Public Health Nutrition: 12(5), 624–629 doi:10.1017/S1368980008002395

Micronutrient deficiency status among women of desert areas of western Rajasthan, India

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Submitted 8 May 2007: Accepted 20 March 2008: First published online 27 May 2008

Abstract

Objective: To assess the magnitude of three micronutrient deficiency disorders (iron, vitamin A and iodine), nutritional deficiencies and their association with related factors.

Material and Methods: Using the three-stage sampling technique, a study was conducted in twenty-eight villages of Jodhpur district. A total of 1193 women, 384 pregnant, 400 lactating and 409 non-pregnant non-lactating controls (15 years and above, women who have not attained their family status) were examined for three micronutrient deficiency disorders, nutritional deficiencies, dietary and associated factors.

Results: Majority of the women were anaemic. Anaemia was higher among pregnant and lactating women (80·7 %). Severe anaemia was three-fold higher among pregnant and lactating women in comparison to controls (4·1 %). Vitamin A deficiency was observed to be higher among pregnant women (8·8 %). A high proportion of women (80·8 %) consumed salt, having inadequate iodine content. Median urinary iodine values were less in pregnant and lactating women than the WHO cut-off points. Consumption of pulses and legumes was low besides leafy vegetables. Average intake of nutrients showed deficiency of protein and energy, iron and folic acid and vitamin A deficiency. Anaemia and iodine deficiency disorder were found to be inversely proportional to education and income.

Conclusions: The proportion of anaemia in this study was higher in comparison to national-level studies besides the low consumption of normal iodised salt. Only 19 % of salt samples had adequate iodine content, which calls for caution. In addition to iodisation of salt, the study suggests the development of nutritional packages utilising local dietary aspects.

Keywords
Anaemia
Iodine deficiency disorder
Vitamin A deficiency
Dietary intake
Desert

Next to young children, pregnant and lactating women are nutritionally the most vulnerable group, especially in developing regions of the world. In desert areas, women may be in a constant state of nutritional stress right from the time of an early marriage, leading to early growth retardation and premature death in their 30s. The nutritional needs are high because of their heavy nature of work in rural desert areas of Rajasthan; however, due to their old custom and traditions, pregnant and lactating women are being deprived of their requisite food intake.

Micronutrient malnutrition is one of the burning problems in developing countries, and deficiency of one or more of the three micronutrients iron, iodine and vitamin A is of major public health significance. WHO[1] and UNICEF[2,3] together urged the establishment of micronutrient monitoring and evaluation system capable of assessing the magnitude and distribution of iodine, vitamin A and iron deficiency disorders. In iron-deficiency anaemia, it is now recognised that even without anaemia, mild to moderate iron deficiency occurs and has adverse functional consequences. It adversely affects cognitive performance, behaviour and physical growth of infants and preschool children, the immune status, morbidity from infections and also work performance. During pregnancy, it increases the perinatal risks for mothers and neonates and increases overall infant mortality. Vitamin A deficiency, subclinical, is defined as tissue concentrations of vitamin A low enough to have adverse health consequences, although there is no evidence of clinical xerophthalmia. Worldwide, iodine deficiency is the single most important preventable cause of brain damage. During pregnancy, it increases the risk of abortions, stillbirths and congenital anomalies. Increased perinatal and infant mortality along with mental deficiency and psychomotor defects are associated with this.

The magnitude and extent of these three micronutrient deficiency disorders are not known for this area. Assessment of the situation for this area requires baseline prevalence of these three micronutrient deficiency disorders,

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i.e. anaemia, vitamin A deficiency and iodine deficiency disorder, which will help to uplift their nutritional status in the community by developing a nutritional package for this region where conditions are very harsh, demanding heavy nature of work. Thus this work aimed to study micronutrient deficiency disorders and their association with dietary and other factors among pregnant and lactating women residing in the desert areas of western Rajasthan, India. The objectives of the study were to study the extent of the micronutrient deficiency disorders, i.e. anaemia, vitamin A deficiency and iodine deficiency disorder; to assess the nutritional status by means of dietary intake as well as through clinical examination; and to study the morbidity profile of diseases.

Profile of Rajasthan: The Great Indian desert or Thar, as it is commonly called, is spread over an area of 2 85 680 km^2 between 22° 30′ N and 32° 50′ N and from 68° 05′ E to 75° 45′ E. Within India it forms a part of the country's North-West arid zone in the states of Rajasthan (69 %), Gujarat (21 %) and Punjab and Haryana (10 %). The desert is bordered by the irrigated plains of river Indus to the West, the Aravalli hill ranges to the East, the Rann of Kutch in the South and the plains of Punjab and Haryana in the North and North-East. The greater part of the desert is arid to hyper-arid. The annual precipitation is low, ranging from less than 100 mm in the West to about 500 mm in the East. It is highly erratic and about 90 % of the rainfall is received in the months of July and August. Delayed onset and early withdrawal of monsoon, the main source of rain, is quite common. The summer temperature remains high, reaching up to 50°C in May and June in some places. Dust storms are quite common, with wind velocity above 50 km/h. The desert dwellers, for centuries, have lived under harsh conditions with bare minimum of potable water, which is fetched from far-off places and is stored as a precious treasure. Milk and milk products are available rather in plenty, but not drinking water. The dominant land use in the Thar is traditionally grazing for livestock, supplemented by rain-fed agriculture, producing millets, pulses and oil seed crops[4]. Hence, millet and wheat constitute their main food. Moong, gram dal and moth are the main pulses consumed by children. Among the vegetables and tubers, they consumed mostly locally available vegetables such as sangri, ker, kachariya, kakra, potato, gwar beans, onion, etc. In Rajasthan, there are thirty-two districts out of which twelve districts are desert areas (Thar Desert). The total population residing in the rural areas of the Thar desert of Rajasthan is 1 39 62 000 people settled in 12 359 villages according to census[5].

Material and methods

Sample size was calculated on the basis of the least prevalence of micronutrient deficiency disorders (vitamin A, iron and iodine), i.e. vitamin A deficiency of 10 % and anticipated error of 20 % as suggested by WHO, i.e. 400 pregnant and 400 lactating women and for comparison with control group, 400 non-pregnant and non-lactating (NPNL) women from the same villages. The inclusion criterion for pregnant mothers was more than 28 weeks of gestation period. Mothers with nulli-pregnancy were excluded. The inclusion criteria for lactating mothers were those mothers who were breast-feeding their child and the cut-off level for breast-feeding was up to 6 months. The inclusion criteria for the control group was 15 years and above, unmarried women or mothers who were more than 15 years, just married, living together and have not attained their family status by becoming pregnant because until the age of 15, the girls were not being sent to stay with husband even though they were married much earlier.

In Jodhpur district, there are six tehsils as per the census book (1991), which are distributed in nine panchayat samithis in the rural area. In the present study one tehsil (sub-unit of district), i.e. Jodhpur tehsil, was selected and from the Jodhpur tehsil one panchayat samithi, i.e. Luni panchayat samithi, was selected by the random sampling technique, which represents the desert area of Jodhpur and has thirty-two Panchayats. From these thirty-two panchayats, twenty-eight villages with more than 2500 people were selected using simple random sampling technique using Tippet's random number tables. The criteria for selecting bigger villages were to obtain the adequate number of pregnant and lactating mothers. The selected villages were totally surveyed, i.e. complete enumeration of the village had been done, and all the pregnant and lactating mothers were registered for the present study.

The data were collected from twenty-eight villages covering 1193 households (384 pregnant women, 400 lactating women and 409 NPNL women (control)). At the household level, information on demographic and socio-economic aspects was collected. All three groups of women were interviewed/examined for nutritional deficiency signs and dietary pattern (24 h recall method) along with morbidity survey following the standard technique and micronutrient deficiency disorders, i.e. anaemia, iodine and vitamin A. Anaemia was assessed by clinical signs (platinichia and koilonichia). Hb levels were estimated using the cyanmethaemoglobin technique and classified according to WHO classification. Iodine deficiency disorders were assessed by clinical examination of the thyroid gland using the standard method as recommended by the joint WHO/UNICEF/ICCIDD consultation[3]. Casual urine samples were collected to estimate urinary iodine excretion (UIE) levels to assess the iodine nutriture status. Iodine was determined by the wet digestion method using the standard laboratory technique[6]. UIE level less than 10 μg/dl was considered an indicator of iodine-deficient nutriture except for pregnant women whose cut-off level was considered to be 15 μg/dl. Sixty per cent of women selected randomly were requested to bring a sample of 20 g salt consumed in their families in autoseal LDPE pouches. Iodine content of the salt sample was estimated using the standard iodometric titration method. Salt samples having iodine content less than 15 ppm were classified as salts with inadequate iodine[3]. Vitamin A deficiency was assessed by administering a pretested semi-structured questionnaire regarding symptoms of night blindness. The women were asked specific questions regarding their vision during sunset and later in dim light, whether they had any problems in cooking at dusk due to lack of proper vision and whether there was any change in their activity pattern due to vision problems at dusk. The subjects with positive response to these questions were classified as suffering from vitamin A deficiency.

Results

A total of 1193 individuals participated in the study, which included 384 pregnant, 400 lactating women and 409 NPNL women. Table 1 shows the distribution of women according to Hb levels. Majority of women were anaemic. Anaemia was observed to be maximum among pregnant and lactating women in comparison to the NPNL control group ($P < 0{\cdot}05$). Anaemia was three-fold more among them (10·5–14·0 %) compared to the NPNL control group (4·1 %).

Education and economic[7] status (Tables 2 and 3) appeared to play important roles in distribution of anaemia. Anaemia was significantly high ($P < 0{\cdot}05$) in pregnant and lactating women with a low educational status, i.e. illiterates (75·9 and 81·1 %), compared to higher educational status (1·7 and 2·8 %). It was also significantly high in the low-income group (43·1 %) compared with the high-income group among lactating women ($P < 0{\cdot}05$).

Consumption of iron and folic acid tablets by anaemic pregnant and lactating women was low (39·0–48·0 %). Abortions (including miscarriages and fetal death), child deaths, stillbirths and premature births were observed to

Table 1 Distribution of women according to Hb levels

	Non-anaemic		Anaemic					
	Normal		Mild		Moderate		Severe	
Women	*n*	%	*n*	%	*n*	%	*n*	%
Pregnant† (*n* 371)	81	21·8*	44	11·9**	194	52·3**	52	14·0
Lactating‡ (*n* 382)	64	16·8	121	31·7**	157	41·1*	40	10·5
Controls‡ (NPNL) (*n* 391)	111	28·4	163	41·7	101	25·8	16	4·1
Total (*n* 1114)	256	22·4	328	28·7	452	39·5	109	9·4

NPNL, non-pregnant non-lactating.
*$P < 0{\cdot}05$: pregnant *v.* NPNL, lactating *v.* NPNL.
**$P < 0{\cdot}01$: pregnant *v.* NPNL, lactating *v.* NPNL.
†Cut-off values for normal: ≥11 g/dl; ‡cut-off values for normal: ≥12 g/dl.

Table 2 Distribution of women according to anaemia and educational status

	Pregnant		Lactating		Controls	
	Anaemic (*n* 290)		Anaemic (*n* 318)		Anaemic (*n* 280)	
Educational status	*n*	%	*n*	%	*n*	%
Illiterates	220	75·9	258	81·1	99	35·4
Primary	49	16·9**	39	12·3**	56	20·0*
Middle	16	5·5**	12	3·8**	55	19·6*
Secondary and above	5	1·7**	9	2·8**	70	25·0*

*$P < 0{\cdot}05$: illiterate *v.* primary, illiterate *v.* middle, illiterate *v.* secondary and above.
**$P < 0{\cdot}01$: illiterate *v.* primary, illiterate *v.* middle, illiterate *v.* secondary and above.

Table 3 Distribution of women according to anaemia and economic status

	Pregnant		Lactating		Controls	
	Anaemic (*n* 290)		Anaemic (*n* 318)		Anaemic (*n* 280)	
Income (Rs. per month)	*n*	%	*n*	%	*n*	%
Low-Income Group (LIG) Up to 600	111	38·3	137	43·1	105	37·5
Middle-Income Group (MIG) 601–1500	78	26·9	89	28·0*	62	22·1
High-Income Group (HIG) Above 1500	101	34·8	92	28·9*	113	40·4

*$P < 0{\cdot}05$: LIG *v.* MIG, LIG *v.* HIG.

be higher in anaemic pregnant and lactating women in comparison to normal women, however, statistically insignificant (Table 4).

In an analysis of 1049 urine samples, median urinary iodine values were observed to be less in lactating women (85 μg/l) and pregnant women (117·5 μg/l) as per WHO cut-off points (100 μg/l for women and 150 μg/l for pregnant women). For pregnant women, new WHO typology states that the median UIE should be between 150 and 250 μg/l with at least 50 % of the sample being above the optimal median UIE and not more than 20 % of samples being below 50 μg/l. In the present study, for 58·8 % of pregnant women and 55·6 % of lactating women, the median UIE is below the optimal values of median UIE, indicating an unsatisfactory situation; however, in the NPNL group, it was 41·9 %. Nearly 42–54 % lactating and pregnant women suffered from mild to moderate iodine deficiency disorder whereas in the NPNL group it was only 34·6 % (Fig. 1). Severe iodine deficiency disorder was observed to be almost twice in lactating (14·2 %) than in the NPNL control group (7·3 %). Iodine deficiency disorders (UIE levels) showed an increasing trend with the decline of income and educational status.

The iodine content of 719 salt samples were estimated using the standard iodometric titration method (Table 5). Overall, a high proportion of women (80·8 %) consumed salt having inadequate iodine content, i.e. less then 15 ppm. Consumption of salt that is deficient in iodine content was significantly high in low income (38·9 to 44·9 %) and illiterate women (nearly 80 %) than in high income and higher educated women.

Sickness at the time of survey was highest in lactating women (9·2 %) followed by pregnant women (6·5 %). Main morbidities were aches (3·8 %) and gastroenterological

Table 4 Distribution of women according to obstetric history and anaemia

Haemoglobin estimation (*n* 753)	Pregnant (371)				Lactating (382)			
	Normal		Anaemic		Normal		Anaemic	
Obstetric history	*n* 81	%	*n* 290	%	*n* 64	%	*n* 318	%
Abortions	4	1·1	33	8·9	11	2·9	28	7·3
Premature births	0	0·0	8	2·2	2	0·5	7	1·8
Stillbirths	2	0·5	12	3·2	1	0·3	18	4·7
Child deaths	12	3·2	45	12·1	12	3·1	34	8·9

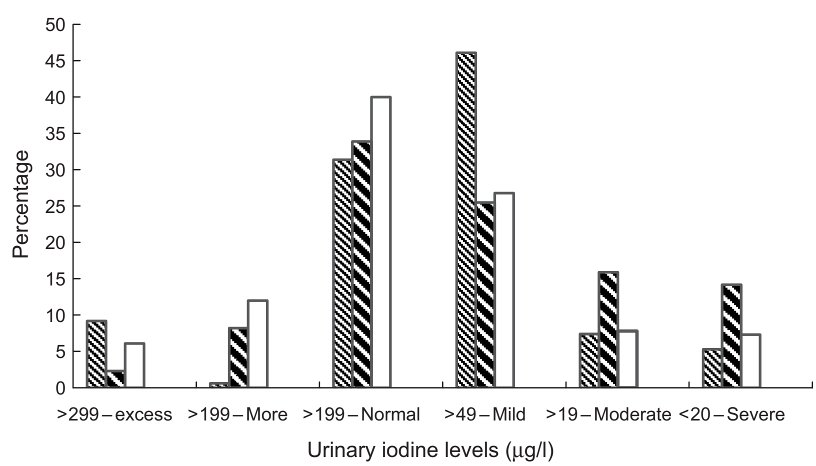

Fig. 1 Distribution of women according to urinary iodine excretion (UIE) level. UIE levels for pregnant (μg/l): mild, 50–149; normal, 150–249 and excess, 250–299 (▨, pregnant; ◪, lactating; □, control)

Table 5 Distribution of women according to Iodine content in salt intake

Iodine content in salt→	Normal (≥15 ppm)		Mild (10 to <15 ppm)		Moderate (5 to <10 ppm)		Severe (<5 ppm)	
Women ↓	*n*	%	*n*	%	*n*	%	*n*	%
Pregnant (*n* 256)	58	22·7	31	12·1	62	24·2	105	41·0
Lactating (*n* 222)	26	11·7	29	13·1	55	24·8	112	50·4
Controls (*n* 241)	54	22·4	28	11·6	66	27·4	93	38·6
Total (*n* 719)	138	19·2	88	12·2	183	25·5	310	43·1

Table 6 Distribution of women according to average daily intake of nutrients

Physiological status	Protein (g)	Total fat (g)	Energy (kcal)	Iron (mg)	Vitamin A (μg)	Folic acid (μg)
Pregnant	52·3	28·5	1530	24·2	843	172
RDA†	65·0	30·0	2525	38·0	600	400
Lactating	57·2	33·5	1680	28·6	748	178
RDA	75·0	45·0	2425	30·0	950	150
Controls	54·9	31·8	1638	25·3	649	178
RDA	50·0	20·0	1875	30·0	600	100

†RDA, Recommended Dietary Allowances (Indian Council of Medical Research[14]).

complaints (2·8 %). Vitamin A deficiency based on night blindness was significantly higher ($P < 0·01$) in pregnant women (8·8 %) than in NPNL controls (0·9 %). Thyroid enlargement was observed in 3·1 % pregnant women whereas in NPNL controls it was 0·5 %.

Analysis of dietary intake revealed that consumption of cereals and fat was low in pregnant and lactating women, i.e. 76–84 % and 80 % of the Recommended Dietary Allowances (RDA), Indian Council of Medical Research (ICMR). Consumption of pulses and legumes was very low, i.e. 47–65 % of RDA and there was very low consumption of leafy vegetables, i.e. 12 % and 7 % of RDA in pregnant and lactating women, but the consumption of milk and milk foods was found to be adequate. Analysing the average intake of nutrients per day in the diet (Table 6) showed high deficiency of protein and energy in pregnant and lactating women (20–40 %) along with high deficiency of iron and folic acid (36·3 % and 57 %) and vitamin A deficiency (20·1 % in lactating women).

Discussion

The study indicated a high prevalence of anaemia and was observed to be maximum among pregnant and lactating women (80·7 %), whereas it was 71·6 % in NPNL women. Severe anaemia was threefold higher in pregnant and lactating women than in the NPNL control group. In the present study, more pregnant and lactating women suffered more from anaemia (81 %) in comparison to other studies, i.e. National Institute of Nutrition (NIN)[8] (micronutrient deficiencies (MND)), 2003 (76·5 %) and National Family Health Survey-II (NFHS-II) (1998) (52·0 %)[9]. Cases of severe anaemia were observed to be almost threefold higher in pregnant women (14·0 %) of the studied population group in comparison to NIN[8] (MND) 2003 (4·3 %).

Abortions, child deaths, stillbirths and premature births were significantly higher in anaemic pregnant and lactating women in comparison to normal women. Consumption of iron and folic acid tablets by these women was observed to be low (39·0–48·0 %) in comparison to NFHS-II (1998)[9] (57·6 %), leading to the higher prevalence of anaemia. Anaemia showed negative association with educational level and income, i.e. high in illiterate (65·0 %) and in low-income women (39·8 %), further contributing to enhance anaemia in this region.

Vitamin A deficiency based on night blindness was higher in pregnant women (8·8 %) than in NPNL controls (0·9 %). Night blindness was threefold higher in the present study compared to ICMR[10] (2001), i.e. 2·8 %.

Overall, a high proportion of women (80·8 %) consumed salt having inadequate iodine content, i.e. less then 15 ppm. In the present study, consumption of normal iodised salt was very low (19·2 %) in comparison to other studies, i.e. NIN[8] (MND) (2003) (30·7 %), NFHS-II (1998) (46·0 %)[9], ICMR (2001) (55·5 %)[10] and Kapil *et al.*[11,12], leading to mild to moderate iodine deficiency disorder to be high among lactating and pregnant women, i.e. nearly 42–54 %. Caste, education and income showed negative association with consumption of normal iodised salt, i.e. higher in backward castes and scheduled castes and least in general caste community, and observed to be more in low education and low-income family women. To overcome the problem of iodine deficiency disorder, the Government of India started intervention programmes in the last decade including National Iodine Deficiency Disorder Control Program and universal salt iodisation (USI). USI[13] involves the iodisation of all salt for human and livestock use, including salt used in the food industry. Adequate iodisation of all salt will deliver iodine in the required quantities to the population on a continuous and self-sustaining basis. During the present study, it was found that only 19 % of salt had adequate iodine content. The salt being consumed by lactating women contained low iodine contents. This indicates that the consumption of iodised salt by women of the desert area is extremely low in spite of the national programmes in operation and hence needs more attention.

Consumption of pulses and legumes was very low, i.e. 47–65 % of RDA, ICMR[14] and there was very low consumption of leafy vegetables, i.e. 12 % and 7 % of RDA in pregnant and lactating women. Analysing the average intake of nutrients (per day in diet) showed high deficiency of protein and energy in pregnant and lactating women along with high deficiency of iron and folic acid and vitamin A deficiency, which is responsible for the higher prevalence of the above-mentioned three micronutrient deficiency disorders in this region in comparison to other studies. Women of this area have to face the harsh conditions of the desert, i.e. frequent occurrence of drought, low rainfall and high temperature, which affect the economy and food intake of the inhabitants[15,16]. According to WHO[1], at present, iron and vitamin A supplementation are the most common strategies currently used to control these deficiencies in developing countries for the time being. This is likely to remain the case until either significant improvements are made in the diets of entire populations or food fortification is achieved. In addition to iodisation of salt, there is a strong need for formulating nutritional intervention packages for this region by introducing adequate bioavailabilty of iron and vitamin A etc. in their local diets, which can be improved by altering the meal pattern to favour enhancers or lower inhibitors.

Acknowledgement

Conflicts of interest: The authors declare that they have no conflict regarding this paper and have had no involvements that might raise the question of bias in the work reported or in the conclusions, implications or opinions stated.

Funding source: Source of funding is intramural, i.e. Desert Medicine Research Centre, Jodhpur, Rajasthan, India.

Authorship declaration: All the authors listed on this paper meet the criteria set down by the International Committee of Medical Journal Editors. All the authors were involved in the set up of the study, in the study itself, writing of the paper etc. No one who might consider that he or she has a right to be an author has been excluded. The authors express their deep sense of gratitude to the Officer-in-charge, DMRC, Jodhpur for guidance and providing facilities.

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