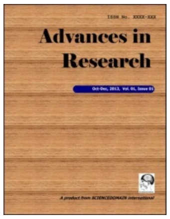

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Health and Nutritional Status of College Students of Different Ethnic Backgrounds of Tripura, a North-East State of India

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Authors' contributions

This work was carried out in collaboration between all authors. The study was planned and designed by the corresponding author CM and research fellow, authors SD and SC, being an expert in anthropometric based studies, helped author SD to procure data by anthropometric measurements. Compilation of data and statistical analysis were undertaken by authors SD, ASD and SC, SD and SC prepared the first draft of the manuscript. Authors ASD and CM prepared the final manuscript. All authors read and approved the final draft.

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ABSTRACT

Aims: To assess nutritional status and general health of college students of two diverse socio cultural origins with the help of anthropometric measures and social risk scores.
Study Design: Cross-sectional study.
Place and Duration of Study: Human Physiology Laboratory, Tripura Institute of Paramedical Sciences, Hapania, Amtali, Tripura (West) 799130, India between October 2011 to March 2013.
Methodology: We included subjects from two diverse socio cultural origin, Group A (Tribal n=132; male: 69; Female 63) and Group B (non-Tribal: n=498; Male: 258; Female: 240), aged 18 to 21 years. Measurements included were height, weight, body mass index (BMI), mid-upper arm circumference (MUAC), fat-free mass index (FFMI), fat mass index (FMI), muscle mass (MM) and fat-free mass (FFM). Social risk score also was determined.

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Results: There was a significant group and gender-based variation in anthropometric measurements and indices. Based on BMI, the prevalence of chronic energy deficiency (CED) was more in tribal group (20.45%), compared to non-tribal group (7.43%). MUAC showed similar trend and proportion in CED as a comparative measure with BMI, except minor exception. Students of both the groups were found in poor health status (Rohrer index [RI] scores: Tribal males [33.33%] and non-tribal males [26.74%]). However, females of both the groups were found less affected. Overall, tribes (24.25%) were seen more in subnormal health state, compared to non-tribes (17.27%). Both RI and social risk scores further indicated that, on a comparative basis, irrespective of gender, tribes are more vulnerable population. Analyses also have shown that, irrespective of groups and genders, FFMI was the best predictor to assess health status (RI) of the studied population.

Conclusion: Tribes are more in subnormal nutritional and health conditions, compared to non-tribes. Local health authorities should implement nutritional assessment programs for managing the burden of under nutrition and poor health status.

Keywords: Anthropometry; nutrition; health; ethnicity; gender.

1. INTRODUCTION

According to the latest census of India, there are more than 84 million tribal people, who constitute 8.2% of the total population [1]. India probably has the largest number of tribal communities in the world [2]. Tripura is a state in North East India. It is the third-smallest state in the country, which covers 10,491km^2 and is bordered by Bangladesh to the north, south and west, and the Indian states of Assam and Mizoram to the east. As of 2011, the state had 3,671,032 residents, constituting 0.3% of the country's total population. Indigenous communities, known in India as scheduled tribes, forms about 31 percent of Tripura's population [3]. With time, like other social groups, there is a trend in towards increasing urbanization through urban migration among tribal communities [3]. As a result, they have developed diverse habitation like forest, rural, semi- rural, urban and semi-urban. In view of this varied habitat, it is expected that the prevalence of under-nutrition and its associated adverse health effects amongst the urban or semi-urban tribal population may have reduced compared to tribal population of other areas habitation-wise. Such anticipation may gain further significance in urbanized or semi-urbanized tribal population because of certain seemingly positive realities in their case like improvement in socio-economic conditions, better access to health services, literacy, hygienic personal habits, decline in participation in adverse cultural practices etc.

Nutritional status plays a vital role in deciding the health status of a community and nutritional deficiencies give rise to various morbidities, which in turn, may lead to increased disability and even mortality. It is now well-established that anthropometric device is an essential feature of nutritional evaluation and for determining nutritional status of a particular community, like being overweight, undernourished, obesity, muscular mass loss, fat mass gain, adipose tissue redistribution, skeletal health etc. Its indicators are used to evaluate the health status of a community and even for prognosis of chronic and acute diseases and to guide medical intervention, if required, in people of all ages. Earlier, several investigators all over the world had used similar anthropometric characteristics and nutritional status of the adults of different ethnic groups [4-11].

The body mass index (BMI) is the most well-established anthropometric indicator used for assessment of adult nutrition status [12]. It is also used as an indicator of overall adiposity [13] and is considered a good indicator of not only the nutritional status but as well as for the socioeconomic condition of a population, especially adult populations of developing countries [14-18]. Another anthropometric measurement that can be used to evaluate adult nutritional status is mid-upper-arm circumference (MUAC). MUAC is particularly effective in the determination of malnutrition among adults in developing countries [14]. It is a simpler measure than BMI, requiring a minimum of equipment and in practice has been claimed to predict morbidity and mortality as accurately as deficits in weight [19].

Like all other tribal people of India, tribes of Tripura are also having geographically isolated life-style. In remote villages, they have inadequate food; exclusively own food habits along with socio-cultural and biological activities, which predictably lead to high proportion of child, pre-adolescent, adolescent and even adult under nutrition, morbidity and mortality. During the last one decade or so, there is a trend in tribal population towards increasing urbanization through urban migration and a sizable proportion of young tribal population enroll every year for college level education. We hypothesized that such urbanization possibly has improved nutritional and health status of tribal population, which although was anticipated but not verified. In this cross-sectional observational study, we therefore aimed to assess the nutritional status of young adult college students (18-21 years) of two diverse socio cultural origin, Kokborok ethno-linguistic group (n=132) and Bengali ethno-linguistic group (n=498) by anthropometric measurements, derived indices and variables and to assess the impact of nutritional status on health in general. The reason for choosing these age groups were primarily because they were in their late adolescence (18-21 years) and had supposedly completed their linear growth, skeletal mass gain, body weight gain, sexual maturity and psychological and cognitive development [20]. Additionally, urbanization effects on nutrition and health status of young adult tribal college students who were in their late adolescence and their comparison with semi-urbanized non-tribal college students was not verified.

2. MATERIALS AND METHODS

This study was carried out during the period from October 2011 to March 2013. As far as socio-demographic, dietary and environmental factors are concerned, the study area was selected in a semi-urban area to satisfy the prerequisite and similar environmental conditions of both the communities of subjects of this study. The area of this cross-sectional study in undergraduate colleges was intentionally selected because of higher concentration of the two groups of ethno-linguistically and socio-culturally (social customs, food habits, education, health, use of traditional medicines, cultural differences etc) varied subjects in a common place, but with similar age and educational background. A multi-stage stratified random sampling method was utilized to finally select the subjects of this study. In the first stage, students of the two ethno-linguistic groups were identified from their physical characteristics and surnames. The information provided by the subjects was subsequently verified from official records. In the next stage, purposive random samplings was employed to select the subjects within the specific age group of this study and the subjects below or above the age (18-21 years) were excluded from study. The age of the subjects was further verified from official records and/or birth certificates. Next, all such randomly selected subjects were explained the objectivity and protocol of the research. In the subsequent stages, subjects were further screened based on their compliance or non-compliance for all kinds of tests and measurements, healthy or unhealthy, history of chronic disease or chronic medication or consumption of alcohol or tobacco use. Finally, only the voluntarily participated subjects with written consent were included in this study.

Since prevalence of nutrition and health status in our selected subjects (both males and females taken together) was not known, a prevalence of 50% was taken [21] to calculate the sample size with 95% confidence interval and absolute precision of 5%.So, the minimum sample size estimated was 384 subjects. The final sample size, however, was higher than this number and consisted of two genders. The final sample size of both groups of subjects and their gender match however could not be achieved because of wide variation in ethnicity ratio (69:31) among the studied population. Thus, the studied population were from two diverse socio cultural origin, Kokborok ethno-linguistic tribal group, Group A (n=132; Male: 69; Female 63) and Bengali ethno-linguistic non-tribal group, Group B (n=498; Male: 258; Female: 240), aged 18 to 21 years. Ethical approval for human studies was obtained from the Advisory Committee of the Institutional Human Ethics Committee.

2.1 Anthropometric Measurements

Each subject was measured for stature, weight, circumferences [mid upper arm circumference (MUAC), thigh circumference, fore arm circumference and calf circumference] and skinfold thickness at desirable sites. All anthropometric measurements were made on the right side of the body by trained investigators by using the standard techniques [22,23].

Similar procedures were used to standardize height and weight measurements. Body weight was measured with a standard weighing scale to the nearest 0.1kg with minimum clothing and standing height to the nearest 0.1cm in the standard arm hanging position with Harpenden type Anthropometer. Triceps and subscapular skinfolds were measured to the nearest 0.1mm with a Holtain skinfold caliper (Holtain Ltd.) and mid upper arm circumferences was measured with a metal tape, with the right arm hanging relaxed at the subject's side. Mid upper arm circumference (MUAC) was measured to the nearest 0.1cm. Measurements were taken twice by the same trained person. The technical errors of measurement (TEM) was calculated by a standard formula: TEM= √ Σ(reading 1−reading 2) 2 /2n; where n is the number of subjects measured [24].

Body Mass Index (BMI) was calculated as the weight in kilograms divided by the square of the height in meters. The nutritional status of individuals was evaluated according to internationally accepted World Health Organization (WHO) [25] guidelines for adults. CED III was defined as BMI less than 16.0, CED II as BMI of 16.0 to 16.9, CED I as BMI of 17.0 to 18.4 and normal as BMI of 18.5 to 24.9. We followed the WHO [23] classification of the public health problem of low BMI (<18.5), based on adult populations worldwide. According to this classification, a low prevalence (5%–9%) of low BMI is considered a warning sign requiring monitoring, a medium prevalence (10%–19%) as indicating a poor situation, a high prevalence (20%–39%) as indicating a serious situation and a very high prevalence (≥40%) as indicating a critical situation. Nutritional status was also evaluated based on internationally recommended [14] cutoff points for MUAC, according to which MUAC is under 22.0cm indicates under nutrition and MUAC of 22.0cm or more normal nutritional status. MUAC was further divided into four groups on the basis of quartile cutoff values to study the differences in mean BMI and the prevalence of CED between these groups. The corresponding cutoff values for MUAC groups I, II, III and IV were ≤19.9cm, 20.0 to 21.5cm, 21.6 to 22.9cm and ≥23.0cm, respectively.

For estimation of FFM, the percentage body fat was calculated by using Slaughter et al.'s skinfold thickness equations for adult males and for all females [26]. These equations are:

% body fat (male) = 1.21 (triceps skinfold + subscapular skinfold) - 0.008 (triceps skinfold + subscapular skinfold)^2 - 6.8
% body fat (female) = 1.33 (triceps skinfold + subscapular skinfold) - 0.013 (triceps skinfold + subscapular skinfold)^2 - 2.5

FFM (kg) = body weight-(% body fat × body weight) / 100

For estimation of FMI and FFMI, first the fat mass was derived from FFM as weight-FFM and % BF was calculated as 100 X FM/weight. FM and FFM were each divided by height squared in meters to give fat mass index (FMI) and FFM index (FFMI) respectively [27].

For estimation of muscle mass (MM), first corrected mid thigh girth (CMTG) and corrected calf girth (CCG) were calculated as [mid thigh girth–3.14 X frontal thigh skin fold/10]^2 and [calf girth–3.14 X mid calf skin fold /10]^2, respectively. Muscle mass (MM) was then estimated following the equation of Martin et al. [28]:

MM = height X {(0.0553 X CMTG^2)+(0.0987 X forearm gifth^2)+(0.0331 X CCG^2)}–2445]/1000

Health status with respect to nutritional state of the students was assessed by Rohrer Index [RI = (Body weight in gm./Stature in cm^3) X 100] or Index of Corpulence (RI≤1.19gm/cm^3) [29].

2.2 Social Evaluation

To obtain information on each student's family and living conditions, a standardized questionnaire was used [30].

The questionnaire results in a social risk score that allows classification of families of the students in to the following categories: ≥8 points (high risk family), 4-7 points (family at risk), ≤3 points (family without risk).

2.3 Statistical Analysis

All statistical tests were performed following standard techniques. All data generated were entered into Statistical Package for Social Science (SPSS) computer software version 11.5 (IBM Corporation, USA) for analysis by descriptive and inferential statistics at 95% confidence level. P<0.05 was considered to indicate statistical significance.

Social risk scores for classifying families at high risk, at risk or without risk.

Factor	Risk indicator	Score*
Social security coverage	Does not have	x
Family group	Single parent	x
Head of household's occupation	Unemployed	x
	Self-employed	x
Size of household	3–5 people/worker	x
	6 or more/worker	xx
	Household without worker	xxx
Overcrowding	2–3 people/room	x
	4–5 people/room	xx
	6 or more/room	xxx
Studies	Primary	x
	Primary incomplete	xx
	Illiterate	xxx
Early maternity	Adolescent mother	xx
Children aged 0–13 year	One point for each child	x
Family dynamic	Altered by violence	x
	Altered by death	x
	With judicial intervention	x

** Score results: ≥8 points = high-risk family; 4–7 points = family at risk; ≤3 points = family without risk*

Descriptive data were presented as mean ± SD. Pearson correlations, simple linear and stepwise multiple regression analyses were performed. Unpaired t-tests were performed to check for differences in between groups. Pearson correlation coefficient (r) was used to study the relationship of MUAC and BMI. Similar correlations were checked among RI and BMI, FFMI, FMI, MM and MUAC. For linear regression analysis, BMI was used as dependent variable and MUAC as independent variable. In stepwise multiple regression analysis, RI was used as dependent variable and corresponding independent variables were FFMI, FMI, MM and MUAC. One-way analysis of variance (ANOVA) with Scheffé's procedure was used to test for differences in mean BMI among the four MUAC groups. The risk ratio was calculated by standard statistical formula to measure the risk. The Chi-square test was used to compare the prevalence of CED in different MUAC groups of both the populations.

3. RESULTS

Data on a total of 132 Group A (tribal origin; male: 69, female: 63) and 498 Group B (non-tribal origin; male: 258, female: 240) young adult college students were included in the analyses.

Table 1 presents population-wise descriptive statistics (mean ± standard deviation) of age, body weight and other anthropometric characteristics, derived indices and variables assessing nutritional and health status of two different ethnic groups of college students. Subjects of both the ethnic groups, Group A (n=132) and Group B (n=498), represent young adulthood of their respective communities and their age ranges between 18-21 years. Age as a variable was found significantly different between males and females of Group B population (P=0.000), whereas, for Group A population, this age difference was insignificant. Similar comparison between males and females of Group A and B populations in respect with height (non-tribal: P=0.000; tribal: P=0.000), body weight (non-tribal: P=0.000; tribal: P=0.000), BMI (non-tribal: P=0.131; tribal: P=0.022), MUAC (non-tribal: P=0.000; tribal: P=0.253), FFM (non-tribal: P=0.000; tribal: P=0.000), FFMI (non-tribal: P=0.000; tribal: P=0.018), FMI (non-tribal: P=0.000, tribal: P=0.000) and RI (non-tribal: P=0.000; tribal: P=0.000), all indicated significant gender variations among the subjects of two different groups, except minor exceptions for BMI (Group B) and MUAC (Group A). When data were further analyzed for comparison among males and females of two groups, it was observed that except age, RI and FFMI, all other variables were significantly different in males and in case of females, no variables could reach at significant level. Table 2 presents nutritional, health and social scores of male and female college students of two different ethnic groups (Group A and B). The prevalence of CED, based on a BMI of less than 18.5 kg/m^2, were 6.59% (CED I) in non-tribal male, 8.33% (CED I) in non-tribal female, 24.64% (CED I, 17.39%; CED II, 7.25%) in tribal male and 15.87% (CED I, 11.11%; CED II, 4.76%) in tribal female. When

CED was assessed by BMI in overall population, 20.45% tribal students were affected, compared to 7.43% students of non-tribal community.

When nutritional status of the studied population was further analyzed by MUAC, highest prevalence of undernutrition (<22cm) was seen in tribal females (39.68%), followed by non-tribal females (28.75%), tribal males (21.74%) and non-tribal males (7.75%). When nutritional status of overall population estimated by MUAC, 30.30% tribal students were found in undernutrition level, compared to 17.87% of non-tribal students. The prevalence of CED, based on a MUAC of less than 22cm, were 2.33%, 6.67%, 18.84% and 9.52% respectively in the non-tribal male, non-tribal female, tribal male and tribal female. There was no significant difference in the proportion of CED according these two methods in all the populations except nontribal male (P=0.015).

A strong significant positive correlation between MUAC and BMI was observed in all groups (Non-tribal male: 0.795, P=0.000; Non-tribal female, 0.719, P=0.000; Tribal male: 0.270, P=0.000) except tribal female (0.149, P=0.242) (Table 3). Regression analysis further showed that MUAC had a significant positive impact on BMI in all groups (Non-tribal male, β=0.923, P=0.000; Non-tribal female, β=1.003, P=0.000; Tribal male, β=0.834, P=0.000) except tribal female (β=0.207, P=0.242); the percentage of the variation in BMI explained by MUAC were 63.2%, 51.7%, 56.7% and 2.2% in non-tribal male, non-tribal female, tribal male and tribal female respectively (Table 3). There were significant differences in mean BMI between the two MUAC groups (MUAC<22cm vs. MUAC≥22cm) in both the populations (Non-tribal male: t=9.95, P=0.000; Non-tribal female: t=9.55, P=0.000; Tribal male: t=9.94, P=0.000) except tribal female (t=1.49, P=0.142). Also a significant difference in prevalence of CED was found between these two MUAC groups (MUAC<22cm vs. MUAC≥22cm) in both the populations (Non-tribal male: χ^2=19.31, P=0.001; Non-tribal female: χ^2=30.94, P=0.000; Tribal male: χ^2=39.72, P=0.000) except tribal female (χ^2 =2.05, P=0.176).

Table 4 shows the results of the analyses of variance of mean BMI by MUAC quartile. The lowest mean BMI was observed in MUAC group I (non-tribal female: 18.57±1.36, tribal male: 16.71±0.13 and tribal female: 19.87±1.95 and in group II (non-tribal male: 18.95±1.03). Highest mean BMI were found in group IV of MUAC quartile in both the populations studied. Analyses further indicate that there exists a significant increasing trend in mean BMI between the MUAC quartiles in both the populations (non-tribal male: F ratio = 45.99, P=0.000; non-tribal female: F ratio = 39.91, P=0.000 and tribal male: F ratio = 22.98, P=0.000) except tribal female (F ratio = 0.86, P = 0.465).

Moreover, there were significant differences in the prevalence of total CED among the four MUAC quartiles in both the populations (Non-tribal male: χ^2 for linear trend = 42.58, P=0.000; Non-tribal female: χ^2 for linear trend = 31.95, P=0.000; Tribal male: χ^2 for linear trend = 36.76, P=0.000; Tribal female: χ^2 for linear trend = 4.71, P=0.030).

The highest prevalence of total CED (100%) was observed in MUAC group I of tribal male, followed by non-tribal female (50%), tribal female (33.33%) and in MUAC group II of non-tribal male (30%).

Compared to MUAC group IV, group I showed high risk ratio in both the populations (non-tribal female: 59.50; tribal male: 40.00 and tribal female: 9.33), except non-tribal male population, where no subject could be classified (Table 4). This implies that male and females of these populations who belonged to the upper MUAC quartile had sixtyfold (non-tribal female), fortyfold (tribal male) and nine fold (tribal female) lower risks of chronic energy deficiency than males and females belonging to MUAC group I. However, for non-tribal male this risk was lower by thirty fold to MUAC group II.

Data further reveals that tribal females exhibit highest prevalence (12.70%) of overweight I, followed by non-tribal females (7.92%), non-tribal males (6.59%) and tribal males (2.90%) (Table 2). When an overall population was considered for overweight I, it was 7.23% and 7.58% respectively for non-tribal and tribal communities. As far as obesity was concerned, only non-tribal and tribal females showed 2.92% and 1.59% obesity respectively, while the males of both the groups did not show any sign of obesity. When an overall population was considered for obesity, it was a meager 1.41% and 0.76% respectively for non-tribal and tribal groups.

Table 1. Descriptive anthropometric characteristics of the young adult college students

Variables	Tribal (Group A)		Non-Tribal (Group B)		P-value *			
	Male (I) (n=69)	**Female (II) (n=63)**	**Male (III) (n=258)**	**Female (IV) (n=240)**	**I vs. II**	**III vs. IV**	**I vs. III**	**II vs. IV**
Age (Years)	19.81±0.83	19.79±0.95	19.84±0.78	19.58±0.80	0.909	0.000	0.791	0.098
Height (cm)	163.54±4.59	153.81±4.27	166.25±5.26	152.71±4.59	0.000	0.000	0.001	0.279
Body Weight (kg)	54.87±6.35	50.82±8.29	59.24±7.55	50.78±7.23	0.002	0.000	0.000	0.969
BMI (kg m^{-2})	20.51±2.21	21.64±3.19	21.42±2.22	21.77±2.95	0.022	0.131	0.003	0.757
MUAC (cm)	23.01±2.01	22.59±2.31	24.08±1.92	22.85±2.12	0.253	0.000	0.000	0.396
FFM (kg)	50.58±4.69	41.93±8.27	52.99±5.82	41.60±5.45	0.000	0.000	0.000	0.761
RI (kg cm^{-3})	1.26±0.14	1.41±0.21	1.29±0.14	1.43±0.20	0.000	0.000	0.092	0.505
FMI	1.60±0.95	3.77±1.57	2.26±1.13	3.93±1.19	0.000	0.000	0.000	0.450
FFMI	18.91±1.54	17.81±3.30	19.15±1.58	17.84±2.23	0.018	0.000	0.262	0.947
MM (kg)	22.04±4.02	18.33±4.23	24.31±4.19	17.09±3.68	0.000	0.000	0.000	0.036

*BMI, body mass index; MUAC, mid-upper arm circumference; FFM, fat-free mass; RI, Rohrer index; FMI, fat mass index; FFMI, fat-free mass index; MM, muscle mass. All the values are expressed as mean ± SD. * Significance level based on unpaired t-tests*

Table 2. Health (RI), nutritional (BMI, MUAC) and social risk of the young adult college students

Anthropometric Variables	Nutritional/Health/ Social Risk Status	Cut-off Value	Population				Population	
			Tribal (Group A)		Non-Tribal (Group B)		Tribal	Non-Tribal
			Male (n=69)	Female (n=63)	Male (n=258)	Female (n=240)	(n=132)	(n=498)
BMI (kg m^{-2})	CED III	<16.00	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %
	CED II	16.00–16.99	7.25%	4.76 %	0.00 %	0.00 %	6.06 %	0.00 %
	CED I	17.00–18.49	17.39%	11.11 %	6.59%	8.33%	14.39 %	7.43 %
	Total CED	<18.50	24.64%	15.87 %	6.59%	8.33%	20.45 %	7.43 %
	Normal	18.50–24.99	72.46%	69.84 %	86.82%	80.83%	71.21 %	83.94 %
	Over weight I	25.00–29.99	2.90%	12.70%	6.59%	7.92%	7.58 %	7.23 %
	Obese	>=30.00		1.59 %		2.92 %	0.76 %	1.41 %
MUAC (cm)	Normal	≥22.00	78.26 %	60.32 %	92.25 %	71.25 %	69.70 %	82.13 %
	Undernutrition	<22.00	21.74 %	39.68 %	7.75 %	28.75 %	30.30 %	17.87 %
	CED Based on MUAC<22 cm		18.84 %	9.52 %	2.33 %	6.67 %	14.39 %	4.42 %
RI (gm cm^{-3})	Very Low	≤1.12	23.19%	9.52 %	11.24%	2.08%	16.67 %	6.83 %
	Low	1.13–1.19	10.14%	4.76 %	15.50%	5.00%	7.58 %	10.44 %
	Middle	1.20–1.25	17.39%	7.94 %	19.77%	11.25%	12.88 %	15.66 %
	Upper Middle	1.26–1.32	17.39%	15.87 %	18.22%	14.17%	16.67 %	16.27 %
	High	1.33–1.39	14.49%	19.05 %	10.85%	16.25%	16.67 %	13.45 %
	Very High	≥1.40	17.39%	42.86 %	24.42%	51.25%	29.55 %	37.35 %
Social Risk	Score (Mean ± SD)		4.25±1.13	3.65±1.00	3.83±0.89	3.60±0.89	3.94±1.10	3.72±0.90
	% of Population without Risk	≤3	21.74 %	42.86 %	38.37 %	44.58 %	31.82 %	41.37 %
	% of Population at Risk	≥4	78.26 %	57.14 %	61.63 %	55.42 %	68.18 %	58.63 %

BMI, body mass index; CED, chronic energy deficiency; MUAC, mid-upper arm circumference; RI, Rohrer index

Table 3. Pearson's correlation coefficient and linear regression analysis of body mass index (BMI) with mid upper arm circumference (MUAC) in young adult college students

Populations	Correlation Coefficient	P Value	Regression analysis		
			β coefficient	R^2	P-Value
Tribal Male	0.757	<0.001	0.834	0.567	0.000
Tribal Female	0.149	0.242	0.207	0.022	0.242
Non-Tribal Male	0.795	<0.001	0.923	0.632	0.000
Non-Tribal Female	0.719	<0.001	1.003	0.517	0.000

Table 4. Distribution of mean BMI and total prevalence of CED according to MUAC groups

	MUAC Groups				F Ratio/ χ^2 for linear trend	P-Value
	Group - I	Group - II	Group – III	Group - IV		
Tribal Male	(n=2)	(n=12)	(n=15)	(n=40)		
BMI (Mean ± SD)	16.71±0.13	17.89±0.99	19.97±1.50	21.69±1.75	F=22.98	<0.001[a]
CED (%)	100.00	83.33	26.67	2.50	χ^2=36.76	<0.001[b]
RR (95% CI) of CED	40.00 (5.78–277.05)	33.33 (4.73–234.71)	10.67 (1.29–87.93)	1.00[c]		
Tribal Female	(n=6)	(n=18)	(n=11)	(n=28)		
BMI (Mean±SD)	19.87±1.95	21.37±3.13	21.84±4.20	22.10±2.99	F=0.86	0.465[a]
CED (%)	33.33	22.22	27.27	3.57	χ^2=4.71	0.030[b]
RR (95% CI) of CED	9.33 (1.00–87.03)	6.22 (0.76–51.31)	7.64 (0.89–65.76)	1.00 [c]		
Non-Tribal Male	(n=0)	(n=20)	(n=39)	(n=199)		
BMI (Mean±SD)		18.95±1.03	19.53±1.03	22.04±2.10	F=45.99	<0.001[a]
CED (%)		30.00	23.08	1.01	χ^2=42.58	<0.001[b]
RR (95% CI) of CED		29.85 (6.45–138.25)	22.96 (5.16–102.21)	1.00[c]		
Non-Tribal Female	(n=6)	(n=59)	(n=56)	(n=119)		
BMI (Mean±SD)	18.57±1.36	19.68±1.87	20.80±1.62	23.43±2.95	F=39.91	<0.001[a]
CED (%)	50.00	22.03	7.14	0.84	χ^2=31.95	<0.001[b]
RR (95% CI) of CED	59.50 (7.22–490.46)	26.22 (3.51–195.67)	8.5 (0.97–74.31)	1.00[c]		

BMI, body mass Index; CED, chronic energy deficiency; MUAC, mid-upper arm circumference; RR, risk ratio.
a. Level of significance based on one way ANOVA
b. Significance based on Chi-square linear trend
c. Reference category

Measurement of health status by Rohrer Index/Index of Corpulence in both genders of the student groups revealed that the tribal and non-tribal males respectively showed 33.33% and 26.74% subnormal state of health (RI≤1.19), whereas, compared to males, females of both the groups exhibited lesser degree of subnormal state of health (tribal: 14.28%; non-tribal: 7.08%) (Table 2). When health status of overall population was considered, 24.25% tribal and 17.27% non-tribal populations were found in subnormal state of health.

Table 2 presents gender wise social risk scores of both groups of students. Results indicate that the tribal males are the most vulnerable population (78.26%) at social risk 4.25±1.13, followed by non-tribal male (61.63%) at social risk 3.83±0.89. When female population was compared, tribal females (57.14%) were found more at social risk 3.65±1.00, compared to non-tribal females (55.42%) at social risk 3.60±0.89.

Pearson's correlation coefficients of Rohrer index (RI) with BMI, MUAC, FFMI, FMI and MM are depicted in Table 5. All the five independent variables, irrespective of gender, showed significant association with RI, except FMI and MUAC in tribal females. The strongest association of RI however was seen, irrespective of gender, with FFMI.

The associations of independent variables (MUAC, FFMI, FMI and MM) with dependent variables (RI) according to population and gender are shown in Fig. 1. It is evident that out of the four independent variables studied, FFMI alone explained between 68% and 84% of the overall variability of RI in males and females of both groups of students.

In stepwise multiple regression analyses with FFMI, FMI, MM and MUAC as potential predictors, FFMI proved to be the predominant predictor for RI, irrespective of gender, with values for R^2 change ranging from 68% to 88.5% in both groups of students (Table 6).

4. DISCUSSION

This study is first of its kind with two different groups of college students of Tripura, a small state in the North-Eastern fringe of India, having a record of low socio-economic and health development compared to even with few other northeastern states of India. In this cross-sectional study, we aimed to investigate the nutritional status of semi- urbanized college students of two different ethnic origins (Tribe and Non-Tribe) of a small township and to assess the impact of nutritional status on health in general. The study area was selected in the semi- urban area to satisfy the prerequisite and similar environmental conditions of both the communities of subjects of this study. The area of this cross-sectional study in undergraduate colleges was intentionally selected because of higher concentration of the two groups of ethno-linguistically and socio-culturally (social customs, food habits, professional opportunities, health services, use of traditional medicines, education, cultural difference etc) varied subjects in a common place, but with similar educational background.

Data generated on anthropometric characteristics of two different ethnic groups of students (Table 1) suggest that there exists a wide gender variation in measures of different variables. Such variations in anthropometric characteristics between two different ethnic groups of diverse origin have been reported earlier by many workers [31-33].

Literature survey shows that, in several recent studies in India [17,34-38], BMI has been utilized to study the nutritional status of tribal populations. Similarly, MUAC cutoff points have been utilized to study nutritional status of adult populations' worldwide [14], particularly in developing countries. Earlier, several studies have well-documented the association and significance of CED with socio-economic, nutrition and health status of adult population [14,15,34,39,40]. Therefore, this study was an effort to investigate the consequences of the functional impairments commonly associated with low BMI in subjects of two different ethnic groups having diverse origin and socio-cultural background.

The outcome of the present study clearly indicated that, when BMI was considered as a nutritional index, the highest prevalence of CED was noted in tribal males and lowest in non-tribal males (Table 2) suggesting that these particular student groups of tribal and non-tribal background respectively were the maximum and minimum affected populations studied. Results of prevalence of CED as determined by both BMI and MUAC suggest that students of both the ethnic groups are possibly suffering from socio-economic deprivation including benefits from partial urbanization, because these same population groups also have shown poor health status (tribal 24.25%, non-tribal 17.27%). Results of RI as health status indicator further suggest that some corrective measures like nutritional intervention programs from local health authority are immediately required for this and similar other populations of the state through government, semi-government or private initiatives. Such recommendation for a nutritional and health surveillance finds support from WHO's [25] classification of the public health problem of low BMI (<18.5), based on adult populations worldwide. Data of social risk score also suggest that the students of both the ethnic groups are at high risk (Table 2). Similar report has been made earlier on tribal population who are at higher risk of under nutrition because of socio-cultural and socio-economic and environmental factors influencing the food intake and health seeking behavior [41]. Thus, anticipation of improvement in social security and socio-economic conditions, better access to health services etc. in these semi-urbanized groups of students, irrespective of ethnicity background, possibly were absent in the entire population studied. Such presumption is further reinforced by our observation of low prevalence of overweight and obesity in the total population studied, because prevalence of overweight and obesity has been linked with improvement of socio-economic conditions, urbanization, better nutrition, growing knowledge and awareness etc [42,43].

Table 5. Pearson's correlation coefficient of Rohrer index (RI) with body mass index (BMI), muscle mass (MM), fat mass index (FMI), fat free mass index (FFMI) and mid upper arm circumference (MUAC) in young adult college students

Populations	Tribal (Group A) (n = male 69, female 63)					Non-Tribal (Group B) (n = male 258, female 240)				
	BMI (kg m^{-2})	MM (kg)	FMI	FFMI	MUAC	BMI (kg m^{-2})	MM (kg)	FMI	FFMI	MUAC
Male	0.972**	0.381*	0.786**	0.911**	0.684**	0.951**	0.559**	0.741**	0.825**	0.719**
Female	0.971**	0.661**	0.154	0.871**	0.173	0.978**	0.675**	0.703**	0.921**	0.669**

*** denotes significance level P<0.01 * denotes significance level P<0.05*

Table 6. Stepwise multiple regression analysis of all subjects between RI (dependent variable) and FFMI, FFM, MM and MUAC (independent variable)

	R^2 change	β coefficient	P-Value
Non-Tribal Male			
FFMI	0.680	0.068	0.000
FMI	0.228	0.071	0.000
MM	0.026	– 0.008	0.000
MUAC			> 0.05
Non-Tribal Female			
FFMI	0.848	0.077	0.000
FMI			> 0.05
MM			> 0.05
MUAC	0.008	0.011	0.000
Tribal Male			
FFMI	0.830	0.077	0.000
FMI	0.114	0.079	0.000
MM	0.017	– 0.007	0.000
MUAC	0.004	– 0.007	0.014
Tribal Female			
FFMI	0.885	0.075	0.000
FMI	0.077	0.064	0.000
MM	0.007	– 0.009	0.000
MUAC	0.004	0.007	0.007

RI, Rohrer index; FFMI, fat-free mass index; FMI, fat mass index; MM, muscle mass; MUAC, mid-upper arm circumference

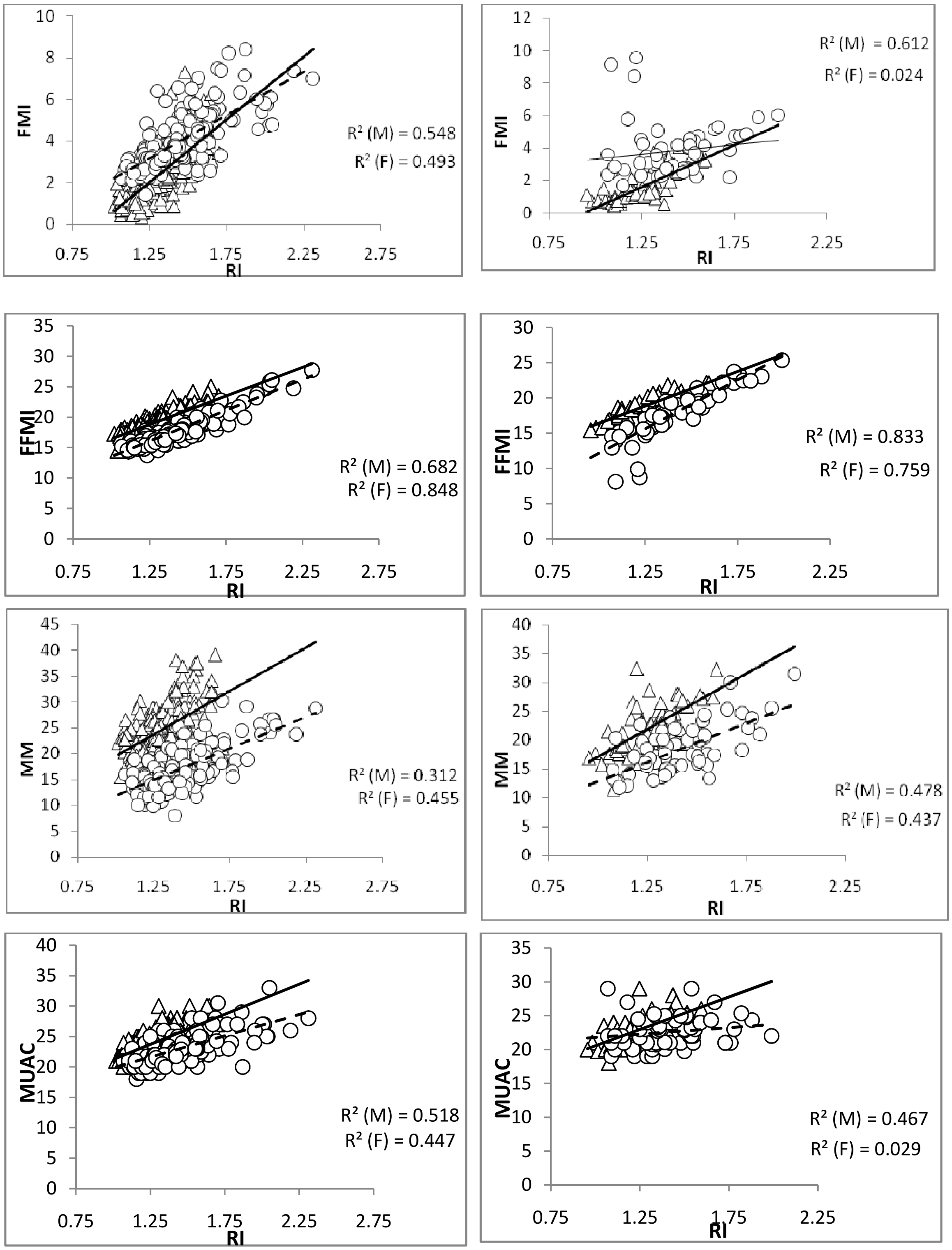

Fig. 1. Relation between RI (Dependent variable) and FMI, FFMI, MM, and MUAC in non-tribal (left) and tribal (right) population. (O, dotted line = female); (Δ, solid line = male)

As far as anthropometric variables as potential predictor of health is concerned, FFMI in our study was found strongly associated with RI, suggesting that in anthropometry-based population study, FFMI may be recommended as a simple anthropometric estimate to assess nutrition and health status (RI) of any adult population. Such perception gets its support from earlier reports of studies with FFMI as an alternative measure of BMI to predict nutritional status of subjects having illness with COPD or obesity [32,44,45].

As far as limitations of this study are concerned, it may be its unequal sample size, particularly for tribal group. But investigators had no alternative in this matter because (i) the total tribal population of the state is only 31%, (ii) only a smaller fraction of this population usually enrolls for college level education and (iii) many subjects of this group were either discarded or dropped during the multi-stage stratified sampling method. Another limitation, however, may be the collection of social risk data which, by and large, had to be recorded from the subjects at study center by recalling method because of logistic issues.

5. CONCLUSION

The present study documents that the entire studied population of diverse ethnic origin in a small semi-urbanized township of Western Tripura (India) is under high social risk and the nutrition and health status of the tribal population is in more serious condition according to WHO classification of the public health problem of low BMI. There is a need for the local health authorities to implement nutritional assessment programs for managing the burden of under nutrition and poor health status of the population studied.

CONSENT

All authors gave their consent to publish the work. Further, all authors declare that written informed consent was obtained from all the participants.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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