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Original Article

Impact of American Heart Association's New Hypertension Guidelines (2017) on Disease Burden And Association with Obesity Indices

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Abstract

Background: Hypertension (HTN) and obesity both are on rise in India as well as other countries. With introduction of new guidelines for HTN by American Heart Association (AHA) in 2017, the burden of disease is expected to be much higher than before. Aim of this study was to assess the impact of new AHA (2017) guidelines of hypertension classification on disease burden and its association with obesity.

Materials and Methods: This cross sectional analytical study was conducted in total 210 subjects from Varanasi, India. Blood pressure and obesity indices (waist circumference, body mass index and waist-height ratio) were measured and analysed. Number of subjects having HTN according to American Heart Association's (AHA) new (2017) and old [Seventh Report of the Joint National Committee (JNC) on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure, 2003] guidelines were compared and association with obesity was estimated.

Results: Total 149 (70.9%) subjects showed HTN according to new (AHA 2017) guidelines, compared to 81 (38.5%) hypertensive subjects according to old (JNC 7, 2003) guidelines. Only 27 subjects (12.8%) were diagnosed hypertension cases, while 122 (58%) subjects were having undiagnosed HTN. HTN was more common in males, compared to females, but obesity was more common in females compared to males. Obesity indices, age, height and body weight were significantly correlated with blood pressure. Increasing age, central obesity (high waist circumference and high waist-height ratio) and male gender was found to be significant risk factor for HTN.

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Conclusions: Burden of HTN is found to be much higher than before when new AHA (2017) HTN guidelines are applied for classification in Indian subjects. There is urgent and increased need to manage measures like lifestyle modifications, diet management and regular exercise to prevent obesity and HTN.

Introduction

Hypertension (HTN) and obesity both are on rise in India, as well as in other countries (1-4). Although HTN is a modifiable risk factor for cardiovascular diseases, still it is the leading cause of mortality (2). After revised guidelines for HTN in 2017 by American Heart Association (AHA), more individuals have come under hypertensive category, as persons having ≥130 mmHg systolic blood pressure (SBP) and ≥80 mmHg diastolic blood pressure (DBP) are now considered as hypertensive (5, 6). This new guideline implies that many of such hypertensive individuals may remain undiagnosed and do not seek medical attention.

Obesity associated with HTN is a well recognized complication now (2, 7, 8). Metabolic abnormalities associated with obesity, like high triglycerides, low high density lipoprotein (HDL), high blood glucose levels and sedentary life style contribute to development of non communicable diseases like HTN and diabetes mellitus (7). Significant positive correlation of obesity and HTN has already been reported in India as well as other countries (5, 8-12). It is established now that risk for development of HTN increases with obesity (7).

Various anthropometric measurements are applied for assessment of obesity, defining generalized and/ or central obesity. Body Mass Index (BMI) is commonly used as a measure for generalized obesity, while parameters like waist circumference (WC) and waist height ratio (WHtR) are used for assessment of central obesity. A meta analysis including population of various ethnicity concluded that abdominal obesity indices (especially WHtR) are better discriminators for HTN risk as compared to BMI (13).

It has been observed that Indian population shows higher risk of cardio-metabolic diseases even at lower values of obesity indices, compared to western populations (1, 14, 15). Although some previous studies in Indian subjects have reported obesity pattern and their association with HTN using previous guideline of Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and treatment of High Blood Pressure (JNC 7, 2003) (16), but with new criteria (AHA 2017) for HTN and obesity classification (especially BMI), there is need of fresh assessment following recent guidelines (1, 5, 17, 18). Contribution of different patterns of obesity in development of different types of HTN (systolic and/ or diastolic) is still not well understood and still needs further exploration. Thus in this study, we examined blood pressure (BP) and obesity in Indian population and compared disease burden according to old (JNC 7, 2003) and new (AHA 2017) guidelines of HTN. We also analyzed association of BP with obesity indices and evaluated generalized and central obesity for assessment of risk of HTN.

Methods

This cross sectional study was conducted in Department of Biochemistry, Institute of Medical Sciences, Banaras Hindu University, Varanasi, India. All procedures involving human subjects were approved (No. Dean/2018/EC/559) by ethical committee of Institute of Medical Sciences, Banaras Hindu University. Residents of Varanasi who voluntarily visited the institute were offered free blood pressure and obesity indices measurements. All consecutive visitors (self reported hypertensive as well as apparently healthy), aged above 18 years, who were willing to participate in this study and who gave written informed consent were enrolled and tested. Upper limit of age was not kept to include subjects of all age groups above 18 years. Subjects younger than 18 years age and unwilling for participation in all measurements were excluded. Total

210 subjects were included in this study. All testing and measurements were performed during Departmental visiting hour (from 10 AM to 4 PM) on 22-23 March 2018.

All measurements were taken by resident doctors of the Department. Subjects were instructed to remove heavy clothing or ornaments and shoes. Calibrated weighing balance (Crown Victoria Dx, Ramon surgical company, India) was used to measure Weight (Wt) (to nearest 0.5 Kg) and wall mounted stature meter (EasyCare, Krives international limited, Hongkong) was used to measure Height (Ht) of subjects (to nearest 0.5 cm) (19). WC was measured with non flexible measuring tape (Futaba, India), at the level between lower border of costal margin and iliac crest, at end of expiration. BMI (kg/m^2) was calculated from Wt and Ht data and following criteria was applied for classification- <18.5- Underweight; 18.5 to 22.9- Normal; 23 to 24.9- Overweight and ≥25- obese (14). WC cut off was taken as ≥90 cm for male and ≥80 cm for female subjects (14, 20). WHtR cut off was taken as ≥0.5 for all subjects (20, 21).

For BP measurement, subjects were made to sit comfortably on a chair and suggested to relax. After rest and relaxation of 5-10 min, BP was measured using a mercury sphygmomanometer (Infi Deluxe, Infinity Mediquip India) with cuff tied appropriately on subject's right arm placed on the table. Average of two consecutive BP values, taken 1-2 minutes apart, was recorded. BP measurement was repeated in subjects showing HTN range readings, for confirmation. For old (JNC 7, 2003) and new (AHA 2017) HTN guidelines BP cut off limits given in supplementary table were followed (5).

Statistical analysis:

Statistical analysis was performed using Statistical Package for Social Science (SPSS) software, version 20. Mean and standard deviations were calculated for descriptive analysis. Comparison of means between groups was done by student t test. Pearson correlation test was applied to find correlation between measured anthropometric parameters and BP. Chi square test and odds ratio were calculated to find associated risk of HTN with obesity between different groups. P value <0.05 was considered significant.

Results

Total 210 subjects participated in the study, out of which 27 subjects (12.8%) were self reported known cases of HTN undergoing medical treatment with antihypertensive drugs. Known cases consisted of 23 males (85%) and 4 females (15%). Among remaining 183 apparently healthy subjects, 132 (72.1%) were males and 51 (27.9%) were females. Blood pressure status of all subjects, according to old and new guidelines is given in Fig. 1. Data shows that number of subjects under HTN category increases from 38.5% to 70.9% in total subjects (including self reported diagnosed cases), and from 25.7% to 58% in only undiagnosed subjects when new guidelines of HTN are used compared to old guidelines. It was also observed that male gender had higher number of elevated and hypertensive BP compared to females, thus indicating male gender as risk factor for hypertension according to both old (JNC 7, 2003) and new (AHA 2017) guidelines (Fig. 1).

For further analysis, known cases of diagnosed HTN were removed to avoid medication related confounding effects. Descriptive statistics of measured parameters and comparison between male and female subjects are given in Table I. Both systolic and diastolic blood pressure, Wt, Ht and WHtR were found significantly different in male and female subjects, but there was no significant difference in age, BMI and WC. Males had higher SBP, DBP, Wt and Ht but lower WHtR than females (Table I). On analysis of obesity pattern, female group showed higher percentage of obese subjects compared to male group in all measured obesity indices, and central obesity was found more than generalized obesity in both groups (Fig. 2). Although number of females were less than males in overweight category of BMI (Fig. 2).

Next, correlations of SBP and DBP with other measured parameters were calculated to identify risk factors for HTN (Table II). Age showed positive correlation with SBP in both male and female subjects

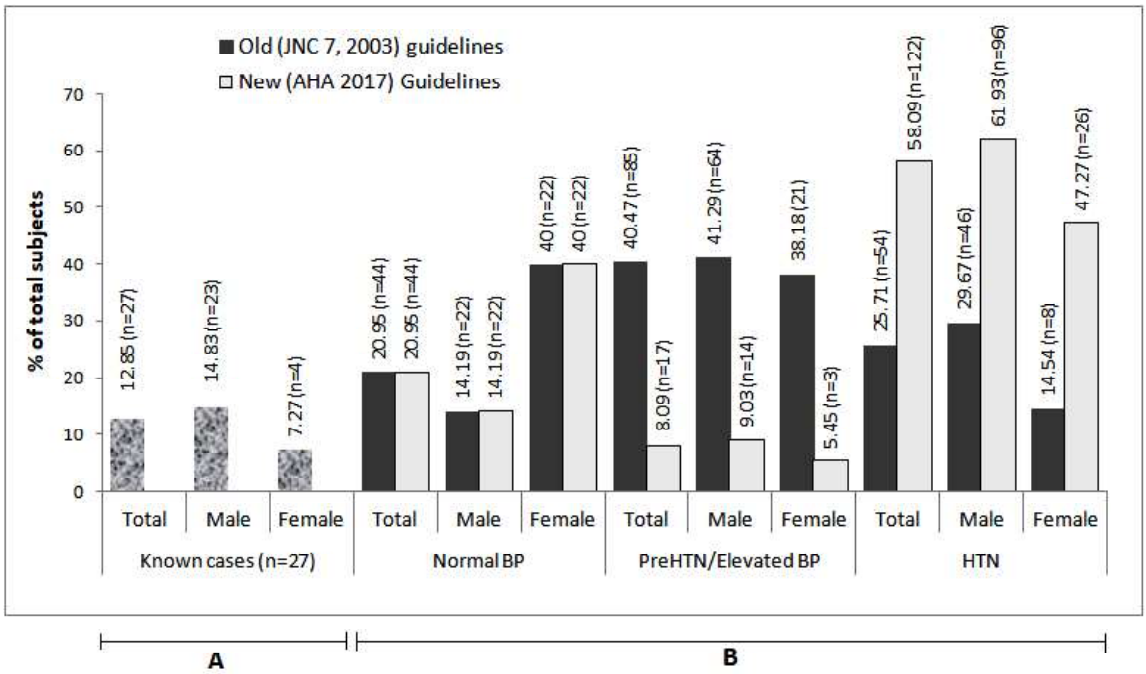

Fig. 1: Percent wise distribution of blood pressure status and hypertension in studied subjects, according to old and new guidelines (% calculated from Total subjects n=210, Males n=155, Females n=55).

TABLE I: Descriptive data and comparison between male and females.

	Total (n=183)		*Female (n=51)*		*Male (n=132)*		*Female vs Male*	
	Mean	*Std. Deviation*	*Mean*	*Std. Deviation*	*Mean*	*Std. Deviation*	*t*	*P value*
Age	37.78	15.18	35.43	13.86	38.68	15.62	-1.301	0.195
SBP (mmHg)	123.92	17.90	115.69	14.73	127.10	18.05	-4.024	<0.000*
DBP (mmHg)	80.99	9.85	76.55	10.29	82.71	9.15	-3.940	<0.000*
Weight (kg)	65.73	13.28	58.67	12.44	68.46	12.61	-4.725	<0.000*
Height (cm)	165.07	9.23	155.39	6.83	168.81	7.08	-11.611	<0.000*
BMI (kg/m^2)	24.11	4.52	24.41	5.52	23.99	4.09	0.495	0.622
WC (cm)	89.59	11.56	89.68	11.18	89.56	11.75	0.066	0.948
WHtR	0.54	0.07	0.57	0.07	0.53	0.07	3.851	<0.000*

(*Statistically significant; SBP, systolic blood pressure; DBP, diastolic blood pressure; BMI, body mass index; WC, waist circumference; WHtR, waist height ratio).

but with DBP in only males, not females. Body weight and BMI showed significant positive correlation with SBP and DBP in all groups (male, female, total). Ht was found significantly associated with SBP only when calculated for total population, not in male or female groups, or with DBP. WHtR was found significantly associated with SBP in males (not in females) and with DBP in both males and females (Table II).

Risk of systolic and diastolic HTN was calculated for all identified risk factors and analysis is given in Table III. Obese range BMI showed higher risk of systolic HTN in females and diastolic HTN in male subjects. High WC and WHtR showed significantly increased risk of elevated SBP and systolic and diastolic HTN in only male subjects, not in females. Male gender was also found as significant risk factor for development of elevated SBP, and systolic and

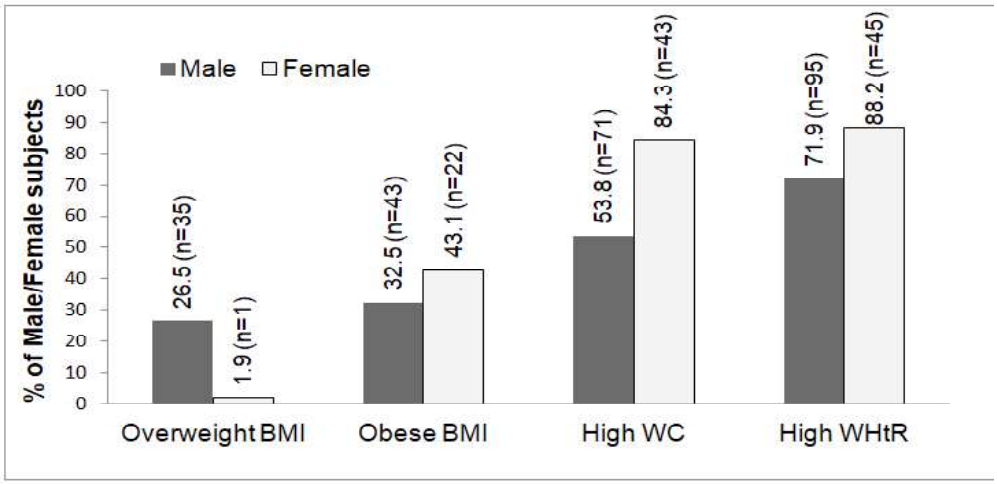

Fig. 2 : Percent wise distribution of male and female subjects having overweight BMI, obese BMI, high WC and high WHtR.

TABLE II : Correlations of measured parameters with systolic and diastolic blood pressure.

		Systolic Blood Pressure			*Diastolic Blood Pressure*		
		Total (n=183)	*Male (n=132)*	*Female (n=51)*	*Total (n=183)*	*Male (n=132)*	*Female (n=51)*
Age	Correlation	0.457**	0.454**	0.436**	0.285**	0.279**	0.252
	P value	<0.000	<0.000	0.001	<0.000	0.001	0.074
Weight	Correlation	0.347**	0.235**	0.424**	0.448**	0.338**	0.521**
	P value	<0.000	0.007	0.002	<0.000	<0.000	<0.000
Height	Correlation	0.146*	-0.012	-0.203	0.067	-0.010	-0.202
	P value	.048	0.887	0.153	0.183	0.911	0.155
BMI	Correlation	0.286**	0.258**	0.464**	0.411**	0.379**	0.553**
	P value	<0.000	0.003	0.001	<0.000	<0.000	<0.000
Waist Circumference	Correlation	0.294**	0.335**	0.219	0.682**	0.358**	0.248
	P value	<0.000	<0.000	0.123	<0.000	<0.000	0.079
WHtR	Correlation	0.207**	0.328**	0.267	0.449**	0.352**	0.289*
	P value	0.005	<0.000	0.059	<0.000	<0.000	0.040

*significant at level 0.05; **significant at level 0.01

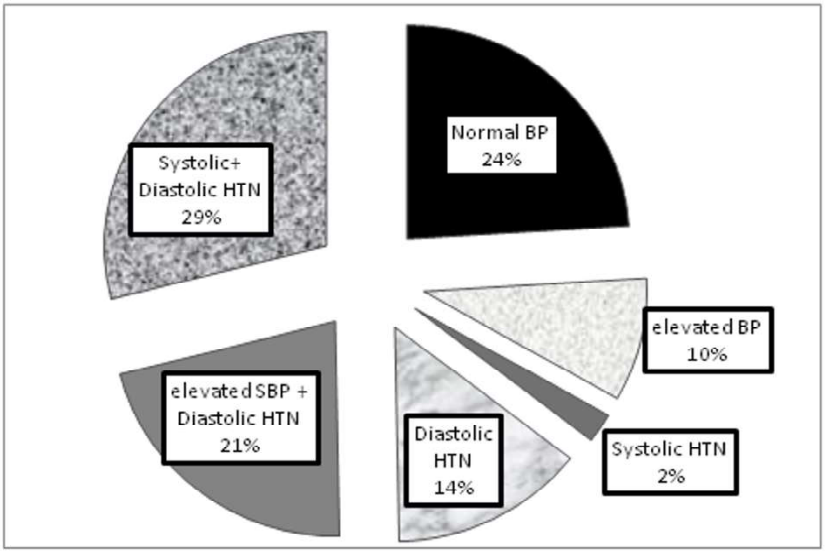

Fig. 3 : Distribution of blood pressure status in study subjects (known cases of hypertension excluded) according to new (AHA 2017) guidelines. n=183.

TABLE III: Risk of systolic and diastolic hypertension associated with risk factors.

Blood Pressure status	*Males*				*Females*			
	Frequency	*X^2 test*	*P value*	*Odds ratio (95% CI)*	*Frequency*	*X^2 test*	*P value*	*Odds ratio (95% CI)*
Obese range BMI (≥25 kg/m²)								
1. Normal SBP	7	–	–	–	9	–	–	–
2. Elevated SBP	16	0.834	0.362	1.71 (0.53–5.47)	4	0.734	0.392	2.00 (0.40–9.90)
3. Systolic HTN	20	2.030	0.154	2.28 (0.72–7.20)	9	12.00**	0.001	–
4. Normal DBP	6	–	–	–	7	–	–	–
5. Diastolic HTN	37	5.103*	0.024	3.30 (1.13–9.59)	15	2.316	0.128	2.57 (0.75–8.78)
6. Overall HTN	37	2.529	0.112	2.387 (0.80–7.10)	15	2.316	0.128	2.57 (0.75–8.78)
High WC (≥90 cm for male and ≥80 cm for female)								
1. Normal SBP	12	–	–	–	25	–	–	–
2. Elevated SBP	46	8.805**	0.003	3.83 (1.55–9.49)	9	0.697	0.404	2.52 (0.27–23.42)
3. Systolic HTN	30	9.324**	0.002	3.97 (1.60–9.80)	9	2.374	0.123	–
4. Normal DBP	15				21			
5. Diastolic HTN	56	5.23*	0.022	2.42 (1.12–5.21)	22	0.004	0.952	1.04 (0.23–4.73)
6. Overall HTN	57	4.421*	0.036	2.29 (1.04–5.03)	22	0.004	0.952	1.04 (0.23–4.73)
High WHtR (≥0.5)								
1. Normal SBP	18	–	–	–	27	–	–	–
2. Elevated SBP	38	12.47**	<0.000	5.54 (2.06–14.89)	9	0.197	0.657	1.66 (0.17–16.22)
3. Systolic HTN	39	12.93**	<0.000	5.68 (2.11–15.26)	9	1.602	0.206	–
4. Normal DBP	22	–	–	–	21	–	–	–
5. Diastolic HTN	73	6.643**	0.010	2.82 (1.26–6.29)	24	0.847	0.357	2.28 (0.38–13.76)
6. Overall HTN	74	4.563*	0.033	2.40 (1.06–5.43)	24	0.847	0.357	2.28 (0.38–13.76)
Gender – Male								
1. Normal SBP	39	–	–	–	–	–	–	–
2. Elevated SBP	46	10.475**	0.001	3.77 (1.64–8.64)	–	–	–	–
3. Systolic HTN	47	12.043**	0.001	4.28 (1.82–10.05)	–	–	–	–
4. Normal DBP	39	–	–	–	–	–	–	–
5. Diastolic HTN	93	11.307**	0.001	2.93 (1.55–5.55)	–	–	–	–
6. Overall HTN	96	7.829**	0.005	2.56 (1.31–5.00)				

*significant at level 0.05; **significant at level 0.01

diastolic HTN (Table III).

Discussion

AHA 2017 guidelines for HTN diagnosis and classification have lowered the cut off limits of hypertensive BP, as persons having ≥130 mmHg SBP and ≥80 mmHg DBP are now considered as hypertensive. Thus, we suspected that disease burden of HTN must rise following AHA 2017 guidelines. To examine it, we conducted this comparative study in 210 subjects from Varanasi, Uttar Pradesh, India, where we measured BP and compared the disease burden according to new (AHA 2017) as well as old (JNC 7, 2003) guidelines; and also analysed association with obesity indices.

This study showed that among total subjects 12.8% were self reported known cases of HTN who were aware of their HTN status and were undergoing medical treatment. Many of remaining population (58%, n=122) also showed hypertensive BP according to new (AHA 2017) guidelines, who were having undiagnosed hypertension but did not seek medical help for this. Previous studies in Indian population also show that majority HTN cases remain undiagnosed and unaware, and do not take medical treatment (22). Overall 149 (70.9%) of our study subjects were having hypertension according to new (AHA 2017) HTN guidelines, while only 81 (38.5%) would be labelled hypertensive according to old (JNC 7, 2003) guidelines. Number of undiagnosed hypertensive individuals in present study population increased from 25% to 58% when new HTN guidelines

were followed, as many individuals who were previously under pre-hypertensive category are now classified as hypertensive (Fig. 1). Present study population showed higher occurrence of HTN compared to many previous reports of Indian population from different states (22-30) and much higher than previous report from same district as our study population (31, 32) which followed old (JNC 7, 2003) criteria for HTN diagnosis. The only study we found that used new (AHA 2017) HTN guidelines is from Rouf et al., which reported prevalence of HTN to be 63.7% in adult population of Srinagar, India (33). This warrants increased disease burden and need of lifestyle changes and resetting of treatment threshold (5). Distribution of BP status and type of HTN in 183 subjects according to new (AHA 2017) guidelines is depicted in Figure 3, showing that only 24% subjects have normal BP, and most (35%) subjects have diastolic HTN (with or without elevated SBP) followed by subjects having both systolic and diastolic HTN (29%).

Male subjects showed higher occurrence of hypertension (62%), compared to females (47%) (Fig. 1), similar to previously reported study in Indian subjects showing prevalence of 18% to 66.9% in males and 16% to 62% in females (12, 23, 29, 32-34), indicating that male gender is associated with higher risk of hypertension. Some previous studies in Indians have shown opposite results as female subjects showed higher prevalence of HTN than males (29, 35, 36). Although previous study in Indians from Puducherry and Nigerian adults reported no significant gender based association of prevalence of HTN (16, 37), Some Indian studies like ICMR-INDIAB study have clearly identified male gender as risk factor for HTN in Indian population from different states (23, 32, 34, 38). When risk for male gender was calculated in our study population, it showed that males are 2.56 times more likely to have any type of HTN overall (3.77 times more likely to have elevated SBP, 4.28 times more likely to have systolic HTN and 2.93 times more likely to have diastolic HTN) compared to females (Table III). Results from present study show higher risk compared to earlier study in Varanasi population which used old HTN guidelines (32).

Male subjects showed higher blood pressure (both systolic and diastolic), Wt and Ht compared to female subjects, but female subjects showed higher WHtR than males (Table I). Mean SBP and DBP of females were lower than previously reported study in Indian females from Delhi, Wardha (Maharashtra), rural West Bengal and Indian tribal villages (12, 27, 30, 34), but higher than rural Assam females (36). Mean SBP and DBP in males was found higher than previous reports of Indian males from Wardha Maharashtra, Bengalee hindu slum dwellers of eastern India, rural West Bengal, different states and tribal population of villages from each state of India (12, 27, 30, 39, 40), but lower than rural Assam and Delhi males (34, 36). Mean SBP and DBP, BMI and WC of total population was higher than previously reported values in studies including central Indian subjects from rural and urban background, and different geographical regions of India (29, 41). Comparing with previous study involving individuals from same district as present study, male subjects showed higher, while female subjects showed lower mean SBP and DBP (32).

Correlation analysis identified that age of subjects, Wt, BMI, WC and WHtR are significantly associated with BP (both systolic and diastolic), as also reported earlier in India as well as other countries (10-12, 16, 30, 34, 37). Female subjects did not show correlation of SBP with WC and WHtR, and DBP with age and WC (Table III). Male subjects showed positive and significant correlation of SBP and DBP with all measured parameters and obesity indices, except Ht (Table II). Increasing age has already been reported to be positively correlated with HTN due to age related degenerative changes in vessel wall, including inflammations and oxidative stress (7, 16, 22, 24, 29, 31, 35).

Central obesity was more prevalent than generalized obesity (Fig. 2), as also reported earlier in Indian subjects (3). Present study also confirmed that risk of HTN increases in obese individuals, agreeing with many previous studies in Indian population (8, 22, 28-30, 38). Although obesity was found more in female subjects, HTN was more common in males (Fig. 1 and Table I). This pattern has already been reported

in Indians (12, 26, 29, 33, 34, 42). Risk assessment of obesity indices in our study population showed that central obesity (high WC and WHtR) is associated with higher occurrence of HTN, more than generalized obesity (obese range BMI) as also reported previously (29, 39, 40, 42). But opposite pattern has also been observed in Indian as well as Chinese studies where generalized obesity (high BMI) was found to have larger association and risk of HTN than central obesity (32, 43, 44). Generalized obese (obese range BMI) male subjects in present study showed higher risk of diastolic HTN, while females showed higher risk of systolic HTN (Table III). In males, obese range BMI did not show significant risk for systolic HTN, but showed higher risk of diastolic HTN, compared to normal range BMI males. Earlier studies in Indians and Nigerian adults have reported 2-4 times higher risk of HTN in generalized obese subjects (9, 16, 32, 34, 38), but present study did not show any such statistically significant risk for overall HTN (Table III).

When observing central obesity, only male subjects with higher WC and WHtR showed higher risk of systolic and diastolic HTN, not females (Table III). Although correlation analysis showed positive correlation of obesity indices with BP in females, the associated risk analysis failed to prove any significant difference in occurrence of HTN among centrally obese and non obese females. Even though females had more number of cases of obesity (Fig. 2) according to all measured indices (BMI, WC and WHtR), they are somehow protected from HTN, suggesting that effects of adiposity are different in males and females. Male subjects in this study with central obesity (high WC and WHtR) showed >2 times higher risk for HTN compared to non obese males (Table III). Previous reports in Indian subjects from Kolkata, also suggest that abdominal obesity (high WC) in men is best measure to predict HTN compared to BMI (26, 45).

Most white adipose tissue (WAT) deposits subcutaneously and around abdomen (central obesity) (2). WAT modulate vascular functions by releasing pro-inflammatory cytokines and ROS, and also by affecting vascular tone (2). This study reports higher burden of HTN in Indian subjects when new guidelines for classification of BP are applied. Significant association of obesity, especially central obesity with BP and risk of HTN was also observed in present study. Such alarming burden of HTN demands urgent measures for BP management, lifestyle modifications like diet control and exercise. Diet management, especially intermittent fasting has shown positive effects on metabolic functions (2). Exercise on the other hand promotes overall improvement in body composition by reducing adipose tissue and increasing growth of lean body mass, which has cardio-metabolic protective effects (2, 46). As most previous studies from India have followed old (JNC 7, 2003) guidelines for HTN and obesity classification (5, 25), it was limiting factor for comparison of results from present study with previous reports. Further studies including data of duration of disease, life style habits, medications, other systemic diseases, effects of substance abuse (alcohol, tobacco etc) and socio-economic characteristics are suggested.

Limitation of the study:

Sample size and study population (Varanasi city only) are limitations of this study. Further research including larger sample size and study area should be performed for better assessment of impact of AHA 2017 guidelines for hypertension classification.

Conclusion

This study shows that burden of hypertensive individuals is much higher according to new AHA 2017 HTN guidelines, compared to old guidelines. Age and obesity indices of subjects are significantly correlated with their BP. Central obesity (high WC and high WHtR) and male gender were identified to be associated with 2-4 times higher risk of HTN in Indian subjects. Following latest guidelines (AHA 2017) for HTN diagnosis and obesity to estimate current disease burden and extensive analysis of data for risk assessment are merits of present study. Results from this study show that there is urgent need of lifestyle modifications like diet management and regular exercise to prevent obesity and HTN.

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