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Research article

PATTERN OF CARDIOVASCULAR FUNCTIONS, NUTRITIONAL STATUS AND OBESITY INDICES AMONG BAIGA AND GOND TRIBES OF MADHYA PRADESH

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ABSTRACT

The Indian population is passing through a nutritional transition with a rise of non-communicable disease burden like cardiovascular disease. **Aims:** The overall aim was to provide detailed information on the current cardiovascular functions, nutritional status and obesity indices among Baiga and Gond tribes of Madhya Pradesh and to compare with other population groups in India. **Materials and Methods:** A cross-sectional study was carried out among 177 males of Baiga and Gond tribes of Madhya Pradesh ranging in range from 20-50 years. Stature, Weight, circumferences, skin fold thicknesses, body fat percentage and physiological measurement were taken. Obesity indices like body mass index (BMI), waist-hip ratio (WHR), waist-height ratio (WHtR), grand mean thickness (GMT) were computed. Cardiovascular functions were assessed by taking systolic (SBP) and diastolic (DBP) pressure, heart rate and pulse rate. **Results:** Gond males were found to be taller and heavier than Baiga males. Upper arm circumference, waist circumference, hip circumference and chest normal circumference were all found to be significantly higher among Gond males as compared to Baiga males. Among the adiposity measurements only the body mass index (BMI) and Grand Mean Thickness were found to be more among Gond males as compared to Baiga males. Diastolic blood pressure (DBP), heart rate (HR), pulse rate (PR) was found to have greater mean value among Gond males but the differences were found to be statistically non-significant. All India comparison on these variables has also been made. **Conclusion:** Subjects belonging to different population groups of India showed marked differences in different body dimensions, adiposity indices and cardiovascular functions. Gender differences were also seen with reference to adiposity measures.

Keywords: Nutritional transition, Cardiovascular functions, Adiposity indices, Populations.

INTRODUCTION

India is the second most populated country in the world that consists of 17% of world population and contributes 16% of world's deaths. Cardiovascular diseases and nutritional problems are prevailing cause of death and disability in the Indian sub-continent. Cardiovascular diseases (Ischemic Heart Disease, Stroke and Congenital Heart Failure) are also contributing towards an ever-increasing proportion of the non-communicable diseases in the Indian Population. The Global Burden of Diseases (GBD) study reported the estimated mortality from coronary heart disease (CHD) in India at 1.6 million in the year 2000[1.] There are many factors which affect the cardiovascular functions. Obesity is one of the most ubiquitous causes. There are various anthropometric indices which define obesity with relative ease and accuracy like body mass index, waist hip ratio and waist circumference. Obesity measured by any index almost correlates with cardiovascular disease risk (CVD) factors; there are differences in the relationship of these anthropometric measures and CVD risk factors in different ethnic groups[2].

The Indian population is passing through a transition phase where subsistence conditions are being replaced by plentiful food but reduced physical work and therefore, an understanding of the changing nutritional scene is critical[3]. Nutritional status of the Indian population also varies significantly across the regions. Certain regions are associated with extremely high rates of childhood undernutrition (ranging from 20% to 80%), whereas others have a high prevalence of adult undernutrition (>50%), and some have both[4].Anthropometric indices are essential features of nutritional evaluation for determining malnutrition, being overweight and obesity. The present study evaluates the anthropometric measurements nutritional status and cardiovascular functions among different population groups of India.

Subjects and area: The Indian population is divided into large number of endogamous groups consisting of different castes, tribes, religions, minorities, scheduled castes etc. The basis of isolation of these populations is varied, but it is mainly geographic, religious, ethnic or occupational[5].

Populations of India can be broadly classified under three categories: Urban Population, Rural Population, Tribal Population

Mann[6] identified eight characteristics which are used as a means for comparing the 'urban' and 'rural' populations. India as a country, mothers 8.43 crores of tribal population, which constitutes 8.2% of the total population. The tribes or aborigines were ascribed the lowest position in the human civilization of which the highest level was said to have been achieved by the white men in the west[7].

The present study was carried out among Baiga and Gond tribal population in Madhya Pradesh, India. The selection criteria for studying these tribes were the lack of adequate literature and heavy concentration of these tribes in the Madhya Pradesh region. A cross sectional study was carried out in three districts namely Anuppur, Dindori and Mandala districts of Madhya Pradesh. Anuppur district is situated in the northeastern part of M.P. The district extends 80 km from east to west and 70 km from north to south. It is a tribal dominated district. Dindori district is part of Shahdol division. In 2006, the ministry of panchyati raj named Dindori one of the country's 250 most backward districts (out of a total of 640). Mandla is a tribal district situated in the east-central part of M.P.

The Baiga are a munda or kolarian people (part of the Baiga tribe) located in the central highland of India. It is one amongst primitive tribes of India. The Baiga houses are actually huts made of wood and bamboo which are mud plastered. The number of rooms in a house depends on their economic status and requirement. The Baiga people are known for their scanty use of cloth. They are short statured with dark brown complexion. Their dress pattern, hair style and jewelry are unique. They are very much fond of tattoo. They are strictly endogamous. The Gonds are among the largest tribal groups in south Asia and perhaps the world. Gondi belongs to the Dravidian family of languages and related to Tamil and Kannada. They live in a hamlet of their own. The hamlet is not a closed cluster of huts for the Gonds, homesteads are spread over a large area within the hamlet. They are also short statured with dark black skin and fuzzy hair. These people are known for their rich socio-culture life. Based on the ethnographic study it was observed that Gonds practice clan exogamy, considering intermarriage within a clan to be incest.

MATERIALS AND METHODS

A cross-sectional study was conducted in 3 districts namely Anuppur, Dindori and Mandla of Madhya Pradesh. A total 177 males between the age group 20-50 yrs. were studied. Out of the total population, 88 males were Baigas and 89 males were Gonds. Detailed information of the tribals were taken with the help of schedule. Data was collected from different villages of Amarkantak, Furrisemar, Amanala, Karanjia, Chauradadar, Ladwani, Thadpathra, Malagaur, Kateltola, Lacchantola, Bhangartola, Hurratolaetc by a door to door survey. Fieldwork was conducted from 17th January 2012 to 20th Feb. 2012.Ethical clearance was taken from the Department of Anthropology, University of Delhi, Delhi. Subjects also gave their written consent to be part of the study.

General information such as clans, household composition, dietary preferences, health status, demographic profile, various anthropometric and 4 physiological variables were taken on all the subjects. Since the female members of the area were mostly busy in the household work so they were excluded and due to easy availability and positive response of male members they were taken into consideration.

Transport bottleneck and sparsely populated villages were the major limitations in the collection of data.

Subjects were measured for stature, body weight, circumferences (minimum waist, mid upper arm, normal chest, hip and calf), skinfold thicknesses (biceps, triceps, suprailiac and subscapular). Anthropometric and physiological measurements were taken using standard protocols given by Weiner and Lourie[8] and Shaver [9]. Stature was taken with the help of anthropometer in the standard arm hanging position; body weight was taken by spring balance with minimum clothing; circumferences were measured with the help of flexible steel tape.Skin fold thicknesses were taken with Holtain's skin fold caliper which exerted a constant pressure of 10 g/mm^2 over the contact surface.

Table 1: List of Variables Studied

Measurements	Unit	Instrument Used
Stature	centimeters	Anthropometer
Body Weight	kilograms(Kg)	Weighing Machine
Circumferences in centimeters (cm)		
Minimum Waist Circumference		Flexible Steel Tape
Mid Upper Arm Circumference		
Normal Chest Circumference		
Hip Circumference		
Calf Circumference		
Skin fold Thicknesses in millimeters (mm.)		
Biceps		Skin fold Caliper
Triceps		
Subscapular		
Supra iliac		
Physiological Measurements		
Systolic and Diastolic Blood Pressure	mmHg	Sphygmomanometer Stethoscope and Stopwatch
Heart Rate	beats/min.	Stethoscope and Stopwatch
Pulse Rate	pulse/min.	Stopwatch

Cardiovascular functions were assessed by taking Systolic (SBP), Diastolic (DBP) blood pressure, heart rate(total number of the heart beat per unit time) and pulse rate(the frequency of blood pressure wave propagated along superficial, periphery arteries such as carotid and radial artery) using sphygmomanometer, stethoscope and stopwatch whereas nutritional status was assessed by BMI (Body Weight (Kg)/ $stature^2$ (m)), body circumferences and skin fold thicknesses. Obesity indices which include body mass index (BMI), grand mean thickness (GMT), waist-hip ratio (WHR) and waist-height ratio were computed statistically.

Waist circumference (WC) was categorized according to the Dobbelsteynet. al [10]. Males and females whose waist circumferences are more than 90 and 80 centimeter were at risk. The classification of BMI was done according to the WHO expert consultation [11]. BMI less than 18.5 as underweight and more than 24.9 as overweight. WHtR cut off points followed for males was 0.50[12].

Blood Pressure was classified in different categories according to JNC7 (Joint National Committee)[13]. Subjects were divided into three classes: normotensive, prehypertensive (120-139 mm Hg systolic; 80-89 mm Hg diastolic), and hypertensive (≥140/90mm Hg).

The data were analyzed using SPSS version 16.0 and window 7.0. Statistical variables such as arithmetic mean, Std. Deviation, std. Error of mean, t-test and correlation coefficient were calculated. Data were also analyzed for the computation of adiposity indices such as Body Mass Index (BMI), Waist-Hip ratio, Waist height ratio and Grand mean thickness.

RESULTS

Table 2 shows mean, std. deviation and std. error for various anthropometric, skin folds and physiological measurements and adiposity indices, body fat percentage of Baiga and Gond males of Madhya Pradesh. Gond males were found to be taller and heavier than Baiga males. upper arm circumference, waist circumference, hip circumference and chest normal circumference were all found to be significantly higher among Gond males as compared to Baiga males. Only triceps and suprailiac skin fold thickness were found to be significantly more among Gond males as compared to Baiga males. Only the systolic blood pressure (SBP)was found to be greater among Gond males as compared to Baiga males ($p<0.01$). diastolic blood pressure (DBP), heart rate (HR), pulse rate (PR) was found to have greater mean value among Gond males but the differences were found to be statistically non-significant. Among the adiposity measurements only the body mass index (BMI) ($p<0.01$) and Grand Mean Thickness were found to be more among Gond males as compared to Baiga males. Body fat percentage was also found to

be more among Gond males as compared to Baiga males (-2.11*).

Table 2: Anthropometric and Physiological Variables among Baiga and Gond Males

Measurement	Mean±SD (Baiga)	Mean±SD (Gond)	t values
Stature(cm.)	160.2±6.07	162.8±5.30	2.99**
Body weight(Kg.)	48.3±5.21	52.1±6.20	4.39***
Mid upper arm circumference (cm)	23.4±1.80	24.2±1.70	2.91**
Minimum waist circumference (cm)	69.6±5.80	71.8±6.06	2.47*
Maximum hip	80.6±4.27	83.2±4.33	4.20***
Chest normal	81.4±3.60	84.3±4.50	4.69***
Maximum calf	30.0±2.33	30.5±2.01	1.65
Biceps	3.1±0.90	3.0±0.90	0.273
Triceps	5.0±1.60	5.7±2.30	2.164*
Subscapular	9.0±2.20	9.7±3.06	1.62
Supra iliac	4.8±1.52	5.4±2.60	2.11*
SBP (mmHg)	127.9±11.6	128.4±13.3	2.82**
DBP (mmHg)	85.0±9.72	87.0±9.50	1.38
Heartrate(beats/min)	76.0±10.80	81.3±86.60	0.581
Pulserate(pulse/min)	75.8±10.20	73.0±10.90	1.805
BMI(kg/m^2)	18.8±1.72	19.7±2.20	2.87**
WHR	0.9±0.80	0.9±0.70	0.287
WHtR	0.4±0.03	0.4±0.03	1.20
GMT (mm)	5.5±1.10	6.0±1.90	2.06
Body fat percentage	11.31±3.10	12.52±4.38	2.11*

*p<0.05,**p<0.01,***p<0.001

Table 3 depicts the distribution of Baiga and Gond males according to their BMI. Most of the Baiga males (52.3%),and Gond males (68.5%) were in the normal category. 3.4% Baiga males and 2.2% Gond males were severely underweight. 6.8% Baiga males and 4.5% Gond males were in moderate underweight category. 36.4% Baiga males and 23.6% Gond males were mild underweight .Only 1.1% of Baiga males and Gond males were overweight.

Table 3: Distribution of Baiga and Gond MalesAccording to Body Mass Index

BMI	Baiga		Gond	
	Frequency	%	Frequency	%
Severe UW	3	3.4	2	2.2
Moderate UW	6	6.8	4	4.5
Mild UW	32	36.4	21	23.
Overweight	1	1.1	1	1.1
Normal	46	52.3	61	68.5
Total	88	100	89	100

Table 4 displays the distribution of Baiga and Gond males according to their blood pressure. For the SBP, most of the Baiga males (67.0%) and almost half of the Gond males (56.2%) were in pre-hypertensive category. 18.2% Baiga males and 18.0% Gond males were normal. Rest 14.8% Baiga males and 25.8% Gond males were Hypertensive.

For the DBP, 44.3% Baiga males and 38.2% Gond males were pre-hypertensive. 20.5% Baiga males and 19.1% Gond males were normal .Rest 35.2% Baiga males and 42.7% Gond males were hypertensive.

Table 4: Distribution of Baiga and Gond Males According to Blood Pressure

Blood pressure	Baiga				Gond			
	SBP		DBP		SBP		DBP	
	N	%	N	%	N	%	N	%
Normal	16	18.2	18	20.5	16	18.0	17	19.1
Pre-hypertensive	59	67.0	39	44.3	50	56.2	34	38.2
Hypertensive	13	14.8	31	35.2	23	25.8	38	42.7
Total	88	100	88	100	89	100	89	100

**Systolic (SBP), Diastolic (DBP) blood pressure*

Table 5 presents the best predictor (βvalue) of cardiovascular health from various anthropometric indices.It is clear from table that BMI is better predictor of cardiovascular risk in Baiga males (β=.223) for SBP and in Gond males (β=.216) for DBP. Waist height ratio is a predictor of cardiovascular risk in Gond males (β=.245) for DBP. Waist circumference is a predictor of CVR in Baiga males (β=.206) for SBP and (β=.258) for DBP. Waist circumference is also a predictor of CVR in Gond males (β=.211) for SBP and (β=.277) for DBP.

Table 5: Predictors of Cardiovascular Risk Among Baiga and Gond Males

Adiposity Indices	Baiga		Gond	
	SBP	DBP	SBP	DBP
General adiposity measures				
Body Mass Indexkg/m^2	**.223**	.136	.113	**.216**
Grand Mean Thickness(mm)	.183	.113	-.036	.046
Fat percentage	.202	.171	.031	.151
Regional adiposity measures				
Waist height ratio	.160	.178	.156	**.245**
Waist circumference(cm)	**.206**	**.258**	**.211**	**.277**
Waist hip ratio	.148	.121	.098	.117

(p<0.01), *Systolic (SBP), Diastolic (DBP) blood pressure

DISCUSSION

The present study clearly represents the double stress of under-nutrition and hypertension among the tribal population of Madhya Pradesh i.e. Baiga and Gond males. The prevalence of both under nutrition and pre-hypertension was quite high which is contradictory to many other studies[14].

Table 6: Comparison with different region of Indian Population (Published)

Area	Population Groups	Sex	Age	Stature	Weight	BMI	WHR	WHtR	SBP	DBP	GMT	Reference
Delhi	Khatri	F	20-30	156.5±6.6	52.0±9.52	21.2±3.6	0.7±0.0	0.4±0.0	104.1±9.1	70.7±6.9	14.4±5.0	Mungreiphy et al[21]
		M		167.2±7.1	61.5±13.6	21.9±3.9	0.8±0.0	0.4±0.0	119.7±9.3	83.4±9.3	10.4±5.1	
	Baniya	M	30-34	167.0±7.4	68.7±15.6	24.62±5.1	0.9±0.6	0.9±0.0	125.2±9.6	89.6±10.0	19.55±8.	Mishra[22]
		F	30-34	155.3±5.0	62.9±10.1	26.15±4.4	0.7±0.0	0.4±0.0	114.8±8.4	81.04±4.3	**26.1±6.1**	
	Punjabi	F	21-50	154.0±5.5	64.9±12.9	27.3±5.1	0.8±0.0	**0.5±0.0**	-	-	23.2±9.5	Kapoor et al[23]
H.P.	Rajput	F	20	154.7±6.2	47.6±8.22	19.8±2.9	0.7±0.0	0.4±0.0	117.5±12.0	76.0±9.8	-	Kapoor et al.[16]
		M		167.6±7.2	56.3±10.8	19.9±2.6	0.8±0.0	0.4±0.0	131.5±12.6	84.8±8.2	-	
		F	50	149.8±6.8	45.9±9.59	20.5±4.0	0.8±0.0	0.4±0.0	124.1±18.4	79.9±11.5	-	
		M		164.8±6.7	58.4±9.62	21.4±2.8	0.8±0.0	0.4±0.0	136.8±29.7	82.5±22.8	-	
	Rajput	F	16-32	152.0±6.	42.0±6.0	18.2± -	0.7± --	-	-	-	-	Kapoor[24]
Haryana	Rajput (Caste Group)	F	20	153.6±5.6	44.2±7.38	18.7±2.5	0.7±0.0	0.4±0.0	113.6±19.0	74.8±9.3	-	Kapoor et al.[16]
		M	20	165.3±7.8	48.0±6.83	17.6±2.3	0.8±0.0	0.4±0.0	120.4±14.2	76.5±10.9	-	
		F	50	151.9±5.7	**40.1±4.85**	**17.4±2.1**	0.8±0.0	0.4±0.0	122.9±18.0	80.2±10.8	-	
		M	50	160.0±9.5	45.2±3.55	17.9±3.5	0.8±0.0	0.4±0.0	125.9±19.0	81.2±8.8	-	
Baigas (Tribe)		M	20-50	160.2±6.0	48.3±5.2	18.8±1.7	0.9±0.8	0.40±0.0	127.9±11.6	85.0±9.7	**5.5±1.1**	Present Study
Gonds (Tribe)		M	20-50	162.8±5.3	52.1±6.2	19.7±2.2	0.9±0.7	0.40±0.0	128.4±13.3	87.0±9.5	6.0±1.9	Present Study
Tadavi (Tribe)		F	20	149.5±4.2	40.4±3.1	18.1±1.3	0.8±0.0	0.41±0.0	113.7±10.5	76.0±5.8	-	Kapoor et al [16]
		M	20	161.1±5.6	50.5±11.2	19.5±4.7	0.8±0.0	0.41±0.0	118.1±5.8	76.4±5.4	-	
		F	50	**148.5±4.9**	41.9±9.6	18.9±3.5	0.8±0.0	0.44±0.0	124.5±7.1	85.0±9.7	-	
		M	50	158.0±5.3	44.8±6.8	17.9±2.3	0.8±0.0	0.44±0.0	126.3±7.4	82.9±3.5	-	
Meena (Tribe)		M	20-25	163.1±5.5	47.1±3.3	17.7±1.1	0.8±0.0	0.41±0.0	121.3±6.8	78.9±6.6	6.98±0.7	Kapoor et al.[25]
			50-55	158.4±4.7	43.8±3.9	17.5±1.4	0.8±0.0	0.44±0.0	125.6±7.8	82.3±7.1	7.40±0.4	
			55-60	159.9±4.8	45.1±5.5	17.7±2.6	0.8±0.0	0.41±0.0	135.5±16.0	89.7±13.0	7.08±0.5	
Manipur	Tangkhul Naga (Tribe)	F	20-30	153.0±5.6	49.6±7.4	21.1±2.2	0.7±0.0	0.45±0.0	106.7±9.7	**70.2±8.2**	13.4±3.7	Mungreiphy[21]
		M	20-30	164.8±5.7	59.1±8.3	21.7±2.6	0.8±0.0	0.43±0.0	121.2±12.8	75.4±10.0	9.86±4.	
		M	20-70	162.0±5.9	54.9±7.4	20.9±2.3	0.8±0.6	0.47±0.0	126.3±17.6	80.0±13.1	7.5±2.8	Mungreiphy[26]
			20-70	151.3±5.5	48.7±7.4	21.2±2.7	0.8±0.7	0.51±0.0	119.8±18.9	75.2±13.2	10.7±3.2	
Assam	Kalita (Caste Group)	F	20-29	155.6±5.0	51.7±7.5	21.3±2.7	0.8±0.0	0.4±0.0	118.7±15.5	74.4±11.8	-	Bordoloi [27]
			30-39	154.0±5.9	52.9±7.7	22.2±2.8	0.8±0.0	0.4±0.0	120.9±13.6	77.6±10.4	-	
			40-49	153.5±5.6	51.9±7.9	21.9±3.0	0.8±0.0	0.4±0.0	132.2±20.0	82.1±10.9	-	
	Brahmin	M	18-62	163.4±6.0	50.3±6.1	18.8±2.0	-	-	-	-	-	Khongs Dier[28]
	Kalita			163.0±5.7	50.5±6.7	18.9±2.1	-	-	-	-	-	
	Jogis			164.0±5.6	50.2±5.62	18.6±2.01	-	-	-	-	-	
	Kaibartas			160.0±6.4	47.0±6.6	18.3±2.0	-	-	-	-	-	
	Ahoms			162.0±5.5	49.27±5.5	18.7±1.5	-	-	-	-	-	
	Kochs			162.5±6.1	50.69±7.7	19.1±2.5	-	-	-	-	-	
	Rajbasnhis			161.3±5.9	51.1±7.6	19.6±2.6	-	-	-	-	-	
	Boro-Kacharis			162.2±5.3	52.1±5.6	19.8±1.8	-	-	-	-	-	
	Lalungs			160.1±6.4	49.2±6.1	19.1±1.3	-	-	-	-	-	
	Mechs			160.3±4.4	52.7±4.2	20.4±1.1	-	-	-	-	-	
	Miris			159.3±5.7	49.6±5.0	19.5±1.9	-	-	-	-	-	
	Pnars			157.6±5.6	49.3±4.5	19.8±1.4	-	-	-	-	-	

Area	Population Groups	Sex	Age	Stature	Weight	BMI	WHR	WHtR	SBP	DBP	GMT	Reference
Andaman	Car(Tribe)	M		160.1±1.7	55.5±1.4	21.7±0.8	-	-	-	-	-	
Nicobar	Nicobarese			158.1±3.7	57.0±2.2	22.8±0.9	-	-	-	-	-	
Orissa	Nolia			162.3±1.8	50.2±1.4	19.0±0.4	-	-	-	-	-	
				160.0±2.1	48.3±1.6	18.8±0.2	-	-	-	-	-	
Kerala	Ezhava	F		155.9±5.3	47.5±8.1	19.5±2.7	0.7±0.0	0.40±0.0	107.5±10.2	72.3±10.3	14.3±3.5	
		M		**170.6±5.9**	56.9±10.3	19.5±3.05	0.7±0.0	**0.39±0.0**	121.2±10.2	81.6±8.8	10.1±3.7	
Andhra Pradesh	Ural population	M		166.3±11	68.9±15.3	24.9±4.9	**0.9±0.0**	-	123.0±16.8	82.0±8.9	-	
		F		158.2±9.4	64.9±14.9	25.9±6.10	0.8±0.0	-	119.9±22.2	81.6±8.2	-	
	Urban population	M		166.5±10	**73.0±15.9**	26.4±5.81	0.9±0.0	-	128.1±18.3	83.39±9.4	-	
		F		157.8±9.8	69.2±13.1	**27.8±5.7**	0.8±0.0	-	128.4±13.5	82.04±8.1	-	

Table 7: **Comparison of various parameters with different region of Indian Population (Published)**

	Population Groups	Sex	Age	Waist Circumference	Hip Circumference	Upper Arm Circumference	Calf Circumference	Biceps Skin fold	Triceps Skin fold	Subscapular Skin fold	Supra-iliac Skin fold	Reference
Delhi	Khatri	F	20-30	67.3±8.0	91.0±7.3	-	-	-	-	-	-	Mungreiphy et al.[21]
		M		76.3±8.5	90.3±7.7	-	-	-	-	-	-	
	Baniya	M	30-34	83.2±11.5	91.7±7.8	**28.3±3.0**	33.3±3.4	7.6±3.3	12.5±5.4	23.8±10.8	26.2±9.8	Mishra[22]
		F	30-34	74.5±7.2	96.5±10.2	27.5±2.5	33.6±3.2	**12.0±4.3**	**24.7±8.1**	27.9±8.1	26.9±8.9	
	Punjabi (Khatri&Arora)	F	21-50	80.7±11	100.3±10.3	-	-	11.8±4.9	21.3±10.3	**29.7±30.3**	**27.7±9.4**	Kapoor et al.[23]
H.P.	Chopal (Shimla)	F	16-32	63.2±5.0	84.2±4.9	**22.1±2.3**	-	5.0±2.3	10.7±3.3	10.4±3.5	11.4±5.1	Kapoor[24]
M.P.	Baigas	M	20-50	69.6±5.8	**80.6±4.2**	23.4±1.8	30.0±2.3	3.1±0.9	**5.0±1.6**	**9.0±2.2**	**4.8±1.5**	Present Study
	Gonds	M	20-50	71.8±6.0	83.2±4.3	24.2±1.7	30.5±2.0	**3.0±0.9**	5.7±2.3	9.7±3.0	5.4±2.6	Present Study
Rajasthan	Meena	M	20-25	67.4±4.4	78.6±2.8	23.6±1.9	**28.9±3.4**	8.6±1.8	4.7±1.1	7.7±1.4	4.3±1.5	Kapoor et al.[25]
			50-55	69.5±3.4	81.3±5.5	23.8±1.5	30.6±4.1	10.2±2.3	5.2±1.4	9.5±1.6	5.1±1.4	
			55-60	66.2±6.2	82.0±5.0	23.7±1.6	30.1±4.0	10.7±2.2	5.6±1.4	7.7±1.3	4.8±1.3	
Manipur	Tangkhul Naga	F	20-30	69.7±7.2	89.4±5.5	-	-	-	-	-	-	Mungreiphy et al.[26]
		M	20-30	72.2±8.7	89.8±4.2	-	-	-	-	-	-	
		M	20-70	76.6±8.1	86.9±5.0	26.0±2.8	**33.7±2.5**	3.5±1.3	6.1±2.3	10.5±3.7	11.5±5.9	
		F	20-70	76.8±9.5	88.1±5.9	25.3±2.4	32.3±3.5	5.4±2.2	11.6±4.1	12.0±4.0	15.1±5.8	
Assam	Kalita	F	20-29	67.58±7.3	84.9±7.9	-	-	-	-	-	-	Bordoloi[27]
			30-39	70.36±9.1	87.7±9.8	-	-	-	-	-	-	
			40-49	70.57±8.9	87.6±10.4	-	-	-	-	-	-	
Andaman Nicobar	Car Nicobarese	M	20-25	-	-	25.5±0.4	-	-	-	-	-	Kapoor et al.[29]
			50-60	-	-	26.0±0.9	-	-	-	-	-	
Orissa	Nolia		20-25	-	-	23.4±0.9	-	-	-	-	-	
			50-60	-	-	23.2±1.4	-	-	-	-	-	
Kerala	Ezhava	F	20-30	**62.5±6.4**	84.0±5.39	-	-	-	-	-	-	Basa[30]
		M	20-30	68.0±7.0	85.1±6.83	-	-	-	-	-	-	
Andhra Pradesh (Chittoor)	Rural Population	M	30-70	86.9±11.1	96.0±13.0	-	-	-	-	-	-	
		F	30-70	87.0±10.4	97.9±12.8	-	-	-	-	-	-	
	Urban Population	M	30-70	**88.2±12**	97.0±13.7	-	-	-	-	-	-	
		F	30-70	86.7±10.7	99.6±14.8	-	-	-	-	-	-	

The main reason for this opposite trend is the high prevalence of under nutrition in the studied population groups. Both Baiga and Gond males had subsistence economy. These ethnic groups with deprived economic resources had high prevalence of pre-hypertension and under nutrition. The strenuous habitual physical activity, difficult terrain and limited and irregular food supply may be the reasons for underweight as also reported among Raji males[15]. The prevalence of pre-hypertension in CED

categories was highest among Tadvi, Rajis, Bhotias and DesiaKhonds[16].

Among Baigas, body mass index and waist circumference, predicted SBP and only Waist circumference was found to predict DBP. Whereas among Gonds, Waist circumference predicted SBP among Gonds while Body Mass Index. Waist Height Ratio and Waist circumference predicted DBP. Waist circumference was the predictor of blood pressure both systolic and diastolic in both Baigas and Gonds. Some previous studies showed that waist circumference had the strongest association with blood pressure among Asian population[17], Americans[18]or European[19]. A recent meta-analysis indicated that the waist to height ratio (WHtR) is a best predictor of cardiovascular disease risk factor[20].

Tables 6 and 7 display a comparison of various anthropo-physiological variables, cardiovascular functions, nutritional status and obesity indicating variables among different population groups. Data was collected from various states from secondary sources during literature review.It is seen that Ezhavamales of Kerala were found to be tallest whereas Tadavi females of Gujarat were shortest. Males of the urban population of Chittoor (Andhra Pradesh) were found to be heaviest with highest BMI and WHR. Maximum of WHtR were seen in Punjabi females of Delhi whereas lowest was seen in males of the Ezhava group of Kerala. The highest SBP and DBP were seen in Rajaput males of Himachal Pradesh and Meena males of Rajasthan whereas lowest SBP and DBP were found in Khatri females of Delhi and Tangkhul Naga tribal females of Manipur which may be due to their low physical activity, dietary intake and sedentary lifestyle as compared to Rajputs and Meenas. The lowest GMT was reported in Baiga males of Madhya Pradesh and highest was in Baniya females of Delhi.

With reference to circumferences and skin folds, highest of waist, hip, upper arm and calf circumferences were noted in males of the urban population of Chittoor, Punjabi females of Delhi, Baniya males of Delhi and Tangkhul Naga males of Manipur whereas lowest was seen in Ezhava females of Kerala, Baiga males of Madhya Pradesh, Rajput females of Himachal Pradesh and Meena males of Rajasthan. Baiga males of Madhya Pradesh were found to be having lowest triceps, subscapular and supra-iliac skin folds among all the reported population groups of India whereas highest values of biceps and triceps skin folds were found in Baniya males of Delhi and highest subscapular and supra-Iliac were seen in Punjabi females of Delhi. These Skinfold thicknesses at specific location on the body estimates the percentage of body fat among different population groups.

This comparative study shows that pre-hypertensive category was prevalent among rural areas of Rajasthan and Himachal Pradesh. Overweight and obesity trend was more in urban population groups (Delhi and Andhra Pradesh). Such scenario was also reported by Shah and Mathur[31]. The rural population (Haryana and Rajasthan) of India are particularly vulnerable to malnutrition whereas semi-urban areas lay in between the urban and rural populations but more inclined towards urban trends. Under-nutrition and pre-hypertensive categories were comparatively high in tribal groups of India as compared to caste groups. Similar trend was observed by Rao et al.[23]This is because of their geographical isolation, uncertainty of food supply, lack of adequate health care facilities and due to certain traditional belief systems and cultural practices. Being hilly area the villages are sparsely populated which made data collection a tedious task.

CONCLUSION

Subjects belonging to different population groups of India showed marked differences in different body dimensions, adiposity indices and cardiovascular functions. Gender differences were also seen with reference to adiposity measures. The double stress of CVD and nutritional imbalance in India is epidemic. It is thus suggested through present study that more efforts should put in place an intervention programme which should be complemented with a robust surveillance mechanism so as to monitor, evaluate and guide policies and programmes.

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