

Sexual Dimorphism in Health and Nutritional Status of Three Communities of Darjeeling District in West Bengal and Comparison with Some Other Populations of Eastern India: An Anthropometric Appraisal

Sudip Datta Banik #, Paramita Bhattacharjee, Saswati Das, Raj Kumar Barman, Subal Das,
Som Prasad Giri, Arpita Jana and Pulakes Purkait

Department of Anthropology, Vidyasagar University, Midnapore 721 102, West Bengal, India

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ABSTRACT A cross-sectional study undertaken in three endogamous populations, viz. Dhimal, Mech and Rajbanshi reveal some significant results of high prevalence of undernutrition and poor health condition. An anthropometric appraisal of health and nutrition of the individuals of both the sexes show remarkable sex differences with respect to the rates of chronic energy deficiency (CED) and undernutrition measured by body mass index ($BMI \leq 18.49 \text{ kg/m}^2$) and frequency of subnormal health condition measured by Rohrer Index / Index of Corpulence ($RI \leq 1.19 \text{ gm/cm}^3$). Samples of both sexes combined exhibit Dhimals (37.45%), Mech (13.02%) and Rajbanshi (23.56%) suffer from variable degrees of undernutrition ($BMI \leq 18.49 \text{ kg/m}^2$). State of health assessed by Rohrer Index records 28.80% of the people of these three communities (both sexes combined) are in below normal range. Dhimals show highest rates of undernutrition (CED 27.04% in males and 46.58% in females) followed by Rajbanshis (CED 17.33% in males and 29.32% in females) and the Meches (CED 9.93% in males and 16.91% in females). Likewise, below standard health ($RI \leq 1.19 \text{ gm/cm}^3$) is prevalent highest among the Dhimals (51.57% males and 35.61% females) subsequently in Rajbanshi (28.67% males and 22.99% females) and Mech (19.86% males and 12.67% females) communities. Conditions of the females are worse compared to the male counterparts of these communities. Results have been compared with further recent reports from some other populations of eastern India.

INTRODUCTION

Nutritional status of the adults can be evaluated in many ways. Anthropometry is of considerable interest to the public health professionals, scientists and policy makers. Body Mass Index (BMI) is most widely used because it is suitable for large-scale surveys (Ferro-Luzzi 1992; James et al. 1994). Variation of BMI with age is significant, which is almost absent for the Rohrer Index (Grande et al. 1999). However, Rolland-Cachera (1989) proposed that the correlation of Rohrer Index with weight is high. This index is useful for understanding nutritional status of the adults (Rolland-Cachera 1989; Rolland-Cachera et al. 1991). In general, data are scarce on the health and nutritional status of various tribal populations of India (Bose 2006a, b, c). In some recent reports, (Datta Banik 2007,

2008; Datta Banik et al. 2005, 2006, 2007, 2008; Bose and Chakraborty 2005) it has been recommended that there is urgent need to evaluate the nutritional status of different endogamous communities including the tribals of India.

Darjeeling is the northern most district of West Bengal state in eastern India. Geographically the district can be divided into two broad divisions, the hills and the plains. The foot-hills of Darjeeling Himalayas, which come under the Siliguri subdivision, is known as Terai. The Terai is the tract lying at the foot of the hills, which is bounded on the north by the mountains, on the south by the Purnia district of Bihar state, on the east by Jalpaiguri district and on the west by Nepal, the Himalayan kingdom.

The population of Darjeeling is exceedingly heterogeneous. The majority of the people in the hills are of Mongoloid origin, belonging chiefly to various Nepalese castes, but also including a large number of Lepchas, Bhotias and Tibetans. The various Nepalese castes are well represented in the district, but the most numerous are Khambus and Murmis. The next most numerous Nepalese caste is the Limbu. Three other

**Corresponding author:*
Dr. Sudip Datta Banik
Department of Anthropology,
Vidyasagar University, Midnapore-721 102,
West Bengal, INDIA.
E-mails: sdbanik.vu@gmail.com;
sdbanik@hotmail.com

numerous castes are the Khas or Chettri, the Mangars and the Gurungs. Dhimal, Mech, Koch, Toto, Garo, Chakma, Bhutia, Lepcha, Rabha and Limbu are some of the Mongoloid tribes of North Bengal. Meches had come from Morong region of Nepal. Some of the Meches of Assam also call themselves Rajbanshis. Ethnohistorically, Dhimal, Limbu and Toto originated from this stock in the bordering areas of India and Nepal in West Bengal, along the valley of river Mechi. Dhimals are Tibeto-Burman language speaking Indo-Mongoloid tribe of North Bengal like the Meches. Dhimal represents a small community. Evidence of anthropological research on this community is not available except a few reports (Datta Banik et al. 2005, 2007, 2008). Rajbanshi, a Dravidian caste of North Bengal originally Koch, now claim to be an outlying branch of Kshatriyas. The Koches formerly possessed a powerful kingdom at the foot of the hills. They gradually became Hinduized by contact with their neighbours in the plains and discarded the name of Koch. The true Koches were a Mongoloid race, and we find that in Jalpaiguri, Cooch Behar and Goalpara, the persons now known as Rajbanshi are either pure Koches who, though dark, have a distinctly Mongoloid physiognomy, or else a mixed breed, in which the Mongoloid element usually preponderates.

The objective of the present study was to report nutritional and health status, based on BMI, and Rohrer Index respectively of the adult (age 18 – 60 years) Dhimals, Meches and Rajbanshis of Darjeeling district in the state of West Bengal.

MATERIALS AND METHODS

The present cross-sectional study among the adult (age 18 to 60 years) Dhimals, Meches and the Rajbanshis was conducted during July 2008. The area of study remained limited to the region of rural parts of this district under Naxalbari and Matigara blocks where the people of these three communities live in separate villages. The villages are located around 45 – 50 kilometers from Siliguri town, which is approximately 580 kilometers from Kolkata, the provincial capital of West Bengal.

The other social and cultural factors like ethnicity, endogamy, clan exogamy, marriage distance and direction etc were kept in mind in order to restore the purity of data of both the sexes belonging to three different ethnic groups - Dhimal (n=305; male-159; female-146), Mech

(n=283; male-141; female-142) and Rajbanshis (n=324; male-150; female-174) of Darjeeling District of the state of West Bengal.

All Anthropometric measurements were taken using standard techniques (Martin and Saller 1956; Lohman et al. 1988). The samples were free from any selection bias. Subjects were not chosen on the basis of bodily structure and proportion. Subjects were apparently healthy, between the ages of 18 to 60 years and were not severely ill during last three months (self-reported). Women were neither pregnant, nor have given any birth during last 6 month and were not be at menstruation. Height and weight were taken to the nearest 0.1 cm and 0.5 kg using standard Martin's anthropometer and weighing scale, respectively. Technical errors of measurements (TEM) were within acceptable limits. Derived anthropometric Indices and ratios were computed using the following standard equation and classifications were presented following international standards (Lee and Nieman 2007; Lohman et al. 1988; WHO 1995; Ferro-Luzzi et al. 1992). Prevalence of chronic energy deficiency and undernutrition has been evaluated by body mass index ($BMI \leq 18.49 \text{ kg/m}^2$). BMI has been computed by the standard formula = $BMI = \text{Weight (kg)} / \text{Height (m)}^2$. Health status with respect to nutritional state of individuals of both the sexes of the three communities has been appraised (according to Pignet, cited in Bhasin and Singh, 2004) by Rohrer Index [$RI = (\text{Body Weight in gm.} / \text{Stature in cm}^3) \times 100$] or Index of Corpulence ($RI \leq 1.19 \text{ gm/cm}^3$). Ethical approval was obtained from Vidyasagar University Ethics Committee before commencement of the study. Informed consent was also obtained from local community leaders and subjects.

Student's t-tests were performed to test for differences in mean Anthropometric characteristics between sexes. Comparisons between the sexes with respect to the different categories of CED as measured by BMI and health status by Rohrer Index have been assessed by Pearson Chi-square test. SPSS (version 11.0) statistical package and MS-Excel have been used to analyse the data. Statistical significance was set at $p < 0.05$.

RESULTS AND DISCUSSION

The group statistics (mean \pm standard errors) of anthropometric measurements, derived indices (BMI and Rohrer Index) and their comparative

statements between the sexes (measured by Student t test) are presented in table 1. The mean (\pm standard errors) age (Range 18-60 years) of the three samples taken altogether (450 males and 462 females) represents much younger adult population (35.40 years \pm 0.69 for males and 35.11 years \pm 0.63 for females) without significant difference between the two sexes. The mean age significantly differ ($p < 0.001$) between the two sexes among the Mech. However, mean age of male Dhimal and Rajbanshi do not significantly vary from their female counterparts.

The adult males ($n = 450$) are taller in stature (mean 163.26 \pm 0.29) and also heavier in body weight (mean 55.05 \pm 0.39) in comparison with the mean stature (151.45 \pm 0.28) and mean body weight (47.06 \pm 0.42) of the females ($n = 462$). The both sexes also differ significantly ($p < 0.001$) in cases of stature ($t = 28.95$) and body weight ($t = 13.96$). Data of the three communities taken separately

show significant sexual dimorphism ($p < 0.001$) with respect to stature and body weight.

The mean BMI (kg/m^2) in case of 450 males (20.59 \pm 0.12) is marginally higher than the value recorded in 462 females (20.45 \pm 0.15), in the combined sample of all three communities (Dhimal, Rajbanshi, Mech). Both the sexes do not differ significantly. No significant sex difference in mean BMI was also recorded in any of these three communities when they were observed separately.

The mean Rohrer Index in case of female (1.35 \pm 1.01) was found to be greater than male (1.26 \pm 7.09). The both sexes differ significantly ($p < 0.001$) with respect to Rohrer Index ($t = -7.20$). Clear and significant ($p < 0.001$) sexual dimorphism was exhibited in regard of this variable in three communities studied individually.

Table 2 represents the nutritional status and frequency of undernutrition measured by body

Table 1: Descriptive statistics (mean \pm standard error) of anthropometric characteristics among both the sexes of Dhimal, Mech and Rajbanshi communities in Darjeeling district, West Bengal

S. No.	Variables	Populations	Male	Female	t-value	Sig.(P<)
1	Age (Years)	Dhimal	35.93 \pm 1.14	32.85 \pm 1.08	1.96	0.051
		Mech	30.74 \pm 0.90	35.78 \pm 1.23	-3.32	0.001
		Rajbanshi	39.21 \pm 1.37	36.47 \pm 0.99	1.62	0.106
		Total	35.40 \pm 0.69	35.11 \pm 0.63	0.30	0.763
2	Height(Cm)	Dhimal	163.34 \pm 0.49	152.42 \pm 0.54	14.94	0.001
		Mech	164.93 \pm 0.51	152.74 \pm 0.48	17.37	0.001
		Rajbanshi	161.59 \pm 0.49	149.59 \pm 0.42	18.60	0.001
		Total	163.26 \pm 0.29	151.45 \pm 0.28	28.95	0.001
3	BW (Kg)	Dhimal	52.25 \pm 0.56	44.61 \pm 0.62	9.19	0.001
		Mech	59.49 \pm 0.71	51.34 \pm 0.83	7.46	0.001
		Rajbanshi	53.84 \pm 0.64	45.63 \pm 0.61	9.29	0.001
		Total	55.05 \pm 0.39	47.06 \pm 0.42	13.96	0.001
4	BMI (Kg/M ²)	Dhimal	19.54 \pm 0.16	19.13 \pm 0.21	1.54	0.125
		Mech	21.82 \pm 0.21	21.93 \pm 0.30	-0.30	0.764
		Rajbanshi	20.56 \pm 0.19	20.35 \pm 0.24	0.69	0.492
		Total	20.59 \pm 0.12	20.54 \pm 0.15	0.75	0.457
5	Roher Index	Dhimal	1.20 \pm 1.00	1.26 \pm 1.39	-3.42	0.001
		Mech	1.32 \pm 1.30	1.44 \pm 1.94	-4.82	0.001
		Rajbanshi	1.27 \pm 1.17	1.36 \pm 1.62	-4.45	0.001
		Total	1.26 \pm 7.09	1.35 \pm 1.01	-7.20	0.001

Table 2: Sexual dimorphism in BMI and nutritional status among the Dhimal, Mech and Rajbanshi communities in Darjeeling district, West Bengal

Nutritional Status	BMI (kg/m^2)	Communities					
		Dhimal		Mech		Rajbanshi	
		Male (N=159)	Female (N= 146)	Male (N=141)	Female (N= 142)	Male (N=150)	Female (n= 174)
CED III	< 16.00	2.52	8.22	2.13	1.41	0.00	4.60
CED II	16.00-16.99	3.77	5.48	1.42	2.82	4.00	9.20
CED I	17.00 – 18.49	20.75	32.88	6.38	12.68	13.33	15.52
Total CED	< 18.49	27.04	46.58	9.93	16.91	17.33	29.32
Normal	18.50 = 24.99	71.07	52.74	77.30	69.01	78.00	62.64
Over weight I	25.00 – 29.99	1.89	0.68	12.77	14.08	4.69	8.04

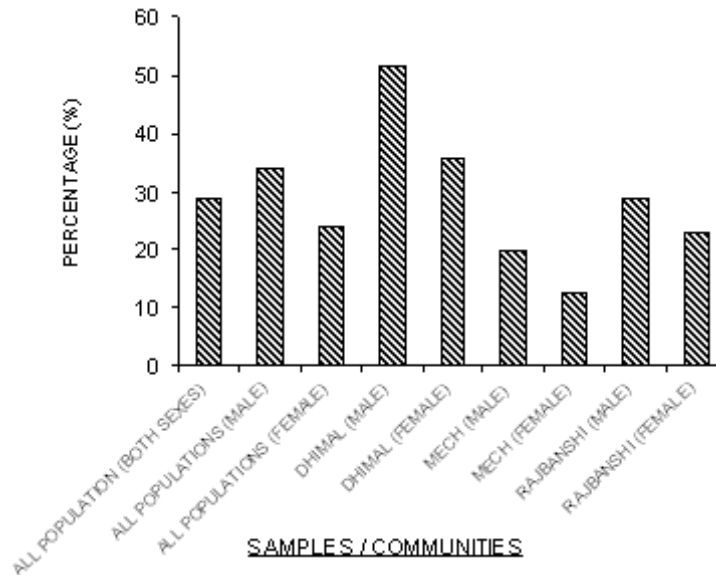
Table 3: Sexual dimorphism in Rohrer Index / Index of Corpulence among the Dhimal, Mech and Rajbanshi communities in Darjeeling district, West Bengal

Health and nutritional status	Rohrer Index	Communities					
		Dhimal		Mech		Rajbanshi	
		Male (N=159)	Female (N= 146)	Male (N=141)	Female (N= 142)	Male (N=150)	Female (n= 174)
Very Low	<1.12	23.27	17.12	9.22	5.63	12.67	10.92
Low	1.13 – 1.19	28.30	18.49	10.64	7.04	16.00	12.07
Middle	1.20 – 1.25	23.27	17.81	7.80	10.56	20.00	11.49
Upper Middle	1.26 – 1.32	13.84	11.65	20.57	9.86	24.66	13.80
High	1.33 – 1.39	3.77	18.49	20.57	12.68	10.00	11.49
Very High	> 1.40	7.55	16.44	31.20	54.23	16.67	40.23

mass index (BMI) in both sexes of three ethnic groups (Dhimal, Rajbanshi, Mech). The overall prevalence of chronic energy deficiency or CED (BMI ≤ 18.49 kg/m²) in the combined sample of three communities is greater in case of female (29.27%) than the male (18.10%). Conspicuous sex differences in rate of undernutrition have been observed in three populations. Highest degree of undernutrition has been recorded in case of Dhimal community. 27.04% males and 46.58% females are suffering from undernutrition in this ethnic group. This is followed by the Rajbanshis where 17.33% males and 29.32% females have been observed to have BMI less than 18.49 kg/m². However, it was remarkable to record the fact

that very less percentage of individuals belonging to the Mech tribe was suffering from undernutrition compared to the two other communities in this region. 9.93% of Mech males and 16.91% of their female counterpart have been observed to be ailing with chronic energy deficiency. The Pearson chi-square test results in these three populations (Dhimal $\chi^2 = 0.70$; Mech $\chi^2 = 0.98$ and Rajbanshi $\chi^2 = 4.86$ at df=2) reveal that there is no significant difference between the two sexes in respect of the different degrees of chronic energy deficiency (CED III, CED II and CED I).

The health status measured by Rohrer Index (RI in gm/cm³) / Index of Corpulence (Table 3, Fig. 1) in the three adult samples combined (n=912)

**Fig. 1. Prevalence of poor health measured by Rohrer Index (RI ≤ 1.19) among the Dhimal, Mech and Rajbanshi communities in Darjeeling district, West Bengal**

reveal that the 34.00% of the males (n=450) have subnormal health ($RI \leq 1.19 \text{ gm/cm}^3$). This condition is worse than the females (23.80%; n=462). 28.80% of all individuals (both sexes combined; n=912) of three communities appear to have poor health status measured by this index. The Dhimals exhibit high prevalence of poor health appraised by this Index of Corpulence. Dhimal males demonstrate higher frequency (51.57%) of subnormal health ($RI \leq 1.19 \text{ gm/cm}^3$) condition compared to the females (35.61%) of the same community. Among the Rajbanshis, 28.67% males and 22.99% females have shown to have ill health. Individuals of the Mech community also exhibit notable frequency of low profile of health ($RI \leq 1.19$) in both male (19.86%) as well as in female samples (12.67%). The Pearson chi-square test results with respect to Rohrer Index in three populations reveal that there is significant difference (at $df = 5$, $p > 0.01$) between the two sexes (Dhimal $\chi^2 = 26.24$; Mech $\chi^2 = 19.61$ and Rajbanshi $\chi^2 = 17.80$).

Recent investigations (Bose et al. 2006a, b, c; Datta Banik 2007, 2008; Datta Banik and Sain 2007; Datta Banik et al. 2005, 2006, 2007, 2008) have reported the anthropometric characteristics and states of nutrition in some other endogamous populations of eastern India. These studies have dealt with Oraons and Saraks of Ranchi, Jharkhand (Datta Banik et al. 2006; Datta Banik 2008); Bathudis (Bose and Chakraborty 2005) and Savars of Orissa ((Bose et al. 2006b); Kora Mudis (Bose et al. 2006c) and Santals of Paschim Medinipur in West Bengal (Bose et al. 2006a); Telugu-speaking Telagas (Datta Banik 2007; Datta Banik and Sain

2007) of Paschim Medinipur, West Bengal and Dhimals (Datta Banik et al. 2005, 2007, 2008) of Darjeeling District in West Bengal. Comparative statement of the prevalence of chronic energy deficiency (CED) and undernutrition based on body mass index (BMI) of adult males of seven other populations of eastern India along with the Dhimal, Mech and Rajbanshi communities of the present study revealed considerable ethnic differences (Table 4, Fig. 2).

Results compared the rates of CED among the ten populations of eastern India. All the communities were found to have very remarkable rates of undernutrition (Table 4, Fig. 2). Wide range of ethnic differences in rates of undernutrition were observed in these communities when both the sexes are combined – highest CED was observed among the Bathudi (57.9%) and lowest in Mech (13.02%) and other communities in between - Oraon (57.42%), Kora Mudi (52.2%), Savar (43.5%), Dhimal (37.45%), Santal (36.8%), Sarak (35.25%), Rajbanshi (23.56%) and Telaga (28.5%). The highest frequency of undernutrition among men was found among Bathudi (52.70%) followed by Oraon (53.10%), Kora Mudi (48.00%), Savar (38.00%), Santal (31.50%), Sarak (27.85%), Telaga (27.45%), Dhimal (27.04%), Rajbanshi (17.33%) and Mech (9.93%). Bathudis, Oraons and Kora Mudi males also had very high (34%) rates of undernutrition and the situation was thus critical. Savar, Santal, Telaga, Dhimal and Sarak males had high (20 - 39%) rates of undernutrition with the situation being serious. Among the females, Bathudi exhibited highest rate of undernutrition (64.5%) followed by Oraon

Table 4: Prevalence of chronic energy deficiency and undernutrition based on body mass index (BMI < 18.5 Kg/m²) in some communities of four districts of three eastern Indian states (Jharkhand, Orissa and West Bengal).

S. No.	Communities	Sample size		Sex combined	Males	Females	Location
		Male	Female				
1.	Sarak*	158	110	35.25	27.85	43.36	Ranchi, Jharkhand
2.	Oraon*	290	216	57.42	53.10	62.50	Ranchi, Jharkhand
3.	Telaga	102	101	28.50	27.45	29.50	Medinipur, West Bengal
4.	Kora Mudi	250	250	52.2	48.0	56.4	Medinipur, West Bengal
5.	Santal	213	197	36.8	31.5	41.8	Medinipur, West Bengal
6.	Bathudi*	183	226	57.9	52.7	64.5	Keonjhar, Orissa
7.	Savar*	300	300	43.5	38.0	49.0	Keonjhar, Orissa
8.	Dhimal*	159	146	37.45	27.04	46.58	Darjeeling, West Bengal
9.	Mech*	141	142	13.02	9.93	16.91	Darjeeling, West Bengal
10.	Rajbanshi*	150	174	23.56	17.33	29.32	Darjeeling, West Bengal

* Significant sex differences.

References - (1) Datta Banik et al. 2006; (2) Datta Banik et al. 2006; Datta Banik, 2008; (3) Datta Banik, 2007; (4,5,6,7) Bose et al. 2006a; (8,9,10) Present study.

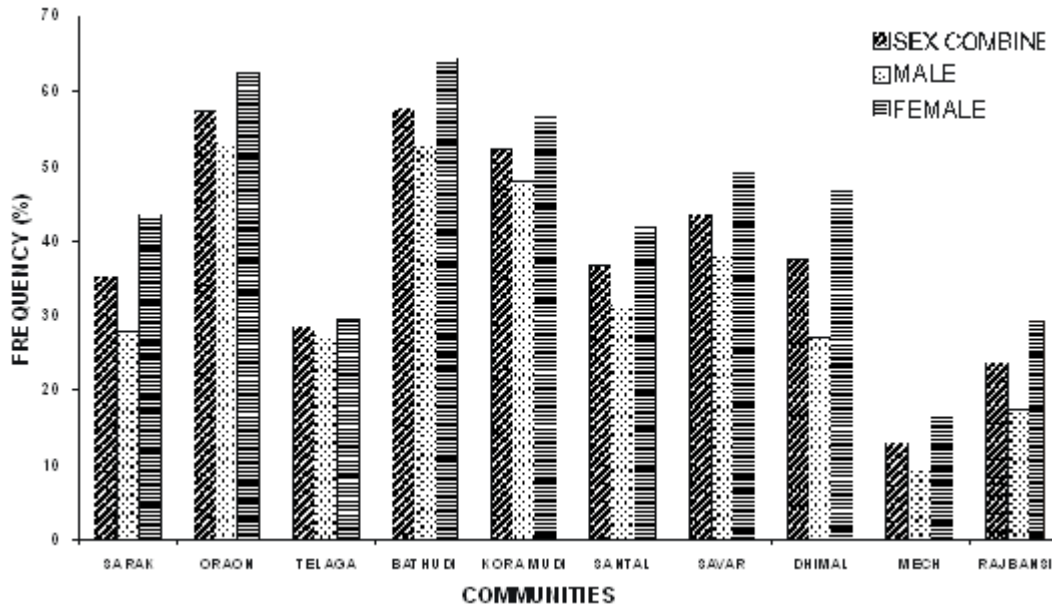


Fig. 2. Prevalence of chronic energy deficiency and undernutrition based on body mass index (BMI < 18.5 Kg/m²) in some communities of four districts of three eastern Indian states (Jharkhand, Orissa and West Bengal).

(62.5%), Kora Mudi (56.4%), Savar (49.0%), Dhimal (46.56%), Sarak (43.46%), Santal (41.8%), Telaga (29.5%), Rajbanshi (29.32%) and Mech (16.9%). Using the WHO (1995) classification of public health problem of low BMI, based on adult populations worldwide, it was observed that the rates of undernutrition and the situation were critical.

CONCLUSION

This study is a kind of preliminary record of information of anthropometric appraisal of health and nutritional status of adult sections of both the sexes belonging to three communities, viz. Dhimal, Mech and Rajbanshi of Darjeeling District in West Bengal. The results show that noteworthy sections of each of these populations of either sex are suffering from undernutrition and chronic energy deficiency as evaluated by body mass index (BMI ≤ 18.49 kg/m²). Health status assessed by Rohrer Index also exhibits high prevalence of subnormal health in both the sexes of these three communities. Remarkable sexual dimorphism has also been observed with respect to these indicators of measuring health and

nutrition. Table 2 and Table 3 present distribution of individuals as per the standard categories of health and nutritional status of both BMI and RI respectively. Both the tables show sex differences in health and nutritional status. However, the pattern is different for BMI and RI. In case of BMI, females show higher frequencies for the CED compared to the corresponding male sections except in Mech (CED III) while in case of RI, the trend is reversed – males show higher frequency of poor state of health in comparison with the females. Moreover, no significant sex-differences have been observed in the three populations with respect to BMI when tested either by student t-test or Pearson Chi-square test. However, conspicuous sexual dimorphisms with respect to RI of three populations have been recorded as tested by both t-test as well as chi-square test. These results open new thoughts about the application of these two indices in assessing the health and nutritional status of the adults.

Data of the present investigation display that the Dhimals are suffering more compared to the two other communities in this region with respect to their ill health and poor nutritional status. Dhimal is a small community and may be consi-

dered as a genetic isolate since inter-community marriage is not prevalent in this ethnic group. Moreover, the sample selected from this community covers almost 85% of the total adult population of this community. So the results can be considered as the truest picture of health and nutritional status of this small community. In other cases, sampling procedure avoided selection bias for choosing individuals for the present study. Utmost care has been taken also for selecting female subjects from all of these three communities. Mech and Rajbanshi are very large endogamous ethnic groups in this region and both of them are settled agriculturists. But most of them are agricultural laborers and have little land of their own. In general, the forest tract of the Terai foot-hill of the Himalayas, beside the Mechi river in Naxalbari and Matigara region of Darjeeling district, malaria is highly endemic and poor sanitation, scarcity of safe drinking water supply and less support of health care delivery system altogether has turned this region into a place of high degree of chronic enteric disorders, anaemia and malnutrition. These facts have been observed and recorded during the present survey. The state of health and nutrition of these communities are also observed to be very poor when the data are compared with the results of other investigations conducted in some other communities in this part of eastern India. The overall scenario of economically underprivileged condition and very poor literacy status push the people of these communities to survive at below sustenance level. Condition of the women with respect to health, nutrition and literacy is even worse compared to the male sections of these communities.

Results of all communities (combined as well as separate for both sexes) thus show that notable percentages of the people under study in this particular Sub-Himalayan Terai region of Darjeeling District are suffering from high degree of undernutrition and poor health condition. Immediate consideration for adequate food and nutrient supplementation is essential for these communities in this region. Besides, call for evaluating health and nutritional status of other neighboring communities is also important. Data from other studies with larger sample size from the different ethnic groups of this region will help the Government as well as non-government agencies to develop policy measures of community health and nutrition in this locality. It

may be mentioned that health and nutritional status of a population has a complex linkage with dietary habits as well as the ecology and environment. Further research should be undertaken to investigate the influence of dietary patterns and environment on health and nutrition of the adult populations in this part of the world. Moreover, studies related to the inter-community differences in these components are also important. The present investigation did not deal with these factors as they were beyond the scope of study. This is a clear limitation of the present study. However, it is essential that future research will include these parameters while investigating the physical conditions of the people in this region in the perspectives of public health and community nutrition.

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REFERENCES

- Bhasin MK, Singh IP 2004. *A Manual of Biological Anthropology*. Delhi: Kamla-Raj Enterprises.
- Bose K, Chakraborty F 2005. Anthropometric characteristics and nutritional Status based on body mass index of adult Bathudis: a tribal population of Keonjhar District, Orissa, India. *Asia Pac J Clin Nutr*, 14: 80-82.
- Bose K, Banerjee S, Bisai S, Mukhopadhyay A, Bhadra M 2006a. Anthropometric profile and chronic energy deficiency among adult Santal tribals of Jhargram, West Bengal, India: Comparison with other tribal populations of Eastern India. *Ecol Food Nutr*, 45: 1-11.
- Bose K, Chakraborty F, Bisai S, Khatun A, Bauri, H 2006b. Body mass index and nutritional status of adult Savar tribals of Keonjhar District, Orissa, India. *Asia Pac J Pub Health*, 18(3): 3-7.
- Bose K, Ganguly S, Mamta H, Mukhopadhyay A, Bhadra M 2006c. High prevalence of undernutrition among adult Kora Mudi tribals of Bankura District, West Bengal, India. *Anthropol Sci*, 114(1): 65-68.
- Datta Banik S 2007. Age-Sex and Diurnal Variation of Blood Pressure in Different Nutritional States Among the Adult Telegas of Kharagpur in West Bengal, India. *Collegium Antropologicum*, 31(3): 717-722.
- Datta Banik S 2008. Nutritional Status of Adult Men from the Oraon Tribe in Ranchi District of Jharkhand India. *Malaysian Journal of Nutrition*, 14(1): 91-99.

- Datta Banik S, Bose K, Bisai S 2005. Anthropometric and Physiometric Assessment of Health and Nutritional Status of Adult Dhimals of West Bengal. *Indian Journal of Biological Sciences*, 11: 26 - 39.
- Datta Banik S, Barman RK, Maity S, Sukul T, Roy V 2006. Anthropometric Appraisal of Nutritional Status of Adult female Oraons and Saraks of Ranchi District, Jharkhand India – A Comparative Study. *Indian Journal of Biological Sciences*, 12: 44-58.
- Datta Banik S, Sain BK. 2007. A Study on Age-Related Changes and Diurnal Variation of Blood Pressure among the Telagas of Kharagpur, West Bengal. India. *Man and Life*, 33 (3-4): 53-60.
- Datta Banik S, Bose K, Bisai S, Jana A, Das S, Purkait P, Bhattacharya M 2007. Chronic Energy Deficiency among Adult Dhimals of Naxalbari West Bengal : Comparison with other Tribes of Eastern India. *Food and Nutrition Bulletin*, 28(3): 348 – 352.
- Datta Banik S, Jana A, Purkait P, Das S. 2008. Age-Sex Variation and Association of OAB Blood Groups with Haemoglobin Level among the Adult Dhimals at Naxalbari in West Bengal. *Anthropologischer Anzeiger*, 66(4): 379-84
- Ferro-Luzzi A, Sette S, Franklin M and James WPT 1992. A simplified approach to assessing adult chronic energy deficiency. *European Journal of Clinical Nutrition*, 46: 173-186.
- James WPT, Ferro-Luzzi A and Waterlow JC 1988. Definition of Chronic energy deficiency in adults. Report of a Working Party of the International Dietary Energy Consultative Group. *Eur J Clin Nutr*, 42: 969-981.
- Lee RD, Nieman DC 2007. *Nutritional Assessment*. New York: McGraw Hill.
- Lohman TG, Roche AF, Martorell R 1988. *Anthropometric Standardization Reference Manual*. Illinois: Human Kinetics Books.
- Martin R, Saller K 1956. *Lehrbuch der Anthropologie*, Vol.3, Stuttgart: G. Fisher.
- Rolland-Cachera MF 1989. The prediction in boys and girls of the weight / height index and various skinfold measurements in adults : a two-decade follow-up study. *Int J Obesity*, 13: 305-311.
- Rolland-Cachera MF, Cole TJ, Sempe M, Tichet J, Rossignol C, Charraud A 1991. Body Mass Index Variations : Centiles from birth to 87 years. *European J Clinical Nutrition*, 45: 13-21.
- WHO 1995. Physical status: The use and interpretation of anthropometry. Report of a WHO Expert Committee. *WHO Technical Report Series 854*. Geneva: World Health Organization.