PRINT: ISSN 0972-0073 ONLINE: ISSN 2456-6802
Anthropologist, 9(3): 189-197 (2007)
DOI: 10.31901/24566802.2007/09.03.03

Biology of the Tribal Groups of Rajasthan, India: 3. Assessment of Nutritional Status Using Heights and Weights

M. K. Bhasin and Sweta Jain

Department of Anthropology, University of Delhi, Delhi 110 007, India

KEYWORDS Anthropmetry. Tribals. Nutrition. Health Status

ABSTRACT Cross-sectional investigation was carried out on 2221 samples consisting of 1133 males and 1088 females belonging to adolescent (8^+ to 18^+) age groups among the tribal groups, namely Minas, Bhils, Sahariyas, Garasias, Damors and Kathodis of Rajasthan. For the purpose of analysis, the subjects were classified into yearly intervals. Heights and weights were collected following the internationally accepted standards and based on the interrelationships of height, weight and age: height for age and weight for age, has been calculated and accordingly their nutritional status has been determined. While comparing the present study tribal groups for the mean values of heights and weights it was found that they were lower than the national and international standards. The present study shows a high prevalence of stunting (low height for age) and underweight (low weight for age) among both males and females. Females show a higher percentage prevalence of chronic malnutrition (<90), with respect to height and also underweight than the males. Most samples fall much below the normal (75^+) standards of weight for age. Thus, malnutrition is largely prevalent among the tribal groups of Rajasthan and the condition is further aggravated as it appears in combination with PEM.

Malnutrition affects the rate of growth, ultimate body size, ultimate body shape and ultimate body composition (Tanner, 1966). On the basis of anthropometry, UNICEF, has made a comprehensive global, regional and country assessment of child malnutrition (Carlson and Warlaw, 1990). Since 1978, a group of economists, demographers and historians have been investigating the usefulness of data on height and weight for the analysis of the impact of long term changes in nutritional status and health on economic, social and demographic behaviors. Height is being used to investigate the effects of improvements in nutrition on social and economic behavior, especially on labor productivity, the selection of individuals for particular occupation and the decline in mortality. Variability in adult weight is recognized as being linked with variation in adult height, which in turn reflects a number of environmental factors active throughout the childhood and adolescence.

Malnutrition takes several forms that often appear in combination, such as protein-energy malnutrition and deficiencies in micronutrients. It was assessed that about 36% of children under five in the developing world, (excluding China) or about 150 million are underweight, about 39% are stunted and 8% are wasted; more than one in six malnourished children are suffering from severe malnutrition in terms of their weight for age. Further Asia, where nearly one in two children is malnourished, is the most affected region and lastly, rural malnutrition prevalence is consistently higher than urban, roughly one and half times greater. In fact Anthropometry has been extensively used to quantitate malnutrition in terms of growth retardation in communities.

The global burden of malnutrition and infectious disease is immense, especially amongst children. In a report by WHO (1998), it was estimated that 168 million children under 5 years of age i.e. 27% of the world's children population in this age group, are malnourished (as measured by weight for age), of which 76% live in Asia, 21% in Africa, and 3% in Latin America. WHO (1998) estimated that in South Asia as many as 17% of children, under 5 years of age are wasted (weight for height) and 60% are stunted (height for age). It further reported that worldwide 160 million children are underweight (weight for age) with over half of these being in South Asia.

Vijayaraghvan and Rao (1998) carried out a survey, which indicated that the diets of the rural population are inadequate and deficient in most of the nutrients. There is a widespread energy deficiency in rural households. About 60% of the school children are underweight and 62% are stunted. About 15% of the children of 1-5 years of age suffer from short duration malnutrition (wasting). This has an adverse effect on physical growth, capacity to use intellectual endowment, emotional unfolding and personality development. Inadequate dietary intake and disease are immediate causes of malnutrition and they

reinforce one another synergistically (Scrimshaw et al., 1968).

Nutritional status of children can be evaluated under three broad headings, namely, clinical, biochemical and anthropometric. A variety of clinical features have been described in PEM (Protein-Energy Malnutrition) and other micronutrient deficiency state. Consequently, for practical purposes, anthropometry is the most useful parameter for assessing the nutritional status of children (WHO, 1986). Rao et al. (1969) showed indicators of nutritional deficiency at various degrees of severity, by comparing undernourished Indian preschool children with Western standards for children. In recent years, International consensus has been achieved to a large extent for defining nutritional status of children with the aid of anthropometry (WHO, 1986; Waterlow, 1992 b).

Based on interrelationships between height, weight and age i.e. weight for age, height for age and weight for height, can be categorized for different forms of Protein-Energy Malnutrition (PEM) i.e. 'normal', 'wasted', 'stunted', and 'stunted and wasted' (Gomez et al., 1956; Waterlow, 1992 c). The recognition of chronic PEM as leading to nutritional dwarfism has long been recognized (Jelliffe, 1959; Downs, 1964), needing height for age measurements for identification. In order to link these two indicators - low weight for height (wasting) and low height for age (stunting) - a practical and important cross tabulation has been advocated (Waterlow, 1974).

In the present study the quantum of malnutrition in different communities is often compared with the aid of anthropometry by comparing with national and international standards and through different anthropometric indices, the extent of malnutrition has been assessed among the tribal groups of Rajasthan.

MATERIALS AND METHODS

Cross-sectional investigation was carried out on 2221 samples consisting of 1133 males and 1088 females belonging to adolescent (8^+ to 18^+) age groups (Table 1). The study was carried out on the Scheduled Tribes, namely Minas, Bhils, Sahariyas, Garasias, Damors and Kathodis, residing in the districts Sawai Madhopur, Udaipur, Baran, Sirohi, Dungarpur, respectively of Rajasthan. Total number of 474 Minas, 471 Bhils, 475 Sahariyas, 273 Garasias, 266 Damors and 262 Kathodis were studied for the purpose. Samples are collected from the place of residence and schools. For the purpose of analysis, the subjects were classified into yearly intervals. Those subjects who had completed 8 years of age but were less than 9 years even by one day were grouped under 8+ age group. Similar pattern was followed for other age groups as well. For more details of the area and people see paper of Bhasin and Jain (2007).

Heights and weights were collected following the internationally accepted standards of Martin and Saller (1957), Tanner et al. (1969), Weiner and Lourie (1969), Singh and Bhasin (1989). Based on the interrelationships of height, weight and age: height for age and weight for age, has been calculated and accordingly their nutritional status has been determined.

RESULTS AND DISCUSSION

As in other stages of life, in adolescence also, the nutritional status is best assessed by using

Table 1: Distribution of sample size in various age groups in six tribes of Rajasthan

Age (Yrs)	*Mina*		*Bhil*		*Sahariya*		*Garasia*		*Damor*		*Kathodi*	
	M	*F*	*M*	*F*	*M*	*F*	*M*	*F*	*M*	*F*	*M*	*F*
8+	21	26	24	20	21	24	13	13	12	12	12	12
9+	21	20	22	20	23	22	12	12	12	12	13	12
10+	21	20	21	23	22	25	14	13	12	11	12	12
11+	24	20	22	23	21	21	14	11	12	12	12	12
12+	25	20	23	23	21	21	14	12	12	12	13	11
13+	25	21	20	21	21	21	12	12	12	12	12	12
14+	21	20	22	21	24	22	12	11	12	12	11	11
15+	21	20	21	20	21	21	13	11	12	12	13	12
16+	21	19	22	20	20	23	13	11	12	11	12	12
17+	24	21	21	20	22	20	12	13	13	13	12	12
18+	22	21	22	20	22	17	12	12	12	12	11	11
Total	246	228	240	231	142	131	238	237	134	132	133	129

anthropometry (de Onis et al., 2001). Nutritional status of the present study was assessed by nutritional anthropometry which predominates over other methods of nutritional assessment (Vijayraghvan, 1987) by using the height- weight ratios i.e. weight for age and height for age.

Table 2 shows the results of heights and weights among both the sexes taken on the Scheduled Tribes of Rajasthan. With respect to height, males of all tribal groups are taller than the females with few exceptions during preadolescent ages. Females of both Minas and Damors comparatively show better heights and among males Minas are the tallest. The mean values of weight indicated that there are little differences during preadolescent ages in Minas and Sahariyas. In Bhil, Garasia, Damor and Kathodi, males are heavier than their female counterparts throughout from 8 to 18^{+} years. At higher ages Mina males and females become heavier than other five populations. The poorest weight status is shown in Bhil and Kathodi females.

Tables 3 to 14 represent the percentage prevalence of various forms of malnutrition, age and sex wise among Mina, Bhil, Sahariya, Garasia, Damor and Kathodi. Height for age reflects the achieved linear growth and its deficits indicate long-term cumulative inadequacies of health or nutrition. Stunting the most easily measured and widespread effect of the malnutrition-infection complex, predicts generalized functional impairment on a wide range of biological, behavioral and social dimensions in children and adults from developing countries (Martorell et al., 1990; Politt, 1990; Waterlow, 1992 a; Martorell et al., 1994). Gopalan (1972) has reported that 80% of preschool children suffer from malnutrition dwarfism. A relationship between malnutrition, infection and poverty has been well documented.

Females show a higher percentage prevalence of chronic malnutrition (<90), with respect to height, than the males at all age except in Sahariyas and Damors. Highest percentage prevalence of stunting (low height for age) is observed in Bhil males (50.0%) at 9 years. Young adult Mina males do not show any prevalence of chronic malnutrition. Bhil females show a much higher percentage prevalence of stunting (maximum of 71.4%) at 14 years followed by Garasia females (63.6%) at 11 years. This reflects a greater failure of Bhils to reach linear growth potential than the others, which may be as a result of suboptimal health and/or nutritional conditions.

Weight for age is considered as an index of current nutritional status. It reflects the body mass, relative to chronological age and underweight (low weight for age) refers to the underlying pathological process. The percentage prevalence of weight for age according to sex and age has been shown in Tables 3 to 14. As compared to height for age, most samples fall much below the normal (75^{+}) standards of weight for age. Higher prevalence of underweight is exhibited by females than the males. Highest percentage prevalence of Grade II (mild or moderate, 65-75) is shown by Garasia males (71.4%) at 11 years followed by Bhil males (68.2%) at 14 years. Among females also highest value is recorded for Garasias i.e. 83.3% at 12 years and Bhil females (80.0%) at 8 years. Severe form (<80) is also seen highest among Bhil males (81.0%) at 17 years. Among females the same is observed to be highest among Damor and Kathodi females (91.7%) at 8 years, followed only by 84.6% at 10 years in Garasia females and 82.6% at 11 years in Bhil females. Thus on the whole Bhil and Garasia males and females show much higher prevalence of underweight as compared to others. Females, in comparison to males, have lower weight for age.

Anthropometry can be used to verify the existence of nutritional problem in a population and to assess its magnitude. Studies carried out in various parts of the country have confirmed that malnutrition exist among the poorest sections of the population (ICMR, 1984; Sharma, 1992). The present study shows a high prevalence of stunting (low height for age) and underweight (low weight for age) among both males and females. Low height for age is reflective of past nutritional and environmental conditions and indicates conditions currently being experienced by younger children in the community. The present study (due to high prevalence of stunting and underweight) reflects the cumulative effect of socio-economic, health and nutrition problems (Singh and Mishra, 2001). Stunting is a predictor of risk and because it is strongly correlated with socio-economic status, reflects the overall development (Scrimshaw, 1964; Patwardhan, 1969; Spyckerelle et al., 1990). Literacy rate of females in Rajasthan is seen much lower than the males (Census of Rajasthan, 1991), which may also be regarded as one of the major reasons for the current nutritional status.

Means of height and weight of the present

Table 2: Anthropometric measurements of the tribal groups of Rajasthan

	Mina				*Bhil*				*Sahariya*			
	Male		*Female*		*Male*		*Female*		*Male*		*Female*	
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
Height (cm)												
8+	118.39	4.79	118.84	5.29	117.72	5.27	116.72	7.05	120.24	4.98	122.37	4.17
9+	127.31	4.62	126.06	3.86	122.19	3.68	123.98	4.52	128.34	3.88	129.92	4.31
10+	130.68	5.81	132.22	4.10	131.11	5.38	128.41	5.44	132.73	6.79	130.57	6.51
11+	136.10	4.54	138.49	3.77	138.11	3.34	132.79	5.56	139.18	5.37	143.98	6.08
12+	124.37	3.69	142.35	4.15	141.48	4.53	139.05	4.52	145.63	8.29	144.10	5.67
13+	145.98	8.12	146.88	5.13	147.68	5.34	145.96	5.36	149.92	8.85	145.62	5.87
14+	155.92	7.77	151.05	4.34	155.53	4.63	147.81	6.57	154.33	7.37	150.53	5.06
15+	159.99	4.30	152.71	4.89	154.48	4.89	151.22	3.83	161.71	4.63	153.36	4.36
16+	165.68	4.09	154.96	4.48	160.39	4.79	151.45	5.71	163.79	4.90	154.46	4.06
17+	167.21	4.05	153.34	3.84	160.59	4.56	150.04	5.21	164.93	5.88	156.63	5.49
18+	169.35	4.25	154.45	4.87	164.22	4.47	151.37	4.32	164.94	6.26	153.92	5.87
Weight (kg)												
8+	17.21	2.07	17.67	2.18	16.94	2.09	15.80	1.40	19.19	2.91	19.48	2.84
9+	20.00	2.64	21.23	1.81	17.41	1.84	18.50	3.43	21.96	2.49	21.95	4.05
10+	23.50	2.85	22.37	2.45	21.64	4.52	20.22	3.65	24.09	4.18	23.20	4.21
11+	25.69	3.86	25.23	6.73	24.95	2.94	22.76	3.68	28.02	3.71	31.58	5.40
12+	28.23	2.95	28.60	3.17	27.46	3.62	27.46	3.70	32.28	6.44	31.05	4.24
13+	30.68	4.73	32.76	3.78	33.35	3.51	31.17	3.26	34.64	5.12	36.12	6.75
14+	37.45	5.59	35.53	4.76	36.36	2.68	33.69	4.40	36.63	5.68	39.68	4.62
15+	40.31	4.72	39.38	4.86	35.87	4.13	37.90	4.06	41.67	5.99	42.47	4.77
16+	44.19	4.22	42.21	3.92	40.00	4.38	36.85	4.56	45.23	3.82	42.07	5.04
17+	48.25	3.98	41.02	3.60	41.83	2.88	35.50	3.42	46.06	4.44	43.88	4.52
18+	50.16	4.69	43.71	4.46	44.04	2.91	38.88	3.20	48.23	5.72	42.88	5.51

	Garasia				*Damor*				*Kathodi*			
	Male		*Female*		*Male*		*Female*		*Male*		*Female*	
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
Height (cm)												
8+	120.06	3.64	118.00	2.53	119.75	5.73	119.40	3.68	117.27	3.38	117.81	1.96
9+	124.40	3.56	122.15	2.46	125.02	3.81	123.73	3.87	124.25	2.95	122.20	6.49
10+	130.62	2.55	124.43	2.11	130.20	3.45	130.29	3.30	129.88	2.92	131.13	3.34
11+	137.05	3.89	131.05	4.25	138.97	3.45	135.73	3.72	134.20	4.66	139.27	3.87
12+	141.09	5.27	140.70	2.36	143.29	3.32	141.28	4.13	139.92	2.98	142.20	2.89
13+	149.55	7.18	142.04	5.28	148.27	5.08	146.72	3.66	146.57	3.77	146.76	4.05
14+	157.29	2.74	147.81	4.32	154.64	4.09	150.57	2.64	151.62	3.48	150.70	4.23
15+	159.00	3.29	150.69	3.28	157.97	4.10	151.61	2.50	156.66	4.39	148.39	4.49
16+	161.69	3.53	151.82	3.25	163.26	5.76	152.98	3.31	159.72	3.72	154.61	5.90
17+	168.15	3.72	153.66	3.23	167.63	4.21	155.03	3.56	162.46	4.42	155.49	6.33
18+	166.71	4.41	152.24	4.10	166.43	6.64	154.64	4.59	165.69	4.41	152.00	5.46
Weight (kg)												
8+	18.23	2.68	17.10	1.35	16.71	2.32	15.71	1.43	17.58	1.69	16.21	1.45
9+	20.37	2.03	19.87	3.93	19.58	1.36	18.96	3.22	19.65	1.61	17.83	1.68
10+	23.43	1.89	20.31	2.14	20.50	3.09	22.59	2.98	22.67	2.75	21.50	2.37
11+	25.68	2.60	23.96	3.01	24.69	2.62	25.92	3.38	23.38	4.07	26.04	3.62
12+	28.00	2.91	29.17	2.25	28.25	3.92	28.88	1.94	30.07	2.38	27.04	2.29
13+	32.69	5.01	30.75	2.30	32.95	3.24	31.79	4.27	32.67	2.79	33.38	3.09
14+	41.12	2.10	32.68	2.96	34.95	3.73	38.75	4.45	35.36	3.35	35.82	3.07
15+	42.15	2.96	35.50	2.28	39.20	3.25	38.54	3.11	39.27	3.49	35.54	2.97
16+	43.53	2.60	38.46	3.18	42.04	4.52	40.68	2.69	41.04	2.93	36.75	3.23
17+	44.45	2.39	37.42	3.22	44.92	3.38	40.96	3.53	45.63	4.48	37.45	2.68
18+	43.37	2.71	39.50	2.45	45.41	3.58	40.63	3.34	47.73	3.71	37.00	3.07

study falls much below the means of reference values of ICMR (well-to-do), 1989 and NCHS, 1979, at all age groups. Dobzhansky et al. (1976), Khongsdier (1995) also reported a similar trend and concluded that children belonging to low socio-economic status in developing countries have shown their growth potential below international standards and their fertility and/or

Table 3: Percentage prevalence of various forms of malnutrition age wise among Mina males

Forms of Malnutrition	*Age (in years)*										
	8+	*9+*	*10+*	*11+*	*12+*	*13+*	*14+*	*15+*	*16+*	*17+*	*18+*
Height as % standard:											
Normal (90+)	61.9	95.2	76.2	83.3	84.0	72.0	76.2	90.5	100.0	100.0	100.0
Chronic malnutrition (<90)	38.1	4.8	23.8	16.7	16.0	28.0	23.8	9.5	-	-	-
Weight as % standard											
Normal (75+)	14.3	14.3	38.1	25.0	16.7	12.0	28.6	23.8	9.5	25.0	40.9
Mild or moderate (65-75)	38.1	42.9	19.0	41.7	41.7	36.0	33.3	42.9	61.9	62.5	50.0
Severe (<65)	47.6	429.0	42.9	33.3	41.7	52.0	38.1	33.3	28.6	12.5	9.1

Table 4: Percentage prevalence of various forms of malnutrition age wise among Mina females

Forms of Malnutrition	*Age (in years)*										
	8+	*9+*	*10+*	*11+*	*12+*	*13+*	*14+*	*15+*	*16+*	*17+*	*18+*
Height as % standard:											
Normal (90+)	69.2	90.0	85.0	90.0	80.0	71.4	95.0	95.0	94.7	95.2	90.5
Chronic malnutrition (<90)	30.8	10.0	15.0	10.0	20.0	28.6	5.0	5.0	5.3	4.8	9.5
Weight as % standard											
Normal (75+)	23.1	20.0	10.0	25.0	5.0	14.3	20.0	35.0	47.4	33.3	66.7
Mild or moderate (65-75)	26.9	65.0	30.0	25.0	60.0	42.9	45.0	50.0	42.1	47.6	23.8
Severe (<65)	50.0	15.0	60.0	50.0	35.0	42.9	35.0	15.0	10.5	19.0	9.5

Table 5: Percentage prevalence of various forms of malnutrition age wise among Bhil males

Forms of Malnutrition	*Age (in years)*										
	8+	*9+*	*10+*	*11+*	*12+*	*13+*	*14+*	*15+*	*16+*	*17+*	*18+*
Height as % standard:											
Normal (90+)	62.5	50.0	81.0	95.5	82.6	75.0	95.5	66.7	68.2	61.9	81.8
Chronic malnutrition (<90)	37.5	50.0	19.0	4.5	17.4	25.0	4.5	33.3	31.8	38.1	18.2
Weight as % standard											
Normal (75+)	12.5	-	28.6	9.1	8.7	30.0	4.5	-	4.5	-	-
Mild or moderate (65-75)	25.0	18.2	9.5	59.1	43.5	35.0	68.2	38.1	18.2	19.0	40.9
Severe (<65)	62.5	81.8	61.9	31.8	47.8	35.0	27.3	61.9	77.3	81.0	59.1

Table 6: Percentage prevalence of various forms of malnutrition age wise among Bhil females

Z Forms of Malnutrition	*Age (in years)*										
	8+	*9+*	*10+*	*11+*	*12+*	*13+*	*14+*	*15+*	*16+*	*17+*	*18+*
Height as % standard:											
Normal (90+)	40.0	70.0	60.9	52.2	39.1	33.3	28.6	90.0	85.0	70.0	94.4
Chronic malnutrition (<90)	60.0	30.0	39.1	47.8	60.9	66.7	71.4	10.0	15.0	30.0	5.6
Weight as % standard											
Normal (75+)	-	5.0	8.7	-	4.3	9.5	14.3	20.0	20.0	5.0	15.0
Mild or moderate (65-75)	80.0	40.0	13.0	17.4	30.4	28.6	33.3	50.0	30.0	20.0	65.0
Severe (<65)	20.0	55.0	78.3	82.6	65.2	61.9	52.4	30.0	50.0	75.0	20.0

Table 7: Percentage prevalence of various forms of malnutrition age wise among Sahariya males

Forms of Malnutrition	*Age (in years)*										
	8+	*9+*	*10+*	*11+*	*12+*	*13+*	*14+*	*15+*	*16+*	*17+*	*18+*
Height as % standard:											
Normal (90+)	71.4	95.7	85.7	90.5	81.0	71.4	79.2	90.5	90.0	86.4	81.8
Chronic malnutrition (<90)	28.6	4.3	14.3	9.5	19.0	28.6	20.8	9.5	10.0	13.6	18.2
Weight as % standard											
Normal (75+)	52.4	39.1	42.9	61.9	52.4	38.1	25.0	28.6	15.0	9.1	31.8
Mild or moderate (65-75)	23.8	47.8	28.6	19.0	23.8	33.3	37.5	33.3	75.0	54.5	45.5
Severe (<65)	23.8	13.0	28.6	19.0	23.8	28.6	37.5	38.1	10.0	36.4	22.7

Table 8: Percentage prevalence of various forms of malnutrition age wise among Sahariya females

Forms of Malnutrition	*Age (in years)*										
	8+	*9+*	*10+*	*11+*	*12+*	*13+*	*14+*	*15+*	*16+*	*17+*	*18+*
Height as % standard:											
Normal (90+)	91.7	100.0	72.0	95.2	85.7	76.2	86.4	95.2	100.0	95.0	88.2
Chronic malnutrition (<90)	8.3	-	28.0	4.8	14.3	23.8	13.6	4.8	-	5.0	11.8
Weight as % standard											
Normal (75+)	50.0	36.4	20.0	71.4	33.3	52.4	54.5	61.9	39.1	65.0	52.9
Mild or moderate (65-75)	20.8	36.4	32.0	19.0	47.6	23.8	36.4	28.6	43.5	25.0	35.3
Severe (<65)	29.2	27.3	48.0	9.5	19.0	23.8	9.1	9.5	17.4	10.0	11.8

Table 9: Percentage prevalence of various forms of malnutrition age wise among Garasia males

Forms of Malnutrition	*Age (in years)*										
	8+	*9+*	*10+*	*11+*	*12+*	*13+*	*14+*	*15+*	*16+*	*17+*	*18+*
Height as % standard:											
Normal (90+)	76.9	66.7	92.9	100.0	85.7	84.6	100.0	92.3	84.6	100.0	8.3
Chronic malnutrition (<90)	23.1	33.3	7.1	-	14.3	15.4	-	7.7	15.4	-	91.7
Weight as % standard											
Normal (75+)	30.8	25.0	35.7	7.1	14.3	23.1	66.7	23.1	7.7	-	-
Mild or moderate (65-75)	30.8	41.7	50.0	71.4	35.7	53.8	33.3	76.9	69.2	58.3	33.3
Severe (<65)	38.5	33.3	14.3	21.4	50.0	23.1	-	-	23.1	41.7	66.7

Table 10: Percentage prevalence of various forms of malnutrition age wise among Garasia females

Forms of Malnutrition	*Age (in years)*										
	8+	*9+*	*10+*	*11+*	*12+*	*13+*	*14+*	*15+*	*16+*	*17+*	*18+*
Height as % standard:											
Normal (90+)	61.5	58.3	7.7	36.4	75.0	41.7	81.8	90.9	90.9	100.0	91.7
Chronic malnutrition (<90)	38.5	41.7	92.3	63.6	25.0	58.3	18.2	9.1	9.1	-	8.3
Weight as % standard											
Normal (75+)	-	8.3	-	9.1	-	-	-	-	9.1	15.4	16.7
Mild or moderate (65-75)	53.8	33.3	15.4	18.2	83.3	41.7	27.3	36.4	63.6	38.5	66.7
Severe (<65)	46.2	58.3	84.6	72.7	16.7	58.3	72.7	63.6	27.3	46.2	16.7

Table 11: Percentage prevalence of various forms of malnutrition age wise among Damor males.

Forms of Malnutrition	*Age (in years)*										
	8+	*9+*	*10+*	*11+*	*12+*	*13+*	*14+*	*15+*	*16+*	*17+*	*18+*
Height as % standard:											
Normal (90+)	75.0	75.0	91.7	92.3	100.0	75.0	91.7	83.3	83.3	100.0	83.3
Chronic malnutrition (<90)	25.0	25.0	8.3	7.7	-	25.0	8.3	16.7	16.7	-	16.7
Weight as % standard											
Normal (75+)	16.7	-	16.7	7.7	16.7	25.0	8.3	-	8.3	-	-
Mild or moderate (65-75)	8.3	50.0	16.7	53.8	50.0	25.0	33.3	58.3	41.7	61.5	75.0
Severe (<65)	75.0	50.0	66.7	38.5	33.3	50.0	58.3	41.7	50.5	38.5	25.0

Table 12: Percentage prevalence of various forms of malnutrition age wise among Damor females.

Forms of Malnutrition	*Age (in years)*										
	8+	*9+*	*10+*	*11+*	*12+*	*13+*	*14+*	*15+*	*16+*	*17+*	*18+*
Height as % standard:											
Normal (90+)	83.3	66.7	81.8	69.2	66.7	83.3	91.7	100.0	100.0	100.0	100.0
Chronic malnutrition (<90)	16.7	33.3	18.2	30.8	33.3	16.7	8.3	-	-	-	-
Weight as % standard											
Normal (75+)	-	8.3	18.2	23.1	-	8.3	41.7	8.3	27.3	38.5	25.0
Mild or moderate (65-75)	8.3	33.3	27.3	15.4	66.7	50.0	41.7	66.7	63.6	53.8	66.7
Severe (<65)	91.7	58.3	54.5	61.5	33.3	41.7	16.7	25.0	9.1	7.7	8.3

Table 13: Percentage prevalence of various forms of malnutrition age wise among Kathodi males.

Forms of Malnutrition	*Age (in years)*										
	8+	*9+*	*10+*	*11+*	*12+*	*13+*	*14+*	*15+*	*16+*	*17+*	*18+*
Height as % standard:											
Normal (90+)	66.7	76.9	91.7	66.7	76.9	75.0	72.7	69.2	66.7	83.3	100.0
Chronic malnutrition (<90)	33.3	23.1	8.3	33.3	23.1	25.0	27.3	30.8	33.3	16.7	-
Weight as % standard											
Normal (75+)	8.3	7.7	25.0	16.7	30.8	75.0	-	7.7	-	16.7	18.2
Mild or moderate (65-75)	41.7	46.2	41.7	25.0	61.5	41.7	63.6	38.5	41.7	41.7	63.6
Severe (<65)	50.0	46.2	33.3	58.3	7.7	33.3	36.4	53.8	58.3	41.7	18.2

Table 14: Percentage prevalence of various forms of malnutrition age wise among Kathodi females.

Forms of Malnutrition	*Age (in years)*										
	8+	*9+*	*10+*	*11+*	*12+*	*13+*	*14+*	*15+*	*16+*	*17+*	*18+*
Height as % standard:											
Normal (90+)	83.3	58.3	91.7	91.7	90.9	76.9	90.9	75.0	83.3	83.3	72.7
Chronic malnutrition (<90)	16.7	41.7	8.3	8.3	9.1	23.1	9.1	25.0	16.7	16.7	27.3
Weight as % standard											
Normal (75+)	8.3	-	-	25.0	-	15.4	18.2	-	-	-	9.1
Mild or moderate (65-75)	-	16.7	41.7	33.3	27.3	53.8	54.5	50.0	58.3	58.3	36.4
Severe (<65)	91.7	83.3	58.3	41.7	72.7	30.8	27.3	50.0	41.7	41.7	54.5

mortality rates are higher than those in developed countries. Gomez (1956), Gopalan (1963), Johnston et al. (1973) reported larger children from high Socioeconomic Status (SES) families and smaller from low SES families. The high SES children were observed to be about the same size as healthy, well-nourished children. This fact plus analysis of the nutritional status of the children, all point to the poor living conditions of the low SES children as the cause for their smaller size compared with high SES children (Bogin and Mac Vean, 1978, 1981, 1983). When chronic undernutrition, disease and child labour are endemic as prevalent in the present study tribal groups, height at every age is reduced compared with less stressed populations (Frisancho, 1977; Little et al., 1983).

Gopalan (1980) considered education as one of the major factors explaining PEM (as suggested by child mortality rates), which is highly lacking in the tribal groups studied. The condition is further accentuated by the lack of awareness prevailing among majority of people regarding the type of foodstuffs required to meet the daily dietary requirements. Prasad and Nath (1976), Vignerova et al. (1998) showed that mother's education is strongly associated with the nutritional status of children. In general, the indirect factors such as food habits, nutrition, occupation, income level, literacy level, housing conditions, water supply, sanitation, medical facilities and awareness are found to be crucial determinants of nutritional profile of individuals and community on the whole. These factors have been found either lacking or much below the average in the Scheduled Tribes of Rajasthan. Ecological factors also add to the adverse conditions. Thus, gross wasting, stunting and underweight are the outcome, which is generally aggravated by low economic level. This has also been reported by Singh and Kulkarni (1999) in the tribal population groups of Maharashtra state.

Rousham (1996) demonstrated both temporal and socio-economic variation in gender inequalities in health. He further reported that landless female children had significantly poorer height for age and weight for age than their male counterparts. Impact of smoking and high nicotine and alcohol intake also affects the overall health and well being of the individuals and the community as a whole (Klesges et al., 1989; Klesges et al., 1991; Williamson et al., 1991; Klesges et al., 1992), which has been highly prevalent in the tribal groups of Rajasthan.

Growth of the present tribal groups is impaired to a large extent owing to the combination of poor nutrition and other socio-economic factors. Malnutrition is largely prevalent and the condition is further aggravated as it appears in combination with PEM (Calder and Jackson, 2000). As a result of this the rate of growth, ultimate body size, ultimate body shape and ultimate body composition is affected (Tanner, 1966, Lasker and Womack, 1975). The effect is visible in terms of slow growth

rate in the present tribal groups as compared to other populations. Lower values of height and weight reflect the community's health and its average nutritional status (Eveleth and Tanner, 1976). Malnourished children are shorter in stature as compared to those who are brought up in better dietary care (Jelliffe, 1966; Zoppi et al., 1996). This can be very clearly visualized while comparing the present study tribal groups with other national and international studies where, their values were found to be lower than the others.

REFERENCES

Bhasin, M.K. and Jain, S.: Biology of the Tribal Groups of Rajasthan, India: 1. Body Mass Index as an Indicator of Nutritional Status. *Anthropologist,* **9(3)**: 165-176 (2007).

Bogin, B. and Mac Vean, R.B.: Growth in height and weight of urban Guatemalan primary school children of high and low socioeconomic class. *Hum. Biol.,* **50:** 477-488 (1978).

Bogin, B. and Mac Vean, R.B.: Body composition and nutritional status of urban Guatemalan children of high and low socioeconomic class. *Am. J. Phys. Anthrop.,* **55:** 543-551 (1981).

Bogin, B. and Mac Vean, R.B.: the relationship of socioeconomic status and sex to body size, skeletal maturation, and cognitive status of Guatemalan city school children. *Child Developm.,* **54:** 115-128 (1983).

Calder, P.C. and Jackson, A.A.: Undernutrition, infection and immune function. *Nutrition Research Review,* **13:** 3-29 (2000).

Carlson, B.A. and Warlaw, T.M.: A global, regional and country assessment of child malnutrition. UNICEF staff working papers Number 7. New York, United Nations Children's Fund (1990).

Census of India, 1991: *Series 21, Rajasthan:* Directorate of Census Operations, Rajasthan, (1994).

De Onis, M., Dasgupta, P., Saha, S., Sengupta, D. and Blosser, M.: The National Center for Health Statistics reference and the growth of Indian adolescent boys. *Am. J. Clin. Nutr.,* **74:** 248-253 (2001).

Dobzhansky, T., Ayala, F.J., Stebbins, G.L. and Valentine, J.W.: *Evolution.* Surjeet Publications, Delhi (1976).

Downs, E.F.: Nutritional dwarfing. *Am. J. Clin. Nutr.,* **15:** 275 (1964).

Eveleth, P.B. and Tanner, J.M.: *World Wide Variation in Human Growth.* Cambridge University Press, Cambridge (1976).

Frisancho, A.R.: Human growth and development among the high altitude populations. In: *Biology of High Altitude Peoples.* P.T. Baker (Ed.), pp. 117-171, Cambridge University Press, Cambridge (1977).

Gomez, F., Ramos-Galvan, R.: Mortality in second and third degree malnutrition. *J. Trop. Pediatr.,* **2:** 77-83 (1956).

Gopalan, C.: Seminar on protein malnutrition. W.H.O., Geneva (1963).

Gopalan, C.: Nutrition and Development. In: *Functional Literacy and Family Life Planning Education* by Population Council of India, Literacy House (South), New Delhi, pp.1-12 (1972).

Gopalan, C.: Nutritional problems in developing countries, In: *World Nutrition and Nutrition Education,* H.M. Sinclair and G.R. Howat, (Eds.) pp.39-40, Oxford University Press, Oxford (1980).

Indian Council of Medical Research, New Delhi: *Growth and physical development of Indian infants and children.* Technical Report Series No., 18 (1989).

Indian Council of Medical Research: Growth and Physical Development of Indian Infants and Children. *Technical Report, Series No. 18,* ICMR, New Delhi (1984).

Jelliffe, D.B.: The assessment of nutritional status of the community. *WHO Monograph Series No.53,* World Health Organisation, Geneva (1966).

Jelliffe, D.B., Bengoa, J.M. and Perez, C.: Some indicators for a broad assessment of the magnitude of protein-calorie malnutrition in young children in population groups. *Am. J. Clin. Nut.,* **7:** 714-720 (1959).

Johnston, F.E., Borden, M. and Mac Vean, R.B.: height, weight and their growth velocities in Guatemalan private school children of high socioeconomic class. *Hum. Biol.,* **145:** 627-641 (1973).

Khongsdier, R.: Growth and nutritional status of war Khasi children. *J. Hum. Ecol.,* **6 (4):** 261-265 (1995).

Klesges, R.C., Meyers, A.W., Klesges, L.M. and La Vasque, M.: Smoking, body weight, and their effects on smoking behavior: A comprehensive review of the literature. *Psychol. Bull.,* **106:** 204-230 (1989).

Klesges, R.C., Klesges, L.M. and Meyers, A.W.: The relationship of smoking status, energy balance, and body weight: analysis of the second National Health and Nutrition Examination Survey. *J. Consult. Clin. Psychol.,* **59:** 899-905 (1991).

Klesges, R.C., Klesges, L.M., Haddock, C.K. and Eck, L.H.: A longitudinal analysis of the impact of dietary intake and physical activity on weight change in adults. *Am. J. Clin. Nutr.,* **55:** 818-822 (1992).

Little, M.A., Galvin, K. and Mugambi, M.: Cross-sectional growth of nomadic pastoralists. *Hum. Biol.,* **55:** 811-830 (1983).

Martin, R. and Saller, K.: *Lehrbuch der Anthropologie.* Gustav Fischer Verlag, Stuttgart (1957).

Martorell, R., Rivera, J. and Kaplowitz, H.: Consequences of stunting in early childhood for adult body size in rural Guatemala. *Ann. Nestle,* **48(2):** 85-92 (1990).

Martorell, R., Khan, L.K., Schroeder, D.G.: Reversibility of stunting: Epidemiological findings in children from developing countries. *Eur. J. Clin. Nutr.,* **48 (Suppl.1):** S45-S47 (1994).

Hamill, V.V., Johnson, C.L., Roche, A. and Moore, W.M.: Physical Growth: National Center for Health and Statistics percentiles. *Am. J. Clin. Nutr.,* **32:** 607-629 (1979).

Patwardhan, V.N.: Hypovitaminosses A and epidemiology of Xerophthalmia. *Am. J. Clin. Nutr.,* **22 (8):** 1106-1118 (1969).

Pollitt, E.: *Malnutrition and Infection in the Classroom, Belgium.* UNESCO, Paris (1990).

Prasad, K. and Nath, L.N.: A controlled study of socio-culturally determined children feeding habits in relation to protein calorie malnutrition. *Ind. Pediatr.,* **13:** 171-176 (1976).

Rao, Prahlad, N., Singh, Darshan and Swaminath, N.C.: Nutritional status of pre-school children of rural communities near Hyderabad city. *Ind. J. Med. Res.*, **51:** 2132 (1969).

Rousham, E.K.: Socioeconomic influences on growth on gender inequalities in child health in rural Bangladesh. *Eu. J. Clin. Nutr.*, **50:** 560-564 (1996).

Scrimshaw, N.S., Taylor, C.E. and Gordon, J.E.: *Interaction of Nutrition and Infection.* WHO, Geneva (1968).

Scrimshaw, N.S.: Ecological factors in nutritional diseases. *Am. J. Clin. Nutr.*, **14(2):** 112-122 (1964).

Sharma, K.K.N.: Assessment of nutritional status of the Khairwar tribal children of Madhya Pradesh, India. *J. Hum. Ecol.*, **3(1):** 47-48 (1992).

Singh, I.P. and Bhasin, M.K.: *Anthropometry.* Reprinted, Kamala-Raj Enterprises, Delhi (1989).

Singh, N.K. and Kulkarni, V.S.: Nutritional assessment of the Warli Tribals of Maharashtra state. *J. Hum. Ecol.*, **10(5-6):** 379-387 (1999).

Singh, N. and Mishra, C.P.: Nutritional status of adolescent girls of a slum community of Varanasi. *Ind. J. Publ. Health*, 45 (4): 128-134 (2001).

Spyckerelle, Y., Herbeth, R. and Didelol, B.L.: Nutrition of adolescent girls in Loraine . *Arch. Fr. Pediatr.*, **47(6):** 455-459 (1990).

Tanner, J.M., Hiernaux, J. and Jarnan, S.: growth and physique studies, pp. 315-340. In: *Human Biology-A Guide to Field Methods.* IBP Handbook No. 9, J.S. Weiner and J.A. Lourie (Eds.), Blackwell Scientific Publication, Oxford (1969).

Tanner, J.M.: Growth and physique in different populations of mankind. In: *The Biology of Human Adaptability*, pp. 45-66. P.T. Baker and J.S. Weiner (Eds.), Clarendon Press, Oxford (1966).

Vignerova, J., Blaha, P. and Lhotska, L.: Physical growth of Czech children and some socioeconomic factors. *J. Hum. Ecol.*, **9(3):** 227-231 (1998).

Vijayraghvan, K.: Anthropometry for assessment of nutritional status. *Ind. J. Pediatr.*, **54:** 511-520 (1987).

Vijayaraghavan, K. and Rao, D.H.: Diet and nutrition situation in rural India. *Ind. J. Med. Res.*, **108:** 243-253 (1998).

Waterlow, J.C.: Some aspects of childhood malnutrition as a public health problem. *Br. Med. J.*, **4:** 88-90 (1974).

Waterlow, J.C.: Biochemical measurements for the assessment of PEM In: *Protein Energy Malnutrition.* Edward Arnold, London, 104-111 (1992a).

Waterlow, J.C.: Nutrition and growth. In: *Protein Energy Malnutrition*. Edward Arnold, London, 187-211 (1992b).

Waterlow, J.C.: Assessment of nutritional status in the community. In: *Protein Energy Malnutrition*. Edward, Arnold London, 212-228 (1992c).

Weiner, J.S. and Lourie, J.A.: *Human Biology: A Guide to Field Methods.* IBP Handbook No.9, Blackwell Scientific Publications, Oxford (1969).

WHO: *World Health Report: Life in 21st century: A Vision for All.* WHO,Geneva (1998).

WHO Working Group: Use and interpretation of anthropometric indicators of nutritional status. *Bull. WHO.*, **64:** 929-941 (1986).

Williamson, D.F., Madans, J., Anda, R.F., Kleinman, J.C., Giovino, G.A. and Byers, T.: Smoking cessation and severity of weight gain in a national cohort. *N. Engl. J. Med.*, **324:** 739-745 (1991).

Zoppi, G., Bressan, F. and Luciano, A.: Height and weight reference charts for children aged 2-18 years from Verona, Italy. *Eur. J. Clin. Nutr.*, **50:** 462-468 (1996).