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Anthropometric and Body Composition Differences among Rural and Urban Ao Naga Tribes: Correlation between Hypertension, Haemoglobin and Obesity.

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KEYWORDS

Rural, urban, anthropometry, Ao, hypertension.

ABSTRACT

Urbanization, shifts in diet, and activity patterns can increase obesity and its associated diseases. Rural Ao Nagas increasing urban migration resulted in changes in body composition variables leading to higher WSR, overweight and obesity as well as anthropometric variables like age, %BF, BFMI, WSR and WHR impacting on systolic blood pressure.

Introduction

Although undernutrition remains a major health problem in many developing countries, obesity is also emerging with the improvement of socio-economic condition and increasing urbanization (Popkin 1998, 2002). This situation, common to many Asian countries, are due to “changing dietary pattern towards energy-dense and high fat diets, together with a more sedentary lifestyle arising from increasing urbanization” (Florentino 2002). These patterns and lifestyles are the key factors to risks of obesity and associated morbidity, such as diabetes mellitus, cardiovascular disease, hypertension and stroke, osteoporosis, and some forms of cancer (WHO/FAO 2003). In North East India Mungreiphy et al. (2011) reported the intensified prevalence of overweight/obesity and hypertension among the Tangkhul Nagas due to changing socioeconomic environment. Longkumer (2013), working among Ao Naga children, found that girls had a higher prevalence of overweight and boys had a higher prevalence of underweight, that is both underweight and overweight coexisted among the Ao Naga children. In Manipur, among diabetic patients, systolic blood pressure, total cholesterol, triglyceride, and smoking contributed significantly to high degree of cardiovascular risk (Tungdim et al. 2014).

The present study was designed to observe rural–urban differences in anthropometric parameters among the Ao Naga tribes and determine cardiovascular risk connected to these anthropometric measurements. The study was cross-sectional in nature using stratified cluster sampling method, where 802 urban and 1001 rural dwellers were studied. Cardiovascular profiles as well as anthropometric measurements were compared between the two populations. The aim was checking possible anthropometric and body composition differences among rural and urban Ao Naga tribes and if so,

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their correlation between hypertension, hemoglobin, obesity and their lifestyles.

Methods

Sampling: The present study was conducted among Ao adults in the Mokokchung district of Nagaland, home of the Ao-Naga tribe. The data were collected from both urban and rural areas. For the rural sample, villages were stratified according to the three Rural Development Blocks, namely, Ongpangkong, Mangkolemba and Changtongya. The primary sampling units for each of the three strata are six villages randomly selected by using random numbers as given in Snedecor and Cochran(1967). The required number of villages for collecting data from each stratum was determined independently, following the optimum allocation method as suggested by the same scholars. An attempt was made to cover more than 30% of the total households from each selected sampling unit (i.e., village or locality). No statistical sampling of individuals was applied for collection of data from each selected village or locality to avoid operational difficulties in the field. Instead, an attempt was made to include in our sample all those adults (aged 18-70 years) who were willing to co-operate with the present work. An attempt was also made to cover as many as 30 individuals for each age group. A cross-sectional method of anthropometric study was adopted for assessing the body composition of 1803 adults aged 18-70 years of age.

After explaining the purpose of the study prior to the data collection, informed written consent was obtained from the participants before the start of the study. The institutional ethical committee approved the study protocol

Bioelectrical Impedance Analyzer

The body composition was estimated using a Bioelectrical Impedance Analyzer with four-point tactile electrodes (HBF–302, Omron Healthcare, Co. Ltd., Japan). This device measures the electrical signals of undetectably low voltage as they pass through the body fat via handheld device. Since fat is a very poor conductor of electricity, a greater fat accumulation in the body would impede the flow of the current. By measuring the resistance to the current, the device estimates the body fat percentage, which can be used for estimating fat-free mass (FFM) by subtracting it from the body weight.

Blood pressure

A mercury sphygmomanometer was used to measure blood pressure of the individuals included in the present study. All measurements were taken on left arm when subjects were in a seated position. Each participant was also asked to relax and take a rest for 10 minutes before taking the measurement. Systolic blood pressure was recorded as the first Korotkov sound (phase 1). Diastolic blood pressure was taken as the disappearance of the Korotkov sounds (phase V). Measurements were recorded by a single investigator for three times, and the average of the three was taken as recorded measurement. Digital blood pressure monitor (M2 Model, Omron Health Care Co. Ltd., Japan) was also used to cross-check the measurements. However, mercury type of measurements were reported for the present study.

Data on adult body dimensions and composition

Some selected anthropometric measurements from the basic list of measurements, which was recommended by the International Biological Programme (Weiner and Lourie, 1981) was taken into consideration for the purpose of the present study. Following are the anthropometric measurements taken on the selected subjects of both sexes wearing light apparel.

Weight: The body weight was taken with a spring weighing machine, asking the subject to stand on it bare foot with an erect posture and light apparel. The weighing machine was checked from time to time with a known standard weight. No tare deduction was made for the weight of light apparel while taking the final reading.

Height: It measures the vertical distance from the floor to the vertex. The subject was made to stand as erect as possible with his/her arms hanging at the sides with thumbs forward, heels holding together and eyes directing towards the horizon. The anthropometer was placed at the back and between the heels of the subject, taking care that it is kept absolutely vertical. The sliding sleeve of the anthropometer was then lowered down towards the middle of the head (Sagital line) so that it would touch the vertex lightly. Reading in centimeter and its fractions were recorded.

Sitting height: It measures the vertical distance from the vertex to the sitting surface of the subject. The subject was made to sit on the stool, or a flat wooden chair, or at the end of a wooden bench. Then the subject was positioned in an erect sitting posture, with ankles crossed, knees spread at about 20 cm apart and hands rested on the thighs. The anthropometer was placed at the back and between the two buttocks, taking care that the lumbar curve of the subject was not flattened, but concave from behind. The sliding sleeve was the lowered down to touch the vertex lightly.

Mid Upper Arm Circumference (MUAC): The measurement was taken with a steel tape at the middle (midway between acromion and elbow) part of the left upper arm on the naked skin, while the arms were hanging at the sides of the body.

Chest Circumference: It measures the circumference of the chest of the adult subject when he/she was breathing normally. This measurement was taken with a steel tape (Precision – 1mm) at the level of the meso-sternale and at the right angle to the axis of the body when the subject exhaled normally.

Waist Circumference: Waist circumference was measured midway between the lower rib margin and the superior anterior iliac spine. This measurement was taken with a steel tape at the right angle to the axis of the body when the subject exhaled normally.

Hip Circumference: Hip circumference was taken at the widest point over the greater trochanters. This measurement was taken with a steel tape at right angle to the axis of the body when the subject exhaled normally.

Biceps: The skinfold was picked up between the thumb and forefinger and the caliper jaws was applied at exactly the level marked. The measurement was read after the full pressure of the caliper jaws was applied to the skinfold. A Harpenden skinfold caliper was used for taking the skinfold thickness. The skinfold was picked up on the front of the upper arm directly above the centre of the cubital fossa and the level marked on the skin for the arm circumference.

Triceps: The skinfold was picked up at the back of the upper arm about 1 cm above the level marked on the skin for the arm circumference and directly in line with the olecranon process.

Subscapular: The skinfold was picked up under the inferior angle of the left scapula. According to the natural cleavage of the skin, the fold was measured either vertical or slightly inclined downward and laterally.

Anthropometric Indices and ratios

Besides the above measurements, following indices and ratio were computed for both adult males and females for correlating with body composition.

1. Body mass index or BMI = weight (kg)/height (m) ^{2}
2. Fat free mass index or FFMI = FFM (kg)/height (m)^2
3. Body fat mass index or BFMI = BFM (kg)/ height (m)^2
4. Cormic index or relative-sitting height = sitting height (cm)/height (cm)
5. Conicity index or CI = waist circumference (m)/0.109×Ö{weight (kg)/height (m)}
6. Waist-to-Hip ratio or WHR = waist circumference (cm)/ hip circumference (cm)

The BMI (body weight in kg divided by the square of height in meters) was separated into two components: body fat mass index (BFMI = BFM in kg divided by the square of height in meters) and fat-free mass index (FFMI = FFM in kg divided by the square of height in meters) to test the relationship between body composition in terms of BFMI and FFMI with morbidity and other parameters.

Hemoglobin: The hemoglobin content was measured with a Sahli haemometer. The haemometer is an absolute measuring system by graduation with g/dl reading. The graduated measuring tube is filled up to the bottom graduation line with hydrochloric acid. A quantity of 20 μl of blood is blown into the tube and water is added until the colour of the solution matches the colour of the test rods. The result can be read by diffused daylight, 3 min after adding the 20 μl of blood to hydrochloric acid.

Physical activity: Respondents were asked if they lead sedentary or moderate activity levels in their day to day activity.

Occupation: Respondents were divided into four groups, viz. those without any occupation, student, farmer/labourer and working groups.

Income: Income was divided into three categories. Low income group (< Rs. 1500), Medium income group (Rs. 1500 -2200) and High income group (> Rs. 2200).

Education: Education level was divided into four categories namely**:** those who cannot read and write, who were classified into the first group called "Illiterate & lower group". The second group was the Primary group consisting of those who studied up to Class IV, Upper Primary were those who studied from Class V-VIII, and Secondary group were those who studied till VII-X).

Family size: Size of the family was categorized into three groups. viz; ideal or small family size (<4 members in total), medium family size (5-6 members in total) and large family size (>7 members in total).

Statistical analyses

The basic design of the study is to analyze and present comparative data between urban and rural areas. In addition, the main focus of the analysis was on the relationship between body composition and its relationship with biosocial variables, such as age, sex, anthropometric variables, blood pressure, hemoglobin, physical activity, occupation, household income, education and family size. Beside descriptive statistics, to test the differences between the two rural-urban groups, a t-test was done. Correlation analyses were done to determine the association between hemoglobin with systolic, and diastolic BP. Logistic regression was performed to explain the impact of predictor variables (high bp, overweight, obesity, smoking status, drinking status, WSR) in terms of odds ratios for CDV. All data was managed and analyzed using SPSS/PC Software. The relationship between body composition and nutritional status was tested, using analysis of covariance (ANCOVA) and multiple regression analysis.

Results

Socio-demographic characteristics

In the present study 889 men and 914 women (Total 1803) belonging to both urban and rural communities of Aos were taken as subjects : 802 of them belonged to the urban population (44.48 %) and 1001 belonged to the rural (55.52%) population. There were 405 men and 517 women in the urban population while the rural population consisted of 484 men and 397 women. The mean age ± SD were 36.84 ± 14.1for the urban dwellers and 38.73 ± 14.9 for rural dwellers. There was no difference in the mean ages of the participant (p=0.006). A detailed demographic profile of males and females in rural and urban areas including education, income, drinking and alcohol intake frequency, exercise frequency, TV watching habits and physical activity levels of the study population are shown in Table 1.

Anthropometric characteristics

Table 2 shows gender specific means for anthropometric measurements in both urban and rural population. Height, weight, sitting height, MUAC, chest circumference, hip circumference, fat mass, fat free mass, skinfold thickness were significantly higher in urban men and women than their rural counterparts ($p< 0.05$). However, waist circumference (cm), BMI (kg/mt^2) and hemoglobin was higher among rural men than urban men. BP (diastolic) was also higher in rural women than their urban counterparts ($p<0.000$).

Blood pressure and hemoglobin characteristics

The mean ±SD of the SBP for the urban and rural population was 131.31±17.05 and 129.42± 16.27 respectively while the mean ±SD of the DPB was 81.63±11.39 and 81.31±10.94 for urban and rural population respectively (Table 2). Among males, both SBP and DBP was higher in urban than rural male populations ($p <0.05$). The reverse is true for the females, where rural females had higher SBP and DBP than urban females though SBP was not significantly different between urban and rural females. A very interesting result that normally does not occur in other reports in India was found with regard to hypertension where it was more prevalent among the rural than the urban population (Table 3). Hemoglobin was found to be higher in rural males than urban males ($p<0.05$), while the opposite is true for the women, where urban females had higher hemoglobin levels than rural females, though not statistically significant.

Prevalence of cardiovascular risk factors.

Table 3 shows the prevalence of cardiovascular risk factors in the two populations. Overweight, obesity and waist stature ratio (WSR) were significantly prevalent and higher among the rural population than the urban population ($p< 0.05$), while there was no significant difference in the smoking habits between the two populations ($p=0.730$). Alcohol consumption was more prevalent among the rural population (<0.05).

Correlation

Tables 4 and 5 show the correlations of anthropometric parameters with mean BP and hemoglobin parameters in men and women respectively. Age had a significant positive correlation with SBP and DBP for both urban and rural male and female population. However, Hb was inversely correlated with age for both the urban and rural populations, though not statistically significant among males. SBP showed a positive correlation with all anthropometric parameters both for the urban and rural populations in males and females, except for the cormic index among both rural males ($p= 0.343$) and urban females ($p= 0.400$). DBP had a significant correlation with most anthropometric parameters except the cormic index in rural male urban females respectively.

For Hb among the males, BMI, WC, WHR, conicity index and WSR all showed both significant and insignificant correlation with Hb either in the rural or urban group. For the women cohort, age, WHR, cormic index, concity index showed the same kind of varied correlation among rural and urban groups. There was an inverse correlation of the conicity index with Hb among urban males and significant ($r=-0.011$, $p<0.05$) and an inverse correlation of age among rural female with Hb ($r=-0.133$, $p<0.05$).

Regression

In a multivariate regression analysis of anthropometric variables predicting systolic blood pressure, the impact of Age, %BF, BFMI, WSR and WHR were evaluated as shown in Table 6. Multivariate regression analysis showed that for urban males, age and %BF was a better predictor of systolic pressure than age alone. While in the rural males, age and BFMI showed significant predictor of Sys BP ($\beta= 0.258$, $R^2= 0.157$, $p =0.016$). For the urban female, BFMI and age were significant predictors for SBP ($\beta=3.646$, $R^2= 0.353$, $p =0.000$), and for the rural female, WSR, age and WHR were significant predictors for SBP ($\beta=188.17$, $R^2= 0.264$, $p =0.000$).

Discussion

Urbanization is an important global phenomenon which has brought about drastic changes such as increase in population size, changes in dietary habits, lifestyle, etc. It is observed that the shifts in diet, activity patterns and body composition are occurring more rapidly in the developing countries (Popkin 1998, 2004). The emergence of obesity is attributed to the increasing intake of protein rich and fat rich diets with lessened physical activity. Khongsdier (2008) has pointed out that the increase in rural-urban migration along with changes in dietary and physical activity patterns is likely to condition many individuals to obesity and its associated diseases such as diabetes, hypertension, etc. He has further pointed out that rural to urban migration and the change of rural settlements into cities in the developing countries are the major cause for the rapid growth of population, and that these changes will lead to the decline in rural population.

A rural-urban comparison in Eastern China reports that urban dwellers are highly associated with metabolic syndrome, which is a result of high dietary fat intake and lower occupational physical activity (Weng et al. 2007). Although generally urban dwellers are considered to be at risk to obesity, studies have reported that obesity does also occur in rural dwellers. In India, a study in South India on BMI and abdominal fat reports that obesity or overweight, hypertension, sedentary lifestyle, etc, are more prevalent among urban population as compared to the rural population and therefore the cardiovascular risk factors are higher in urban populations (Venkatramana and Reddy, 2002). Study among the adults of Calcutta and a village about 80 km away from the city was undertaken to investigate the rural-urban differences in the prevalence of cardiovascular diseases (Das et al. 2008). This study showed that significant differences existed for anthropometric, metabolic and blood pressure variables between rural and urban areas. It also revealed that the urban population was more susceptible to cardiovascular diseases and that this was due to the influence of effective urbanization and modernization.

It is clearly evident from the present study that urban areas are more advanced in both education and economic conditions consistent with earlier reports. For example, the National Family Health Survey-3 (IIPS 2009) revealed that more than one-third of the households (35%) in the urban areas of Nagaland belonged to the highest wealth index as compared to only 7% of the households in rural areas. The same is true with regard to literacy rates, which were 76.07% and 90.47% in rural and urban areas, respectively (Census of India 2001). On the basis of the present findings on education and household income, it is likely that urban areas are more advanced than rural areas.

It is further observed that there were significant differences between rural and urban areas as to anthropometric characters. With the exception of few cases, anthropometric characters are significantly greater in urban than in rural areas. Our findings, therefore, corroborate earlier studies which have also reported such findings from several countries such as Papua New Guinea (Yamauchi and Umezaki, 2005), Eastern China (Weng et al. 2007) 26 sub-Saharan countries in Africa (Uthman and Aremu, 2008), south India (Venkatramana and Reddy, 2002), Calcutta (IIPS 20089) and Northeast India among the Meitei women in Manipur (Devi et al. 2008).

In view of these findings on socioeconomic and anthropometric characters, it is clear that we cannot pool the rural and urban data without a proper adjustment. Therefore, our segregation of rural and urban data seems to be justified as far as the present study is concerned.

Concluding Remarks

Body composition and nutritional status are just like two sides of the same coin, which are greatly influenced by urbanization, demographic and socioeconomic factors. In developed countries, obesity has become an epidemic. The situation is more serious in developing countries, where both underweight and overweight co-exist.

It may be recalled that Popkin (1998, 1994) has stressed the `nutrition transition' in the developing countries, or the shift from traditional diets and lifestyles to `Western' diets (i.e. high in saturated fats, sugar and refined foods), and the combination of reduced levels of physical activity and increased stress, particularly in the rapidly growing urbanization. The feared outcomes of the nutritional transition are increased levels of obesity and chronic and degenerative diseases. In Nagaland, increasing rural-urban migration in the state could be associated with various factors and in particular search of better jobs, education and living conditions. Consequently, there are changes in economic conditions, dietary intakes, physical activity and lifestyles, which may be responsible for overweight and obesity among urban individuals.

Although this study is cross-sectional in nature, it has evolutionary implications for understanding the health and nutritional status of the population.

Limitations: This study was cross sectional in nature. Hence causal effect could not be conclusively proved as in a longitudinal study.

Author's contributions

TM and LRV participated in the design of the study, data analysis, interpretation of the data, and writing of the paper. All authors participated in the revision of the manuscript and approved the version submitted for publication.

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Table 1: Socio demographic characteristic of study population

Variables	Rural men n=484 (%)	Urban men n=405 (%)	P-value	Rural women n=517 (%)	Urban women n=397 (%)	P-value
Age in years						
18-20	46 (9.5)	43 (10.6)		50 (9.7)	48 (12.1)	
21-30	126 (26.0)	143 (35.3)		159 (30.8)	136 (34.3)	
31-40	98 (20.2)	61 (15.1)		101 (19.5)	63 (15.9)	
41-50	93 (19.2)	65 (16.0)		86 (16.6)	69 (17.4)	
51-60	68 (14.0)	66 (16.3)		65 (12.6)	65 (16.4)	
61-70	53 (11.0)	27 (6.7)	0.098	56 (10.8)	16 (4.0)	0.085
Marital Status						
Single	158 (32.6)	190 (46.9)		132 (25.5)	157 (39.5)	
Married	326 (67.4)	215 (53.1)		354 (68.5)	224 (56.4)	
Divorced/widowed	0	0	0.000*	31 (6)	16 (4)	0.000*
Family Group						
Ideal or small (<4)	167 (34.5)	148(36.5)		200 (38.7)	145(36.5)	
Medium (5-6()	239(49.4)	237 (58.5)		237 (45.8)	230(57.9)	
Large (>7)	78 (16.1)	20(4.9)	0.000*	80 (15.5)	22(5.5)	0.000*
Occupation						
None	27 (5.6)	47 (11.6)		54(10.4)	158(39.8)	
Student	50 (10.3)	134 (33.1)		58(11.2)	119(30.0)	
Farmer/labourer	267 (55.2)	18 (4.4)		360(69.6)	13(3.3)	
Working	140 (28.9)	206(50.9)	0.000*	45(8.7)	107(27.0)	0.000*
Level of education						
Illiterate & lower primary (upto class iv)	84 (17.4)	3(0.7)		194 (37.5)	20(5)	
Upper Primary(class v-viii)	155 (32)	17(4.2)		151 (29.2)	48(12.1)	
Secondary(vii-x)	164(33.9)	47 (11.6)		111 (21.5)	75(18.9)	
Higher Secondary and above	81(16.7)	338 (83.5)	0.000*	61 (11.8)	254(64)	0.000*
Income (Rupees)						
Low (<1500)	385 (79.5)	61(15.1)		417 (80.7)	65(16.4)	
Medium (1500-2200)	59 (12.2)	157(38.8)		57 (11)	160(40.3)	
High (>2200)	40 (8.3)	187(46.2)	0.000*	43 (8.3)	172(43.3)	0.000*
Standard of living						
Low (0-14)	56 (11.6)	6 (1.5)		77 (14.9)	6(1.5)	
Medium (15-24)	323 (66.7)	66 (16.3)		335 (64.8)	69(17.4)	
High (25-67)	105(21.7)	333 (82.2)	0.000*	105 (20.3)	322(81.1)	0.000*
Self assessment						
Unhealthy	8.7(1.7)	2 (0.5)		8 (1.5)	-	
Good	400 (82.6)	372 (91.9)		409 (79.1)	367(92.4)	
Not so good	76 (15.7)	31 (7.7)	0.000*	100 (19.3)	30(7.6)	0.000*
Investigators observation						
Thin	271 (56)	214 (52.8)		252 (48.7)	147(37)	
Healthy	174 (36)	152 (37.5)		216 (41.8)	201(50.6)	
Fat	39 (8.1)	39 (9.6)		48 (9.3)	49(12.3)	
Obese	-	-	0.557	1(0.2)		0.003*

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Table 1: Socio demographic characteristic of study population (following)

Tobacco/smoking						
Never	147 (30.4)	218(53.8)		515 (99.6)	397(100)	
Smoking before	60 (12.4)	53(13.1)		2 (0.4)	-	
Current smoker	277 (57.2)	134 (33.1)	0.000*	-	-	0.215
Alcohol consumption						
Never	216 (44.6)	236 (58.3)		514(99.4)	386(97.2)	
Drinking before	135 (27.9)	94 (23.2)		1(0.2)	3(0.8)	
Current drinker	133 (27.5)	75 (18.5)		2(0.4)	8(2.0)	
			0.000*			0.028*
TV viewing						
0 = No watching TV	137 (28.3)	24 (5.9)		132 (25.5)	10(2.5)	
1 = 30mins-2 hours	261(53.9)	193(47.7)		200 (38.7)	73(18.4)	
2= 3-4 hours	82(16.9)	186(45.9)		181(35.0)	310(78.1)	
3= >5 hours	4(8)	2(0.5)	0.000*	4 (0.8)	4(1.0)	0.000*
Exercise						
0=No exercise	469 (96.9)	379 (93.6)		517(100)	396 (99.7)	
1=1- 2 hours	15 (3.1)	26 (6.4)	0.019*	-	1(0.3)	0.254
Hours of working daily						
0=not working	27 (5.6)	47 (11.6)		54(10.4)	158(39.8)	
1=1-4 hours	37 (7.6)	45 (11.1)		25(4.8)	39(9.8)	
2=5 hours and above	103 (21.3)	161(39.8)		20(3.9)	68(17.1)	
3=6 hours and above (students)	50 (10.3)	134(3.1)		58(11.2)	119(30.0)	
4= 6 hours and above (farmers/labourers)	267(55.2)	18(4.4)	0.000*	360(69.6)	13(3.3)	0.000*
Physical activity level						
Sedentary	141 (29.1)	336(83)		157(30.4)	380(95.7)	
Moderate	343 (70.9)	69(17)		360(69.6)	17(4.3)	
			0.000*			0.000*

Table 2: Anthropometric and metabolic indices of study population

Variables	Rural men n=484 (%) mean ±SD	Urban men n=405 (%) mean ±SD	P-value	Rural women n= 517 (%) mean ±SD	Urban women n= 397 (%) mean ±SD	P-value
Height (cm)	162.7±4.64	166.2±3.91	0.000*	152.72±4.01	153.3±31.3	0.000*
Weight (kg)	54.99± 6.88	56.85± 7.03	0.001*	47.74±6.84	49.1±8.10	0.001*
Sitting Height (cm)	83.40± 3.23	83.85±2.28	0.002*	78.41±3.66	79.21±2.76	0.000*
MUAC (cm)	24.14±2.02	24.21±2.18	0.071	22.26±2.18	22.78±2.30	0.006*
Chest circumference (cm)	80.54±4.63	80.76±4.07	0.000*	78.68±6.06	80.02±5.43	0.000*
Hip circumference(cm)	79.31±5.13	80.15±4.69	0.052	78.71±6.97	81.00±6.40	0.042*
Waist Circumference(cm)	69.51±6.57	68.61±9.72	0.000*	65.30±7.08	66.83±10.36	0.000*
BMI (kg/mt²)	20.76±2.36	20.58±2.54	0.004*	20.46±2.76	20.89±3.37	0.285
Fat Mass (kg)	9.20±3.32	9.69±3.10	0.017*	11.84±3.92	12.68±4.55	0.682
Fat Free Mass(kg)	45.79±4.42	47.16±4.24	0.017*	35.91±3.51	36.43±4.00	0.682
Skinfolds						
Biceps (mm)	3.42±1.28	3.59±1.39	0.003*	4.65±2.03	4.83±1.92	0.155
Triceps (mm)	7.69±2.29	7.91±2.82	0.000*	10.73±3.56	10.98±3.57	0.006*
Subscapular (mm)	12.42±4.03	12.86±5.17	0.000*	15.04±5.99	16.64±6.93	0.000*
BP						
Systolic (mmHg)	129.42± 16.27	131.31±17.05	0.008*	123.02±19.97	121.31±17.86	0.502
Diastolic (mmHg)	81.31±10.94	81.63±11.39	0.038*	79.54±10.65	75.87±11.99	0.000*
Haemoglobin (g/gl)	12.9±0.83 (n=216)	12.45±1.08 (n=56)	0.013*	10.65±0.94 (n=226)	10.92 ± 0.71 (n=44)	0.553

Table 3: Logistic regression for CDV prevalence factors.

Variable	Rural (n=1001) (n/%)	Urban (n= 802) (n/%)	x^2	OR	95%CI		p-value
					Lower	Upper	
High BP	231(23.1)	179(22.3)	0.137	0.96	0.77	1.20	0.711
Overweight	162(16.2)	175(21.8)	9.32	1.45	1.14	1.84	0.002*
Obesity	2 (0.2)	2(0.2)	8.97	1.44	1.13	1.82	0.003*
Smoking	277(27.7)	134(16.7)	24.58	0.00	0.59	0.48	0.730
Drinking	135(13.5)	83(10.3)	5.28	0.78	0.63	0.96	0.022*
WSR (>0.50)	67(6.7)	100(12.5)	17.62	1.99	1.44	2.75	0.000*

Table 4: Correlation of anthrop indices with mean BP and haemoglobin among the men cohort.

		Age		BMI		WC		WHR		%BFAT		Cor indx		Concit		BFMI		BFFMI		WSR	
		U	R	U	R	U	R	U	R	U	R	U	R	U	R	U	R	U	R	U	R
Sys (mmHg)	r	0.540**	0.314**	0.365**	0.272**	0.441**	0.314**	0.390**	0.170**	0.447**	0.305**	0.259**	.018	0.435**	0.252**	0.436**	0.312**	0.201*	0.183**	0.465**	0.348**
	p	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.343	0.000	0.000	0.000	0.000	0.003	0.000	0.000	0.000
Dias (mmHg)	r	0.430**	0.294**	0.382**	0.226**	0.478**	0.310**	0.423**	0.206*	0.403**	0.320**	0.229**	0.013	0.465**	0.292**	0.412**	0.308**	0.257**	0.108**	0.489**	0.343**
	p	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.386	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hb	r	-0.109	0.109	0.335*	0.272**	0.173**	0.262**	0.024	0.181*	0.312*	0.194*	0.143	0.093	-0.011*	0.102	0.311*	0.206*	0.289*	0.271**	0.191	0.214*
	p	0.212	0.055	0.006	0.000	0.102	0.000	0.430	0.004	0.010	0.002	0.147	0.087	0.0467	0.068	0.010	0.001	0.015	0.000	0.080	0.001

Sys (systolic blood pressure), Dias (diastolic blood pressure), Hb (Haemoglobin)
BMI = body mass index, WC= waist circumference, WHR = waist hip ratio, %BFAT=percent body fat, C Index=cormic index, Con Index+ conicity index, BFMI=body fat mass index, BFFMI= body fat free mass index, WSR=waist stature ratio.
*r= Pearson correlation coefficient, p = p-value, * = significant at p < 0.05, ** =significant at p<0.000.*

Table 5: Correlation of anthropometric indices with mean BP and haemoglobin among the women cohort.

		Age		BMI		WC		WHR		%BFAT		Cor indx		Concit		BFMI		BFFMI		WSR	
		U	R	U	R	U	R	U	R	U	R	U	R	U	R	U	R	U	R	U	R
Sys (mmHg)	r	0.504**	0.379**	0.542*	0.385**	0.517**	0.431**	0.401**	0.142*	0.513**	0.315**	0.013	-0.039	0.408**	0.353**	0.553**	0.367**	0.464**	0.343**	0.521**	0.465**
	p	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.400	0.186	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Dias (mmHg)	r	0.466**	0.197**	0.557**	0.314**	0.505**	0.324**	0.436**	0.099*	0.522**	0.272**	0.045	0.099*	0.375**	0.246**	0.493**	0.312**	0.555**	0.262**	0.508**	0.356**
	p	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.012	0.000	0.000	0.185	0.013	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hb	r	0.037	-0.133*	0.487**	0.282**	0.443*	0.243**	0.427*	0.016	0.520**	0.303**	0.226	-0.069	0.320*	0.067	0.528**	0.294**	0.365*	0.213*	0.416*	0.201*
	p	0.406	0.023	0.000	0.000	0.001	0.000	0.002	0.406	0.000	0.000	0.070	0.149	0.017	0.158	0.000	0.000	0.007	0.001	0.002	0.001

BMI = body mass index, WC= waist circumference, WHR = waist hip ratio, %BFAT=percent body fat, C Index=cormic index, Con Index+ conicity index, BFMI=body fat mass index, BFFMI= body fat free mass index, WSR=waist stature ratio.
*r= Pearson correlation coefficient, p = p-value, * = significant at p < 0.05, ** =significant at p<0.000.*

Table 6: Summary of multiple regression analysis for anthropometric variables predicting systolic blood pressure in the study population.

Variables	Explanatory variables	Adjusted R^2	Co-efficient	SE	P value
(Urban male) Model 2: Age, BMI, WC, WHR, %BFAT, CrI, CoI, BFMI, BFFMI, WSR.	Age % BFAT	0.342 -	0.498 0.877	0.053 0.152	<0.000 <0.000
(Rural male) Model 3: Age, BMI, WC, WHR, %BFAT, CrI, CoI, BFMI, BFFMI, WSR.	WSR Age %BF	0.153 - -	58.44 0.220 0.567	25.43 0.53 0.238	<0.022 <0.000 <0.018
(Urban female) Model 2: Age, BMI, WC, WHR, %BFAT, CrI, CoI, BFMI, BFFMI, WSR.	BFMI Age	0.353 -	3.646 0.359	0.461 0.065	<0.000 <0.000
(Rural female) Model 3: Age, BMI, WC, WHR, %BFAT, CrI, CoI, BFMI, BFFMI, WSR.	WSR Age WHR	0.264 - -	188.17 5.65 -48.27	20.282 1.132 13.716	<0.000 <0.000 <0.000

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