) 205* (146, 216)	215 (172) 205 (145, 205)	0.17	163 (86) 179 (120, 206)	165 (93) 182 (132, 205)	0.64

[1] Mean (SD) and Median (1st and 3rd quartile): Nonparametric test (Wilcoxon); * statistically significant ($p \leq 0.05$) higher intake during summer or rainy season within groups: Human milk consumption was standardized: 500ml for children aged 6 to 12 months, 350 ml for children aged > 12 months (20). (Experimental villages: Summer (8), rainy (11); Control villages: summer (5), rainy (11) repeated 24-h recall); [2] Recommended levels for 1-3 year old boy and girls (26): Energy: 5,208 kJ; protein: 21 g; iron: 11.5 mg; vitamin C: 25 mg; vitamin A: 400 µg RE; [3] RE indicates Retinol Equivalent (1µg Retinol = 1µg RE, 6 µg Provitamin A carotenoids = 1µg RE)

tating women.[25]

The Indian RDA is 600 µg RE of vitamin A for non-lactating and pregnant women and 950 µg RE for lactating women.[25] Median vitamin A intakes for all mothers were below recommendations during both seasons and fat intakes were fairly limited (~10% of total energy). During the rainy season, green leafy vegetables provided half of the vitamin A in mothers with the majority from uncultivated greens, especially in rural and intervention villages. In rural Andhra Pradesh, sedentary lactating women aged ≥ 18 years had lower mean energy (9,131 kJ), mean protein (50 g), and median iron (8.9 mg) intakes than intakes observed in this study.[14] However, median fat (25.6 g) and vitamin A (106 µg) intakes were similar and vitamin C intake (22 mg) was higher. In India, marginal-farm households (0.5 to 1 acre) were reported to have lower energy (9,500 kJ) and protein (59 g) intakes and similar fat (33 g) intake per person per day compared with those reported here.[13]

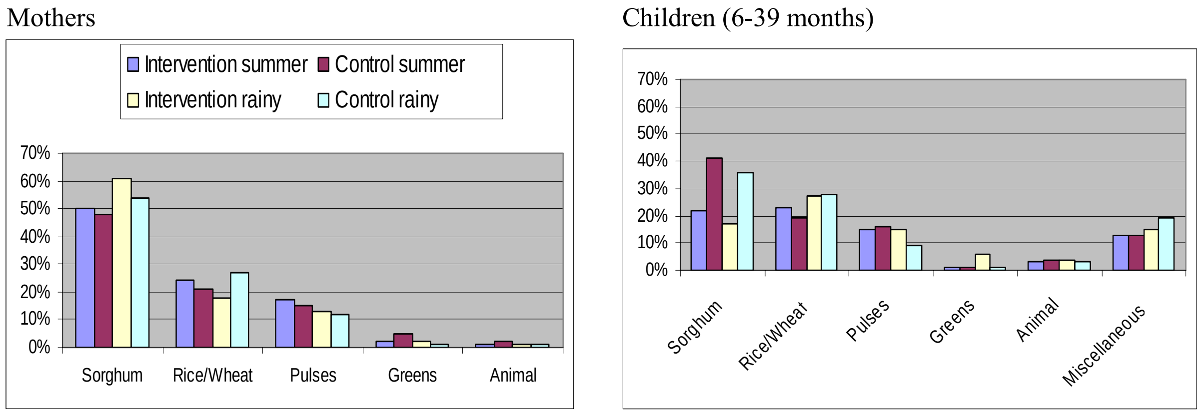
Dietary intake in young children

Energy and protein requirements for 1-3 year old Indian children are estimated at 5,208 kJ and 21 g protein per day.[25] Despite the fact that 37% of children in summer and 24% of children in the rainy season were aged <1 year, energy and protein intakes were much below recommendations. In India, it is recommended that young children aged 1-3 years have an intake of 11.5 mg iron per day.[25] Median intakes of iron in all children in this study were greatly below recommendations in both seasons. Most iron came from sorghum, rice and pulses; sorghum is not recommended as a major food source for children because of poor digestibility.[28]

Median vitamin C intakes were similar to Indian RDA of 25 mg[25] and it may therefore be assumed that iron is absorbed. The Indian RDA for children aged 1-3 years is 400 µg RE of vitamin A[25] and median vitamin A intakes in our study were <200 µg RE in the rainy season.

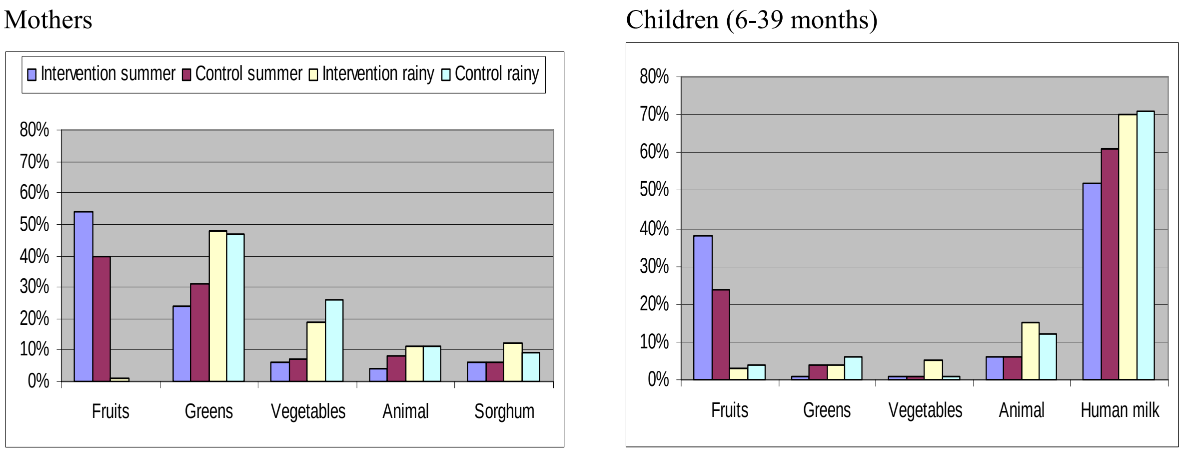
Research with tribal children in other parts of India showed differences with our results in that nutrients reported were higher or lower for energy and vitamin A, and higher for protein and iron, but seasonal differences and intakes from traditional cultural sources of food were not discussed.[29,30]

There are some limitations in this study. Firstly, vitamin A intakes reported here are likely overestimated, because



Pulses: Chickpea, black gram, green gram, khesaridal, lentil, pigeon pea, dry pea; Greens: 9 species of cultivated and 7 species of uncultivated green leafy vegetables; Animal: Eggs, 5 species of meat, milk and milk products; Miscellaneous: Jaggery, white bread /bun, iron-fortified biscuits, iron-fortified baby-food (Cerelac©, Boost©) and local nutritional supplement (soya-corn blend)

Figure 1. Percentages of total iron intakes in *Dalit* mothers and children from intervention and control villages by summer and rainy seasons



Fruits: Banana, grapes, mango, mulberry, orange, guava, lime and papaya; Greens: 9 species of cultivated and 7 species of uncul tivated green leafy vegetables; Vegetables: 20 species of vegetables, roots and tubers; Animal: Eggs, 5 species of meat, milk and milk products

Figure 2. Percentages of total vitamin A intakes in *Dalit* mothers and children from intervention and control villages by summer and rainy seasons

by necessity we converted the values estimated by colorimetry representing the sum of total carotene to β-carotene (no values were available for α-carotene and B-cryptoxanthin), and RE was used instead of the more recently recommended RAE to work in the Indian mode of dietary analysis. The recent finding that the bioconversion of carotene in dark green leafy vegetables is <¼ of that previously thought has raised doubts about the degree of efficacy of green leafy vegetables to improving vitamin A status.[31] Nevertheless, epidemiological evidence from India supports good bioavailability of dietary carotenoids, because vitamin A deficiency is rarely seen in communities where many carotene rich foods are consumed.[15] Secondly, while it is well established that 24-hour recalls are most appropriate for assessing average intakes of food and nutrients for large groups, vitamin A is not easily estimated with this technique[26], nor are nutrient intakes in young children.[32] Finally, assuming standard amounts of breast milk intake by age reduced the true variance of nutrient intakes and may have limited comparisons, particularly in the younger aged children.

In summary, mothers from villages with the APDS had higher energy, protein, dietary fibre and iron intakes than mothers from control villages. Mothers in all study villages had mean energy and protein intakes above, and median iron, vitamin C and vitamin A intakes below recommendations during both study seasons. Despite the assumed higher energy needs during the rainy season, energy and nutrient intakes were higher during the summer, which confirms that food is scarce during the rainy season. For mothers, traditional food items including sorghum, pulses and green leafy vegetables were major sources of energy, protein, iron, vitamin C and vitamin A. Uncultivated green leafy vegetables were a more important source of vitamin A in the intervention villages during the rainy season. Both groups of young children had median intakes of energy, protein, iron and vitamin A intakes below recommendations and are at risk for malnutrition. For children, no differences were seen between intervention and control villages. Human milk was a major source of energy, protein and vitamin A, and traditional food items including sorghum and pulses were important sources of energy, protein and iron.

In conclusion, traditional food items were widely consumed and were the main sources of energy, protein, iron, vitamin C and vitamin A in all villages for both mothers and young children. However, mothers from villages with support of the traditional food system through promoting indigenous agriculture practices showed increased energy, protein and iron intakes. These findings contribute evidence to evaluate, consider and promote traditional food systems as a first step to increase intake of critical nutrients in rural poor communities in India.

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Original Article

Intervention with traditional food as a major source of energy, protein, iron, vitamin C and vitamin A for rural *Dalit* mothers and young children in Andhra Pradesh, South India

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以傳統食物當作主要熱量、蛋白質、鐵質、維生素 C 及 A 來源介入印度南部 Andhra Pradesh 鄉下的 *Dalit* 母親及幼童

在印度，熱量、蛋白質、鐵質及維生素 A 的攝取通常被報告為不足。為確認傳統食物系統是能持久，多樣性高及富含營養素。我們比較居住在有無介入改善傳統 *Dalit* 食物系統可近性的村落中的 *Dalit* 母親及他們的小孩之飲食攝取及營養素來源在 2003 年夏季及雨季，以 24 小時回憶法評估 *Dalit* 母親及他們 6-39 個月大的小孩。我們發現在介入村落的母親，在夏季的熱量(平均值±標準差:12,129±3,515 KJ vs. 11,172 ± 3,352 kJ; p = 0.02) 及蛋白質 (77.5 ± 25.1 g vs. 71.1 ± 25.2 g; p= 0.05)顯著較高，在雨季則熱量(11,168 ± 3,335 kJ vs. 10,168 ± 3,730 kJ; p= 0.04)，蛋白質 (68.9 ± 22.6 g vs. 60.4 ± 23.8 g; p<0.01)及鐵質(15.8 ± 6.6 mg vs. 13.7 ± 9.1 mg; p<0.01)攝取較多。幼童部分不論是介入村落或是控制組村落之間均沒有差異。母親方面，29%的熱量、33%的蛋白質及 53%的鐵質來自高粱；21%的維生素 C 及 38%的維生素 A 來自綠色蔬菜。我們的結果指出，如高粱、豆類植物及綠色蔬菜等傳統食物是熱量、蛋白質、鐵質、維生素 C 及維生素 A 的主要來源，而那些有傳統食物介入的村落母親有較高的熱量、蛋白質及鐵質的攝取。

關鍵字：食物基礎介入、營養不良、印度、原住民、***Dalit***。