Chapter 6

The Dalit food system and maternal and child nutrition in Andhra Pradesh, South India

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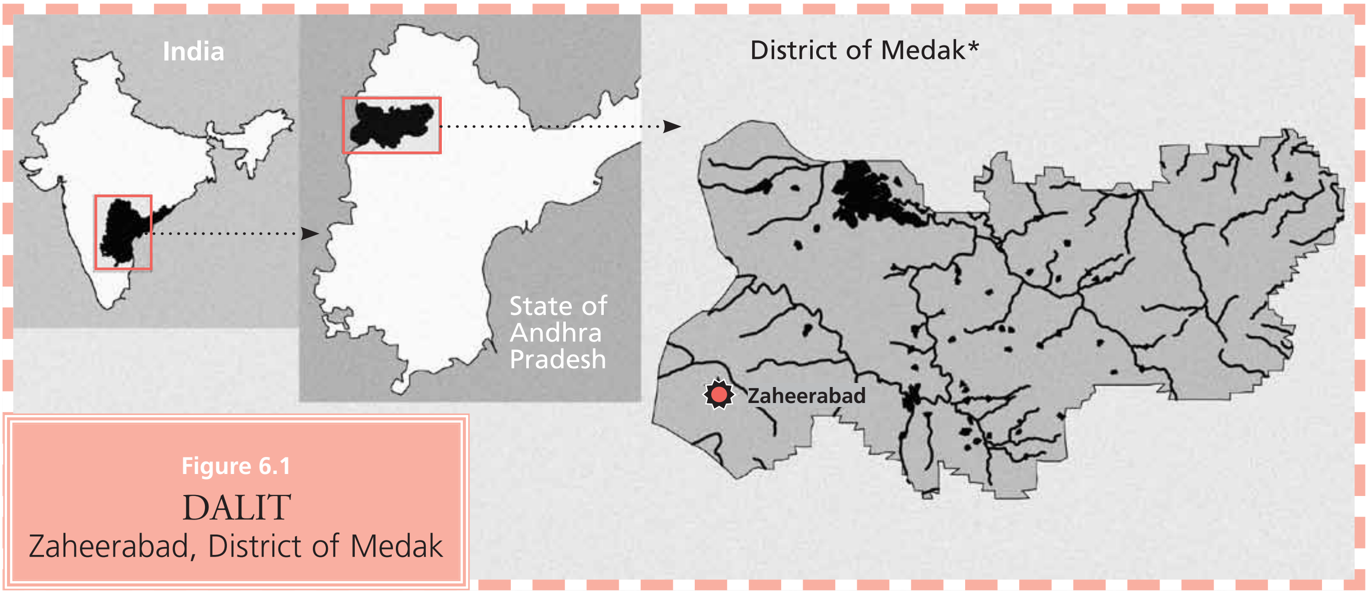

Figure 6.1

DALIT
Zaheerabad, District of Medak

Data from ESRI Global GIS, 2006.
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Photographic section >> VII

"Today, if I look back, I can sense a sea-change in my life, and what is so exhilarating about it is the feeling of control that we are experiencing. Earlier, we were like drift-logs being swept here and there by external forces. We had to work for others on lands alien to us. We did not feel that anything belonged to us. We were just being used. But now, thanks to the *sangham*, we are shaping our life in a way that we have chosen on our own."

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Abstract

The food system of Dalit rural communities in the Zaheerabad region of south India includes 329 species/varieties of plants and animals, and unique patterns of food use. This chapter describes the effectiveness of using the local food system promoted through women farmers' organizations – called *sanghams* – in the area. The *sanghams* modified a national food distribution system for the poor, and named it the Alternative Public Distribution System (APDS). *Sanghams* worked closely with the Deccan Development Society to conduct many activities promoting local foods. A cross-sectional evaluation of APDS was conducted among pairs of a Dalit mother and her child (aged six to 39 months), from 57 villages in Medak District, 19 of which had active *sanghams*. Information was collected through dietary interviews in two seasons, socio-cultural interviews, anthropometry, and clinical examinations in the rainy season when health risks are highest. Results demonstrated that 58 percent of mothers suffered from chronic energy deficiency (CED), with higher rates among illiterate and active women; one-third of women were affected by night blindness during pregnancy; and 10 percent were identified as iron-deficient, based on pallor under the eyelid.

While children in all villages were similarly nourished, mothers in villages with the APDS programme had higher intakes of energy, protein, fibre, vitamin C and iron from greater consumption of sorghum, pulses, vegetables and animal-source foods. Traditional food fats, pulses and vegetables, roots and tubers showed protective associations against women's CED, after adjusting for number of children under five years of age and sanitation situation. Greater consumption of eggs and dairy products protected against night blindness, and uncultivated leafy greens were important for providing vitamin A during the rainy season. In conclusion, traditional Dalit foods were widely consumed, with associated positive health benefits in poor, rural communities in this district of India. These biodiverse, often unique foods should be promoted for their contributions to ecological farming and local culture and their benefits for food and nutrition security.

Context

Sorghum (*jowar*), pearl millet (*bajra*), finger millet (*ragi*) and foxtail millet (*korra*) are coarse cereals that have been mainstays of agriculture, diet and cultural systems in rural India. This is especially so in the vast dryland belts spreading across the Deccan plateau, north Karnataka, Marathwada, the deserts of Rajasthan, and many tribal areas in central India. These drylands are heavily populated with poor rural people. Agriculture is rainfed, and farming of these crops covers up to 65 percent of the geographical area, demanding few external inputs such as irrigation and fertilizer. For poor rural communities, such crops provide food security and sustainability at minimal cost. However, there is lack of political will in the country to achieve food security through such coarse cereals.

The Dalit are recognized as the "untouchables" (formally known as the "scheduled castes"), the fifth group below the four classes in the Hindu religion. There are more than 180 million Dalit in India; the majority are illiterate and landless, and work as farm labourers. Although the term "untouchability" has been abolished in law, Dalit are known to suffer severe caste-imposed discrimination that affects every aspect of life (IHEU, 2010; Minority Rights Group International, 2010), and Dalit women and children are likely to be the most poorly nourished sub-groups in India. Within the area studied, self-identified Dalit women are farm labourers, living and working close to the food growing areas of Zaheerabad.

Surprisingly, one of the major contributors to the problem of food insecurity for Dalit and others is the Public Distribution System (PDS). Possibly the largest affirmative action in the world, the PDS provides subsidized food at cheap prices to the poor, but concentrates on only two grains: refined rice and wheat. This massive programme covering all of India provides a regular and continued supply of these grains from the market and distributes them to the poorest people; the resulting steady prices make agriculture remunerative and attractive for rice and wheat farmers, who are already supported by subsidized irrigation, subsidized fertilizers and adequate crop insurance.

Deccan Development Society initiatives

This is the context in which the Deccan Development Society (DDS) operates. The 5 000-plus members of this grassroots organization are primarily agricultural labourers and marginal farmers owning 1 or 2 acres (about 0.4 to 0.8 ha) of farmland. In most cases, these lands are either *inam* (gift) lands given to the farmers by their landlord-employers, or lands assigned by the government as part of its land reform programme. Most of these lands are degraded red soils, producing only about 30 to 50 kg of grains per acre (75 to 125 kg/ha). The grains produced by members of DDS *sanghams*[1] satisfy food needs for six to seven months a year. Addressing food insecurity for the other four to five months is a challenge, for both families and DDS.

The PDS has the potential to be a crucial policy instrument for food security and political stability in India. It plays an important role in averting famines by purchasing grain from surplus regions to be sold for a fair price in food-deficit/low-income regions. However, as part of the market-driven/irrigation-centred agricultural policies of the government and development agencies, the PDS has encouraged a new pattern of food consumption in the semi-arid tropical regions of India. The poor have shifted from a diet of locally grown rainfed cereals such as sorghum and millets to one of rice and other irrigated crops imported from distant areas, leading to a decline in the cultivation of dryland cereals and associated intercrops (pigeon pea, field bean, cow pea and other beans). Recognizing that the cheap rice-based PDS was destroying the agriculture of the poor in dryland areas, women members of DDS articulated the crux of the problem:

- "Cheap rice is attractive. But in the bargain we left our lands fallow."
- "We hanker after rice and neglect our own lands."

Extended discussions between women farmers and DDS since as far back as the mid-1980s have sought solutions to the problems of threatened agricultural practices and food insecurity for rural societies. When imports of subsidized rice through the PDS made it uneconomical for small farmers to cultivate their lands and grow the coarse cereals and pulses that are the backbone of their agriculture and traditional food, the plots owned by small and marginal farmers were left fallow, leading to the abandonment and degradation of productive land. The direct result of this increase in fallow land was a marked decline in the production and availability of traditional cereals, pulses and animal fodder. This affected the nutrition of rural people,

1 A *sangham* is a volunteer collective of poor women farmers, primarily Dalit, working within DDS in Andhra Pradesh, where each village has its own *sangham*.

especially women and children, and increased the shortage of draught animal power (Women's *Sanghams* of the Deccan Development Society, Satheesh and Pimbert, 1999).

One strategy suggested was to reclaim the fallow land, and to use deep ploughing and manure to grow food crops for family use. However, this approach required investments of approximately 2 600 rupees (INR) per acre (equivalent to about USD 83 per acre at the time). To obtain funding, women farmers of dryland crops campaigned to reverse unfavourable loan policies, and DDS approached the Indian Ministry of Rural Development. In 1994, this resulted in approval of the Community Grain Fund (CGF), which was distributed in agreement with the Government of India through the PDS. Under this arrangement, groups of largely illiterate and poor women set up and ran a community-managed Alternative PDS (APDS) based on coarse grains, which are produced, stored and distributed locally in 30 villages around Zaheerabad. The women deposit their excess grain in the CGF to repay for the loans they receive from the PDS.

Each *sangham* formed a committee of about five women to design and implement activities on about 100 acres (40 ha) of fallow land in each of the 30 villages. Overall, the committees found a total of 2 675 acres of suitable land, divided fairly equally among the villages. The women's committees then each selected about 20 acres (8 ha) on which to supervise the work of other women farmers, to ensure appropriate ploughing, manuring, sowing and weeding practices on the reclaimed fallow land. The committee members collect input support funds from the government and distribute them among the women's collectives managing the reclaimed fallow land. Under the current system, after each crop harvest, the committee members are responsible for collecting loan repayments in the form of grain from participants, and for storing the grain. Later in the year, during the season of food scarcity, the committee members sell this grain at greatly reduced prices to poorer households in the village, applying a quota system, with sale proceeds deposited in the village CGF account. Each of the 30 villages has its own account, controlled and managed by women committee members who are accountable to the villagers and to DDS.

By using the grain received from participating farmers to distribute to poorer households at a subsidized price, this system feeds the participating farmers' loan repayments back into the local village economy to support the very poorest, allowing them to obtain sufficient food and become more productive members of the community. Transparent procedures ensure that the money earned from sales of sorghum goes back into the CGF account held by the village committee. This money is used annually to reclaim more fallow land in the village, thus helping to increase productivity through diversifying farming systems and the use of locally available resources. More food is produced and sold locally, and job opportunities are created for people who would otherwise be excluded from the mainstream economy.

DDS documented the local food resources of the APDS communities in the Zaheerabad region of Andhra Pradesh. An amazing array of 329 species/varieties of local foods were recorded in their scientific, local Telugu and common English names, along with information about how they are prepared by village women (Salomeyesudas and Satheesh, 2009). Several previously unidentified plants were documented, as well as several plants recognized as "uncultivated greens". Nutrient composition was analysed in collaboration with scientists at the National Institute of Nutrition (NIN) in Hyderabad, and several food items were analysed for the first time. These food data were instrumental in creating the database for nutrient analysis of dietary data reported in this chapter.

Other major intervention activities

In addition to reclaiming land and redistributing it to women farmers, other community interventions that had a large impact on the food and nutrition security of families, mothers and children included:

- awareness campaigns focusing on traditional food systems;
- establishment of "Café Ethnic", serving millet-based foods;

- establishment of a community media trust, producing films on millets, recipes and uncultivated foods;
- cooking classes for family carers and hostel cooks;
- development of a millet processor;
- distribution of educational material to various agencies;
- promotion of food production systems based on agricultural biodiversity;
- food festivals at public places, fora, schools and colleges;
- formation of an organic farmers' association;
- formation of Zaheerabad consumer action group;
- provision of millet-based meals at day care centres;
- mobile biodiversity festivals;
- development of a mobile organic shop;
- networking with voluntary organizations from the local to the international level;
- establishment of an organic shop for sales of traditional foods;
- participation at national and state-level food festivals;
- publication of scientific information in the local language (Telugu);
- recipe competitions;
- screenings of recipe films;
- training in product packaging for traditional food crops;
- creation of a women's radio station by a community media trust.

Major impacts of the Alternative Public Distribution System

The main impacts of the APDS perceived by participants and others are:

- increased soil fertility;
- increased soil conservation;
- decreased crop disease, due to diverse cropping systems;
- increased availability of uncultivated greens from *sangham* fields;
- increased diversity of food for families;
- increased self-reliance;
- more work opportunities in the villages;
- reduced seasonal migration;
- increased animal fodder and livestock population;
- more dried plant materials for roofing, fencing, etc.;
- revival of rural livelihoods, such as blacksmithing and basket weaving;
- better and more food;
- improved health in families;
- increased knowledge about nutrition from local foods;
- more children attending school.

Rationale and research questions

The rationale for the study reported in this chapter was the need to evaluate the overall effects of APDS activities on the health of *sangham* households, especially among mothers and children, in the Zaheerabad Region of Medak District, Andhra Pradesh, south India. Mothers and young children agreed to take part to help increase knowledge about the seasonal use of traditional food crops; intakes of energy, protein, iron, vitamin A and other nutrients; and clinical signs of malnutrition. Comparative evaluation was conducted in villages with and those without the APDS. The following research questions were asked:

- Do Dalit mothers and their young children aged six to 39 months living in villages where the APDS is operating consume more traditional food during the summer season and the rainy season than Dalit mothers and their children from control villages (without the APDS)?
- Do Dalit mothers and their young children living in villages with the APDS have higher nutrient intakes (energy, protein, carbohydrates, fat, dietary fibre, iron, vitamin C and vitamin A) during the summer season and the rainy season, and better nutrition status during the rainy season than Dalit mothers and their children in control villages?
- Are consumption patterns and nutrient intakes predictors of nutrition status (chronic energy deficiency [CED], anaemia and vitamin A

deficiency) in Dalit mothers and their young children during the rainy season?

The research was epidemiological in nature. This chapter summarizes its results to evaluate the overall impact of DDS activities on food use and nutrition status among Dalit in the Zaheerabad Region of Andhra Pradesh.

Methods

Participatory research process

All the villages participating in the study were asked for their consent. *Sangham* leaders were consulted first, and the purpose of the study was explained to them at a meeting organized by DDS. Formal ethical approval was obtained from the Human Research Ethics Committee of McGill University (Canada). The village leaders discussed issues with the researchers and project leaders, and agreed to cooperate in the study. Researchers then visited individual villages to participate in *sangham* meetings and select individual study participants. Written consent was obtained from each of the identified mothers and from the *sangham* leaders. NIN trained six graduate students from Indian universities in interview techniques, which included a seasonal food frequency questionnaire, a 24-hour recall, a socio-cultural questionnaire, anthropometric measurement, and assessment of clinical signs. All interview schedules were translated into the local Telugu language and field tested to improve their validity. Data were obtained at the subjects' convenience, in their own homes and with their families' consent. The objectives and purpose of the study were clearly explained in *sangham* meetings to ensure maximum cooperation, and results were similarly presented. Two fruit trees were given to each participating household, in appreciation of its time and effort.

A cross-sectional sampling design was used in six rural townships (*mandals*) in Medak District, where a total of 263 Dalit mothers, each with a child aged six to 39 months, were found eligible, from 19 villages that had been implementing the APDS since its inception in 1995 and 18 villages without the APDS. All the participating households were members of their village DDS *sangham*, and only one mother per household was included. In households were there were two eligible mothers, the mother who was at home at the time of the survey was chosen. Mothers under 15 years of age and/or with twins were excluded. Of the 263 eligible mothers contacted, 223 participated in interviews in both the summer season and the rainy season of 2003. Of the 43 (16 percent) mothers who were unable to participate, 19 were working in the nearby city (7 percent), seven had recently given birth (3 percent), 16 were absent from the village at the time of the survey (6 percent), and one refused.

Summer season interviews administered an 83-item food frequency questionnaire (FFQ) and rainy season interviews one of 106 items. The FFQs were based on existing information from DDS on the seasonal availability of food species, personal preferences and market availability. Thirty-one items of foodgrains, nuts, oilseeds, pulses and animal foods were included in both seasons. Fruits, green leafy vegetables, other vegetables, roots and tubers were included according to seasonal availability. The summer season FFQ included 14 vegetables, six cultivated green leafy vegetables, ten wild green leafy vegetables, 11 cultivated fruits and 11 wild fruits. The rainy season FFQ included 15 vegetables, 14 cultivated green leafy vegetables, 36 wild green leafy vegetables, six cultivated fruits and three wild fruits. Frequencies were in number of days that the food item had been consumed during the season (each season was of two months or 60 days). Mothers' consumption frequencies of nuts and oilseeds, vegetables, roots and tubers, animal foods, green leafy vegetables, eggs, milk and milk products, meat and fruits were averaged across both seasons. The two-season average consumption frequencies of sorghum, rice and pulses were combined with the average amounts consumed, obtained from 24-hour recalls, to estimate average total amount consumed per day.

Mothers' nutrient intakes were calculated from a minimum of two 24-hour recalls per season. Recalls were obtained according to standard procedures adapted from the National Nutrition Monitoring Bureau surveys used by NIN. Each mother was asked to recall her own and her child's food intakes from the preceding day, and detailed descriptions of all the food and beverages consumed were recorded, including cooking methods and brands. Quantities of food consumed were weighed on digital kitchen scales (ATCO Model No D2RS-02-W) to the nearest gram, or were estimated with household measures or standardized vessels. For cooked dishes, such as dhal and curry, all the raw ingredients used for the family were weighed, and the volumes consumed by the mother and child were estimated from this. A standardized 12-vessel set was used to estimate volumes of cooked foods and liquids. The individual raw intake of each ingredient of cooked dishes was calculated, and standardized recipes and standard conversion factors for cooked rice were used for missing ingredients or missing volumes of dishes cooked for the family. Standard breastmilk consumption was assumed for breastfed children: 500 ml per day for children aged six to 12 months, and 350 ml per day for those aged one to three years (Belavady, 1969).

Nutrient values published by India's NIN (Gopalan *et al.*, 1989) were used, with missing nutrient values or food items and the values of total dietary fibre taken from Association of Southeast Asian Nations (ASEAN) food composition tables (Puwastien *et al.*, 2000) or European food composition and nutrition tables (Souci, Fachmann and Kraut, 1994). Food energy was calculated by assuming protein, carbohydrate and fat yields of 4, 4 and 9 kcal/g respectively. These were then converted into kilojoules (kJ) using the conversion rate of 4.2 J per calorie (4.2 kJ = 1 kcal). Pro-vitamin A carotenoids were converted into retinol equivalents (RE), assuming 6 µg β-carotene equals 1 µg RE. In the absence of β-carotene values, it was assumed that 6 µg total carotene equals 1 µg RE. The β-carotene values determined by high-performance liquid chromatography from recent publications were used whenever available (Bhaskarachary *et al.*, 1995; Rajyalaksmi *et al.*, 2001).

For some multivariate analyses, nutrient intakes from intervention (with APDS) and control (without APDS) villages were determined as population group totals for mothers and children, using a single 24-hour recall. Within each population group, nutrients were pooled into nine food groups, separately for the summer season and the rainy season: other food grains (wheat and maize); nuts and oilseeds (eight species); pulses (nine species); animal foods (nine items); green leafy vegetables (nine cultivated and seven wild species); vegetables (20 species); fruits (seven species); drinks (three items); and miscellaneous (11 items). The percentage contribution to each season's total nutrient intakes made by each of the food groups and single food items (sorghum, rice, cooking oil) was determined and ranked. Nutrient intakes were estimated using Candat (Canadian Nutrient Data Analysis Toronto, Version 5.1, 1988, Godin Incorporated, London, Ontario, Canada), based on nutrient values from the Indian food composition tables (Gopalan *et al.*, 1989).

Anthropometric measurements

Anthropometric measurements, a socio-cultural questionnaire and an eye examination were administered during the rainy season. Portable height rods (Galaxy Informatics, Delhi, India) were used to measure the height of mothers, with an accuracy of 1 mm. Mothers' weights were measured on a digital balance (SECA BELLA 840, Hamburg, Germany), with an accuracy of 100 g. Women with a body mass index (BMI) of less than 18.5 kg/m² were classified as CED, using standard cut-off points (James, Ferro-Luzzi and Waterlow, 1988). Pregnant women (n = 14) were excluded from the CED analyses.

Young children were measured with portable infantometers (Galaxy Informatics, New Delhi, India), measuring lengths of 56 to 92 cm with an accuracy of 1 mm; the digital balance was a Tansi (Tamilnadu Small Scale Industry) hanging manual baby balance with a maximum measurable weight of 20 kg and an accuracy of 50 g; non-stretchable plastic tape (Dritz, Germany) with an accuracy of 1 mm was used to measure arm circumference.

Standard procedures based on international standards were used for all measurements (Lohman, Roche and Martorell, 1988). Weight and height measurements were taken without shoes and with minimal clothing. Mid-upper-arm circumference (MUAC) was measured on the left arm. The weight of the jewellery worn by mothers and children was recorded – mothers know this weight because of the economic value of silver. If a mother or child had more than 100 g of jewellery, which was rare, the weight was subtracted from the measured weight. Interviewers had one day of training, with practice measurements performed on children in a nearby village school.

Table 6.1 Variables of interest for determinants of CED, clinical vitamin A deficiency symptoms and iron deficiency in Dalit mothers

Variable	*Index category*
Variables for chronic energy deficiency (BMI < 18.5 kg/m²)	
Energy intake	kcal/day
Carbohydrate intake	% of energy
Fat intake	% of energy
Dietary fibre intake	g/day
Rice consumption	g/day
Sorghum consumption	g/day
Pulse consumption	g/day
Frequency of nuts and oilseeds	days
Frequency of vegetables, roots and tubers	days
Frequency of animal foods (meat, eggs, milk, milk products)	days
Variables for clinical vitamin A deficiency (Bitot's spot, conjunctival xerosis, night blindness)	
Nutritional supplement (enriched flours)	yes
Fat intake	% of energy
Vitamin A intake (RE)	µg RE/day
Sorghum consumption*	g/day
Pulse consumption*	g/day
Frequency of green leafy vegetables	days
Frequency of eggs, milk and milk products	days
Frequency of fruits	days
Variables for iron deficiency (under eyelid pallor)	
Nutritional supplement (enriched flours)	yes
Iron-folic acid tablets	yes
Energy intake	kcal/day
Dietary fibre intake	g/day
Iron intake	mg/day
Vitamin C intake	mg/day
Rice consumption*	g/day
Sorghum consumption *	g/day
Pulse consumption*	g/day
Frequency of green leafy vegetables	days
Frequency of meat	days

Dietary intakes and consumption frequencies for the summer season and the rainy season of 2003.
* Obtained from averages of two to four 24-hour recalls and food frequency questionnaires during the summer season and the rainy season.
Source: Adapted from Schmid *et al.*, 2007.

Table 6.2 Variables of interest for determinants of stunting, wasting, underweight and iron deficiency in Dalit children aged 6 to 39 months

Variable	*Index category*	*Reference category*
Adjusting variables		
Age	6–12, 13–24 or 25–39 months	6–12 months
Sex	male or female	female
Housing	permanent house or traditional hut	permanent house*
Feeding status	weaned, complementary fed or breastfed	weaned
Duration of exclusive breastfeeding (including water)	≥ 6 months or < 6 months	≥ 6 months
Nutrition supplements (enriched flour)	yes	no
Vitamin A drops	yes	no
Protein energy malnutrition (stunting, wasting, underweight)		
Energy intake	≥ 1 220 kcal/day or < 1 220 kcal/day	≥ 1 200 kcal
Protein intake	≥ 21 g/day or < 21 g/day	< 21 g
Vitamin A intake (RE)	≥ 200 µg RE/day or < 200 µg RE/day	< 200 ±g
Frequency of sorghum consumption	days	-
Frequency of pulses consumption	days	-
Frequency of green leafy vegetables consumption	days	-
Frequency of animal food consumption	none, less than daily or daily	none
Iron deficiency (under eyelid pallor)		
Energy intake	≥ 1 220 kcal/day / < 1 220 kcal/day	≥ 1 200 kcal
Fibre intake	≥ 5 g/day / < 5 g /day	< 5 g
Iron intake	≥ 6 mg /day / < 6 mg /day	< 6 mg
Vitamin C intake	≥ 25 mg /day / < 25 mg /day	< 25 mg
Frequency of sorghum consumption	days	-
Frequency of pulse consumption	days	-
Frequency of green leafy vegetable consumption	days	-
Frequency of meat consumption	none/less than weekly/weekly	none

Nutrient intakes (from 24-hour recalls) and food consumption frequencies (from food frequency questionnaires) for the rainy season of 2003.
* House with or without a permanent roof.
Source: Adapted from Schmid *et al.*, 2007.

Eye examination

Mothers self-reported any night blindness (XN) they were suffering at the time of the survey and/or had suffered during their last pregnancy, noting the month(s) of pregnancy affected. Standardized terms for night blindness in Telugu were used, according to NIN procedures. The eyes of mothers and children were examined by trained interviewers who assessed the prevalence of clinical vitamin A deficiency, including Bitot's spot (X1B), conjunctival xerosis (X1A) and corneal xerosis (X1A), as classified by the World Health Organization (WHO) (McLaren and Frigg, 2001). Iron deficiency was classified according to whiteness or pallor in the inside lower eyelid (Gibson, 1990).

Statistical analysis

Data from mothers and children were analysed separately for the summer season and the rainy season. Chi-square analysis was used for dichotomous and categorical characteristic variables. When the expected count of the Chi-square was below 5, Fisher's Exact Test was used. The non-parametric (Wilcoxon) test was used for abnormally distributed data, including for all the nutrient intakes of children, and for the fat, dietary fibre, iron, vitamin C and vitamin A intakes of mothers. The paired Student's t-test was used to compare the means of normally distributed continuous variables between intervention and control villages. The paired Student's t-test and signed rank test were used to compare summer season and rainy season data in intervention and control villages. Differences in the intakes of each nutrient in each season between the intervention and control groups were tested for, and no significant differences were observed. A two-sided alternative hypothesis was tested with alpha at 0.05. Data from one child from a control village in the summer season were missing.

Descriptive statistics were used to provide means, standard deviations and percentages. Unadjusted relative risks and 95 percent confidence intervals (CIs) were calculated for categorical risk factors. Beta coefficients, standard errors and p-values were obtained from multivariate logistic regression analyses in which nutrient exposures were evaluated for their associations with outcomes, taking into consideration important determinants. Determinants for CED, clinical vitamin A deficiency and iron deficiency in mothers were examined separately. The following variables were considered in univariate and multivariate analyses: mother's age (years), number of children under five years of age (one or more), mother's physiological status (lactating, pregnant or neither), mother's activity level (moderate or low), household income above or below the poverty line (INR 1 000 per month), mother's literacy (ability to read and write), and household's lack of sanitation (i.e., an open field toilet). One woman was both pregnant and lactating, and was considered pregnant in all analyses.

Table 6.1 gives the nutritional variables explored for their association with CED, clinical vitamin A-deficiency symptoms and iron deficiency (pallor) in mothers. Nutritional factors that were correlated with each other in bivariate analyses were not entered together into multivariate models. Variables of interest for determinants of stunting, wasting, underweight and iron deficiency (pallor) in children aged six to 39 months are given in Table 6.2. Statistical analyses were conducted with SAS Version 8 (SAS Institute Inc., Cary, North Carolina, United States of America). Data sampling, rationale and analysis processes are described in greater detail by Schmid *et al.* (2006 and 2007).

Results and discussion

Mothers' dietary intake

The characteristics of mothers in intervention and control villages are given in Table 6.3. Mothers in both groups were similar with respect to most variables, but mothers from intervention villages (who were generally further from village centres) were daily labourers in the rainy season, so were assumed to have increased energy needs. More mothers were pregnant during the summer season than the rainy season, and about half of the mothers had taken iron-folate tablets while pregnant with the child included in the study.

Mothers from intervention villages had significantly higher intakes of energy (by about 1 000 kJ), protein (by about 8 g) and dietary fibre (by about 8 g) during both the summer season and the rainy season than mothers from control villages (Table 6.4). The percentage of total energy from fat was approximately 10 percent for all mothers in both seasons. The median iron intake of mothers from intervention villages was higher in both seasons, and significantly higher during the rainy season. Vitamin C intakes during the summer season were similar in both groups, but the median vitamin C intake in mothers from control villages was significantly higher during the rainy season. Mothers' fat and vitamin A intakes were similar in both intervention and control villages. In both groups, all nutrient intakes except for vitamin C were higher ($p \le 0.05$) during the summer season than the rainy season.

Mothers' main sources of energy and protein were sorghum, rice and pulses, contributing 31, 48 and 9 percent, respectively, of total energy, and 35, 36, and 22 percent of total protein in intervention villages; similar values were found in control villages. Millet was consumed by fewer than 1 percent of mothers in both groups.

Table 6.3 Characteristics of Dalit mothers in intervention and control villages

Variable	*Description*	*Mothers (n = 220)*
Age	mean years (SD)	24.3 (3.9)
Weight*	mean kg (SD)	40.9 (5.7)
Height	mean cm (SD)	150.0 (5.0)
MUAC	mean cm (SD)	22.5 (2.0)
BMI*	mean kg/m² (SD)	18.2 (2.2)
BMI	grade 0 (BMI ≥ 18.5 kg/m²)	42%
	grade 1 (BMI < 18.5 kg/m²)	28%
	grade 2 (BMI < 17.0 kg/m²)	20%
	grade 3 (BMI < 16.0 kg/m²)	10%
Literate	read and write	79%
Open field toilet	lack of sanitation	94%
Woman's status	lactating	81%
	pregnant	6%
	neither	13%
Active	work in fields and other agricultural activities	71%
Clinical vitamin A deficiency		
None	no symptoms	84%
Night blindness (XN)	self-reported	7%
Bitot's spot (X1B)	examined	5%
Conjunctival xerosis (X1A)	examined	6%
Reported night blindness during pregnancy	yes	35%
Iron deficiency		
Inside of lower eye lid	white (pallor)	10%

Figures are means with SDs in brackets, or percentages from data collected during the rainy season of 2003.
* n = 207, pregnant mothers excluded.
Source: Adapted from Schmid *et al.*, 2007.

Primary sources of iron were sorghum, rice and pulses (Figure 6.2), contributing 56, 16 and 15 percent, respectively, to total iron intake in intervention villages, and similar percentages in control villages. Animal-source food contributed less than 2 percent in both groups. Cereals (sorghum, rice and wheat) contributed 79 percent in intervention villages compared with 68 percent in control villages. Cultivated and uncultivated green leafy vegetables contributed 2 percent of total iron intake and 11 percent of total vitamin C intake in intervention villages, and about three times as much to intakes in control villages.

Fruits and vegetables were major sources of vitamin A (Figure 6.3). During the summer season (mango season), fruits contributed 54 percent of vitamin A in intervention villages and 40 percent in control villages; in the rainy season, uncultivated green leafy vegetables contributed 43 percent of vitamin A in intervention villages and 36 percent in control villages. Vegetables, roots and tubers contributed 19 percent in intervention villages and 26 percent in control villages. Overall, sorghum and animal-source food items contributed 9 and 8 percent, respectively, of vitamin A in intervention villages, and similar percentages in control villages.

Mothers from intervention villages had higher energy and protein intakes in both seasons than mothers from control villages. Surprisingly, the difference in energy intakes was similar in both the summer season

Table 6.4 Nutrient intakes of Dalit mothers in intervention and control villages, by season

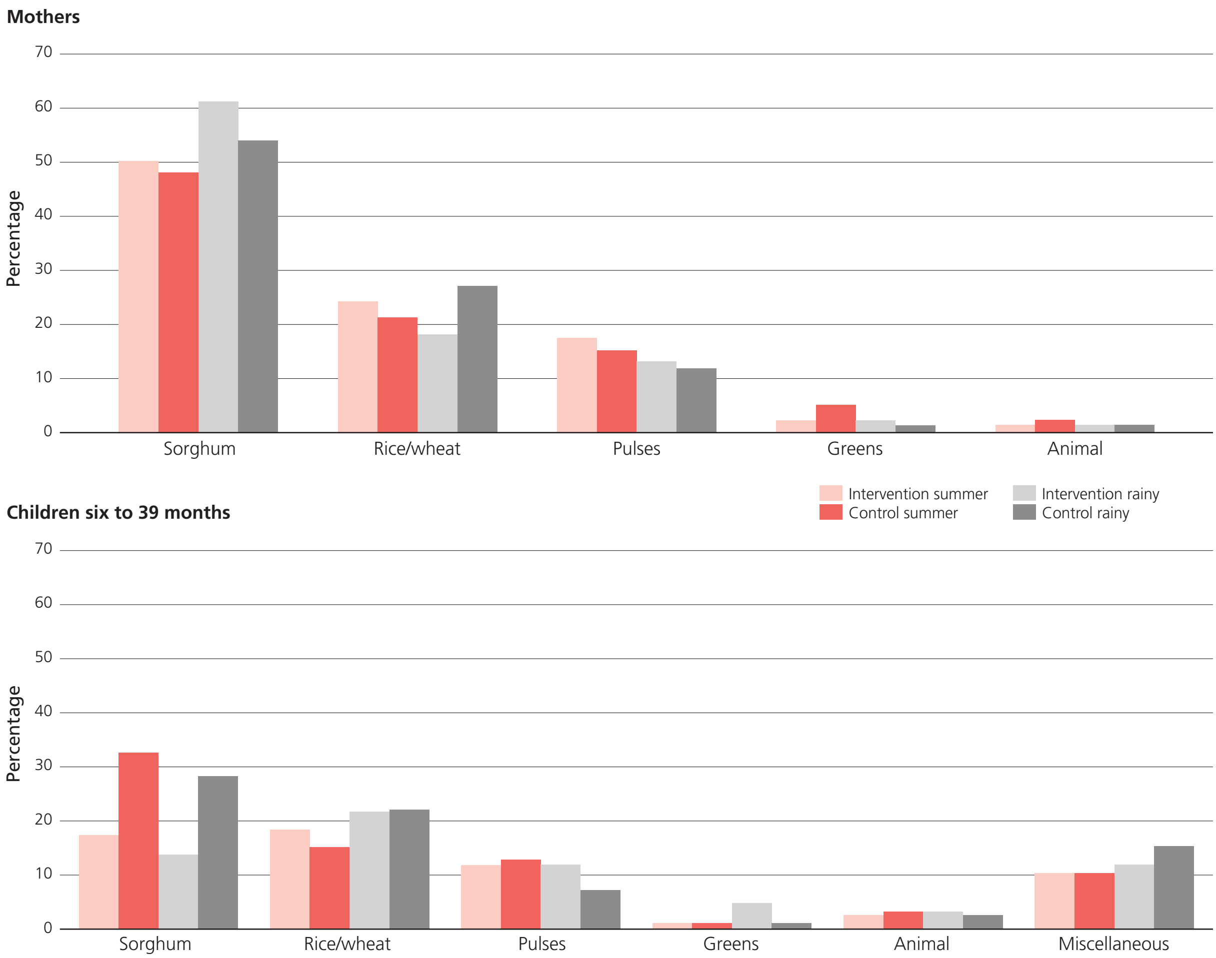
	Summer season			*Rainy season*		
Nutrient	**Intervention villages** (*n* = 125)	**Control villages** (*n* = 109)	***p***	**Intervention villages** (*n* = 124)	**Control villages** (*n* = 96)	***p***
Energy, kJ[a]	12 218 (3 511)	11 155 (3 347)	0.02[b, c]	11 189 (3 335)	10 193 (3 738)	0.04[b, c]
	11 437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

Figures are means with SDs in brackets, or medians with first and third quartiles in brackets. Non-parametric test (Wilcoxon).
[a] 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.
[b] *p* from two-sample pooled Student t-test.
[c] $p \leq 0.05$ statistically significant, all nutrient intakes (expect vitamin C) are higher ($p \leq 0.05$) in the summer season than the rainy season: intervention villages – summer season (17), rainy season (11); control villages – summer season (11), rainy season (12) repeated 24-hour recall.
[d] 1µg retinol = 1µg RE, 6 µg provitamin A carotenoids = 1µg RE.
Source: adapted from Schmid *et al.*, 2007.

and the rainy season, perhaps because in both seasons more mothers in the intervention villages were pregnant. According to 1993/1994 data from the National Sample Survey, about 80 percent of India's rural population had energy intakes below the 10 080 kJ recommended for adults in rural areas. The poorest 30 percent of India's population consumed on average less than 7 140 kJ per day, and the poorest 10 percent less than 5 460 kJ (Measham and Chatterjee, 1999). In this study of the poorest segment of rural Dalit communities, mean energy intakes in both seasons and both groups were higher than 10 000 kJ, indicating the better provision of food sources in settings where poor rural women control their own agricultural production.

It was assumed that the activity levels of mothers in all villages were sedentary during the summer season, when labour demand was low. During the rainy season, mothers who were working as agricultural labourers

Figure 6.2 Percentages of total iron intake in Dalit mothers and children from intervention and control villages and by season



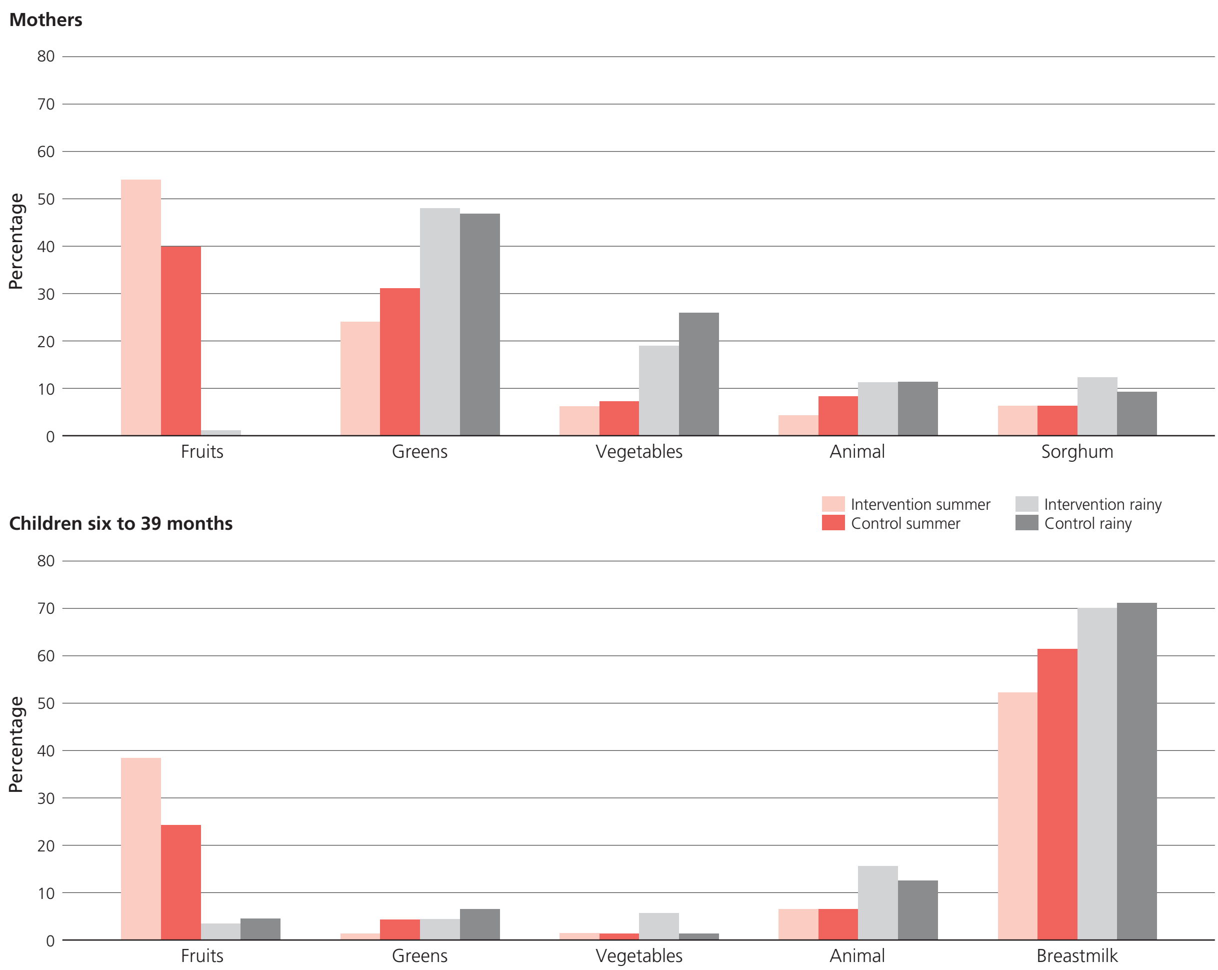
Pulses: chickpea, black gram, green gram, *khesaridal*, lentil, pigeon pea, dry pea; ***greens:*** nine species of cultivated and seven of uncultivated green leafy vegetables; ***animal:*** eggs, five species of meat, milk and milk products; ***miscellaneous:*** jaggery, white bread/bun, iron-fortified biscuits, iron-fortified babyfood (Cerelac©, Boost©) and local nutritional supplement (corn-soya blend).

Source: Adapted from Schmid *et al.*, 2007.

were classified as moderately active. According to the Indian recommended dietary allowance (RDA), the energy requirement of an average Indian woman (weighing 45 kg and aged between 18 and 30 years) increases by approximately 1 500 kJ/day with moderate activity level, to reach 9 257 kJ, compared with the 7 792 kJ of sedentary women (ICMR, 1990). For both groups of women in the study, mean energy intake surpassed that calculated for the moderate activity level.

The Indian adult requirement for protein is 1.0 g/day per kilogram of body weight, with an additional 15 g during pregnancy and 18 g during lactation, to give average standard requirements of 60 g of protein for pregnant and 63 g for lactating women (ICMR, 1990). In this study, mean protein intakes in the intervention and control groups were greater than 60 g in both seasons. According to Gopalan *et al.* (1989), the majority of Indians obtain 70 to 80 percent of daily energy needs and more than 50 percent of daily protein needs from cereals; intakes of cereals tend to be highest in low-income families. Marginal-farmer households in rural India are reported to obtain 72

Figure 6.3 Percentages of total vitamin A intake in Dalit mothers and children from intervention and control villages and by season



Fruits: banana, grapes, mango, mulberry, orange, guava, lime and papaya; ***greens:*** nine species of cultivated and seven of uncultivated green leafy vegetables; ***vegetables:*** 20 species of vegetables, roots and tubers; ***animal:*** eggs, five species of meat, milk and milk products.

Source: Adapted from Schmid *et al.*, 2007.

percent of energy and 68 percent of protein from cereals, which are similar to the findings of this study, but only 4 percent of energy and 10 percent of protein from pulses, which are lower than this study's findings (FAO, 2002). This too demonstrates the relatively higher quality of the diet of impoverished Dalit Indian women.

India's iron RDAs are 30 mg for lactating and non-lactating women and 37 mg for pregnant women, based on an average absorption rate of 3 percent (ICMR, 1990). In North America, the estimated average requirements for women aged 19 to 30 years are 8.1 mg for non-lactating women, 6.5 mg for lactating women and 22 mg for pregnant women, based on an absorption rate of 18 percent (Food and Nutrition Board Institute of Medicine, 2001). In this study, mothers from all villages had median intakes of less than 20 mg of iron in both seasons. Although cereals are not rich sources of iron, they are important contributors when they are consumed regularly. Mothers from intervention villages consumed more iron and dietary fibre during the rainy season, probably

Table 6.5 Characteristics of Dalit children aged six to 39 months in intervention and control villages

Variable	*Description*	*Intervention villages (n = 124)*	*Control villages (n = 96)*	*p*
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[a]	Yes	51 (39%)	41 (41%)	0.67
	No	80 (61%)	60 (59%)	
Vitamin A supplement since birth[b]	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[c]
	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%)	

Figures are counts with percentages of n in brackets. Chi-square test.
[a] Corn-soya blend and muruku (enriched chickpea flour).
[b] Vitamin A Prophylaxis Programme for children aged six to 36 months: six monthly doses of 100 000 IUs of vitamin A for infants and 200 000 IUs for young children.
[c] $p \leq 0.05$ statistically significant.
Source: Adapted from Schmid *et al.*, 2007.

because of frequent sorghum consumption. However, pulses, rice and grains are also rich in phytates and tannins, which interfere with iron availability. Vitamin C may enhance availability, but median vitamin C intakes in the study were less than 15 mg, which is lower than the Indian RDAs of 40 mg for non-lactating and pregnant women and 80 mg for lactating women (ICMR, 1990).

The Indian RDAs for vitamin A are 600 µg RE for non-lactating and pregnant women and 950 µg RE for lactating women (ICMR, 1990). Median vitamin A intakes for all mothers in the study were below these recommendations during both seasons, and fat intakes were fairly limited (at approximately 10 percent of total energy). During the rainy season, green leafy vegetables provided half of the vitamin A for mothers, mainly from uncultivated greens, especially in intervention villages. In a study of rural Andhra Pradesh (National Nutrition Monitoring Bureau, 2002), 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 those observed in this study. However, median fat (25.6 g) and vitamin A (106 μg) intakes were similar, and vitamin C intake (22 mg) was higher. In India (FAO, 2002), adults in marginal-farming households (with 0.5 to 1 acre/0.2 to 0.4 ha) were reported to have lower energy (9 500 kJ) and protein (59 g) intakes and a similar fat (33 g) intake compared with those reported in the current study.

Children's dietary intake

The characteristics of children in intervention and control villages (Table 6.5) were similar. Most were either the first- or second-born in their families, and were given complementary foods. About half received vitamin A drops at least once. More children in intervention than control villages were given de-worming tablets at least once.

Similar amounts of energy, protein, carbohydrate, fat, dietary fibre, iron, vitamin C and vitamin A were consumed by children in both intervention and control villages in both seasons (Table 6.6). These children had higher dietary fat, vitamin C and vitamin A intakes relative to requirements than their mothers. For all children, in both seasons, approximately 23 percent of energy came from fat. Among children in the intervention group, intakes of protein ($p \leq 0.04$), dietary fibre ($p \leq 0.05$) and iron ($p \leq 0.05$) were significantly higher during the rainy season, and vitamin A intake ($p \leq 0.02$) was higher during the summer season. In the control group, energy ($p \leq 0.01$), protein ($p \leq 0.01$), carbohydrate ($p \leq 0.01$), dietary fibre ($p \leq 0.01$) and iron ($p \leq 0.01$) intakes were higher during the rainy season.

Overall, in intervention villages, breastmilk, rice and pulses contributed 34, 33 and 5 percent, respectively, of total energy intake, and 29, 28 and 14 percent of total protein intake. Percentages were similar in control villages (data not shown). Sorghum, rice and pulses provided most dietary iron (Figure 6.2). Miscellaneous food (including iron-fortified baby food) and animal-source food items contributed about 13 and 4 percent, respectively, of iron intake in both intervention and control villages. During the rainy season, sorghum contributed 41 percent of iron intake in intervention villages and 34 percent in control villages; cultivated and uncultivated green leafy vegetables contributed 6 percent of vitamin C in both groups. Breastmilk was the primary source of vitamin C, contributing about 70 percent in both groups.

Breastmilk, fruits and animal foods were main vitamin A sources for children aged six to 39 months (Figure 6.3). Overall, breastmilk and animal food contributed 61 and 11 percent, respectively, of vitamin A intake in intervention villages, and similar percentages in control villages. Sorghum contributed approximately 1 percent of vitamin A in both groups. During the summer season, fruits contributed 38 percent of vitamin A in intervention villages and 24 percent in control villages. During the rainy season, vegetables, roots and tubers contributed 5 percent of vitamin A in children from intervention villages.

Continued breastfeeding with delayed initiation of complementary feeding is common practice in India. In this study, 75 percent of all children aged six to 39 months were breastfed either exclusively or in combination with complementary food. In the summer season, more than half of the children aged six to 12 months had not yet begun to consume complementary food. Limited supplementation programmes distributing enriched flour, iron-folic tablets, iodized salt and vitamin A drops reached fewer than half of the rural Dalit families in this study.

Requirements for Indian children aged one to three years are estimated to be 5 208 kJ/day of energy and 21 g/day of protein (ICMR, 1990). In this study, 37 percent of children in the summer season and 24 percent in the rainy season were under one year of age, and their energy and protein intakes were below recommendations. Indian dietary standards recommend that young children aged one to three years have an iron intake of 11.5 mg/day (ICMR, 1990); the median

Table 6.6 Nutrient intakes of Dalit children aged six to 39 months from intervention and control villages, by season

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

Figures are means with SD in brackets, or medians with first and third quartiles in brackets. Non-parametric test (Wilcoxon).

[a] Recommended levels for boys and girls aged one to three years (26): energy – 5 208 kJ; protein – 21 g; iron – 11.5 mg; vitamin C – 25 mg; vitamin A – 400 μg RE.

[b] $p \leq 0.05$ statistically significant higher intake during the summer season or the rainy season within group. Breastmilk consumption standardized at 500 ml for children aged six to 12 months, 350 ml for children over 12 months (20): intervention villages – summer season (8), rainy season (11); control villages – summer season (5), rainy season (11) repeated 24-hour recall.

[c] 1μg retinol = 1μg RE, 6 μg provitamin A carotenoids = 1μg RE.

Source: Adapted from Schmid *et al.*, 2007.

intakes of iron for all the children in this study were well below this in both seasons. Most iron came from sorghum, rice and pulses. Sorghum is not recommended as a major food source for children because of its poor digestibility (McLean *et al.*, 1981). As median vitamin C intakes were similar to the Indian RDA of 25 mg/day (ICMR, 1990), it may be assumed that iron is absorbed. However, the Indian vitamin A RDA for children aged one to three years is 400 μg RE (ICMR, 1990), and median intakes in the study were less than 200 μg RE in the rainy season.

Limitations to the dietary evaluation in this study include likely overestimated intakes of vitamin A because, by necessity, they were derived from the values estimated by colorimetry representing the sum of total carotene, converted into β-carotene (no values were available for α-carotene and β-cryptoxanthin). RE was used instead of the retinol activity equivalent recently recommended for Indian dietary analysis. The finding that the bioconversion of carotene from dark-green leafy vegetables is less than previously thought has raised doubts about the efficacy of green leafy vegetables in improving vitamin A status (Castenmiller and West, 1998); nevertheless, epidemiological evidence from India implies there is good bioavailability of dietary carotenoids, because vitamin A deficiency is rarely seen in communities where many carotene-rich foods are consumed (Tontisirin, Nantel and Bhattacharjee, 2002). In addition, although 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 from this technique (Food and Nutrition Board Institute of Medicine, 2001), nor are the nutrient intakes of young children (Gibson, 1990). A further limitation arises from the assumption that breastmilk intakes were standard for age, which reduced the true variance of nutrient intakes and may have limited the validity of comparisons, particularly in children in the younger age groups.

Mothers' health

The average age of the mothers was 24.3 years (SD = 3.9) (Table 6.7). Some 16 percent of the mothers were less than 145 cm in height, and mean BMI was slightly below the cut-off point for a healthy body weight (BMI ≥ 18.5 kg/m²) (James, Ferro-Luzzi and Waterlow, 1988). Overall, 58 percent of mothers were classified as having CED, and 10 percent of these were classified as severely malnourished (BMI < 16 kg/m²); 1 percent were classified as overweight (BMI ≥ 25 kg/m²). The majority of women were illiterate (78.6 percent), used open field toilets (94.1 percent), and were lactating at the time of the study (80.9 percent). In addition, 41.4 percent of the women had a household income below the poverty line. The majority of women were characterized as moderately active owing to their work in agricultural fields (70.9 percent). Literate women were less likely to use an open field toilet and be characterized as active than illiterate women were (Fisher's exact test, $p \le 0.01$).

In evaluating CED (Table 6.8), mothers with only one child under five years of age had a 45 percent greater risk of CED than those with two or more children under five (rate ratio [RR] = 1.45, $p \le 0.05$); and mothers without sanitation in their homes had a fourfold greater risk (RR = 4.1, $p \le 0.05$) of CED. Illiterate and active women were more likely to have CED than literate and non-active women (RR = 1.6 and 1.4, respectively, $p \le 0.05$), but literacy and activity level were not significant in multivariate analyses including sanitation and number of children under five years of age (not shown). Increasing levels of fat as a percentage of total energy were significantly associated with lower risk of CED (the RR of the lowest 25th percentile compared with that of the 75th percentile or above was 1.6, $p \le 0.05$); these findings remained significant in multivariate analyses. Intake of pulses (g/day) was also inversely related to CED in univariate and multivariate analyses. Carbohydrate as a percentage of total energy was inversely related to percentage of energy from fat (RR = - 0.96, $p \le 0.010$), and although positively related to CED in univariate analyses, carbohydrate consumption was not significant in multivariate analyses. Vegetable, root and tuber consumption was inversely related to CED in analyses adjusting for sanitation, having children under five years of age, and pulse intake (g/day) ($p \le 0.05$). As consumption of vegetables, roots and tubers was significantly related to fat intake, these two variables were not considered in the same model. Intake of pulses (g/day) was highly related to energy intake (RR = 0.48, $p \le 0.001$). Mothers' total energy intake, age, physiological status and income level were not related to CED in univariate or multivariate analyses. There was too little variability in the percentage of energy from protein to evaluate this variable as a determinant of CED (i.e., the 25th percentile was 9.8 and the 75th percentile 10.9).

At the time of the survey, 16 percent of mothers were suffering from one or more signs of clinical vitamin A deficiency, including night blindness, Bitot's spot and conjunctival xerosis (Table 6.3). Mothers'

Table 6.7 Characteristics of Dalit mothers in intervention and control villages

Variable	*Description*	*Intervention villages* (n = 124)	*Control villages* (n = 96)	*p*
Age	Years (SD)	24.5 (4.1)	24.0 (3.5)	0.30[a]
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[b]	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 labourer	Yes	100 (81%)	55 (57%)	< 0.001[c]
	No	24 (19%)	41 (43%)	
BMI[d]	Body weight (kg)/height (m)²	18.2 (2.0)	18.3 (2.3)	0.71[c]
		Both Seasons		
		(n = 140)	*(n = 114)*	
Participated in both seasons	Yes	110 (79%)	91 (80%)	0.81
	No	30 (21%)	23 (20%)	

Figures are counts with percentages of n in brackets, or means with SDs in brackets. Chi-square test.
[a] *p* from two-sample pooled Student t-test.
[b] Corn-soya blend and *muruku* (enriched chickpea flour).
[c] $p \leq 0.05$ statistically significant.
[d] Pregnant women were excluded: experimental villages n = 114; control villages, n = 91.
Source: Adapted from Schmid *et al.*, 2007.

age in years and income were positively related to these signs of vitamin A deficiency, with 20 percent of women with incomes above the poverty line having symptoms, compared with 11.0 percent of women below the poverty line (X^2, $p = 0.07$), a difference that became significant in multivariate analyses including the mother's age (Table 6.8). Mothers' physiological status (lactating, pregnant or neither), activity level, number of children under five years of age, sanitation conditions and literacy were unrelated to vitamin A

Table 6.8 Prevalence, RRs and adjusted ORs of correlates of CED and vitamin A deficiency symptoms in Dalit mothers

Variable	*Category*	*No.*	*%*	*RR*	*Adjusted OR (95% CI)*
Chronic energy deficiency (BMI < 18.5 kg/m²)					
No. of children ≤ 5 years of age[a]	1	139	64	1.5[b]	2.54 (1.39–4.99)
	> 2	61	44	1.0	
Open field toilet[a]	Yes	194	61	4.1[b]	7.99 (1.66–38.81)
	No	13	15	1.0	
Fat intake[a]	% of energy				
	< 25th percentile	51	75	1.6[b]	2.97 (1.19–7.42)
	26th–74th percentile	104	54	1.1	0.99 (0.47–2.11)
	> 75th percentile	51	47	1.0	
Vegetables, roots and tubers[c]	Days/season	207	-	-	0.99 (0.98–0.99)
Pulses[a.,d]	g/day	207	-	-	0.99 (0.98–0.99)
Clinical vitamin A deficiency[e]					
Age[f]	Years	220	-	-	1.12 (1.02–1.23)
Income > poverty line of INR 1 000/month[f]	Yes	91	20	1.8	2.41 (1.02–5.20)
	Below	129	11		
Sorghum consumption[f]	g/day	208	-	-	0.99 (0.99–0.99)
Dairy[g. h]	Low, intermediate, high	220	-	-	0.69 (0.42–1.12)
Night blindness during past pregnancy					
Dairy[g]	Low	56	42.9	2.0[b]	2.74 (1.26–5.94)
	Intermediate	94	39.4	1.8[b]	2.38 (1.18–4.82)
	High	70	21.4	1.0	1.0

[a] Model includes number of children up to five years of age (one or more), sanitation situation (open field or toilet), fat intake and intake of pulses.
[b] $p \leq 05$.
[c] Includes 20 species of vegetables, roots and tubers (green leafy vegetables excluded).
[d] Includes seven pulses: chickpea, black gram, green gram, *khesaridal*, lentil, pigeon pea and dry pea.
[e] Bitot's spot, conjunctival xerosis and/or night blindness.
[f] Model includes age, income (above or below the poverty line) and sorghum intake.
[g] Includes eggs, cow and buffalo milk, curd, butter milk and ghee.
[h] Model includes age, income (above or below the poverty line) and dairy intake.
Source: Adapted from Schmid *et al.*, 2007.

deficiency in univariate and multivariate analyses. Analyses with dietary exposure showed that sorghum consumption was significantly and inversely related to vitamin A deficiency (β = -.004, SE =.002, p =.04), and the consumption of dairy products (coded as low, intermediate or high consumption of eggs, cow and buffalo milk, curd and ghee) was protective (but not statistically significant) against it (β = - 0.420, SE = 0.257, p = 0.10) in analyses adjusting for mother's age and income level. Sorghum consumption was also positively related to iron intake (RR = 0.49, $p \leq$ 0.001), and iron intake was positively related to intake of vitamin A (RR = 0.34, $p < 0.001$) and vitamin C (RR = 0.53, $p \leq 0.001$) (not shown). No nutritional variables other than sorghum and dairy products were significant or of border-line significance in univariate or multivariate analyses.

Approximately one-third (35 percent) of the women reported having experienced symptoms of night blindness during their pregnancies. Of these, 75 percent said it occurred in the last trimester. This is of concern given the WHO recommendation that a prevalence of 5 percent of pregnant women with night blindness be considered of public health significance (Christian, 2002).

Mothers' age was positively related to night blindness during pregnancy, and consumption of eggs, milk and milk products was negatively associated. Women consuming low, intermediate or high amounts of dairy products had prevalence rates of night blindness during pregnancy of 42.9, 39.4 and 21.4 percent, respectively (providing RRs of 2.0 and 1.8, with the highest consumption group serving as the referent). These findings were significant in age-adjusted analyses (Table 6.8). No other nutritional variables were identified as significant determinants of night blindness during pregnancy.

Some 10 percent of women were classified as iron-deficient, based on pallor under the eyelid (Table 6.3). In univariate analyses, income, physiological status, literacy, activity level and number of children under five years of age were not significantly related to iron status. In multivariate analyses, mothers' age in years ($\beta = 0.18$, SE = 0.06, $p \leq 0.01$), physiological status ($\beta = 2.5$, SE = 1.3, $p \leq 0.05$) and activity level ($\beta = -1.1$, SE = 0.58, $p \leq 0.06$) were determinants of iron deficiency. No nutritional variables were identified as determinants of iron deficiency.

Correlates of diet with women's health

After controlling for important correlates of CED, including age, and adjusting for number of children under five years of age and sanitation situation, women's intake of traditional food (fat, pulses, and vegetables, roots and tubers) showed protective associations against CED. Paradoxically, women with only one child had higher prevalence of CED, perhaps reflecting higher infertility in the most malnourished women.

Women's consumption of sorghum showed protective association for clinical vitamin A deficiency symptoms after adjusting for age and income. This may be because sorghum (as *roti*) is consumed with vegetables and fat. Mothers with higher fat and pulse intakes and more frequent consumption of vegetables, roots and tubers had odds ratios (ORs) below 1 for CED.

For women during their last pregnancy and at the time of the survey, higher consumption of dairy products (buffalo and cow milk, curd and buttermilk) was protective against occurrence of night blindness, and no other variables were significant. The percentages of mothers suffering night blindness, Bitot's spot and/or conjunctival xerosis at the time of the survey, and especially the prevalence of night blindness during the last pregnancy, were higher than those reported in other Indian data (ICMR, 1990).

Other studies have shown that consumption of traditional foods improves vitamin A status. Among Bangladeshi men with low vitamin A diets, daily consumption of cooked and pureed Indian spinach (*Basella alba*) had a positive effect on vitamin A stores (Haskell *et al.*, 2004). In this study of Dalit women, the amount of sorghum consumed every day was negatively associated with clinical vitamin A deficiency symptoms; and low frequencies of egg, milk and milk product consumption were positively associated with night blindness during pregnancy. The surprising finding that mothers from households with incomes above the poverty line were at greater risk of clinical vitamin A deficiency than those with lower incomes may be explained by the higher-income households' lower intakes of traditional foods such as sorghum and the green vegetable dishes with which it is usually consumed.

WHO reported that 87 percent of pregnant women in India were suffering from iron deficiency in 1995 (WHO, 2000). Iron deficiency data distinguishing between moderate (7.0 to 9.9 g Hb/dl) and severe (< 7.0 g Hb/dl) deficiency reported prevalence rates in married or previously married rural women aged 15 to 45 years in Andhra Pradesh of 16 percent moderate deficiency and 2 percent severe, which were similar to findings from women in scheduled caste (IIPS and ORC Macro, 2000). The current study identified 10 percent of mothers as iron-deficient, using the subjective measure of eyelid pallor, but – as in other studies – this study was unable to support the hypothesis that nutritional variables are correlates of iron status.

Anthropometry and clinical data were collected during only the rainy season, whereas dietary data were collected in both the summer season and the rainy season and averaged between the two for data analysis. Ideally, data on seasonal variations in women's health and diet would have been collected for all the three major seasons of the Dalit annual cycle in Medak District, and averaged to give an annual estimation. Despite this constraint, however, the finding that consumption of traditional dietary items has a positive effect during the season of greatest health risk is important.

Dalit women are probably the most disadvantaged of Indian adults. Prevalence rates of CED and night blindness during pregnancy were higher among Dalit mothers in rural Medak District than the national data reported for rural women from scheduled castes. However, the consumption of traditional Dalit food items – including sorghum, pulses, vegetables, roots, tubers, eggs, milk and milk products – was negatively associated with the prevalence of CED and clinical vitamin A deficiency symptoms in the women in this study. Mothers from APDS villages 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 the recommendations, in both study seasons. Despite the assumed higher energy needs during the rainy season, energy and nutrient intakes were higher during the summer season, confirming 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 particularly important source of vitamin A in the intervention villages during the rainy season.

Children's health

Anthropometry and clinical signs of vitamin A and iron deficiency are summarized in Table 6.9. Based on the 1977 National Center for Health Statistics growth curves, mild and severe stunting were reported in more than 30 percent of children; mild and severe wasting in more than 50 percent; and underweight in about two-thirds (National Center for Health Statistics, 1977). Clinical signs of vitamin A deficiency were seen in 4 percent of children, and pallor in the lower eyelid in 8 percent. These measures were addressed with multivariate models using the variables of interest for children shown in Table 6.2. ORs for the determinants of stunting, wasting, underweight and iron deficiency (pallor) are shown in Table 6.10. Children aged 25 to 39 months were at highest risk of stunting, followed by those aged 13 to 24 months, who were at greatest risk of underweight. Young boys were at higher risk than young girls. Children in houses classified as "permanent" were at higher risk than those in traditional huts (with earthen floors and plant materials for walls and roofs). Exclusive breastfeeding after six months also presented higher risk of wasting and symptoms of iron deficiency (pallor) (Schmid, 2005).

From 1998 to 1999, the second National Family Health Survey collected data on nutritional status in Indian children aged six to 35 months (IIPS and ORC Macro, 2000). It reported slightly greater percentages of severe (24 percent) and mild (24 percent) stunting, and much lower percentages of severe (3 percent) and mild (13 percent) wasting than found by the current study. Another survey of children aged one to five years from scheduled castes in rural Andhra Pradesh (National Nutrition Monitoring Bureau, 2002) reported more severe stunting (26 percent) among children, but less severe underweight (23 percent) and severe wasting (3 percent). Similar proportions of children were reported stunted in the current and the Andhra Pradesh studies, but this study reported higher percentages of severely wasted and underweight children.

It is well established that the prevalence of stunting increases in children up to 24 or 36 months, and then tends to level off (WHO Working Group, 1986). In the Andhra Pradesh study, the proportion of children who were underweight (< 2 SD) increased rapidly with age from 12 to 23 months (IIPS and ORC Macro, 2000). This is reflected in the current study's findings, where the highest risk of stunting was in children aged 25 to 39 months and the highest risk of underweight in those aged 13 to 24 months.

Protein-energy malnutrition may result from not only poor food supply and early growth faltering,

Table 6.9 Anthropometric measurements and the prevalence of clinical vitamin A deficiency symptoms and iron deficiency (pallor) in Dalit children aged six to 39 months

Variable	*Description*	*Children (n = 220)*
Anthropometric measurement		
MUAC	> 13.5 cm	110 (50%)
	12.5–13.5 cm	76 (36%)
	< 12.5 cm	34 (15%)
Stunted*	Normal (≤ -2 SD height-for-age Z-scores)	148 (67%)
	Mild (> -2 SD height-for-age Z-scores)	44 (20%)
	Severe (> -3 SD height-for-age Z-scores)	28 (13%)
Wasted*	Normal (≤ -2 SD weight-for-height Z-scores)	105 (48%)
	Mild (> -2 SD weight-for-height Z-scores)	55 (25%)
	Severe (> -3 SD weight-for-height Z-scores)	59 (27%)
Underweight*	Normal (≤ -2 SD weight-for-age Z-scores)	81 (37%)
	Mild (> -2 SD weight-for-age Z-scores)	49 (22%)
	Severe (> -3 SD weight-for-age Z-scores)	90 (41%)
Clinical vitamin A deficiency		
None		212 (96%)
Night blindness (XN)	Reported	6 (3%)
Bitot's spot (X1B)	Examined	0 (0%)
Conjunctival xerosis (X1A)	Examined	2 (1%)
Iron deficiency	White (pallor)	18 (8%)
Inside lower eyelid	Pink	202 (92%)

Figures are counts with percentages in brackets from data collected during the rainy season of 2003.
* Based on 1977 NCHS growth curves.
Source: Adapted from Schmid *et al.*, 2007.

but also low birth weight, inappropriate feeding practices and high morbidity rates (Gopaldas, Patel and Bakshi, 1988; Bhandari *et al.*, 2001). In India, delayed introduction of complementary foods, the use of foods with low energy and nutrient density, small servings at meals, and food restrictions due to cultural beliefs are all common (Bhandari *et al.*, 2004). The study results show that predominantly breastfed children aged six months and more had higher risks of wasting and iron deficiency. It is suggested that other factors, including the availability of health care facilities and a protected water supply, personal hygiene and environmental sanitation are also important determinants of nutrition status in preschool children (Laxmaiah *et al.*, 2002). The study found that children living in permanent houses were at greater risk of stunting than those living in traditional huts. This surprising finding might be explained by the more frequent consumption of traditional foods such as sorghum, pulses and wild fruits by children living in rural households with incomes below the poverty line.

The National Nutrition Monitoring Bureau (2002) reported absence of night blindness in rural preschool children in Andhra Pradesh and prevalence rates of 0.2 percent for conjuctival xerosis and 0.7 percent for Bitot's spot. A survey conducted in five states reported prevalence of 0.7 to 2.2 percent for Bitot's spot in children aged six to 71 months. Night blindness was reported in 1.6 to 4.0 percent of children aged 24 to 71 months (Chakravarty and Sinha, 2002). The current study reported higher percentages of children with night blindness and conjunctival xerosis than those reported

Table 6.10 Adjusted ORs and 95 percent CIs of significant determinants for stunting, wasting, underweight and iron deficiency (pallor) in Dalit children aged six to 39 months

Variable	*Category*	*n = 220*	*%*	*OR (95% CI)*
Stunting (< 2SD height-for-age)				
Age group	6–12 months	53	8%	1.00 (reference)
	13–24 months	83	33%	8.46[a] (1.93–37.14)
	25–39 months	84	48%	23.86[b] (4.50–126.41)
Gender	Female	110	25%	1.00 (reference)
	Male	110	41%	2.10[a] (1.08–4.09)
Housing	Traditional hut	64	19%	1.00 (reference)
	Permanent house[c]	156	39%	2.43[a] (1.07–5.54)
Wasting (< 2SD weight-for-height)				
Duration of exclusive breastfeeding (including water)	≥ 6 months	156	58%	1.98[a] (1.00–3.90)
	< 6 months	64	39%	1.00 (reference)
Underweight (< 2SD weight-for-age)				
Age group	6–12 months	53	40%	1.00 (reference)
	13–24 months	83	80%	3.67[a] (1.12–12.03)
	25–39 months	84	62%	1.27 (0.31–5.18)
Energy intake	≥ 1 220 kcal/day	38	42%	1.00 (reference)
	< 1 220 kcal/day	182	68%	3.33[a] (1.13–9.85)
Iron deficiency (under eyelid pallor)				
Duration of exclusive breastfeeding (including water)	≥ 6 months	156	10%	10.16[a] (1.05–98.2)
	< 6 months	65	2%	1.00 (reference)

Stunting, wasting and underweight were calculated from the NCHS growth curves (1977). Nutrient intake and food frequency consumption were obtained during the rainy season of 2003.
[a] $p \leq 0.05$.
[b] $p \leq 0.01$.
[c] House with or without a permanent roof.
Source: Adapted from Schmid *et al.*, 2007.

for Andhra Pradesh, but its results were similar to those from other smaller studies. More than 50 percent of the children did not receive vitamin A supplementation, which is normally provided by the Indian Government, so breastmilk and complementary foods were the primary sources of vitamin A. The second National Family Health Survey (IIPS and ORC Macro, 2000) reported that 46 percent of Indian children aged six to 35 months were moderately and 5 percent severely iron-deficient. This study found 8 percent of children to be iron-deficient.

Young children in both APDS and control villages had median energy, protein, iron and vitamin A intakes that were below recommendations, putting them at risk of malnutrition. No differences were seen between the two groups. Breastmilk 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.

Conclusions

This study examined the highly diverse food system of the Zaheerabad Dalit to identify its significance for Dalit women and children according to whether they were or were not participating in a food intervention programme that promoted knowledge about and use of local food systems. The great diversity of Dalit food systems in rural India has still to be studied and compared with non-Dalit food systems in the same ecosystem, to develop understanding of and remedies for social injustice and disparities. In the meantime, existing studies already indicate the potential for improving health by promoting local traditional foods, as in the APDS applied by DDS.

The study found that traditional cultural food items were widely consumed and were the main sources of energy, protein, iron, vitamin C and vitamin A for both mothers and young children in all the study villages. However, mothers in APDS villages, which supported the traditional food system through the promotion of indigenous agricultural practices, had higher energy, protein and iron intakes than mothers in control villages. These findings provide evidence for evaluating, considering and promoting traditional food systems as a first step to increasing the intakes of critical nutrients in poor rural communities in India.

The prevalence rates of CED and night blindness during pregnancy were higher among Dalit mothers in rural Medak District than the national average reported for rural women from scheduled castes. The consumption of traditional food items including sorghum, pulses, vegetables, roots and tubers, eggs, milk and milk products was negatively associated with the prevalence of CED and clinical vitamin A deficiency symptoms in these women.

Severe stunting and wasting were important problems among preschool children and were found to be more prevalent than the usual for rural Andhra Pradesh. Above-recommended energy intakes were associated with lower prevalence of underweight among children. While there were no differences between children from intervention and control villages, the findings clearly show the importance of and potential for using the traditional food system and its dietary diversification to combat malnutrition.

When poor, rural Dalit mothers have access to agricultural land for home food production and to work as field labourers both they and their children have greater intakes of many foods that protect against chronic energy and protein deficiency and micronutrient deficiencies of vitamin A and iron. Sorghum, millet, wild fruits and uncultivated greens are of particular importance in this. These and many other foods –particularly those of animal source – in the traditional Dalit food system should be promoted to improve nutrition status. High frequencies of CED, night blindness and clinical vitamin A deficiency indicate a need for public health interventions for all Dalit women, which should include the promotion of locally available, traditional food for the women and their children

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