Anthropometric Characteristics and Nutritional Status of Adult Mech Population of Darjeeling (India) in Relation to Blood Pressure, Haemoglobin Level, Blood Sugar, Lipid Profile and Serum Proteins

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ABSTRACT: A cross-sectional study was done (2010-2011) of 100 adults (50 males, 50 females), aged 30 to 59 years of Mech community who were randomly selected from 17 villages in and around Naxalbari and Matigara blocks of Darjeeling district in West Bengal. Nutritional status was evaluated by body mass index (BMI). Coexistence of remarkable rates of under nutrition (chronic energy deficiency or CED: BMI < 18.49 kg/m^2: 10% males and 17% females) and overweight (BMI e" 25 kg/m^2 13% males, 14% females) was recorded. Males were taller and heavier, had higher fat free mass. On contrary, females had higher mean skinfold, percentage of body fat, and fat mass. Males had higher levels of haemoglobin, blood sugar, and lower cholesterol compared to females. Blood pressure, haemoglobin level, fasting blood sugar level, triglycerides, conjugated and total bilirubin, albumin, globulin, total protein have been found to rise with nutritional level in adults.

INTRODUCTION

Anthropometric parameters like height, weight, circumferences (waist, hip, mid upper arm), derived indices like body mass index (BMI), waist-hip ratio etc. are efficient indicators of nutritional and health status of adults (WHO, '95). Cardiovascular and hepatic diseases are associated with habits of smoking and alcohol consumption, diet and nutritional factors. The levels of serum albumin act as indicators of the severity of acute hepatic diseases including jaundice, hepatitis and cirrhosis (Sood, '99; Godgar and Godgar, 2003). Reports are available from Hispanics and Black non-Hispanic Americans (Stewart, 2002). Studies also reported that elevated levels of low-density lipoprotein (LDL-C) and decreased high-density lipoprotein cholesterol (HDL-C) were associated with cardiovascular risk (Chan *et al.*, '97, '99).

According to the Census of India (2001), more than 84 million tribal people comprise 8.2% of the total population (Mittal and Srivastava, 2006). High

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rate of under nutrition among adults in rural and tribal areas is one of the major public health concerns in India. However, data on demography, anthropometric assessment of health and nutritional status of adults in rural and tribal communities are not available in abundance in eastern India (Datta Banik, 2006, 2007, 2008, 2009, 2011a; Datta Banik *et al.*, 2006, 2008a) and particularly in the Darjeeling district of West Bengal (Datta Banik, 2011b; Datta Banik *et al.*, 2007; 2008b, c; 2009).

Mech is a tribal community in Darjeeling and are primarily agriculturists. During field work, they were also found to be engaged in business and were employed in army and general services. The present study is aimed at investigating sexual dimorphism of health and nutritional status and association with cardiovascular and hepatic risk factors in adult Mech of Naxalbari in Darjeeling district of West Bengal, India. The major objectives of the study are follows as:

1. To measure height, weight, skinfolds (biceps, triceps, sub-scapular and supra-iliac), and circumferences (mid upper arm, waist, and hip).
2. To estimate derived indices and ratios: body mass index (BMI), waist-hip ratio, percentage of body fat, fat mass, and fat free mass.
3. To estimate haemoglobin level, fasting blood sugar, lipid profiles – total lipid, total cholesterol, triglyceride and lipoproteins (high-density lipoprotein cholesterol or HDL-c, low-density lipoprotein cholesterol or LDL-c and very low-density lipoprotein cholesterol or VLDL-c, levels of bile pigment bilirubin, serum proteins – albumin (A) and globulin (G), A - G ratio, and total protein concentration, and
4. To observe association between biochemical parameters and BMI-based nutritional status.

METHODS AND MATERIALS

The present study was carried out during 2010-2011. The area of study was Naxalbari and Matigara blocks in Siliguri, the administrative headquarters of the subdivision in Darjeeling district of West Bengal, India. Siliguri town was approximately 580 kilometers from Calcutta (Kolkata), the State capital of West Bengal. Mech families were identified in 17 villages selected at random from the voters' list (available with appropriate authority). Household survey was conducted among 165 families that comprised 999 individuals (539 males and 460 females). Sample size for the present study included 100 adult Mech individuals (50 male) aged between 30 and 59 years representing 169 families who were selected without any bias of physical or socio-economic characteristics. The sample was a part of the bigger database (283 adults of 450 families) generated in a research project sponsored by the Indian Council of Medical Research (ICMR) during 2009-2011. Basic socio-demographic data on sex-ratio (female to male ratio or FMR), household size, age dependency ratio, and rates of fertility, work participation, and literacy have been collected through household survey method with a standard, pre-validated questionnaire (Ram Kumar, '86). Monthly family income, irrespective of family size was recorded to be between ₹ 2000 and ₹ 4780.

The method was cross-sectional. Anthropometric measurements followed standard international protocols (Lohman *et al.*, '88; WHO, '95). Anthropometric measurements of 100 adults (50 men) were recorded. Height and weight were taken to the nearest 0.1 cm and 0.5 kg using standard Martin's anthropometer and weighing scale (Libra, New Delhi, India), respectively. Circumferences (mid upper arm, waist and hip) were measured by a non-stretchable, flexible tape. Body mass index (BMI) was computed following the standard formula (WHO, '95) of weight (kg) divided by height (m^2). Nutritional status was determined by BMI-cut off values for undernutrition, normal and overweight (WHO, '95, 2004; James *et al.*, '94). Waist to hip ratio was calculated.

Skinfold thickness measurements were recorded with skinfold caliper that measured the compressed double fold of fat plus skin (Lohman, 1981) estimating actual subcutaneous fat thickness. The calculation of percentage of body fat (PBF) involved measuring four skinfold sites, triceps (TSF), biceps (BSF), sub-scapular (SSSF) and supra-iliac (SISF) (Durnin and Womersley, '74). PBF was calculated using Siri's equation (Siri, '56). PBF in adults has been categorized with reference to the body fat ranges for persons 18 years of age and older (Nieman, '99 cited

in Lee and Nieman, 2007). Fat mass (FM in kg), and fat free mass (FFM) were calculated following the standard formulae (Vanltalie *et al.*, '90).

For clinical biochemistry, 18 adults (10 males, 8 females) were randomly selected from those 100 individuals. Arterial blood pressure (systolic and diastolic) was recorded using mercury sphygmomanometer (Diamond, New Delhi) following standard protocol (*Pickering et al., 2005*). Collection of blood sample and methods in biochemical tests (colorimetric method) followed international standards and recommended laboratory procedures of clinical biochemistry (Sood, '99; Godgar and Godgar, 2003). Lipid profile tests included: total cholesterol (TC) (mg/dL), triglycerides (TG) (mg/dL), high density lipoprotein cholesterol (HDL-c) (mg/dL), low density lipoprotein cholesterol (LDL-c) (mg/dL), and very low density lipoprotein cholesterol (VLDL-c) (mg/dL). Liver function tests included: bilirubin (mg/dL), albumin (A) (g/dL), globulin (G) (g/dL), total protein (g/dL), and AG Ratio (Albumin-Globulin Ratio). Total cholesterol, and total proteins, albumin-globulin ratio were calculated following standard equations. Quantitative estimation of total and direct bilirubin in serum or plasma has been done with standard reagents and following standard method (Jendrassik and Grof, 1938). Haemoglobin level (gm/dL) was estimated by standard Cyanmethemoglobin Method for Colorimeter. Fasting Blood Sugar (mg/dL) was also estimated.

Ethical clearance was obtained from Vidyasagar University Ethics Committee. Verbal and written consent was obtained from the community leaders and the subjects. Measurements among the female subjects were taken with prior consent and in presence of other female members of the community. The Principal Investigator (Dr. Datta Banik) of the research project received help of his girl-student who was also present during the data collection. Technical errors of measurements were within acceptable limits (Ulijaszek and Kerr, '86). Standard statistical tests were applied to fulfill the objectives of the study as well as test all hypotheses. SPSS (Version 13.0) statistical package was used to analyze the data with standard statistical methods. For all statistical tests, $p < 0.05$ was taken as the significance level.

RESULTS

The sample represented matured adults representing Mech community. Sex-ratio (female to male ratio or FMR) (all ages) of Mech community (based on survey of 165 families) was 853.43 indicating more males than females (based on the census taken through household survey. General fertility rate (GFR) was 55.79 in the calendar year of 2010. Age dependency ratio was 0.518 and the percentage of old age was 1.5%. Work participation rate was recorded as 65.26 and mean household size was 5.91. Females had lower literacy rate (could sign or not) (37.26) compared to males (85.03).

Mean age of men (40.80 years) and women (39.91 years) did not differ significantly. The adult males were taller in stature and heavier in body weight compared to females with significant sex difference ($p < 0.001$). Males had significantly ($p< 0.01$) higher fat free mass (FFM) and females had significantly ($p< 0.01$) higher biceps and triceps skinfolds, and percentage of body fat. Females also had higher BMI, fat mass, circumferences and ratio of waist and hip. However, no significant sex difference was observed with respect to those variables (Table 1).

Prevalence of chronic energy deficiency or CED (BMI < 18.49 kg/m^2) was greater in females (16.91%) than males (9.93%) (Table 2). Frequency of overweight (12.77% male and 14.08% female) was also remarkable. There was no obese individual. BMI cut-off values for Asian populations also displayed similar prevalence in the present data (WHO, 2004). Sex difference in rates of nutritional status was not statistically significant (tested by Pearson Chi-Square).

As discussed in methods section, 18 adults (10 males and 8 females) were randomly selected for physiometric test (blood pressure) and blood samples were collected for clinical biochemistry. Males were taller and heavier in the sub-sample with significant ($p < 0.05$) sex difference. However, with respect to BMI, rates of nutritional status, blood pressure (SBP and DBP), and biochemical parameters, no significant sex difference was observed. Haemoglobin level, fasting blood sugar, and triglycerides were higher in males. On the other hand, females had higher mean cholesterol.

TABLE 1

Descriptive statistics and sexual dimorphism of anthropometric and body composition characteristics in Mech community

Parameters	sex	n	Mean	Std. Deviation	t- value	p-value (Sig. 2-tailed)
Age (years)	Male	50	40.80	7.79	0.558	0.578
	Female	50	39.92	7.98		
Body weight (kg)	Male	50	59.50	8.07	3.698	<0.001
	Female	50	52.50	10.68		
Height (cm)	Male	50	163.71	5.35	10.382	<0.001
	Female	50	152.43	5.51		
BMI (kg/m^2)	Male	50	22.17	2.53	-0.534	0.595
	Female	50	22.53	4.08		
MUAC (cm)	Male	50	26.16	2.36	0.998	0.321
	Female	50	25.59	3.24		
Waist circumference (CM)	Male	50	79.58	6.61	-1.735	0.086
	Female	50	82.63	10.55		
Hip circumference (CM)	Male	50	86.33	5.71	-1.177	0.242
	Female	50	88.02	8.40		
Waist-hip ratio	Male	50	0.92	0.06	-1.230	0.222
	Female	50	0.94	0.05		
BSF (mm)	Male	50	3.51	1.65	-3.787	<0.0001
	Female	50	5.30	2.92		
TSF (mm)	Male	50	6.40	2.74	-3.593	0.001
	Female	50	8.45	2.96		
SSSF (mm)	Male	50	9.16	4.49	-0.076	0.940
	Female	50	9.22	3.31		
SISF (mm)	Male	50	7.61	5.02	1.813	0.073
	Female	50	6.15	2.68		
PBF (%)	Male	50	26.50	6.45	-3.572	0.001
	Female	50	30.72	5.32		
Fat mass (kg)	Male	50	16.14	5.76	-0.403	0.688
	Female	50	16.62	6.17		
Fat free mass (kg)	Male	50	38.86	5.76	2.809	0.006
	Female	50	35.88	4.81		

BMI: Body mass index; MUAC: Mid upper arm circumference; BSF: Biceps skinfold; TSF: Triceps skinfold; SSSF: Sub-scapular skinfold; SISF: Supra-iliac skinfold.

TABLE 2

BMI and nutritional status (%) among Mech adults

Nutritional status	BMI cut-off (kg/m^2)	Male	Female
CED	< 18.49	9.93	16.91
Normal	18.50 – 24.99	77.30	69.01
Over weight	25.00 – 29.99	12.77	14.08

CED: Chronic energy deficiency

TABLE 3

Sexual dimorphism with respect to the parameters of clinical biochemistry

Group statistics	Male (n=10)		Female (n=8)			
	Mean	SD	Mean	SD	t-value	p-value (sig. 2-tailed)
Height (cm)	164.70	4.28	151.68	3.78	6.75	<0.001
Weight (kg)	61.35	8.30	49.69	9.86	2.73	0.01
BMI (kg/m^2)	22.57	2.50	21.51	3.52	0.75	0.47
SBP (mmHg)	125.80	19.33	131.50	17.46	-0.65	0.53
DBP (mmHg)	87.80	8.82	80.50	6.91	1.91	0.07
Haemoglobin (g/dL)	12.91	1.36	11.84	1.86	1.42	0.18
Fasting blood sugar (mg/dL)	102.30	26.83	91.13	5.74	1.15	0.27
Cholesterol (mg/dL)	290.70	84.01	313.00	64.08	-0.62	0.54
Triglycerides (mg/dL)	103.50	47.07	93.75	56.35	0.40	0.69
HDL_Cholesterol (mg/dL)	42.30	11.86	51.25	8.19	-1.81	0.09
LDL_Cholesterol (mg/dL)	227.50	72.18	242.75	53.87	-0.50	0.63
VLDL_Cholesterol (mg/dL)	20.90	9.29	19.00	11.21	0.39	0.70
Conjugated bilirubin (mg/dL)	0.63	0.15	0.51	0.24	1.33	0.20
Total bilirubin (mg/dL)	0.93	0.22	0.75	0.20	1.80	0.09
Total protein (g/dL)	7.57	0.49	7.76	0.79	-0.63	0.54
Albumin (mg/dL)	4.93	0.17	4.79	0.38	1.06	0.31
Globulin (mg/dL)	2.64	0.57	2.98	0.73	-1.10	0.29
Albumin-Globulin ratio	1.98	0.59	1.69	0.44	1.15	0.27

In the sub-sample of 18 adults, rates of under nutrition (11.11%), normal (72.22%) and overweight (16.67%) were estimated for both sex combined. Accordingly, blood pressure and biochemical parameters were distributed at levels of BMI-based nutritional status of the adults. Blood pressure, haemoglobin level, fasting blood sugar level, triglycerides, conjugated and total bilirubin, albumin, globulin, total protein have been found to rise with nutritional level. Significant ($p < 0.05$) difference (tested by one-way ANOVA) was observed in case of fasting blood sugar.

TABLE 4

Distribution of physiometric and biochemical parameters by nutritional status (based on BMI)

Clinical biochemistry	Nutritional status	Mean	SD	F(ANOVA)	p-value (sig.)
SBP (mmHg)	Under nutrition	123.00	24.04	0.091	0.913
	Normal	128.77	19.14		
	Overweight	130.00	17.32		
DBP (mmHg)	Under nutrition	79.00	1.41	0.623	0.550
	Normal	84.62	8.88		
	Overweight	88.00	10.58		
Haemoglobin (g/dL)	Under nutrition	12.10	1.41	0.192	0.827
	Normal	12.36	1.71		
	Overweight	12.97	1.96		
Fasting blood sugar (mg/dL)	Under nutrition	90.50	13.44	5.805	0.014
	Normal	91.54	4.93		
	Overweight	127.00	42.57		

contd. table 4

Clinical biochemistry	Nutritional status	Mean	SD	F(ANOVA)	p-value (sig.)
Cholesterol (mg/dL)	Under nutrition	293.00	56.57	0.350	0.711
	Normal	309.23	84.93		
	Overweight	268.33	16.04		
Triglycerides (mg/dL)	Under nutrition	49.00	9.90	1.156	0.341
	Normal	104.85	53.28		
	Overweight	108.00	37.04		
HDL_Cholesterol (mg/dL)	Under nutrition	45.50	10.61	0.130	0.879
	Normal	47.08	12.59		
	Overweight	43.33	4.62		
LDL_ Cholesterol (mg/dL)	Under nutrition	237.00	43.84	0.402	0.676
	Normal	241.00	72.16		
	Overweight	203.33	13.05		
VLDL_ Cholesterol (mg/dL)	Under nutrition	10.50	2.12	1.054	0.373
	Normal	21.15	10.62		
	Overweight	21.67	7.37		
Conjugated bilirubin (mg/dL)	Under nutrition	0.45	0.00	0.409	0.672
	Normal	0.59	0.22		
	Overweight	0.60	0.15		
Total bilirubin (mg/dL)	Under nutrition	0.68	0.11	0.898	0.428
	Normal	0.85	0.20		
	Overweight	0.95	0.38		
Total protein (g/dL)	Undernutrition	7.55	0.07	0.415	0.668
	Normal	7.60	0.71		
	Overweight	7.97	0.40		
Albumin (mg/dL)	Undernutrition	4.85	0.07	0.003	0.997
	Normal	4.87	0.34		
	Overweight	4.87	0.12		
Globulin (mg/dL)	Under nutrition	2.70	0.00	0.388	0.685
	Normal	2.73	0.74		
	Overweight	3.10	0.36		
Albumin-Globulin ratio	Under nutrition	1.80	0.03	0.469	0.635
	Normal	1.92	0.61		
	Overweight	1.58	0.18		

DISCUSSION

The present study has shown coexistence of remarkable rates of under nutrition and overweight in Mech adults. Situation of women was worse in either side. Males had higher blood sugar than females that also marginally crossed the upper limit of normal range (70-100 mg/dL). Haemoglobin level was low in either sex with reference to standard range (male = 13.5-18.0 g/dL, female = 11.5-16.4 g/dL). Females also had higher cholesterol than males. Cholesterol level has crossed the normal limit (<200 mg/dL) in either sex. Total protein was also towards higher side in the adults (normal range: 6.4-7.8 g/dL). Blood pressure and fasting sugar were observed to rise with nutritional status. Therefore, nutritional status and health condition of adult Mech individuals should be monitored and medical intervention and food supplementation programme should be introduced.

BMI was higher and rate of under nutrition was lower in adult Mech individuals compared to other communities in the region (Datta Banik *et al.*, 2009). BMI of adult Dhimals (male: 19.54 kg/m^2, female: 19.13 kg/m^2) and Rajbanshis (male: 20.56 kg/m^2, female: 20.35 kg/m^2) was relatively lower. Rates of

under nutrition was also higher in Dhimal (male: 27.04%, female: 46.58%) and Rajbanshi (male: 17.33%, female: 29.32%) communities (Datta Banik *et al.* 2009). Another study in eastern India (Datta Banik *et al.*, 2006, 2008a) also reported higher prevalence of under nutrition among adult Saraks (male: 27.85%, female: 43.36%) and Oraons (male: 53.10%, female: 62.50%) in comparison with Mech community in Darjeeling.

The present study has contributed new information from a community that was relatively less studied. Further bio-anthropological research on health and nutrition including anthropometric, physiometric and biochemical assessment, dietary habits, and physical activity among Mech and other neighboring communities in relation with socio-economic conditions will help in understanding and developing welfare policies for the underprivileged sections of our society.

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