Age and Sex Variations in Anthropometric Characteristics and Body Composition of Adults Belonging to the Rajbanshi Population of Darjeeling District, West Bengal

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ABSTRACT: The present cross-sectional study was undertaken to assess the age and sex variations in anthropometric and body composition characteristics of adult Rajbanshi individuals of North Bengal. The study has been carried out among 350 adult individuals belonging to the Rajbanshi individuals in the age-group of 19-49 years and residing in the district of Darjeeling, West Bengal, India. Height and weight were recorded using standard techniques. Body subcutaneous fat, whole body skeletal fat, body fat, BMI and visceral fat level were recorded using an Omron body fat analyser. The statistical tests (ANOVA, Pearson correlation) were done using SPSS (version 17.00). The results showed that most of anthropometric variables were highly significantly correlated with each other ($p<0.05$). Age and skeletal muscle of whole body was negatively significantly ($r=-0.203$, $p<0.01$), ($r=-0.447$, $p<0.01$) correlated with height respectively. On the other hand, it was positively significantly correlated higher with subcutaneous whole body ($r=0.237$, $p<0.01$), body fat ($r=0.345$, $p<0.01$) and visceral fat ($r=0.239$, $p<0.01$). Height and weight were significantly ($p<0.05$) correlated with all other variables except BMI. All anthropometric and body composition variables (height, weight, whole body subcutaneous fat, whole body skeletal fat, body fat, BMI and visceral fat) were correlated with each other and showed a significant sex heterogeneity between these variables.

INTRODUCTION

Assessment of body composition is an important study of nutritional status, various disease processes and in examinations of risk profiles. It has been well established that the use of anthropometry is an efficient indicator of nutritional and health status of adults. General population data on body composition provide important references for interpreting results from such studies. Major changes in the body mass components and body dimensions are described to provide an enhanced awareness of the utility and increased needs for body composition information in applied and research settings. Age related changes also include changes in body composition. A decrease in fat-free mass (FFM) and an increase in body fat mass (BFM) are both considered hallmarks of human aging and can be used to assess functional status, disability and mortality. Among women, age-related changes in body composition have been observed particularly after menopause. FFM usually increases as humans

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grow, remains relatively stable throughout maturity and declines during senescence. Generally, FFM peaks between the fourth and fifth decades of life, occasionally earlier, and then declines slightly (Kuk *et al*., 2009; Borrud *et al*. 2010). The decrease in FFM primarily occurs as a result of losses in muscle mass, component of FFM, and is considered the most constant marker of aging. Various techniques can be used to measure human body composition. Overweight and obesity are commonly assessed in the research and clinical settings using anthropometric measures including the body mass index (BMI) as a measure of overall adiposity. This simple index of weight-for-height is calculated as weight in kilograms divided by the square of height in meters (kg/m^2). Waist circumference (WC) can also be used as a simple anthropometric index of abdominal obesity. Unlike total and abdominal obesity, skeletal muscle mass is not typically measured in the clinical setting and is primarily assessed for research purposes alone.

One of the most straightforward measures for muscle mass that is appropriate for large, epidemiological studies involves bioelectrical impedance analysis (BIA). Simply put, BIA involves a small electric current that is sent through the body from hand to foot while the body's resistance to the flow of the current is measured. Based on basic assumptions involving human tissue hydration, the measured resistance values allow for estimation of skeletal muscle mass or total lean body mass. BIA output can also be used to estimate body fat mass (e.g., body fat mass = body weight – lean body mass). Other more sophisticated imaging techniques also exist for measurement of body composition, including dual-energy X-ray absorptiometry, computed tomography and magnetic resonance imaging. While appropriate and useful for smaller laboratory based studies, these techniques are often impractical for routine use in the clinical setting and in large epidemiological studies due to high cost, time considerations, and difficulty accessing such machines. As such, anthropometric indicators and BIA are more commonly employed in these types of studies. These needs for additional body composition data include the following uses: to prevent malnutrition in institutionalized persons; to screen for health risks; to plan intervention and evaluate therapy; to study mechanisms of fat pattern change and correlates of stature loss; to study associations among fat patterning and mortality; as a prognostic indicator for conditions receiving treatment; and to develop improved reference standards for ambulatory and non-ambulatory individuals. This need for body composition information may be viewed in two ways. Firstly, why is body composition information important and necessary and how is it used for various purposes? Secondly, from a research point of view, what is lacking and what research data are needed in the area of body composition information? These are legitimate and important interpretations of these issues to be addressed.

The region popularly known as North Bengal, constitutes the districts of Darjeeling, Jalpaiguri, Koch Behar, Kalimpong, Alipurduar, North Dinajpur, South Dinajpur and Malda. The region is inhabited by a number of ethnic populations such as Dhimal, Lepacha and Scheduled Caste (for example Rajbanshi) and general caste Hindu population. Studies have indicated that the populations of the region are affected by high levels of undernutrition. High levels of undernutrition have been documented both among children and adolescents belonging to different populations of the region. Here the studies of Debnath *et al*. (2017, 2018), Roy *et al*. (2016), Tigga *et al*. (2016) and Sen and Mondal (2012; 2013) may be cited. Studies have also focussed on undernutrition among adults (Tigga *et al*. 2018; Datta Banik, 2011; Banik *et al*., 2009). Some studies are also present on low birth weight (Mondal *et al*., 2018; Sen *et al*., 2010). A thorough search of the literature has yielded a scarcity of studies in the field of body composition in terms of whole body subcutaneous fat, whole body skeletal muscle, percentage body fat and visceral fat levels among the different ethnic populations of the above mentioned region.

The present study focuses on the age and sex variations in height and weight, along with some body composition variables such as whole body subcutaneous fat percentage among adult individuals belonging to an ethnic population of North Bengal.

MATERIALS AND METHODS

The present cross-sectional study has been carried out among 350 adult Rajbanshi individuals (aged 20-

49 years) residing in the villages of Atharoghai Gram Panchayat of Darjeeling District within the state of West Bengal. Four localities under this gram panchayat were covered during the investigation, namely New Rangia, Batalavita, Salkavita and Bataliguri due to their accessibility and location. All the four localities of the villages are at a distance of near about 5 km from the North Bengal University campus and approximately 12 km from the city of Siliguri.

It is generally agreed that ethnically the Rajbanshi show resemblances with the Koch population of neighbouring states of Assam and it is been conjectured that they belong to a mixed race Australasian/Dravidian and Mongolian population (Risley, 1891). It has also been opined that they belong to a Dravidian stock and came in contact with heterogeneous Mongoloid population (Dalton, 1872). A study on genetic markers among the populations of north-eastern India showed that the Rajbanshi was a semi Hinduized caste group located in between the clusters of Caucasoid caste and Mongoloid tribal populations (Kumar *et al.*, 2004). In West Bengal they constitute the second largest percentage of population among the schedule caste population of the State.

A two-stage stratified random sampling method was used to identify and include the study participants. Participation was completely voluntary. In the first stage, the households of those individuals belonging to the Rajbanshi population were identified based on the surnames, physical and cultural features. These were also verified from the official records. In the second stage, Rajbanshi adult individuals constituting the age-group of 20-49 years were identified and approached to voluntarily participate in the study. Initially 380 adults were approached to take part in the study. Twenty three of them were excluded from the study as they did not belong to the age-group under study. The study protocol was explained to these 357 individuals, after which 7 of them did not agree to take further part in the study. Hence the final study sample consisted of 350 adult Rajbanshi individuals in the age-group 20-49 years (males 189; females 170). An informal consent was taken from each individual prior to recording the data. All the individuals were categorized into 3 age-groups: age-group I (20- 29 years), age-group II (30-39 years) and age-group III (40-49 years). Data from each individual was collected at his/her respective household. In some cases, a common place was selected for recording the data.

Anthropometric measurements : Anthropometric measurements of height and weight were recorded using standard procedures (Hall *et al.*, 2007). Intra-observer and inter-observer technical errors of the measurements (TEM) were calculated to determine the accuracy of the anthropometric measurement using the standard procedure of Ulijaszek and Kerr ('99). For calculating TEM, height and weight were recorded from a different data set of 30 adults other than those selected for the anthropometric data collection by two of the authors (AP and JS). The coefficient of reliability (R) of the measurements was calculated for testing the reliability of the measurements. Very high values of R (>0.97) were obtained for height and weight and these values were observed to be within the recommended cut-off of 0.95 (Ulijaszek and Kerr,'99). Hence, the measurements recorded by AP and JS were considered to be reliable and reproducible. All the measurements in this present study were subsequently recorded by AP.

A total of body composition variables were recorded using an Omron Karada body fat analyser. A literature search has revealed that a number of studies on body composition have utilized the Omron body fat analyser to estimate body fat (e.g., Martin Moreno *et al.* 2001; Mullie *et al.*, 2008). The variables were whole body subcutaneous fat, whole body skeletal muscle, body fat, BMI and visceral fat level. This scanner works using the principle of BIA. The BIA device measures resistance in broadband frequencies (1, 5, 50, 250, 500 and 1,000 kHz) and reactance in mean frequencies (5, 50 and 250 kHz). All the measurements were carried out with an alternating current of 90lA (1 kHz) and 400lA (other frequencies). The surface of the hand electrode was placed in contact with each of the five fingers (the thumb was placed lightly on the electrode, and the other four fingers were placed along the bottom of the electrode), while the participant's heels were placed on the sole electrode In accordance with the manufacturer's guidelines, the participants held out their arms and legs so that they would not come into contact with any other body segments during the procedure. The arms were held at 90° away from the trunk, and legs were positioned 45° apart. The procedure took approximately 2 minutes and it requires no specific skills. Before the measurements were taken, the participant's name and surname, date of birth, height, weight and sex were entered into the software of the scanner.

Statistical analysis: All statistical analysis was performed using the Statistical Package for Social Science (SPSS version 17.00). The descriptive statistics (mean±sd) of the anthropometric and body composition variables were obtained and also tabulated on the basis of age and sex. One-way ANOVA was performed to test for age group differences in mean anthropometric and body composition characteristics. The age group differences in mean anthropometric and body composition characteristics are recorded for entire population, afterward for total male population and also for total female population. Pearson correlation coefficient (r) was utilized to study associations between age and anthropometric and body composition characters with each other. The p-values of <0.05 and <0.01 were considered to be statistically significant.

Limitations: Several limitations of this study should be considered. This study was cross-sectional, and body composition is dependent on age; therefore, it may not provide the same results as a longitudinal or semi-longitudinal study. However, other longitudinal and cross-sectional studies have observed similar results that support the findings of present work. Although the study sample includes nearly three fifty participants, the unequal distribution of participants among the age groups may limit statistical power.

RESULTS

The descriptive statistics of the anthropometric and body composition variables is being depicted in Table 1. For a better understanding of the data, the individuals have been classified into 3 age groups: a) Age-group I (20-29 years); b) Age-group II (30-39 years); and c) Age-group III (40-49 years).

The age-group I contained 140 individuals (males: 80; females: 60). The age-group II comprised of 74 individuals (males: 30; females: 44). The last age-group (III) comprised of 136 individuals (males: 70; females: 66).

Male individuals tended to be taller and heavier than their female counterparts in each age-group. The mean height and weight were observed to be significantly higher ($p<0.05$) among the males (164.45±7.10 cm and 59.60±12.15 kg) than females (151.74±6.27 cm and 51.16±10.02 kg). While considering the three age- groups, males of age-group I were taller (166.81±6.63 cm) than those in the other two age-groups (164.53±6.62 cm and 164.30±7.31 cm respectively). In case of female individuals, age-group II represents the tallest members with a mean height of 153.06±6.10 cm and the age-group III being the least height member's group has a mean height value of 150.46±7.23cm. The male individuals show a trend of general increase of body weight according to age. Table 1 shows mean weight of males in age-group I to be 58.42±12.72 kg which increases in age-group II (59.13±10.57) kg and reaches a peak in age group III (61.15±12.10 kg). This kind of linear increase in body weight was, however, not observed in case of female individuals. The female individuals show attainment of highest weight (54.99±10.11 kg) in age-group II. The two other age-groups showed lower mean weight than age-group II (49.56±9.11 kg and 50.07±10.22 kg respectively).

The whole body subcutaneous fat percentage was significantly ($p<0.05$) higher in females (25.06±5.54) than males (12.42±5.38 %) in each age-group. In case of both sexes, percentage of whole body subcutaneous fat increased with advancement of age. In male individuals the lowest percentage of whole body subcutaneous fat was recorded in age-group I (10.26±5.82) and it linearly increased in age-group II (12.32±4.02 %) and age- group III (14.92±4.21 %). The scenario was same for female individuals (age-group I: 22.92±5.96 %, age-group II: 26.09±5.56 % and age-group III: 26.33±4.53%). The whole body skeletal muscle percentage shows a reverse trend when compared with the whole body subcutaneous fat percentage. To be more precise, it shows gradual decline with advancement of age. The whole body skeletal muscle percentage was significantly higher ($p<0.05$) in males (33.32±3.98) than in females (24.98±2.76). The individuals of age-group I show a peak value skeletal muscle whole body percentage

TABLE 1

Age and sex specific distribution of anthropometric measurements and body composition variables among the Rajbansis of Darjeeling

Age in years	Number		Variables: Height (cm)		Weight (kg)		Subcutaneous fat whole body (%)		Skeletal muscle whole body (%)		Body fat (%)		BMI (kg/m²)		Visceral fat (%)	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
20-29	80	60	166.81 ±6.63	152.19 ±4.96	58.42 ±12.72	49.56 ±9.11	10.26 ±5.82	22.92 ±5.96	35.80 ±3.91	25.59 ±2.37	14.83 ±8.02	26.29 ±6.56	20.95 ±4.21	21.41 ±3.91	4.89 ±4.13	3.57 ±2.95
30-39	30	44	164.53 ±6.62	153.06 ±6.10	59.13 ±10.57	54.99 ±10.11	12.32 ±4.02	26.09 ±5.56	33.47 ±2.28	25.32 ±2.20	17.69 ±5.72	29.79 ±5.42	21.79 ±3.31	23.46 ±4.06	6.23 ±3.69	5.68 ±3.64
40-49	70	66	164.30 ±7.31	150.46 ±7.23	61.15 ±12.10	50.07 ±10.22	14.92 ±4.21	26.33 ±4.53	30.43 ±2.43	23.28 ±2.47	21.75 ±5.87	32.09 ±5.04	22.53 ±3.73	21.97 ±3.33	8.29 ±4.50	5.29 ±2.79
Total	180	170	165.45 ±7.10	151.74 ±6.27	59.60 ±12.15	51.16 ±10.02	12.42 ±5.38	25.06 ±5.54	33.32 ±3.98	24.98 ±2.76	18.00 ±7.55	29.44 ±6.21	21.71 ±3.94	22.15 ±3.80	6.44 ±4.47	4.78 ±3.20

(males: 35.80±3.91%; females: 25.59±2.37%) which gradually declined in age- group II (males: 33.47±2.28%; females: 25.32±2.20%) and reaches the lowest in age-group III (males: 30.43±2.43%; females: 23.28±2.47%). The total body fat percentage recorded was higher in females (29.44±6.21%) than males (18.00±7.55%). Total body fat percentage showed a linear increment with advancing age in both sexes in all the three age-groups (Table 1). The mean BMI was observed to be significantly ($p<0.05$) higher in females (22.15±3.80 kg/m^2) than in males (21.71±3.94 kg/m^2). In case of female individuals, members of age-group II showed highest value for BMI (23.46±4.06 kg/m^2). The male individuals belonging to age-group III showed the highest level of BMI (22.53±3.73 kg/m^2). The age-specific visceral fat level was found to be higher among males (6.44±4.47 %) than their female counterparts (4.78±3.20 %). Advancement of age caused increase in the visceral fat levels in case of both male and female individuals (Table 1).

The age and sex specific mean differences of various anthropometric and body composition variables are shown in Tables 2a and 2b. Utilizing ANOVA, age specific mean comparison showed statistically significant differences among the 3 age-groups with the anthropometric and body composition variables for both males and females (Table 2). The male individuals showed statistically significant ($p<0.05$) differences between the 3 age-groups in BMI (F value = 3.093, $p<0.05$) and highly significant ($p<0.01$) differences between the 3 age-groups in subcutaneous whole body percentage (F value = 16.404, $p<0.01$), skeletal muscle whole body percentage (F value = 53.914, $p<0.01$), body fat percentage (F value = 18.901, $p<0.01$) and visceral fat percentage (F value = 12.212, $p<0.01$). However, age specific differences were observed to be statistically not significant in both height and weight among them ($p>0.05$). On the other hand, female individuals showed statistically significant ($p<0.05$) differences between the 3 age groups in weight (F value = 4.567, $p<0.05$) and BMI (F value = 3.948, $p<0.05$) and highly significant ($p<0.01$) differences in subcutaneous whole body percentage (F value = 7.533, $p<0.01$), skeletal muscle whole body percentage (F value = 31.298, $p<0.01$), body fat percentage (F value = 16.278, $p<0.01$) and visceral fat percentage (F value = 7.413, $p<0.01$). The age specific difference was found to be statistically not significant in height among the female individuals ($p>0.05$).

TABLE 2a

Age specific mean differences using ANOVA

Variables	Males (N = 180)			Females (N = 170)		
	F-ratio	d.f	sig.	F-ratio	d.f	sig.
Height	2.690	2	0.071	2.555	2	0.081
Weight	0.972	2	0.380	4.567*	2	0.012
+Subcutaneous fat whole body %	16.404**	2	0.000	7.533**	2	0.001
Skeletal muscle whole body %	53.914**	2	0.000	31.298**	2	0.000
Body fat %	18.901**	2	0.000	16.278**	2	0.000
BMI	3.093*	2	0.048	3.948*	2	0.021
Visceral fat %	12.212**	2	0.000	7.413**	2	0.001

Note: * $p<0.05$; ** $p<0.01$

The sex differences in anthropometric and body composition variables were also evaluated using ANOVA. The results are depicted in Table 2b. The sex specific differences were found to be highly significant ($p<0.01$) in all of the variables except BMI, which was observed to be statistically not significant ($p>0.05$).

TABLE 2b

Sex specific mean differences using ANOVA

Variables	F-ratio	d.f	Significance
Height	364.991**	1	0.000
Weight	49.958**	1	0.000
Subcutaneous fat whole body %	469.484**	1	0.000
Skeletal muscle whole body %	512.315**	1	0.000
Body fat %	238.701**	1	0.000
BMI	1.187	1	0.277
Visceral fat %	15.751**	1	0.000

Note: * $p<0.05$; ** $p<0.01$

The results of the Pearson's correlation analysis between the anthropometric variables among the adult Rajbanshi individuals are presented in Table 3a. The results have also been presented among male individuals (Table 3b) and female individuals (Table 3c) separately. The results showed that most of anthropometric variables were statistically highly significantly correlated with each other ($p<0.01$). In

Table 3a i.e. while considering the entire population (N=350), age was negatively significantly correlated with height ($r = -0.203, p<0.01$) and skeletal muscle whole body percentage ($r = -0.447, p<0.01$). On the other hand, it was positively significantly correlated higher with subcutaneous whole body percentage ($r = 0.237, p<0.01$), body fat percentage ($r = 0.345, p<0.01$) and visceral fat percentage ($r = 0.239, p<0.01$). Only exceptions were weight and BMI which were not significantly correlated with age. Height and weight were positively significantly ($p<0.01$) correlated with all the variables except in height with BMI ($p>0.05$), age (negatively correlated, $p<0.01$), whole body subcutaneous fat percentage (negatively correlated, $p<0.01$) and body fat percentage (negatively correlated, $p<0.01$) and weight with age ($p>0.05$) only. Subcutaneous whole body fat percentage was positively significantly correlated with every other variable but showed negative significance ($p<0.01$) of correlation with height and skeletal muscle whole body percentage. Skeletal muscle whole body percentage showed negatively significant ($p<0.01$) correlation with every variable considered except weight ($p>0.05$). Body fat percentage was significantly correlated higher ($p<0.01$) with age, weight, subcutaneous fat whole body percentage, BMI and visceral fat percentage, while it showed negative higher significance ($p<0.01$) in correlation with height and skeletal muscle whole body percentage. The BMI was significantly correlated ($p<0.01$) with weight, subcutaneous fat whole body percentage, body fat percentage and with visceral fat percentage. Visceral fat percentage was in a higher significance ($p<0.01$) of correlation with all the variables considered though with skeletal muscle percentage it showed negative correlation($r=-0.217, p<0.01$).

The next table (Table 3b) represents correlations between anthropometric and body composition variables among male Individuals (N=180). Age was significantly highly positively correlated in ($p<0.01$) with subcutaneous whole body percentage, body fat percentage and visceral fat percentage. It was negatively correlated with skeletal muscle whole body percentage, while it had no significant ($p>0.05$) correlation with weight and BMI. Height was significantly highly ($p<0.01$) correlated with only weight and skeletal muscle whole body. Weight on the other hand, showed no significant ($p>0.05$) correlation with age. Other variables showed highly statistically significant ($p<0.01$) correlations with age except skeletal muscle whole body percentage that showed a negative statistically significance ($r = -0.374, p<0.01$). Subcutaneous whole body percentage was highly significantly ($p<0.01$) correlated with every other variable except height ($r = 0.063, p>0.05$). Skeletal muscle whole body percentage showed negative higher significant ($p<0.01$) correlations with all the variables except height ($r = 0.297, p<0.01$). Body fat percentage showed positive statistically higher significant ($p<0.01$) correlations with age, weight, subcutaneous fat whole body percentage, BMI and visceral fat percentage. The BMI showed positively statistically significant correlations ($p<0.01$) with weight, subcutaneous fat whole body percentage, body fat percentage and visceral fat percentage. Visceral fat percentage showed statistically significant ($p<0.01$) correlation with all the variables except height ($r=-0.008, p>0.05$).

The correlations between the anthropometric and body composition variables among females (N=170) are shown in Table 3c. Age was not significantly ($p>0.05$) correlated with weight and BMI, but negatively correlated in higher significance ($p<0.01$) with height and skeletal muscle whole body percentage. Height was not statistically significantly ($p>0.05$) correlated with subcutaneous fat whole body percentage, body fat percentage, BMI and visceral fat percentage and negatively correlated with age ($r = -0.287, p<0.01$). Weight showed positive higher significance ($p<0.01$) with height, subcutaneous fat whole body percentage, body fat percentage, BMI and visceral fat percentage. Subcutaneous fat whole body percentage showed high significant positive ($p<0.01$) correlation with all the variables except height ($p>0.05$) and skeletal muscle whole body percentage ($r = -0.724, p<0.01$). Skeletal muscle whole body percentage was highly significantly correlated ($p<0.01$) positively with only height. Body fat percentage showed high correlation ($p<0.01$) with every variable (negatively with skeletal muscle whole body) except height ($r = -0.099, p>0.05$). The BMI and visceral fat percentage were significantly higher ($p<0.01$) correlated positively with most of the variables except in BMI with age ($r = -0.014, p>0.05$) & height ($r = 0.076, p>0.05$) and visceral fat with height ($r = -0.031, p >0.05$).

TABLE 3a

Correlations between anthropometric and body composition variables among the individuals (male and female combined)

N = 350	Age	Height	Weight	Subcutaneous fat whole body (%)	Skeletal muscle whole body (%)	Body fat %	BMI	Visceral fat %
Age	1	-.203**	-0.044	0.237**	-0.447**	0.345**	0.059	0.239**
Height	-.203**	1	0.571**	-0.529**	0.709**	-0.458**	0.012	0.138**
Weight	-0.044	0.571**	1	0.191**	0.086**	0.252**	0.822**	0.831**
Subcutaneous fat whole body %	0.237**	-.529**	0.191**	1	-0.900**	0.968**	0.598**	0 . 3 7 8 * *
skeletal muscle whole body %	-.447**	-.709**	0.086	-0.900**	1	-0.901**	-.364**	-0.217**
Body fat %	0.345**	-.458**	0.252**	0.968**	-0.901**	1	0.612**	0.461**
BMI	0.059	0.012	0.822**	0.598**	-0.364**	0.612**	1	0.911**
Visceral fat %	0.239**	0.138**	0.831**	0.378**	-0.217**	0.461**	0.911**	1

Note: * p<0.05; ** p<0.0

TABLE 3b

Correlations between anthropometric and body composition variables among the male individuals

Males (N= 180)	Age	Height	Weight	Subcutaneous fat whole body %	Skeletal muscle whole body %	Body fat %	BMI	Visceral fat %
Age	1	-0.208**	0.031	0.368**	-0.657**	0.392**	0.119	0.299**
Height	-0.208**	1	0.482**	0.063	0.297**	0.063	0.077	-0.008
Weight	0.031	0.482**	1	0.730**	-0.374**	0.702**	0.907**	0.839**
Subcutaneous fat whole body %	0.368**	0.063	0.703**	1	-0.807**	0.991**	0.798**	0.823**
skeletal muscle whole body %	-0.657**	0.297**	-0.374**	-0.807**	1	-0.820**	-0.551**	-0.623**
Body fat %	0.392**	0.063	0.702**	0.991**	-0.820**	1	0.765**	0.798**
BMI	0.119	0.077	0.907**	0.798**	-0.551**	0.765**	1	0.961**
Visceral fat %	0.299**	-0.008	0.839**	0.823**	-0.623**	0.798**	0.961**	1

* p<0.05; ** p<0.01

TABLE 3c

Correlations between anthropometric and body composition variables among the female individuals

Females (N = 170)	Age	Height	Weight	Subcutaneous fat whole body %	Skeletal muscle whole body %	Body fat %	BMI	Visceral fat %
Age	1	-0.287**	-0.111	0.245**	-0.650**	0.437**	-0.014	0.193*
Height	-0.287**	1	0.492**	-0.012	0.459**	-0.099	0.076	-0.031
Weight	-0.111	0.492**	1	0.790**	-0.211**	0.605**	0.902**	0.814**
Subcutaneous fat whole body %	0.245**	-0.012	0.790**	1	-0.724**	0.944**	0.907**	0.896**
skeletal muscle whole body %	-0.650**	0.459**	-0.211**	-0.724**	1	-0.869**	-0.444**	-0.574**
Body fat %	0.437**	-0.099	0.605**	0.944**	-0.869**	1	0.731**	0.775**
BMI	-0.014	0.076	0.902**	0.907**	-0.444**	0.731**	1	0.948**
Visceral fat %	0.193*	-0.031	0.814**	0.896**	-0.574**	0.775**	0.948**	1

Note: * p<0.05; ** p<0.01

DISCUSSION

Many studies worldwide (e.g., Shimokata *et al.*,'89; Miccozi and Harris,'90) have reported effects of age on anthropometry and body composition from different parts of the world. However, only a few studies from India (Ghosh *et al.*, 2001; Bose and Das Chaudhuri, 2003) have dealt with age changes in anthropometric and body composition variables.

Moreover, to date, little is known about sexual dimorphism in age variations in anthropometric and body composition characteristics among tribal population of India. There are a few studies, though, on these issues from the tribal populations of the country (Bose *et al*., 2006, 2007; Chowdhury and Ghosh 2013; Savanur *et al*., 2017). The present study reports that with increasing age, values of body composition characteristics rise significantly among the adult Rajbanshi individuals (Table 1). There have been studies that showed decreasing age-trend in anthropometric and body composition variables (Chumlea et al.,'86, '89, Shimokata *et al*.,'89; Chandler and Bock,'91; Strickland and Ulijaszek,'93, Chilima and Ismail,'98, Ghosh *et al*., 2001; Bose and Das Chaudhuri, 2003; Ghosh, 2004; Santos *et al*., 2004; Zverev and Chisi, 2004; Bose *et al*., 2007; Bisai *et al*., 2008; Bisai *et al*., 2009). However, some studies have demonstrated positive age-trend in anthropometric and body composition measures, such as Sadhukan *et al.* (2007). The results of the present study indicated that there existed significant sex and age differences in means of several variables. It is noteworthy to point out that BMI, which is a measure of overall adiposity, was significantly higher among females and especially at the age group II of the females. Other means for measures of adiposity (other than visceral fat), i.e. subcutaneous fat whole body and body fat percentage were significantly higher among females. The means for non-fat variable skeletal muscle whole body was significantly higher among men. This implied that there existed significant sexual dimorphism in fat versus non-fat components of body composition. The present study has observed that there existed significant age variations in both sexes. Similar findings have been reported in earlier studies conducted among non-tribal populations worldwide (Chilima and Ismail,'98; Ghosh *et al*., 2001; Bose and Das Chaudhuri, 2003; Zverev and Chisi, 2004; McLorg, 2005). The results also demonstrated that in males BMI (overall adiposity) increases with advancement of age in a linear stream which was not observed among female. Moreover, significant ($p < 0.05$) sex heterogeneity existed between the correlations of age with other body composition variables. This was suggestive of a significant sexual dimorphism in age variations in these variables. Body fat mass (subcutaneous fat whole body) is the most variable component of the human body. In general, body fat mass peaks in adult stage of life, and it then remains constant or decreases slightly. However, this decline does not appear to be large in magnitude. Several longitudinal studies have reported the amount that subcutaneous fat whole body increases throughout the lifespan, but they have reported different results. The Fels Longitudinal Study involving 108 white women demonstrated that body fat mass increased with age. Kyle *et al*. (2001) observed a non-significant increase of 0.20 kg (male: 0.32 kg; female: 0.04 kg) in body fat mass in both genders over a 1 year of follow-up, but there was a statistically significant increase of 0.62 kg in body fat mass (male: 0.75 kg; female: 0.44 kg) over 3 years of follow-up. Dey *et al.* (2009) reported age-related changes in body composition in a study of eighty-seven randomly selected 75-year-old subjects. The body fat mass increased only in the men, whereas it was stable in the women. There have been numerous cross-sectional studies on the pattern of changes in body adiposity. According to the results of the US National Health and Nutrition Examination Survey (NHANES), body fat mass percentage estimated by dual energy X-ray absorptiometry, peaked at 42.4 %, between the sixth and seventh decades of life, and they declined slightly thereafter.

It is well established that regional differences in body fat distribution are reliable predictors of health complications. The distribution of BFM seems to be a strong independent predictor of all-cause mortality in both females and males. There is also growing evidence that visceral fat accumulation is associated with age. In a longitudinal study, Lara-Castro *et al.* (2002) demonstrated that significant increases in visceral fat were associated with age. In present investigation, the mean skeletal muscle whole body decreased slightly with advancement of age in both the sexes. The peak level of skeletal muscle whole body was observed in age group I for both male and female individuals. The NHANES results indicated that skeletal muscle whole body increased from childhood, peaked between 40 and 59 years and declined thereafter.

CONCLUSION

In conclusion present study demonstrated the following:

- The presence of sexual dimorphism in means of several variables.
- The present study also reports that with increasing age, the values of body composition variables (subcutaneous fat whole body percentage, skeletal muscle whole body percentage, body fat percentage, BMI and visceral fat percentage rise significantly.
- There exist significant ($p<0.05$) correlation among most of the variables.

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