Short Communication

Chronic energy deficiency and its association with dietary factors in adults of drought affected desert areas of Western Rajasthan, India

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Objective: To asses the impact of drought on nutritional status of adults of a rural population in desert area. Design: Three-stage sampling technique. Setting: 24 villages belonging to 6 tehsils (sub units of district) of Jodhpur district, a drought affected desert district of Western Rajasthan, in 2003. Subjects: 1540 adults were examined for their anthropometry, dietary intake and nutritional deficiency signs. Results: Overall chronic energy deficiency (CED) was found high (42.7 %). Severe CED was 10.7 percent, significantly higher in males than females. Regarding vitamin A deficiency, overall prevalence of Bitot spot and night blindness was 1.8 and 0.2 percent respectively, higher in females than males. Regarding vitamin B complex deficiency, angular stomatitis, cheliosis, and glossitis was 1.0, 2.6 and 5.4 percent. Anemia was 35.6 percent. Overall mean calorie and protein intake deficit was very high (38 & 16.4 %). The comparison of present drought results with earlier studies in desert normal and desert drought conditions showed higher deficiencies of calories and proteins in their diet. Conclusions: Severity of malnutrition is critical as CED was more than the cut-off point of 40 percent stated by World Health Organization. Vitamin A and B complex deficiencies, anemia, protein calorie malnutrition along with deficit in calories and proteins in their diet were higher in comparison to non desert areas, which may be due to the harsh environmental conditions in desert areas. Efforts should be made to incorporate intervention measures to ensure the supply of adequate calories and proteins to all age groups.

Key Words: malnutrition, dietary intake, BMI, drought, anemia

INTRODUCTION

Drought and famine are commonly featured in desert areas. During nutritional emergencies such as drought or famine, one of the first relief priorities is the provision of food to the community and disease prevention through prompt attention to nutrition and to various aspects of environmental health.[1] Food security implies that all people at all times have both physical and economic access to enough food for an active and healthy life. Attempts have been made to study the various aspects of nutrition and food security during famine, war, flood and economic crisis at international and national levels.[2-5] In desert areas of western Rajasthan, India, drought conditions occur quite frequently of which desert districts of Western Rajasthan had been the worst affected. During the last century, the arid region experienced 47-62 percent droughts of varying intensities[6] which had weakened the rural economy and largely eroded the coping capacity and economic potential of the people, with heavy livestock losses and reduced harvests leading to increased poverty and chronic malnutrition. In 1987, the Desert Medicine Research Centre (DMRC) conducted a health and nutrition survey of drought affected parts of Rajasthan and revealed that children and adults had severe degree of Fat fold at Triceps (FFT) reduction, as indicated by frequency distribution of FFT values, and a high prevalence of vitamin A and B complex deficiencies. Calorie intake was reported significantly reduced in all age groups in all districts in comparison to Recommended dietary allowances (RDA) of Indian Council of Medical research (ICMR).[7]

A survey was planned to study the impact of drought on nutritional status of adults of rural populations in an area facing frequent drought conditions. In view to find out the magnitude and extent of malnutrition in this area with regard to adults which have not been given due attention in research priorities. The main objectives of the study was to assess the nutritional status of adults of drought affected areas of Western Rajasthan by means of nutritional anthropometry, dietary intake as well as through clinical examinations and to perform the time trend analysis of malnutrition and to suggest possible remedial measures. The results of this study have also been compared with the findings of 1987 drought survey and baseline health survey (conducted by DMRC) to de-

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termine the factors responsible for higher prevalence of various morbidities.

MATERIALS AND METHODS

The great Indian desert or Thar, as it is commonly called, is an areas with that spreads over 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 encompassing the states of Rajasthan (69%), Gujrat (21%) and Punjab & Haryana (10%).

The three stage sampling technique was used for the assessment of health and nutritional status in this study. A drought survey was conducted by DMRC[3] in 1987 in which Jodhpur and Barmer districts were found worst affected in terms of nutritional deficiencies, calorie deficits and protein energy malnutrition (PEM). The three-stage sampling technique was implemented and at the first stage, Jodhpur district was selected based on random selection criteria. At the second stage the tehsils (sub units of district) and at third stage, the villages were selected. Jodhpur district has 6 tehsils. All the tehsils were included in the sampling to avoid the intra district variation as the tehsils are considered as population-wise homogeneous for the sampling purpose. From each tehsil, four villages were selected in different directions by simple random sampling criteria, using random number tables. This sampling gave complete picture of the district. During drought situation all nutritional deficiencies and calorie with protein intakes are affected due to lack of rains and water and the consumption of nutrients differ very prominently from normal situation which in turn affect the weight and heights of both children and adults and PEM cases creep in. As the nutritional and health problems increase during drought, their prevalence might rise to more than 1%. When the prevalence increases more than 1 % then it becomes a matter of concern as it affects particularly the children besides adults. The sample size has been calculated, based on the prevalence rates of nutritional deficiencies (Vitamin A and B complex deficiency and PEM), considering more than 1% prevalence which becomes a public health problem. Considering this and using the standard procedure for determining the sample size (n) by the formula, with 20% error and 10% non response, 95% Confidence Interval (CI) using ± 2 SD limits, a sample of 1560 was calculated to be covered from Jodhpur district.[1] On the basis of this, 65 adults were covered from each village.

Rapid drought survey was conducted and the data were collected on a total of 1540 adults (complete in all senses) i.e., 15-45 years covering 24 villages belonging to 6 tehsils of Jodhpur district in May, 2003. The adults were examined at household level following simple random sampling technique. Information on Demography and Socio-Economic aspects had been collected by means of interview technique using pre tested schedules. Each individual was examined for the nutritional anthropometry and dietary intake as well as clinically for nutritional deficiency signs in order to assess nutritional status. Adults were examined by trained a Medical Anthropologist and a Physician using standard equipment and methods. All the anthropometric measurements (height, weight, and fat fold at triceps) were taken following standard techniques.[8,9] According to WHO,[1] the 'gold standard' in anthropometric assessment of adults is Body Mass Index with the usual practice being to measure height and weight of adults as well as for adolescents (aged 10-18 years). BMI-for-age has been considered the best indicator of thinness. Overall prevalence of chronic energy deficiency was calculated using WHO classification. For nutritional deficiency signs, classification of clinical signs that are considered to be of value in nutritional and clinical assessments of malnutrition were considered, as prescribed by Jellife.[9] Each adult was examined clinically from head to foot for nutritional deficiency signs. For dietary intakes, 24 hour recall method using oral questionnaire[8] was adopted. Due to the rapid nature of a drought survey, only cereal and millets consumption survey were done as nearly 85 percent of the total daily calorie intake of the rural population of India is supplied from cereals and millets and in desert residents this proportion is more then 85 percent.[3,11]

The results of the present study have been compared with the earlier surveys conducted in Jodhpur district by DMRC during drought conditions[3] (1987) and normal conditions[11] (Baseline health survey, 1986), besides, the normal non-desert conditions[11] (DMRC, 1986). Methodologies adopted in these surveys for diagnosing nutritional deficiency signs, anthropometry and dietary intake were the same as in the present study. The comparisons were made between males and females for different age groups by applying Chi square and Proportion Test as per feasibility. For dietary analysis the mean calorie and protein intakes were compared with the DMRC drought survey and Baseline health survey by applying t-test for difference of means.[12]

RESULTS

Analysis of data revealed that 57.8 percent females and 33 percent males were illiterate and the majority of them belonged to lower and middle income groups (85.7 %), being involved mainly in labour and famine work employed at drought relief work spots, followed by agriculture.

Table 1. Percentage of BMI distribution in adults (15-45 years) by gender of Jodhpur district

Distribution	Normal (>=18.5)		CED I (17-18.4)		CED II (16-16.9)		CED III (<16)	
Gender	M	F	M	F	M	F	M	F
Total	54.2	60.5	22.4	20.1*	10.5	10.6*	12.7	8.7*

*p< 0.01 between M & F

Table 2. Percent prevalence of nutritional deficiency signs

Clinical Nutritional Deficiency Signs	Present Study (%) N = 1540 15-45 years M	F	G.T	Non desert (%) N = 747 15-45 years G.T
Protein calorie Malnutrition				
Marasmus	0.3	0	0.2	NA
Vitamin A Deficiency				
Night Blindness	0.1	0.2	0.2	0.0
Bitot Spot	0.5	3.1**	1.8	0.5**
Vitamin B Complex deficiency				
Angular Stomatitis	0.6	1.5**	1.0	0.8
Cheliosis	2.1	3.0	2.6	0.2**
Glossitis	4.4	6.4	5.4	0.0
Vitamin C deficiency				
Gums Bleeding	2.1	2.8	2.5	NA
Teeth caries	7.7	9.3	8.5	30.1**
Mottled Enamel	39.6	36.9	38.3	4.4**
Anemia: pallor conjuctiva	27.4	43.9**	35.6	2.8**

*p< 0.01 **p< 0.05

Analysis revealed that 45.8 percent males and 39.5 percent females showed chronic energy deficiency which was high and needs attention (WHO classification for BMI). Males suffered from severe chronic energy deficiency, significantly higher (12.7 %) than females i.e., 8.7 percent (p< 0.01) (Table 1). Reduction in calorie consumption is likely to affect the fat deposits. Cumulative percentage distribution of FFT in adults revealed that overall 16 to 66 percent of the adults had nearly 50 percent reduced fat deposits (FFT < 6 mm) in comparison to standards[9] i.e., 16 percent in Shergarh tehsil (minimum) and 66 percent in Jodhpur tehsil (maximum) had fat fold at triceps less than 6 mm in Jodhpur district. Six mm of fat is 50 percent of 12 mm fat (approximately) which normal adult[9] should have. This has been calculated on the basis of cumulative percentage frequency distribution of adults (15-45 years) for FFT (mm) according to gender.

The overall prevalence of anemia was 35.6 percent, diagnosed on the basis of conjunctival pallor and platynichia and koilonichia, significantly higher in females (43.9 %) than males (27.4 %). Prevalence of marasmus[1,9] was 0.2 percent (severe wasting of fat and muscle, which the body breaks down for energy, leaving "skin and bones"). With regards to vitamin A deficiency, overall prevalence of bitot spot and night Blindness was 1.8 and 0.2 percent. For vitamin B complex deficiency, overall prevalence of angular stomatitis, cheliosis, and glossitis was 1.0, 2.6 and 5.4 percent. Vitamin A and B complex deficiencies were significantly higher in females than males. Vitamin C deficiency was observed 2.5 percent (gums bleeding). Teeth caries and mottling of enamel were 8.5 and 38.3 percent respectively (Table 2). Mottling of enamel was very high which may be due to high content of fluoride in drinking water in this area.

The findings of present study when compared with earlier drought survey of Jodhpur district, it was observed that prevalence of vitamin A deficiency and B complex deficiencies were found highly reduced in comparison to the 1987 study i.e., bitot spot reduced from 24.4 to 1.8 % and vitamin B complex deficiency from 89.2 to 9.0 %. Overall prevalence of anemia was also reduced to 35.6 percent in comparison to earlier study (74.1 %).[3]

Table 2 also shows the comparison of data of nutritional deficiency signs in studied population with non desert data of Jaipur district.[11] This table showed that vitamin A and B complex deficiencies along with anemia were significantly higher in the present studied population as compared to the non desert areas. This may be attributed to the harsh environmental conditions and related socio-economic factors.

Table 3. Comparative table of mean calorie intakes and mean protein intakes in different surveys according to gender

Different Surveys	Mean calorie intakes Males	Females	Mean protein intakes Males	Females
Present drought study, 2003	1447.7*±624.24 (745)	1168.9*±614.13 (774)	50.9*±21.95 (745)	41.1*±21.59 (774)
Desert drought 1987	2466±896.4 (571)	2258±856.6 (583)	82.6±29.88 (571)	76.3±28.55 (583)
Desert Normal 1986	1586 (107)	1825 (131)	46.6 (107)	58.0 (131)
Non Desert 1986	2685 (89)	2418.5 (89)	84.0 (89)	74.5 (89)
RDA	2425	1875	60.0	50.0

*(p<0.01) ( ) Values in the parenthesis are number covered RDA- Recommended Dietary Allowances, ICMR.

Nearly 85 percent of the total daily calorie intake of the rural population of India is supplemented from the cereals and millets, however in desert residents this proportion is more then 85 percent. Since it was a rapid drought survey, due to urgency and shortage of time, only cereal and millets consumption surveys was carried out. Table 3 showed that mean calorie intake was very poor in comparison to recommended dietary allowances (RDA), ICMR[7] i.e., 1447.7 and 1168.9 calories in males and females respectively. Calorie deficit was found higher i.e. 38 percent in comparison to RDA, ICMR[7] . In the present study, mean calorie intake (1168-1447 calories) was significantly low (p<0.01) in comparison with earlier studies[3,11] in drought and normal conditions, which might be responsible for the prevalence of protein calorie malnutrition (PCM) in the present study (Table 3).

Nearly 85 percent calories of the total daily calorie intake of the rural population of India is supplied from the cereals and millets and in desert residents this proportion is more then 85 percent (It is based on the evidence of the results of earlier studies Desert drought[3], 1987 and Desert normal and Non Desert, 1986[11] where overall calorie and protein intake was higher in Desert Drought study (1987) than Desert Normal and Non Desert study (1986) though in Desert Drought study (1987), only cereals and millets consumption survey was carried out whereas in Desert Normal and Non Desert study (1986), calorie and protein intakes was calculated from full information on whole diets consumed by population. This indicates that in the desert area, total daily calorie intake of rural population is supplied mainly from cereals and millets. Overall protein intake was 50.9 and 41.1 gm in males and females respectively, which was lower in comparison to recommended dietary allowances (RDA).[7] Overall mean protein intake deficiency was 16.4 percent, calculated in comparison to recommended dietary allowances (RDA).[7] In the present study, mean protein intake (41-51 gm) was significantly low (p<0.01) in comparison to earlier studies[3,11] which might be the probable reason for the increase in prevalence of protein calorie malnutrition (Table 3).

Wheat and millets were the staple diet in this area. But due to crop failure, the inhabitants were mainly dependent on wheat supplied in lieu of work under relief programs. Green leafy and other vegetables were not available. There was no local production of agricultural and animal products during drought, leading to shortage of food grains, fodder and increased unemployment of the people with direct economic consequences along with food insecurity leading to malnutrition.

The frequency distribution of protein intake revealed that 1 to 20 percent of adults had protein intake less than 22.5 gm which was nearly half of the RDA[7] values i.e., ranging from nearly 1 percent in Bhopalgarh tehsil to 20 percent in Bilara tehsil. Percentage of protein deficiency was found to be high.

Table 3 also showed the comparison of data of calorie and protein intakes with non-desert area.[11] The overall deficit in calories and proteins intakes was significantly higher (p< 0.01) in the present study as compared to non-desert areas.[11] This may be due to the typical harsh environmental conditions of the desert where the population is exposed to extreme environmental conditions, frequently occurring drought leading to poor economy affecting their dietary intake in turn.

DISCUSSION

The proportion of the population with low BMIs that would define a public health problem is closely linked to available resources for correcting the problem, the stability of the environment, and government priorities, according to the WHO.[1] Overall chronic energy deficiency was 42.7 percent which was very high indicating that adults are in the critical situation category as per the WHO[1] classification i.e., if the adult population with BMI < 18.5 is more then or equal to 40 percent, it indicates a critical situation and needs attention. Severe CED was 10.7 percent which was significantly higher in males than females, and may be due to the fact that males have to work hard during drought situations to support their families.

In NIN studies[4,5], the prevalence of CED among adults during drought was 43.3 percent in 2000 and 39.8 in 2003. The prevalence of CED in the studied adult population was higher than the NIN[5] study during drought (2003) both in males as well as in females i.e. 42 and 38 percent.

The results of the present study revealed that adults of desert areas suffered more from vitamin A and B complex deficiencies, anemia along with protein calorie malnutrition. The prevalence of vitamin A and B complex deficiencies along with anemia in the present study have shown a declining trend, in comparison to the earlier drought study in Jodhpur district,[3] which may be due to the supply of vitamin A and Iron by State Government. The NIN[5] study during drought (2003) indicated that the prevalence of Bitot spot, angular stomatitis and dental fluorosis were 0.1, 0.1 and 4.0 percent respectively, lower than the studied adult population which may be due to prolonged harsh environmental condition of desert in addition to the frequent droughts. Mottling of enamel was very high which may be due to high content of fluoride in drinking water in this area.

The adults during present study showed deficiencies in calories and proteins intake in their diet in comparison to earlier drought study, which may be responsible for the prevalence of protein calorie malnutrition in present study population. This may be due to the fact that there was almost failure of monsoon for 3 years consecutively leading to reduced harvests and poor economy; further declining the availability and accessibility of food to the community.

This study showed that malnutrition is prevalent not only in children but also in adults and that the preschoolers[14] exhibited the highest (under weight 46 %) prevalence. Vitamins A and B complex deficiencies along with anemia were significantly higher in desert area population as compared to non-desert area[11] and other rural areas, NIN[5] where vitamins A and B complex deficiencies were 0.2 and 0.1 percent respectively in adults. Overall calorie and protein deficiency was higher in the present study in comparison to non desert areas[11] as well as other parts of country.[15-17] It might be due to the harsh environmental conditions of the desert areas where drought occurs quite frequently and adversely affects the economy, largely eroding the coping capacity and economic potential of the people, with heavy livestock losses and reduced harvests

leading to increased poverty and poor food intake of the inhabitants, which in turn might be responsible for higher protein deficiency in the studied group. Due to inadequate consumption of daily foods the adults suffered from chronic energy deficiency, vitamin A and B complex deficiencies along with protein calorie malnutrition. Efforts should be made to incorporate the measures such as ensuring the supply of adequate calories and proteins to all age groups including adults.

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AUTHOR DISCLOSURES

The authors declare that they have no conflict regarding this paper and have had no involvements that might raise questions of bias in the work reported or in the conclusions, implications or opinions stated. Source of funding is intramural, i.e. Desert Medicine Research Centre, Jodhpur, Rajasthan, India.

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印度乾旱影響的西部 Rajasthan 沙漠地區之成年人慢性熱量缺乏及其與膳食因子之相關性

目的：評估乾旱對於沙漠地區之鄉村成年人口營養狀況之影響。設計：三階段抽樣方法。地點：在 2003 年受乾旱影響的印度西部 Rajasthan 沙漠區域，屬於 Jodhpur 區的 6 分區中的 24 個村落進行此研究。研究對象：1,540 位成年人接受體位測量、膳食評估，及臨床營養缺乏症狀檢測。結果：整體有高比率(42.7%)的慢性熱量缺乏(CED)，嚴重 CED 佔 10.7%，男性缺乏比率顯著地高於女性。有關維生素 A 的缺乏，整體 Bitot 斑及夜盲症的盛行率分別是 1.8 及 0.2%，且女性高於男性。維生素 B 群缺乏方面，口角炎、唇炎及舌炎的盛行率分別是 1.0、2.6 及 5.4%。貧血者有 35.6%。整體平均熱量及蛋白質攝取缺乏率很高(38 及 16.4%)。比較目前乾旱的結果與之前研究在沙漠正常及沙漠乾旱的情況比較，顯示在他們的飲食更嚴重的缺乏熱量及蛋白質。結論：由 CED 比率超過 WHO 的切點 40%來看，此地區的營養不良是非常嚴重而緊急的。比起非沙漠地區，此區人口在維生素 A 及 B 群缺乏、貧血、蛋白質熱量營養不良及飲食缺乏熱量及蛋白質的比率較高，可能是因為沙漠地區嚴苛的環境所致。當局應致力介入，以確保供應各年齡層適當的熱量及蛋白質攝取。

關鍵字：營養缺乏、膳食攝取、身體質量指數、乾旱、貧血