PRINT: ISSN 0970-9274 ONLINE: ISSN 2456-6608
J Hum Ecol, 7(1-3): 90-97 (2020)
DOI: 10.31901/24566608.2020/70.1-3.3223

A Study on Obesity and Hypertension among Adults of Meghwal Community, Udaipur District, Rajasthan (India)

Ananya Jyoti Gogoi[1] and Kallur Nava Saraswathy[2]

[1]Department of Anthropology, Gauhati University, Gauhati 781 014, Assam, India
Mobile: 7002646191, E-mail: jgogoi126@gmail.com
[2]Department of Anthropology, University of Delhi, Delhi 110 007, India

KEYWORDS Adiposity Indices. Association. Blood Pressure. Korotkoff Sounds

ABSTRACT A cross-sectional investigation was carried out among Meghwal individuals of five villages of Udaipur District, Rajasthan with the aim to understand the extent of obesity and hypertension among adult individuals of the population, to understand the association of various adiposity indices with blood pressure and to do a comparative analysis of the magnitude of association between them.163 adult individuals of the age group 18 to 70 years were studied through door-to-door investigation. Mean stature, weight, waist circumference, waist-to-hip ratio, systolic and diastolic blood pressure were found to be significantly higher in males than in females. Individuals at high risk due to waist-to-hip ratio were found to be significantly higher among females than among males. Arterial blood pressure increased with an increase in general and central obesity. Relationship of systolic and diastolic blood pressure was highest with waist-to-hip ratio among male individuals and with waist-to-height ratio among female individuals.

INTRODUCTION

Blood pressure can be understood as the force of circulating blood against the artery walls of the human body; high blood pressure or hypertension is when the blood pressure is too high (WHO 2019). Hypertension is found to be a leading risk factor for disease burden globally, accounting for 9.4 million deaths in 2010 (Lim et al. 2012). In India, the prevalence of hypertension was found to be 27.6 percent in rural areas and 33.8 percent in urban areas, and the overall estimates for the prevalence of awareness, treatment, and control of blood pressure were 25.3 percent, 25.1 percent, and 10.7percent for rural Indians and 42.0 percent, 37.6 percent and 20.2 percent for urban Indians (Anchala et al. 2014).

Overweight and obesity are two of the major health issues that have been on a rise in the developing countries including India (Srikanth et al. 2011). This can be attributed to industrialisation and urbanisation that has led to the rise in the living standards among the populations of developing countries (Dua et al. 2014). In India the prevalence of general obesity was found to be 24.6 percent (Tamil Nadu), 16.6percent (Maharashtra), 11.8 percent (Jharkhand) and 31.3 percent (Chandigarh), and the prevalence of abdominal obesity was found to be 26.6 percent, 18.7 percent, 16.9 percent, and 36.1 percent, respectively. Central obesity was found to be in 19.3 percent (Tamil Nadu), 13.0 percent (Maharashtra), 9.8 percent (Jharkhand) and 26.6 percent (Chandigarh) among the populations. The prevalence of general obesity and abdominal obesity was significantly higher among urban residents compared to rural residents in all four regions (Pradeepa et al. 2015).

A number of epidemiological researches have been conducted to understand the relationship between obesity and blood pressure. Body mass index is positively associated with blood pressure among various Asian populations including the urban population of Delhi (Dua et al. 2014; Dhall et al. 2018). Hypertension was also found to be significantly associated with both general as well as central obesity among the Sonowal Kachari tribe individuals of Dibrugarh District, Assam, Northeast India (Gogoi 2019). The population of India is undergoing rapid

Address for correspondence:
Ananya Jyoti Gogoi
PhD Scholar
C/O Tikendrajit Gogoi,
NizKadamani, Bairagimoth,
House No. 481 Ward No. 2.
Dibrugarh 786 003, Assam, India
Mobile: 7002646191
E-mail: jgogoi126@gmail.com

changes with the increase in the prevalence of overweight/obesity, under-nutrition and hypertension at an alarming rate (Dua et al. 2014; Kshatriya and Acharya 2016). The study of such changes is very much important from the public health point of view among different populations and population sub-groups due to racial and ethnic differences among them. Racial and ethnic differences may lead to differences in the various long-term health outcomes among the population groups and sub-groups (Dua et al. 2014). Such studies help in the identification of the population groups at risk and also in coming up with health policies targeting the specific needs of such populations.

Objectives

The present investigation aims to study the extent of obesity and hypertension among the male and female adult individuals of the population, to understand the association of various adiposity indices with blood pressure and to do a comparative analysis of the magnitude of association between them.

MATERIAL AND METHODS

A cross-sectional investigation was carried out among the Meghwal caste individuals of five villages, namely, Dhinkli, Gudli, Debari, Gowla and Merta of Udaipur District, Rajasthan from 25th February 2019 to 4th March 2019. A total of 163 adult individuals of the age group 18 to 70 years were studied, out of which 81 individuals were female and 82 individuals were male. The collection of data was done through a door-to-door investigation. Various somatometric measurements such as stature, weight, waist circumference (WC), hip circumference (HC), and physiological dimension like blood pressure were taken for each participant. The techniques used for the collection of somatometric and physiological dimensions as well as the purpose of taking these were well explained to each participant. A written constant was taken from each participant before proceeding with the measurements.

Standard protocols were followed while taking the measurements (Weiner and Lourie1981). Measurement of stature was done with the help of an anthropometer while body-weight was measured with the help of a portable spring weighing machine. Waist Circumference (WC) and Hip Circumference (HC) were measured with the help of an anthropometric measuring tape. While measuring the stature, weight, waist circumference and hip circumference, the participants were asked to remove their footwear, excess clothing as well as any kind of headgear. Blood pressure was measured by following the new recommendations given by the American Heart Association for blood pressure measurement (Smith 2005). A mercury sphygmomanometer was used for the measurement by following the Korotkoff's sound technique. The participants were requested to sit in a relaxed position on a chair with their left arm resting comfortably on a flat surface. It was ensured that the arm was rested at the heart level of each participant. The cuff was then placed around the bare left arm 2 cm to 3 cm above the elbow joint. The forearm was propped so as to keep the device at the level of the heart. The cuff of the sphygmomanometer was inflated rapidly in order to reach the pressure above which the radial pulse could no longer be felt. The diaphragm of the stethoscope was then placed over the brachial artery. The mercury column was then immediately allowed to fall at the rate of 2 mmHg per second. The first perception of the Korotkoff sound was taken as the systolic pressure. After that the mercury was allowed to fall further till the sound could no longer be heard. The level where the Korotkoff sound could no longer be heard was taken as the diastolic pressure. The cuff was then allowed to deflate completely. In order to maintain accuracy the measurement of blood pressure was taken twice with a gap of five minutes and the average of the two measures was recorded (Mungreiphy et al. 2011).

Calculation of adiposity indices such as body mass index (BMI), waist-to-height ratio (WHtR) and waist-to-hip ratio (WHR) were done. The body mass index cut-offs for overweight and obesity as recommended by the World Health Organisation for Asian populations were used. A general healthy cut off for WHtR for both males and females was taken as 0.5 (Browning et al. 2010). WHtR exceeding 0.5 indicates an in-

creased risk of cardiometabolic disorders (Ashwell et al. 2012). Based on WHR, health risk can be classified into low risk, moderate risk and high risk (Bhurosy and Jeewon 2013). WHR less than 0.95 and less than 0.80 is considered to be a low risk for men and women respectively, whereas WHR of .96-1.00 in men and 0.81-0.85 in women is considered to be at moderate risk. A WHR of greater than 1 in men and greater than0.85 in women is considered to be at high risk (Bhurosy and Jeewon 2013). In case of blood pressure, the categories given by the American Heart Association for both systolic as well as diastolic blood pressure were used. Statistical analysis was done using Statistical Package for Social Sciences (SPSS) version 16.0.

RESULTS

Table 1 reveals the sex-wise distribution of the various measurements of the studied population. In the present study, the mean value for stature, weight and waist circumferences were found to be significantly higher in males than in females. On the other hand, the mean hip circumference was found to be equal in both genders. It was also observed that the mean body mass index and the mean waist-to-height ratio were greater in the case of females than in the case of males. However, the difference was not found to be statistically significant (p greater than .05). On the other hand, the mean waist-to-hip ratio, mean systolic blood pressure and the mean diastolic blood pressure were found to be significantly greater in the case of the males than in the case of the females.

Table 2 displays the prevalence of obesity and high blood pressure among the studied population. The frequency of underweight individuals was higher among the male (36.60%) than among the female (28.40%). On the other hand, the frequencies of overweight individuals and individuals with general obesity were found to be higher in the case of females (23.50% and 4.9%, respectively) than in the case of males (19.50% and 1.2%, respectively). However, the difference was not found to be statistically significant (χ^2 equals to 2.98, d.f. equals to 3, p greater than 0.05). For the assessment of central obesity, waist circumference, waist-to-hip ratio and waist-to-height ratio were used. The frequency of individuals with central obesity based on waist circumference was found to be higher among the females (27.20%) than male individuals (18.30%). However the difference was not found to be statistically significant (χ^2 equals to 1.83, d.f. equals to 1, p greater than 0.05). Again, it was observed that the overall frequency of individuals with high risk due to waist-to-height ratio was found to be higher in the case of male 31.70 percent than in the case of female 25.90 percent. However the difference was also not found to be statistically significant (χ^2 equals to.664, d.f. equals to 1, p greater than 0.05). Lastly, it was observed that based on the waist-to-hip ratio, the frequency of individuals at low risk was found to be higher in the case of males (82.90%) than in the case of females (39.50%). The frequency of individuals at high risk due to the waist-to-hip ratio was found to be significantly higher in the case of females (28.40%) than in the case of males (4.90%). The present study revealed that the frequencies of individuals with normal systolic as well as diastolic blood pressure were higher in the case of females (53.10%and 46.90%, respectively) than in case

Table 1: Sex-wise distribution of the various measurements of the studied population

Parameters	*Male* *Mean ± SD*	*Female* *Mean ± SD*	*Total* *Mean ± SD*	*F-test value*	*p-value*
Stature (cm)	167.71± 5.93	154.52±5.68	161.15±8.81	208.59	0
Weight (kg)	56.91±11.59	50.9±10.23	53.92±11.31	12.33	0.001
Waist Circumference (cm)	77.26±12.45	72.76±11.20	75.02±12.02	5.8	0.016
Hip Circumference (cm)	89.47±7.86	89.48±8.65	89.47±8.24	0	0.997
Body Mass Index	20.19±3.82	21.30±4.08	20.75±3.98	3.21	0.075
Waist-to-hip Ratio	0.86±0.09	0.81±0.08	.84±0.09	12.9	0
Waist-to-height Ratio	0.46±0.07	0.47±0.07	.47±0.07	0.81	0.37
Systolic Blood Pressure (mmHg)	126±13	119±17	122.57±15.34	8.31	0.004
Diastolic Blood Pressure (mmHg)	83±10	79±10	80.82±10.43	7.31	0.008

Table 2: Sex-wise distribution of the participants based on adiposity indices and blood pressure

Sex		*Male*	*Female*	*Total*
Waist Circumference(cm)				
Normal	N	67	59	126
	percent	81.70	72.80	77.3
Obese	N	15	22	37
	percent	18.30	27.20	22.7
Body Mass Index				
Underweight	N	30	23	53
	percent	36.60	28.40	32.52
Normal	N	35	35	70
	percent	42.70	43.20	42.94
Overweight	N	16	19	35
	percent	19.50	23.50	21.47
Obese	N	1	4	5
	percent	1.20	4.90	3.07
Waist-to-hip Ratio				
Low Risk	N	68	32	100
	percent	82.90	39.50	61.35
Moderate Risk	N	10	26	36
	percent	12.20	32.10	22.09
High Risk	N	4	23	27
	percent	4.90	28.40	16.56
Waist-to-height Ratio				
Low Risk	N	56	60	116
	percent	68.30	74.10	71.17
High Risk	N	26	21	47
	percent	31.70	25.90	28.83
Systolic Blood Pressure (mmHg)				
Normal	N	17	43	60
	percent	20.70	53.10	36.81
Elevated	N	32	19	51
	percent	39.00	23.50	31.29
Stage I	N	22	8	30
	percent	26.80	9.90	18.4
Stage II	N	11	11	22
	percent	13.40	13.60	13.5
Diastolic Blood Pressure (mmHg)				
Normal	N	15	38	53
	percent	18.30	46.90	32.52
Elevated	N	4	1	5
	percent	4.90	1.20	3.07
Stage I	N	37	27	64
	percent	45.10	33.30	39.26
Stage II	N	26	15	41
	percent	31.70	18.50	25.15

of male (20.70%and 18.30%, respectively). The frequency of individuals with stage II systolic blood pressure was found to be significantly higher in the case of females (13.60%) than in the case of males (13.40%).On the other hand, the frequencies of individuals with stage II diastolic blood pressure was found to be significantly higher in the case of male (31.70%) than in case of female (18.50%).

Table 3 displays the blood pressure values in different adiposity index categories. Blood pressure increased significantly with the increase in body mass index. In the case of BMI categories, it was found that the mean systolic and diastolic pressure was lowest, that is, 118.49 mmHg and 78.60 mmHg respectively, in the underweight category while it was highest at 152.80 mmHg and 96.00 mmHg respectively, in the obese category. In the case of waist circumference, both mean systolic and diastolic blood pressures were lower in the normal category and higher in the obese category. A similar trend was also seen in the case of waist-to-height ratio. Both the mean systolic and diastolic blood pressures were lower in the low-risk category and higher in the high-risk category. Thus, it showed that blood pressure increased significantly with the increase in both waist circumference as well as a waist-to-height ratio. In the case of the waist-to-hip ratio, it was observed that the mean systolic and diastolic pressure increased from the low-risk category to the high-risk category. The minimum mean systolic (121.26 mmHg) and diastolic blood

Table 3: Distribution of mean systolic and diastolic blood pressures in different adiposity indices

	Systolic blood pressure	*Diastolic blood pressure*
	Mean±SD	*Mean±SD*
BMI Category		
Under Weight	118.49±12.27	78.60±10.00
Normal	122.97±15.07	81.43±10.10
Over Weight	123.63±15.59	80.80±10.35
Obese	152.80**±14.60	96.00**±8.49
F-Test Value	8.94	4.71
p-value	0.000	0.004
Waist Circumference Category		
Normal	120.06±14.183	79.76±10.457
Obese	131.11**±16.244	84.43*±9.593
F-Test Value	16.21	5.92
p-value	0.000	0.016
Waist-to-Height Ratio Category		
Low Risk	119.59±14.358	79.33±10.4
High Risk	129.94**±15.352	84.51**±9.632
F-Test Value	16.70	8.66
p-value	0.000	0.004
Waist-to-Hip Ratio Category		
Low Risk	121.26±13.703	80.38±10.248
Moderate Risk	122.25±16.006	81.33±10.276
High Risk	127.85±19.263	81.78±11.534
F-Test Value	1.20	0.24
p-value	0.139	0.783

pressure (80.38 mmHg) were found in the low-risk category while the maximum mean systolic (127.85 mmHg) and diastolic blood pressure (81.78 mmHg) were found in the high-risk category. Thus, it showed that blood pressure also increased with the increase in waist-to-hip ratio. However, the difference was not found to be statistically significant.

Table 4 displays the correlation of various adiposity indices with systolic and diastolic blood pressure. There was a significant (p less than 0.05) positive correlation of body mass index with both systolic as well as diastolic blood pressure only in the case of the female individuals. In the case of male individuals, though positive correlation was seen in between body mass index and blood pressure, it was not statistically significant (p greater than 0.05). A significant positive correlation was found between both systolic and diastolic blood pressure and the adiposity indices, namely waist circumference, waist-to-height ratio and waist-to-hip ratio. Thus, it shows that with the increase of waist circumference, waist-to-height ratio or the waist-to-hip ratio both the systolic as well as diastolic blood pressure increased in both the genders. The correlation coefficient showed that the relationship of both systolic blood pressures as well as diastolic blood pressure was highest with the waist-to-hip ratio in the case of male individuals and with the waist-to-height ratio in the case of female individuals. The relationship of both systolic blood pressure as well as diastolic blood pressure was found to be lowest with the body mass index in the case of male individuals and with the waist-to-hip ratio in the case of female individuals.

Table 4: Binary Correlation between age and various adiposity indices with blood pressure

Adiposity indices	*Male*		*Female*	
	SBP	*DBP*	*SBP*	*DBP*
Age	0.267*	0.110	0.603**	0.866**
Height	0.111	0.102	-.030	-.023
Weight	0.234*	0.168	0.352**	0.308**
BMI	0.205	0.136	0.393**	0.346**
WC	0.380**	0.255*	0.520**	0.428**
WHR	0.387**	0.263*	0.376**	0.266*
WHtR	0.359**	0.233*	0.533**	0.440**

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

DISCUSSION

The prevalence of various cardiovascular diseases has been on the rise throughout the world. Thus a better understanding of the various risk factors involved and their correlates has been given utmost priority (Blair et al. 1984; Rao 2012). Studies have found that the prevalence of obesity and diabetes is highest among the Asian population, especially Indians (Sanya et al. 2009; Savita et al. 2014; Svec et al. 2014).

The present investigation revealed that the frequency of underweight individuals was higher among males than among females. The frequencies of overweight and individuals with general as well as central obesity were found to be higher in the case of females than in the case of males. Studies done by various other authors reveal similar observations where the prevalence of obesity is found to be higher among the female (Mungreiphy and Kapoor 2010). Such differences in the prevalence of overweight and obesity are found to be worse among women in developing countries (Kanter and Caballero 2012). In the present study, the mean systolic, as well as the mean diastolic blood pressure, was found to be significantly higher in the case of the male individuals than in the case of the female individuals. Studies have found that gender differences in blood pressure are observed at the adolescence stage and persist through adulthood (Dua et al. 2014; Everett and Zajacova 2015). In all ethnic groups, men tend to have higher mean systolic blood pressure as well as mean diastolic blood pressure than women, and through middle age, the prevalence of hypertension is higher among men than women (Stamler et al. 1976; Dua et al. 2014; Everett and Zajacova 2015). Age was found to be positively correlated with both systolic blood pressure as well as diastolic blood pressure. The correlation between systolic blood pressure and age was found to be significant in both male and female individuals while the correlation between diastolic blood pressure and age was found to be significant only among the female individuals. In the present study, the correlation between blood pressure and age was found to be stronger in the case of women than in the case of men. Similar results have been found in many other studies where a significant relationship

has been found between blood pressure and age among both male and female individuals. With age, the blood pressure of individuals rises. Age is one of the known risk factors for high blood pressure (Gardner and Poehlman 1995; Rohrer et al. 2007; Jervase et al. 2009).

Statistically, a significant correlation has been found in the present investigation between almost all somatometric measurements (except stature) and systolic as well as diastolic blood pressure in both the genders. Exceptions include weight, which was found to have a significant positive correlation with both systolic and diastolic blood pressure in case of female and only systolic blood pressure in case of male. Stature was found to have a positive correlation with systolic and diastolic blood pressure in the case of male and negative correlation with the systolic and diastolic blood pressure in the case of females. But both were found to be statistically insignificant. These results vary from previous studies done among various populations (Gardner and Poehlman 1995; Jervase et al. 2009; Dua et al. 2014). A significant correlation has been found between blood pressure and variables such as weight, skinfold thickness, etc. (Cassani Roerta 2009).

Researches regarding the relationship between body mass index and blood pressure have been going on since the 1950s. With time the focus of research has shifted to measures of central obesity such as waist circumference, waist-to-height ratio, waist-to-hip ratio, etc. Studies have found that the association of blood pressure with various anthropometric indices is not uniform (Zhou et al. 2009; Nakamura et al. 2011). It has been found that some of the anthropometric indices are more strongly associated with elevated blood pressure than others. The present study revealed that blood pressure significantly increased with the increase in body mass index. Similar results have been observed among the adult urban population of Delhi (Dhall et al. 2018). Correlation analyses between body mass index and blood pressure revealed that there was a significant positive correlation between systolic blood pressure as well as diastolic blood pressure and body mass index among the female individuals. A similar result has been found in a study conducted among Punjabi girls of Delhi (Kapoor 2000). Among the male individuals, although a positive correlation was observed, it was not found to be statistically significant. Positive associations between body mass index and blood pressure have also been reported in other Indian populations (Gupta et al. 1995; Tandon 2006; Khanikar and Konwar 2016; Kishor et al. 2017).In the case of waist circumference, both mean systolic and diastolic blood pressures were lower in the normal category and higher in the obese category. A similar trend was also seen in the case of waist-to-height ratio. Both the mean systolic and diastolic blood pressures were lower in the low-risk category and higher in the high-risk category. In the case of the waist-to-hip ratio, it was observed that the mean systolic and diastolic pressure increased from the low-risk category to the high-risk category. The minimum mean systolic (121.26 mmHg) and diastolic blood pressure (80.38 mmHg) were found in the low-risk category while the maximum mean systolic (127.85 mmHg) and diastolic blood pressure (81.78 mmHg) were found in the high-risk category. A significant positive correlation was found between both systolic and diastolic blood pressure and the adiposity indices, namely waist circumference, waist-to-height ratio and waist-to-hip ratio. Thus it shows that with the increase of waist circumference, waist-to-height ratio or the waist-to-hip ratio both the systolic as well as diastolic blood pressure increased in both the genders. Similar results have also been observed in various other populations (Rouf et al. 2018; Yeole and Patel 2017; Gogoi 2019). The correlation coefficient showed that the relationship of both systolic blood pressures as well as diastolic blood pressure was highest with the waist-to-hip ratio in the case of male individuals and with the waist-to-height ratio in the case of female individuals. A similar study has been done among adult Thai population where waist to height ratio was found to be a better predictor of hypertension than waist circumference and waist to hip ratio in case of both the genders (Nguyen et al. 2019). The relationship of both systolic blood pressure as well as diastolic blood pressure was found to be lowest with the body mass index in the case of male individuals and with the waist-to-hip ratio in the case of female individuals.

CONCLUSION

Based on the observations made in the field investigation and keeping in view the limitations (very small sample size) it can be concluded that as obesity (general as well as central) increased arterial blood pressure also increased. Thus, general obesity, as well as central obesity, has been found to be an important risk factor of elevated blood pressure. In the case of male individuals, the relationship of blood pressure was found to be higher with the waist-to-hip ratio while in the case of female individuals the relationship was found to be higher with the waist-to-height ratio. Thus, the present investigation contributes to the increasing knowledge that one of the most significant risk factors for high blood pressure is abdominal obesity. Hence, such obesity measures can be used to obtain preliminary information regarding cardiovascular risk.

RECOMMENDATIONS

The study reveals relatively high prevalence of high blood pressure as well as obesity among the Meghwal caste individuals of the five villages. Steps must be taken to make the individuals of the villages aware of the risk posed by such disorders. Awareness about the need for proper weight management and an overall healthy lifestyle is needed among the population.

LIMITATIONS

Limited sample size is one of the important limitations of the present investigation. A similar investigation with a larger sample size in more villages will be helpful to understand the relationship between obesity and blood pressure better.

ACKNOWLEDGMENTS

The authors would like to thank all the participants for their help in the successful completion of the field study. Heartfelt gratitude also goes out to the Anthropological Survey of India, Western Regional Centre, Udaipur, Rajasthan and its entire associated staff for providing with the necessities and comfort throughout the stay at their guesthouse during the study. A deep sense of gratitude also goes towards the members of the entire team for being the pillars of this research work.

REFERENCES

Anchala R, Kannuri NK, Pant H, Khan H, Franco OH, Di Angelantonio E, Prabhakaran D 2014. Hypertension in India: A systematic review and meta-analysis of prevalence, awareness, and control of hypertension. *Journal of Hypertension*, 32(6): 1170–1177.doi: 10.1097/HJH.0000000000000146.

Ashwell M, Gunn P, Gibson S 2012. Waist-to-height ratio is a better screening tool than waist circumference and BMI for adult cardiometabolic risk factors: Systematic review and meta-analysis. *Obesity Reviews*, 13(3): 275-286.

Bhurosy T, Jeewon R 2013. Pitfalls of using body mass index in the assessment of obesity risk. *Curr Res Nutr Food Sci*, 1(1): 71–76. http://dx.doi.org/10.12944/CRNFSJ.1.1.07

Blair D, Habicht JP, Sims EA, Sylwester D, Abraham S 1984. Evidence for the increased risk of hypertension with centrally located fat and the effect of race and sex on this risk. *Am J Epidemiol*, 119(4): 526–540.

Browning LM, Hsleh SD, Ashwell M 2010. A systematic review of waist-to-height ratio as a screening tool for the prediction of cardiovascular disease and diabetes: 0.5 could be a suitable global boundary value. *Nutr Res Rev*, 23(2): 247-269.

Cassani Roerta SL, Nobre F, Pazin-Fiho A, Schmidt A 2009. Relationship between blood pressure and anthropometry in a cohort of Brazilian men: A cross-sectional study. *Am J Hypertens*, 22: 980–984.

Dhall M, Devi KS, Niluphe, Gupta U, Tyagi R, Kapoor S 2018. Hypertension and its correlate with general and central adiposity: A study among urban population of Delhi. *Diabetes Metab Syndr*, 12(6): 881-884. doi: 10.1016/j.dsx.2018.05.008.

Dua S, Bhuker M, Sharma P, Dhall M, Kapoor S 2014. Body mass index relates to blood pressure among adults. *North American Journal of Medical Sciences*, 6(2): 89–95. doi:10.4103/1947-2714.127751.

Everett B, Zajacova A 2015. Gender differences in hypertension and hypertension awareness among young adults. *Biodemography and Social Biology*, 61(1): 1-17. https://doi.org/10.1080/19485565. 2014.929488.

Gardner AW, Poehlman ET 1995. Predictors of age related increase in blood pressure in men and women. *J Gerontol A Biol Sci Med Sci*, 50A: M1–6.

Gogoi AJ 2019. Obesity and hypertension: A cross-sectional study among the adult individuals of Sonowal Kachari Tribe of Hatimora Village, Assam, India. *Stud Tribes Tribals*, 17(1-2): 8-18. DOI: 10.31901/24566799.2019/17.1-2.417

Gupta RS, Gupta VP, Prakash H 1995. Prevalence and determinants of hypertension in the urban population of Jaipur in western India. *Journal of Hypertension*, 10(13): 1193–1200.

Jervase E, Barnabas D, Emeka AG, Osondu N 2009. Sex differences and relationship between blood pressure and age among the Igbos of Nigeria. *Internet J Biol Anthropol*, 3: 2.

Kanter R, Caballero B 2012. Global gender disparities in obesity: A review. *Advances in Nutrition*, 3(4): 491–498.https://doi.org/10.3945/an.112.002063.

Kapoor SS 2000. Blood pressure, waist to hip ratio and body mass index among affluent Punjabi girls of Delhi. *Acta Medica Auxologica*, 32(3): 153–157.

Khanikar A, Konwar SS 2016.A study of correlation of body mass index and waist circumference with blood pressure. *JMSCR*, 4(3): 9808-9813. doi: http://dx. doi.org/10.18535/jmscr/v4i3.40.

Kishor KC, Sridhar K, Sasikala C, Sangeetha K, Rajini S, Sridharan R 2017. Prevalence of prehypertension among medical students in Puducherry, India. *International Journal of Recent Scientific Research*, 8(10): 20632-20636.

Kshatriya GK, Acharya SK 2016. Triple burden of obesity, undernutrition, and cardiovascular disease risk among Indian tribes. *PLoS ONE*, 11(1): e0147934. doi:10.1371/journal.pone.0147934.

Lim SS, Vos T, Flaxman AD, Danaei G, Shibuya K, Adair-Rohani H, Memish ZA 2012. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990- 2010: A systematic analysis for the global burden of disease study 2010. *Lancet*, 380(9859): 2224-2260. doi:10.1016/S0140-6736(12)61766-8 [doi]

Mungreiphy NK, Kapoor S 2010. Socioeconomic changes as covariates of overweight and obesity among Tangkhul Naga tribal women of Manipur, north-east India. *J Biosoc Sci*, 42(3): 289-305. doi:10.1017/S0021932009990587.

Mungreiphy NK, Kapoor S, Sinha R 2011. Association between BMI, blood pressure, and age: Study among Tangkhul Naga Tribal Males of Northeast India. *Journal of Anthropology*, Vol. 2011(Article ID 748147) 1-6.

Nakamura K, Nanri H, Hara M., Higaki Y, Imaizumi T, Taguchi N, Sakamoto T, Horita M, Shinchi K, Tanaka K 2011. Optimal cutoff values of waist circumference and the discriminatory performance of other anthropometric indices to detect the clustering of cardiovascular risk factors for metabolic syndrome in Japanese men and women. *Environmental Health and Preventive Medicine*, 16(1): 52-60. https://doi.org/10.1007/s12199-010-0165-y

Nguyen Ngoc H, Kriengsinyos W, Rojroongwasinkul N, Aekplakorn W 2019. Association of adiposity indices with hypertension in middle-aged and elderly Thai population: National Health Examination Survey 2009 (NHES-IV). *Journal of Cardiovascular Development and Disease*, 6(1): 13. doi:10.3390/jcdd6010013

Pradeepa R, Anjana RM, Joshi SR, Bhansali A et al. 2015. Prevalence of generalized and abdominal obesity in urban and rural India—the ICMR-INDIAB Study (Phase-I) [ICMR- NDIAB-3]. *The Indian Journal of Medical Research*, 142(2): 139–150. doi:10.4103/0971-5916.164234.

Rao S 2012. Anthropometric indices for obesity and hypertension in Indian affluent adolescents. In VR Preedy (Ed.), *Handbook of Anthropometry: Physical Measures of Human Form in Health and Disease*. DOI 10.1007/978-1-4419-1788-_83: pp. 1371. Springer Science & Business Media.

Rohrer JE, Anderson GJ, Furst JW 2007. Obesity and prehypertension in family medicine: Implications for quality improvement. *BMC Health Serv Res*, 7:212.

Rouf A, Rasool M, Khan SMS, Haq I et al. 2018. Prevalence of hypertension and its association with waist circumference in adult population of Block Hazratbal, Srinagar, India. *Ann Med Health Sci Res*, 8: 68-73.

Sanya AO, Ogwumike OO, Ige AP, Ayanniyi AO 2009. Relationship of waist hip ratio and body mass index to blood pressure of individuals in Ibadan North Local Government. *AJPARS*, (1): 7–11.

Savita SP, Dinesh RR, Nandakumar BS, Jayasrees SS 2014. Correlation of waist hip ratio and BMI with hypertension and diabetes mellitus in an urban area of Bangalore city. *Natl J Community Med*, 6: 105.

Smith L 2005. New AHA recommendations for blood pressure measurement. *Am Fam Physician*, 72(7): 1391-1398.

Srikanth J, Jayant KK, Narasimha NS 2011. Factors influencing obesity among urban high school children Bangalore City. *Indian J Nutr Dietet*, 48: 8-17.

Stamler J, Stamler R, Reidlinger WF, Algera G, Roberts RH 1976. Hypertension screening of 1 million Americans. Community Hypertension Evaluation Clinic (CHEC) Program. *JAMA*, 235(2): 299–306.

Svec F, Rivera M, Huth M 2014. Correlation of waist to hip ratio to the prevalence of diabetes and hypertension in black females. *J Natl Med Assoc*, 82(4): 257–261.

Tandon K 2006. *Obesity, Its Distribution Pattern and Health Implications among Khatri Population*. PhD Thesis. Delhi, India: Department of Anthropology, University of Delhi.

Weiner JS, Lourie JA 1981. *Practical Human Biology Anthropometry*. New York: Academic Press.

WHO 2019. Hypertension. From <https://www.who.int/news-room/fact-sheets/detail/hypertension> (Retrieved on 31 January 2020).

Yeole R, Patel S 2017. Correlation between body mass index and waist circumference with blood pressure indices in healthy adolescents. *Int J Recent Sci Res*, 8(1): 15142-15144.

Zhou Z, Hu D, Chen J 2009. Association between obesity indices and blood pressure or hypertension: Which index is the best? *Public Health Nutrition*, 12(8): 1061-1071. doi:10.1017/S1368980008003601.

Paper received for publication in December, 2019
Paper accepted for publication in February, 2020