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Ethnic Diversity with Preventable Risk Factors for Cardiovascular Diseases

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ABSTRACT The objective of present paper is to investigate the extent of association of selected anthropometric markers with cardiovascular health risk among different environmental and culturally diverse population groups. A cross-sectional survey among 1,843 respondents (including 984 females and 859 males) was carried out covering population groups from five geographic zones of India. Data was collected for anthropometric and physiological variables using standardized techniques. Body mass index (BMI), waist to hip ratio (WHR) and waist to height ratio (WHtR) were computed. Odds ratios were obtained using multiple logistic regressions. Anthropometric markers, WHR, WHtR and WC showed highest association with cardiovascular (CV) health risk. The waist height ratio (WHtR) is found to be a better predictor of cardiovascular health risk amongst all the central adiposity indices. A model anthropometric score scale incorporating BMI and selected central adiposity indices may be a quick and meaningful screening tool for cardiovascular health risk assessment and its timely management.

INTRODUCTION

Hypertension and obesity has been reported to be strongly associated. Obesity finds its roots in dynamics of diet, socioeconomic status, physical inactivity (Tyagi et al. 2015), change in family structure, lack of regular health check up, stress, smoking and alcohol consumption among others. (Tyagi et al. 2008; Prabhakaran 2016). Obesity has been considered as a risk factor for chronic diseases including cardiovascular disease, diabetes and musculoskeletal disorders (World Health Organization 2013). In India, cardiovascular diseases (CVDs) are the foremost cause of mortality (Reddy et al. 2005). Low and middle-income countries are sharing an alarming percentage of the global burden of cardiovascular diseases (CVD) related deaths (Gaziano 2005; Yusuf et al. 2014). There is an excessive risk of coronary heart diseases (CHD) among Indians due to their genetic susceptibility (Hughes and Lee 2002; Patel et al. 2006; Vamadevan and Prabhakaran 2010). Cardiovascular diseases (CVD) are not only prevalent among the affluent but are also affecting the socioeconomically and nutritionally deprived population groups (Kapoor et al. 2012). In India, cultural diversity has implications for how health and illness are experienced and acted upon. According to Herskovits (1948), culture is a screen between man and nature and hence changes in body composition (BC) of humans cannot be explained by genes and biology alone. It implies that culture along with biology and environment determines health status of an individual.

Age, genes and gender play vital roles in development of adiposity and consequently effect cardiovascular function of people from different ethnic backgrounds (Bhasin et al. 2017). The age change in body fat mass favoring central adiposity increases the associated health risk (Tyagi et al. 2005; Mungreiphy et al. 2012). Prevalence and prevention of CVD related risk factors especially hypertension and obesity need to be paid more attention. In order to make an assessment of CVD and associated health risk an appropriate diagnosis is needed. Magnetic Resonance Imaging (MRI), Computed To-

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mography-Scan (CT-Scan) and Dual-energy X ray Absorptionmetry (DEXA) are the gold standards of adiposity measurement and related co-morbidities (Bauer et al. 2012; Bigornia et al. 2013; Bosch et al. 2015) with maximum accuracy. However, these techniques involve high cost and irradiation (Bauer et al. 2012; Bigornia et al. 2013). Due to the risk of exposure, time and cost involved in these sophisticated techniques, anthropometry being simple, safe and cost effective overweighs all the other techniques for screening purpose at mass level for the obesity and associated health risk. Standardized anthropometric techniques help make nutritional assessment, cardio metabolic risk assessment, public health issues including lifestyle diseases. Therefore, to assess the co-morbidities associated with overweight and obesity, the identification of simple and accurate anthropometric methods is essential. Research analyzing the relationship between the easy-to-use anthropometric measures for adiposity and cardiovascular risk factors remain highly contentious. Copious studies suggest that body mass index (BMI) alone constitutes an accurate predictor, whereas others focus on the potential role of waist-to-hip ratio (WHR), waist circumference (WC), and waist-to-height ratio (WHtR). The present paper has examined multiple anthropometric markers (BMI, WHR, WHtR and Waist circumference) to predict cardiovascular risk factors in populations inhabiting different environmental zones with cultural diversity. It has become apparent that environmental factors rather than genetic factors are major drivers for ethnic differences in obesity and associated health risk.

Area and People

Different ethnic groups taken up for the present research included Saharia from Madhya Pradesh (Central India), Ezhava from Kerela (South India), Tangkhul Naga from Manipur (East India), Siddis from Gujarat (West India) and an urban population group from Delhi (North India). All these population groups are described in the next section of the paper.

Saharia

The Government of India has identified the ‘Saharia’ tribe under the Particularly Vulnerable Tribal Groups (that is PVTGs) with distinct identification such as pre-agricultural level of technology, very low level of literacy, and declining or stagnant population. Traditionally, the Saharias pursue their indigenous socio-cultural rules, customs and norms, which affect the healthcare system (Biswas and Kapoor 2004). They practise shifting cultivation, hunting, gathering, and pastoralism. (Kapoor et al. 2009). Deforestation, scarcity of rainfall and limited resources has compelled them to abandon their traditional activities. Since last one decade, majority of the Saharia have taken up daily wage earning or jobs in government sector, which have resulted in their mixing with the mainstream population. Saharias follow strict clan exogamy and tribe endogamy. Alcohol consumption and smoking is part of their regular diet and their literacy rate is significantly poor (Biswas and Kapoor 2003; Biswas 2006).

Ezhava

Ezhava of Amboori village of Thiruvananthapuram district, Kerala was studied. Ezhava is Other Backward Caste (OBC) group of Kerala. In earlier days the social status of Ezahava was very poor as they did not get educational opportunities and they were not allowed to enter the temples. They were involved in agricultural practices mainly as laborers, while some were cultivators, toddy tappers and liquor businessmen. In addition, females helped in household activities. Rice and fish constituted their staple food. The Ezhava followed community endogamy, clan exogamy, patrilineal, and patriarchal system.

Tangkhul Naga

Tangkhul Naga is a sub-tribe of the Naga tribe. In India they are found mainly in hilly areas covering Nagaland, Manipur, Assam and Arunachal Pradesh. Present research work was carried out among Tangkhul Naga of Manipur. Tangkhul follow tribe endogamy and clan exogamy. Their traditional occupation was farming especially terrace and wetland farming. They are also associated with small-scale industries, animal husbandry, forest and river wealth. However, many are getting associated with business and jobs (Mungreiphy and Kapoor 2008).

Siddis

The Siddis (Afro-Indians) belong to PVTGs of rural Gujarat. There are about 250,000 Afro-Indians, that is Indians of African origin, in India, settled in the state of Gujarat, Andhra Pradesh, Maharashtra, Kerala and Karnataka, and former Portuguese territories of Daman, Diu and Goa. This research work was carried out among Siddis in the Junagarh district of Gujarat. They work as agriculturists as well as agricultural laborers. Their occupation involves high physical activity. Rice and Bajra is their staple diet. They have adopted urban life-ways from contiguous Gujarati urbanites in certain lifestyle factors particularly nutrition and transportation.

Urban Delhi Population

The Delhi population (including 'Khatri' and 'Aroras', the traditional members of the Hindu community) has common ancestry and they cross-marry (Bhasin and Kapoor 2013). This population group is fully modernized in food patterns, choices and occupations (business and jobs), which involve less physical work. Wheat is their staple diet, however their food patterns show that there has been a considerable increase of fat-rich and processed foods. Their reliance on processed or packaged food for cooking and frequent eating out at restaurants and food kiosks are the primary reasons for the fast food prominence. The education level for the total sample varied from literate to graduate and higher.

METHODOLOGY

In the present research, 364 Saharias (including 168 males and 196 females) ranging between 18-64 years were studied. A total 210 Ezhavas including 100 males and 110 females of age range 20-30 years were studied. Total 603 Tangkhul Naga (including 346 females and 257 males ranging between 20-70 years of age were studied from Ukhrul district and Imphal valley in Manipur). Total 217 Siddis (including 78 females and 139 males) of age range 17-60 years were included in this research. In Urban Delhi population, 449 (including 195 females and 254 males) of age range 20-60 years were taken. The sample distribution is shown in Table 1.

Table 1: Sample distribution

Population group	*Females (n)*	*Males (n)*	*Total (n)*
Saharia	196	168	364
Ezhava	110	100	210
Tangkhul Naga	346	257	603
Siddis	78	139	217
Urban Delhi	254	195	449
Total	984	859	1843

Each subject was measured for stature, weight and circumference at waist and hip following the recommended techniques (Weiner and Lourie 1981). Four adiposity markers (BMI, WHtR, WHR and Waist circumference) were compared. Systolic and diastolic blood pressure was taken with sphygmomanometer and stethoscope following standardized techniques. Mean of the two readings was considered. Subjects were classified into two categories as normotensive (normal) and pre-hypertensive or hypertensive (National Cholesterol Education Program 2002). Body fat was assessed by bioelectric impedance technique.

For present research, body mass index was categorized as underweight (<18.5), normal (=or >18.5 to 25.0), overweight (>25.0 to <30.0), and obese (=or >30.0) following the WHO international standards (World Health Organization 1998). The WC of more than 80 cm in women and more than 90 cm in man is considered a risk group for CVDs (Dobbelsteyn et al. 2001). The waist hip ratio (WHR) of more than 0.80 for females and more than 0.95 for males has been taken as and indicator of abdominal obesity (Willett et al. 1999). The waist height ratio (WHtR) of more than 0.50 was taken as risk category (Ashwell 2005). Mean, standard deviation, ANOVA, and logistic regression were applied to analyze the data. The SPSS Version 20.0 was used. Cross tabulation of the subjects categorized under different blood pressure categories was calculated as (x/n)*100, where x, is the frequency under each cross tab category and n is the total number of subjects involved in the analyses. The present research was in accordance with the ethical standards of the institutional committee. The purpose of the research was explained to each participant, and an informed consent was taken from all the participants prior to start the data collection.

RESULTS

The findings of the paper are displayed as Table 2 to Table 7. It was aimed to examine the nutritional status and association of markers of adiposity with cardiovascular health in several population groups spread over different geographic zones (east, west, north, south and center) of India. Four of the population groups were found to belong to normal weight category. However, the Delhi population including both males and females were found to be overweight (Table 2).

Table 2: Nutritional status of different populations

Populations	*BMI (kg/m²)*	
	Males	*Females*
	Mean ± S.D	*Mean ± S.D*
Saharia	19.1± 2.6	19.1± 1.9
Ezhava	22.6± 7.9	20.6± 3.6
Tangkhul Naga	20.9± 2.4	21.2± 2.8
Siddi	22.5± 5.3	22.0± 4.9
Delhi-Urban	25.9± 4.2	27.7± 5.0

As per BMI, a considerable percentage of Saharia males (32.1% as per SBP and 33.3% as per DBP) were found to be malnourished and pre-hypertensive or hypertensive. More than half of the Saharia males (51.5%) were found to belong to risk category as per WHR. As per SBP, none of the adiposity markers showed significant Chi square values. Though, as per DBP significant differences were reported for the WHR, indicating a significant contribution of WHR towards hypertension (Table 3). As per SBP, 32.6 percent of females in WC risk category were found to be pre-hypertensive or hypertensive. The WHR was found to be incluencing the chances of being hypertensive significantly among Saharia females as per SBP. However, as per DBP, none of adiposity markers reported significant differences (Table 3).

Among Ezhava males, as per SBP, nine percent and as per DBP, thirteen percent males in WHtR -risk category were found to be pre-hypertensive or hypertensive. These cardiovascular inconsistencies increased to as high as twenty-fight percent and thirty-five percent among males belonging to the risk category of WHR. The males belonging to the risk category of WC showed an incidence of cardiovascular irregularities of twelve percent and fifteen percent as per SBP and DBP, respectively. As per SBP, the chi square values for all the adiposity markers except BMI were found to be significant among Ezhava males. On the other hand, as per the DBP, waist circumference and WHtR showed a significant contribution towards prevalence of hypertension. As per SBP, the OR values showed 6 times likelihood of developing hypertension among males belonging to the risk categories of WHR. The odds value showed likelihood of developing hypertension among males 2.7 times (as per SBP) and 3.2 times (as per DBP) for the risk WHtR. Similarly, the likelihood of developing hypertension is found to be 3.3 times (as per SBP) and 3.4 times (as per DBP) among males belonging to the risk categories of WC (Table 4).

Ezhava females of malnourished category (underweight/overweight/obese) were found to be pre-hypertensive or hypertensive (9.9% as per the SBP and 12.6% as per DBP). Similar percentage of Ezhava females, belonging to risk WHtR category, were reported to be pre-hypertensive or hypertensive. As per both SBP and DBP, the significant contribution of WHtR towards hypertension was found among Ezhava

Table 3: Cross tabulation for adiposity indices and blood pressure among Saharia

Adiposity markers		*SBP*				*DBP*			
		Pre-Hyper-tensive n (%)	*Normal n (%)*	*χ^2/ F-exact*	*OR*	*Pre-Hyper-tensive n (%)*	*Normal n (%)*	*χ^2/ F-exact*	*OR*
Males									
BMI	UW/OW	54 (32.1)	41 (24.4)	-	-	56 (33.3)	39 (23.2)	-	-
WHR	Risk	86 (51.5)	60 (35.9)	0.0	1.1 (0.3-3.5)	82 (49.1)	64 (38.3)	6.9*	0.3 (0.1-0.7)
WHtR	Risk	2 (1.2)	4 (2.4)	1.6	1.0 (1.0-1.1)	02 (1.2)	4 (2.4)	1.7	1.3 (1.2-1.4)
Females									
BMI	UW	16 (8.2)	56 (28.6)	-	-	12 (6.1)	62 (31.6)	-	-
WHR	Risk	2 (1.0)	-	16.8***	0.9 (0.8-1.0)	-	2 ((1.0)	0.2	1.0 (0.9-1.0)
WHtR	Risk	-	7 (3.6)	0.8	1.1 (1.0-1.1)	-	7 (3.6)	0.6	1.0 (1.0-1.1)
WC	Risk	64 (32.6)	125 (63.8)	-	-	36 (18.4)	153 (78.1)	-	-

UW- Underweight; *p< 0 .05. ; ***p<0 .001.

females. None of other adiposity markers namely BMI, WHR and WC showed any significant influence towards hypertension. As per SBP, 22.8 times and as per DBP, 6.9 times was found to be the likelihood of developing hypertension among the WHtR-risk category females. As per SBP, 7.6 times and as per DBP, 4.1 times likelihood of developing hypertension were reported among the females belonging to BMI risk category (Table 4).

Among Tangkhul males of WHR-risk category, 38.5 percent as per SBP and 35.4 percent as per DBP were found to be pre-hypertensive or hypertensive. Males belonging to the WHtR risk category showed prevalence of pre-hyertension or hypertension among 15.6 percent as per SBP and among 16.7 percent as per DBP. Similar prevalence trend was observed for the waist circumference. As per SBP and DBP, significant Chi square differences were reported for BMI, WHR and WC indicating an important contribution of the adiposity markers towards hypertension. Males belonging to the risk category of WC and WHR were 2.77 times and 2.47 times more likely to develop hypertension. Males belonging to risk category of BMI and WHtR were found to be 2.04 and 2.36 times more likely to develop hypertension (Table 5).

As per both SBP and DBP, highest proportions (14.2%) of the Tangkhul females of WHR risk category were found to be hypertensive. Females belonging to the WHtR risk category showed prevalence of pre-hypertension or hypertension as 19.1 percent as per SBP and 17.3 percent as per DBP. Among Tangkhul females of WC-risk category, more than five percent as per SBP and 4.3 percent as per DBP were found to be pre-hypertensive or hypertensive. As per both SBP and DBP, all the chi square values were found to be statistically significant among Tangkhul females. Females belonging to the risk values of WHR, WHtR and WC were found to be at about 3 to 4 times and BMI at 2 times likelihood of developing hypertension (Table 5).

Siddi males belonging to the WHtR risk category showed highest prevalence of prehypertension or hypertension as 22.3 percent (as per SBP) and 12.2 percent (as per DBP). Few males were found to belong to the WHR-risk category. Prevalence of prehypertension or hypertension among WC-risk category males was found to be 17.9 percent as per SBP and 18.7 percent as per DBP. As per SBP, the chi square value was reported to be significant for WC only highlighting its vital contribution towards hypertension among Siddi males. As per DBP, all the adiposity markers except WHR showed significant chi square values indicating their potential contribution towards hypertension among Siddi males. As per SBP and DBP, Siddi males of WC risk category were found to be 4.82 times and 4.44 times respectively, more likely to develop hypertension (Table 6).

Siddi females belonging to the WHtR risk category showed prevalence of prehypertension or hypertension as 25.6 percent as per SBP and 12.8 percent as per DBP. Prevalence of prehypertension or hypertension among WHR-risk category females was found to be 48.7 percent as per SBP and 19.2 percent as per DBP. Those

Table 4: Cross tabulation for adiposity indices and blood pressure among Ezhava

Adiposity markers		*SBP*					*DBP*				
		Pre-Hyper-tensive n (%)	*Normal n (%)*	χ^2/ *F-exact*	*OR*		*Pre-Hyper-tensive n (%)*	*Normal n (%)*	χ^2/ *F-exact*	*OR*	
Males											
BMI	OW	10 (10.0)	34 (34.0)	0.8	0.6	(0.3-1.6)	16 (16.0)	28 (28.0)	1.2	0.6	(0.3-1.4)
WHR	Risk	25 (25.0)	49 (49.0)	6.3*	5.9	(1.3-26.9)	35 (35.0)	39 (39.0)	2.8	2.3	(0.9-6.2)
WHtR	Risk	9 (9.0)	11 (11.0)	3.9*	2.8	(0.9-7.7)	13 (13.0)	7 (7.0)	5.2*	3.2	(1.1-3.9)
WC	Risk	12 (12.0)	14 (14.0)	6.3*	3.3	(1.3-8.6)	15 (15.0)	11 (11.0)	3.4*	2.3	(0.9-5.8)
Females											
BMI	UW/OW	11 (9.9)	41 (36.9)	8.4*	7.6	(1.6-36.9)	14 (12.6)	38 (34.2)	4.1*	2.7	(1.0-7.4)
WHR	Risk	3 (2.7)	9 (8.1)	2.3	2.9	(0.6-12.8)	4 (3.6)	8 (7.2)	1.8	2.4	(0.6-8.9)
WHtR	Risk	11 (9.9)	19 (17.1)	24.8***	22.8	(4.7-111.9)	13 (11.7)	17 (15.3)	15.9***	6.9	(2.5-19.5)
WC	Risk	1 (0.9)	1 (0.9)	2.9	8.1	(0.5-137.8)	2 (1.8)	0 (0.0)	8.7**		

UW/OW/OB- Underweight/Overweight/Obese*p< 0 .05. ***p*<0 .01. ****p*<0 .001.

Table 5: Cross tabulation for adiposity indices and blood pressure among Tangkhul Naga

Adiposity markers		*SBP*				*DBP*			
		Pre-Hyper-tensive n (%)	*Normal n (%)*	*χ^2/ F-exact*	*OR*	*Pre-Hyper-tensive n (%)*	*Normal n (%)*	*χ^2/ F-exact*	*OR*
Males									
BMI	UW/OW	8 (31.1)	6 (2.3)	1.7	2.0(0.7-6.1)	10 (3.9)	4 (1.5)	6.9*	4.4(1.3-14.4)
WHR	Risk	99 (38.5)	136 (52.9)	3.1	2.5(0.9-6.9)	91 (35.4)	144 (56.0)	0.4	1.3 (0.5-3.4)
WHtR	Risk	40 (15.6)	32 (12.4)	9.4**	2.4(1.4-4.1)	43 (16.7)	29 (11.3)	19.8***	3.5 (1.9-6.2)
WC	Risk	46 (17.9)	34 (13.2)	13.9***	2.8(1.6-4.8)	48 (18.7)	32 (12.4)	23.5***	3.8 (2.2-6.6)
Females									
BMI	UW/OW	14 (4.0)	20 (5.8)	4.9*	2.2(1.1-4.7)	13 (3.7)	21 (6.1)	4.8*	2.3 (1.1-4.8)
WHR	Risk	49 (14.2)	73 (21.1)	21.6***	3.2(1.9-5.2)	47 (13.6)	75 (21.7)	25.1***	3.6 (2.2-6.1)
WHtR	Risk	66 (19.1)	115 (33.2)	24.3***	3.7(2.2-6.4)	60 (17.3)	121 (34.9)	21.5***	3.6 (2.0-6.3)
WC	Risk	18 (5.2)	15 (4.3)			15 (4.3)	18 (5.2)		

UW/OW- Underweight/Overweight *p< 0 .05. **p<0 .01. ***p<0 .001.

females belonging to the WC risk category showed prevalence of prehypertension or hypertension as 30.8 percent and 14.1 percent as per SBP and DBP, respectively. As per SBP, all the adiposity markers (BMI, WHtR and WC) except WHR showed significant chi square values. As per DBP, WHtR and WC displayed their significant involvement towards hypertension among Siddi females. Females belonging to risk category of WHtR were 8.5 times (as per SBP) and 7.0 times (as per DBP) more likely to develop hypertension. Females belonging to risk category of WC were 4.83 and 5.12 times more likely to develop hypertension as per SBP and DBP, respectively (Table 6).

As per SBP, 42.6 percent and as per DBP, 32.3 percent Delhi males of the overweight/obese category were found to be pre-hypertensive or hypertensive. The males belonging to the risk category of WHR showed an incidence of pre-hypertension or hypertension at 24.6 percent and twenty percent as per SBP and DBP, respectively. Males of risk category of WHtR showed a prevalence of hypertension as forty-two percent as per SBP and 32.8 percent as per DBP. All the indices of adiposity, as per SBP, displayed significant chi square values among Delhi males. As per DBP, all except WC showed significant differences between normal and risk category males. Males belonging to the risk category of WHR were 3 to 6 times more likely to be hypertensive, whereas males belonging to the risk category of WHtR were thrice and as per WC were twice more likely to develop hypertension (Table 7).

Table 6: Cross tabulation for adiposity indices and blood pressure among Siddis

Adiposity markers		*SBP*				*DBP*			
		Pre-Hyper-tensive n (%)	*Normal n (%)*	*χ^2/ F-exact*	*OR*	*Pre-Hyper-tensive n (%)*	*Normal n (%)*	*χ^2/ F-exact*	*OR*
Males									
BMI	UW	19 (13.7)	17 (12.2)	-	0.9 (0.5-2.1)	3 (2.1)	33 (23.7)	4.3*	0.3 (0.1-0.9)
WHtR	Risk	31 (22.3)	19 (13.7)	2.4	1.7 (0.9-3.5)	17 (12.2)	33 (23.7)	8.9**	3.6 (1.50-8.4)
WHR	Risk	3 (2.1)	3 (2.1)	0.0	0.87 (0.2-4.5)	1 (0.7)	5 (3.6)	0.1	0.8 (0.1-6.8)
WC	Risk	14 (10.1)	3 (2.1)	6.6*	4.8 (1.3-17.7)	8 (5.7)	9 (6.5)	8.5**	4.4 (1.5-12.9)
Females									
BMI	UW	4 (5.1)	13 (16.7)	6.7*	0.2 (0.1-0.7)	1 (1.3)	16 (20.5)	2.5	0.2 (0.3-1.8)
WHtR	Risk	20 (25.6)	4 (5.1)	14.2***	8.5 (2.5-28.4)	10 (12.8)	14 (17.9)	11.2***	7.0 (2.0-23.8)
WHR	Risk	38 (48.7)	34 (43.6)	0.8	2.2 (0.4-12.9)	15 (19.2)	57 (73.1)	1.5	-
WC	Risk	24 (30.8)	9 (11.5)	10.5**	4.8 (1.8-12.9)	11 (14.1)	22 (28.2)	7.3**	5.1 (1.5-17.9)

UW- Underweight *p< 0 .05. **p<0 .01. ***p<0 .001.

Table 7: Cross tabulation for adiposity indices and blood pressure among Delhi population

Adiposity markers		*SBP*				*DBP*			
		Pre-Hyper-tensive n (%)	*Normal n (%)*	*χ^2/ F-exact*	*OR*	*Pre-Hyper-tensive n (%)*	*Normal n (%)*	*χ^2/ F-exact*	*OR*
Males									
BMI	OW/OB	83 (42.6)	28 (14.4)	17.1***	-	63 (32.3)	48 (24.6)	17.5***	-
WHR	Risk	48 (24.6)	6 (3.1)	17.1***	5.9 (2.4-14.7)	39 (20.0)	15 (7.7)	10.1***	2.9 (1.5-5.8)
WHtR	Risk	82 (42.0)	23 (11.8)	14.5***	3.3 (1.7-6.1)	64 (32.8)	41 (21.0)	4.6*	1.9 (1.0-3.0)
WC	Risk	55 (28.2)	6 (3.1)	6.4*	2.4 (1.2-4.9)	45 (23.1)	16 (8.2)	1.0	1.4 (0.7-2.5)
Females									
BMI	OW/OB	124 (48.8)	61 (24.0)	6.1*	2.1 (1.1-3.8)	104 (40.9)	80	4.5*	1.9 (1.0-3.3)
WHR	Risk	81 (31.9)	40 (15.7)	NS	1.5 (0.9-2.4)	73 (28.7)	47 (18.5)	6.8**	1.9 (1.2-3.2)
WHtR	Risk	124 (48.8)	60 (23.6)	7.5**	2.2 (1.2-3.9)	106 (41.7)	77 (30.3)	8.9**	2.4 (1.3-4.2)
WC	Risk	106 (41.7)	51 (20.1)	4.8*	1.8 (1.1-3.0)	90 (35.4)	66 (25.9)	4.9*	1.8 (1.1-3.0)

UW/OW/OB- Underweight/Overweight/Obese; *p< 0 .05. ***p*<0 .01. ****p*<0 .001.

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Females belonging to the overweight or obese BMI category showed prevalence of prehypertension or hypertension as much as 48.8 percent as per SBP and 40.9 percent as per DBP. Prevalence of prehypertension or hypertension among WHR-risk category females was found to be 31.9 percent as per SBP and 28.7 percent as per DBP. Those females belonging to the WHtR risk category showed prevalence of prehypertension or hypertension as 48.8 percent and 41.7 percent as per SBP and DBP, respectively. Delhi females of risk category of WC showed a prevalence of hypertension as 41.7 percent as per SBP and 35.4 percent as per DBP (Table 7). As per cross tabulation of SBP with adiposity markers, significant chi square values are reported for BMI, WHtR and WC. For DBP, all the adiposity markers displayed significant differences in risk group and normal group females. Females belonging to the risk category of BMI, WHtR and WHR showed two times likelihood of developing hypertension (Table 7).

DISCUSSION

Saharia, despite being a socioeconomically weaker group with low literacy level showed clustering of adiposity indicators like high blood pressure and high central body fat accumulation. Ironically, the Saharia in the given paper, belong to underweight as well as overweight category. Such co-existence of under nutrition and over nutrition has been reported earlier among adult Saharia (Kapoor et al. 2009) and other populations (Swinburn 2011). On one hand, Saharias are struggling with hunger, infectious diseases due to scarce health amenities and at the same time they are burdened with the hypertension (Kapoor et al. 2010). Many of them have shifted their occupation from hunting/gathering to daily wage earning or jobs/business. They are adopting distinct eating habits including more fast foods, and as a result, are becoming overweight or obese. Among Saharias, the WHR is found to be best marker reflecting the cardiovascular health risk among both males and females. Saharia males have higher centripetal fat, which may be responsible for them being more predisposed to hypertension. Changing lifestyle and related health risk are evident in this tribal population (Kapoor et al. 2010).

Significant chi square values for BMI, WHtR and WC among Siddi males and females highlight their considerable contribution towards development of hypertension. Siddis of Gujarat are, known for their African descent and are steatopygic. Their WHR tends to underestimate risks with ratio being much lower than real estimates. The WC among Siddi males and WHtR among Siddi females are found to be the best adiposity marker for cardiovascular health risk. Among Ezhava males, WC, WHR and WHtR and among females WHtR and BMI show risk towards hypertension more clearly. This signifies an important contribution of regional adiposity markers (that is WHR, WHtR and WC) towards hypertension. The WHR among males and WHtR among females are found to be the best marker towards cardiovascular health risk. These findings are consistent with the trend observed earlier (Lee et al. 2008) that has been occurring in many developing and transitional economies, contributing to the growing global epidemic of obesity and related health issues. Central obesity has been reported to reduce the cardiovascular fitness and increase the risk of hypertension (Mungreiphy et al. 2012).

Among Tangkhul females, BMI, WHR, WHtR and WC point towards occurrence of hypertension. Similar associations between BMI and high blood pressure indicating overweight as significant determinant of hypertension and have been reported earlier (Mungreiphy et al. 2011; Gupta and Kapoor 2012; Tyagi et al. 2015). Waist circumference (WC) among Tangkhul males and WHtR among Tangkhul females were found to be best adiposity marker predicting cardiovascular health risk. Tangkhul females are usually lean and have slender waist and hip with WHR equaling one. It may overestimate individual fallacy in risk categories. The transition of the Tangkhul Naga tribe in terms of socioeconomic factors and lifestyle, alteration in dietary habits and reduced physical activity are likely contributing to the increasing prevalence of overweight/obesity and its accompanying health problems. The Delhi population is found to show highest prevalence of pre-hypertensive or hypertensive as per BMI risk category. Significant associations between indices of general and regional adiposity with the blood pressure are obtained as also reported in earlier studies (Tyagi et al. 2008; Patel et al. 2017). The WHR among Delhi males and WHtR among Delhi females are reported to be best adiposity marker for the cardiovascular health risk.

Such ethnic difference in the pattern of fat distribution has been observed in Indian subjects in earlier studies (Mungreiphy et al. 2012). Both genetic and environmental factors may be responsible for ethnic difference in adiposity (Dhall et al. 2012). Though obesity was found to be higher among females, males were found to be at higher risk of hypertension (Dhall et al. 2012; Gupta and Kapoor 2010). Since BMI is not able to distinguish between someone with excess adipose tissue and someone with high muscle mass, the cardiovascular health risk may not be assessed based on BMI alone. Measures of central obesity, that is, WHR and WC were clearly superior. Both WC and WHR predicted CVD and CHD mortality, but WHR showed the strongest risk ratios.

Each of the populations under the present research showed how environment and lifestyle are contributing to the levels of obesity. It is based on an anthropological approach of contextual issues in the community, which can be aimed at designing community-based interventions at multiple ecological levels. Such studies can be used to develop intervention strategies that systematically target mechanisms of change at each level of influence. In the present research, irrespective of genes, clustering of socio-cultural factors like irregular and unhealthy eating patterns, sedentary lifestyle and job stress forms an intricate mesh providing a possible explanation for the obesity and hypertension variation.

Differences in prevalence of hypertension among various ethnic groups are complex, likely involving genetics, physiology, culture, socioeconomic status (SES), environment, and interactions among these variables as well as others. Global awareness of the health risks is associated with a risk norm of adiposity markers but they should be assessed and promoted at the community level, and with appropriate guidelines for interpretation and management. Determination of cut-off points of adiposity markers is of paramount importance for prevention, optimum management, and prediction of cardiovascular diseases. Heterogeneity of composition of adipose tissue, skeletal muscle, their location, changing relations with metabolic factors and cardiovascular risk factors in different ethnic groups do not allow a simple definition of cardiovascular diseases that could be applied uniformly. For instance, the Asians appear to have higher morbidity at lower cut-off points for various adiposity markers than other populations. International health agencies that deal with cardiovascular health (like WHO-IOTF) should refer such data and consider formulating new cut-off points for adiposity markers to assess cardiovascular health risks for multi ethnic Indian populations. Understanding different markers and developing population specific standardized cut-offs will be critical for developing public policies and effective clinical interventions to prevent, reduce and manage CVD risk and burden.

CONCLUSION

This research work highlights the efficacy of the anthropometry as a standard, cost efficient and timely technique of CVD risk assessment. It also adds to the literature by means of understanding the relationship between ethnicity and health in India. Tribal populations with lower socioeconomic status and high CVD risk face greater stress on their limited resources resulting in a vicious cycle of poor health and poor economic conditions. A simple screening tool for diverse population groups involving four adiposity markers (BMI, WC, WHR and WHtR) provided relative significance towards cardiovascular (CV) health, although at varying degrees of importance across ethnicity and gender. The WHR, WHtR and WC showed higher and significant association with cardiovascular (CV) health risk. The waist height ratio (WHtR) is found to be a better predictor of prevalent hypertension amongst all the central adiposity indices.

RECOMMENDATIONS

Using a combination of adiposity markers improves the prediction of cardiovascular health risk among adults. BMI is a key determinant of metabolic abnormalities, which contributes to cardiovascular risk. Measures of central obesity particularly waist circumference (WC), WHR and WHtR, give a better assessment of obesity related cardiovascular risk. Considering present research findings, a model anthropometric score scale incorporating BMI and selected anthropometric central adiposity indices may be an answer to quick and meaningful screening for CVD risk and its timely management.

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