EUROPEAN JOURNAL OF BIOMEDICAL AND PHARMACEUTICAL SCIENCES
http://www.ejbps.com

ISSN 2349-8870
Volume: 4
Issue: 12
624-629
Year: 2017

PREVALENCE OF PREHYPERTENSION AND ITS ASSOCIATION WITH OBESITY MARKERS IN YOUNG INDIAN ADULTS

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Article Received on 10/10/2017 **Article Revised on 30/10/2017** **Article Accepted on 20/11/2017**

ABSTRACT
High blood pressure (BP) is a growing global public health problem. Hypertension (HT) and obesity are threatening facts of public health. Thus it is lifesaving to carryout BP and obesity measurements for early detection of cardiovascular risks. Prehypertension (PreHT) predicts the individuals who entertain a risk of HT. Thus the aim of this study was to determine prevalence of PreHT and its association with obesity markers.This cross sectional survey was conducted in semi urban college students of West Bengal, India. The anthropometric and BP measurements were carried out on 1653 (males-655 and females-998) students. General obesity was estimated from body mass index (BMI), Central obesity from waist circumference (WC) and waist-to-height ratio (WHtR) and upper body obesity from neck circumference (NC) and neck-to-height ratio (NHtR). Body height, weight, WC, NC and BP were measured by standard methods. BMI, WHtR and NHtR were estimated. Pearson's correlation was done to determine correlation between BP and anthropometric indices. Percentiles of BMI, NC, WC, NHtR and WHtR and prevalence of PreHT were determined. $P<0.05$ values were considered as statistically significant. The overall prevalence of PreHT was 20% and it was 25% for males and 19% for females. Prevalence of PreHT was significantly higher in male than their female counterpart. All the obesity markers are positively correlated with BP. Correlation coefficient of NC with BP was higher than all other correlation coefficient. All the indices above 85th percentile values may be consider as predictors for PreHT. Out of three obesity markers, NC was the best marker for early Prediction of PreHT risks among young Indian adults.

KEYWORDS: Prehypertension, BMI, neck circumference, waist circumference, neck-to-height ratio, waist-to-height ratio.

INTRODUCTION
Hypertension (HT) is the commonest non communicable disease affecting both sexes in all races.[1] It places the affected individuals at an increased risk of cardiovascular accident, ischemic heart disease and renal failure.[2] This disease is a silent threat to the health of people all over the world. Around one billion adult world population was found to have HT in the year 2000 and this is expected to increase to 1.56 billion by 2025.[3,4] HT-induced complications are responsible for 9.4 million deaths worldwide every year.[5] The development of hypertension in younger age causes greater reduction of life expectancy if the blood pressure is left untreated.[6] It has also been noted that even asymptomatic adolescents with blood pressure elevation can have target organ damage including left ventricular hypertrophy and pathological vascular changes.[7,8] Prehypertension is an important aspect of elevated blood pressure. It predicts the individuals who entertain a risk of hypertension in future life. It is a cautionary signal for patients and health professionals to take intervention measures with regards to lifestyle.[9]

Obesity is rising to pandemic proportions and is an important risk factor for cardio metabolic diseases including diabetes, hypertension and coronary heart disease.[10] The distribution of excess body fat play an essential role in the development of cardiovascular risk factors.[10] Visceral fat, upper body subcutaneous fat and lower body fat exert an independent effect toward for the development of cardiovascular risk.[11] General obesity was measured by BMI but it restricted in screening regional body fat distribution. WC is superior to BMI in identifying central adiposity reflecting higher cardiovascular risk.[12] Neck circumference (NC) has been suggested as an index of upper body fat distribution.[13] High NC is cardiovascular risk factor in adults.[14,15] Both NC and WC are better predictors of some obesity related complications including hypertension and other cardiovascular events.[16]

Prevalence of obesity is high in India. Thus it is fundamental to carryout BP and body fat measurement for early detection of cardio vascular risks. Although some research has been carried out on hypertension and obesity but data about prehypertension was limited. No previous study has investigated association between PreHT and obesity among East Indian young adults.

The aim of this study was to determine prevalence of prehypertension and its association with general, central and upper body fat markers.

METHODS

Subject: The present study was conducted among normal healthy college students aged 18-20 years from two colleges in West Bengal, India during their college hours. The prior written permission of college authority was taken. Written consent from the students experimented in the study was obtained. 1685 students were included in this study. Every students in this study was given a predesigned questionnaire to obtain the information regarding age, last blood pressure readings, diabetes, kidney disease, congenital heart defect, myocardial infarction and/or stroke. 32 subjects were excluded from the statistical analysis because they had any of the following diseases: endocrine disorder, diabetes mellitus, kidney diseases, cardiovascular diseases or congenital heart defects.

Measurement of blood pressure: Blood pressure was measured with a standard mercury sphygmomanometer. Before recording the blood pressure students were allowed to wait in separate room for 10 minutes to relieve their restlessness and anxiety. Each student was then called one by one and pressure was measured in the sitting posture in the right upper arm. Three readings were taken at 5 minute intervals and their mean was taken as subject's blood pressure. Systolic blood pressure was recorded on hearing the first sound (phase I) while diastolic blood pressure was taken on complete disappearance of Korrotkov sounds (phase V). Normotensive, pre hypertensive and hypertensive status of blood pressure were estimated by considering National high blood pressure education program, 2005.[17]

Anthropometric measurements: Prior to the weight and height measurement subjects were asked to remove their shoes and heavy clothing. Body weight was measured using bathroom scale accurate to 0.5kg. The scale was kept on a flat surface and adjusted with '0' mark. Now the subject was requested to step on it in bare feet. Weight was recorded to the nearest 0.5kg.

For the measurement of height and NC subjects were asked to stand still and quiet and erect position, hanging their arms freely and keeping their head aligned in the Frankfort plane. Two measurements were recorded to the nearest 0.1 cm for each subject. Height was measured using anthropometric rod. NC was measured just below the laryngeal prominence (Adam's apple) using calibrated plastic tape.[10] WC was measured mid-way between iliac crest and lowermost margin of the ribs in quiet breathing using plastic tape.[10]

Waist- height- ratio (WHtR) was calculated by dividing waist circumference with height. WHtR= WC (cm) / height (cm). Similarly neck-height-ratio was calculated using following equation: NHtR= NC (cm) / Height (cm). BMI was calculated from the height and weight using following equation: BMI (kg/m^2) = weight (kg) / $height^2$ (m).

Percentiles of all obesity markers were obtained using Microsoft software. Prevalence of PreHT both above and below 85^{th} percentile of every markers were calculated.
Statistical analysis: Data obtained from the study were given as mean ± SD. The statistical significance was determined by student's t test. Two tailed p values were used throughout and p value less than 0.05 were judged as statistically significant. Pearson correlation coefficient was calculated to find out the degree and direction of association between two parameters.

RESULTS

Among 1653 study subjects aged 18-20 years, 655 (39.6%) were male and 998 (60.4 %) were female. The mean age of the participant was 19 years. There was no significant difference between male and female on the basis of age. Males are significantly taller and heavier than females. Mean values of BMI, NC, WC, NHtR and WHtR were significantly higher in male subjects. The overall prevalence of prehypertension was 21.96% but it was 25.65% for male and 19.54% for female (table-2). Thus prevalence of hypertension was significantly higher in male than female counterparts.

Table 1: Characteristics of study population on the basis of gender.

Variable	Total (n=1653)	Male (n=655)	Female (n=998)	P value
Age (year)	19.28 ± 1.16	19.36 ± 1.22	19.23 ± 1.11	>0.05
Weight (kg)	54.60 ± 12.31	60.74 ± 12.73	50.56 + 10.17	<0.05
Height (cm)	159.02 ± 9.04	167.20 ± 6.72	153.66 + 5.77	<0.05
BMI (kg/m2)	21.51 ± 4.09	21.70 ± 4.48	21.40 ± 4.03	>0.05
WC (cm)	77.39 ± 10.73	78.60 ± 11.02	76.62 ± 10.46	<0.05
NC (cm)	32.43 ± 3.06	34.63 ± 2.56	31.00 ± 2.45	<0.05
WHtR	0.487 ± 0.067	0.470 ± 0.063	0.499 ± 0.068	<0.05
NHtR	0.204 ± 0.016	0.207 ± 0.015	0.202 ± 0.017	>0.05
SBP (mmHg)	118.59 ± 14.42	124.57 ± 13.30	114.66 ± 13.78	<0.05

DBP (mm Hg)	74.54 ± 9.27	76.10 ± 9.02	73.52 ± 9.16	<0.05
Normotensive	1290 (78.04%)	487 (74.35%	803 (80.46%)	<0.05
PreHT	363 (21.96%)	168 (25.65%)	195 (19.54%)	<0.05

Data represent mean ± standard deviation

Association between BP and anthropometric indices were given in table-2. Significant positive correlation was observed between BP and all anthropometric study parameters. The degree of association with systolic blood pressure (SBP) was more than diastolic blood pressure (DBP) in all cases of male and female subjects. All the correlation coefficients were more in female than male counterpart. Maximum correlation was noted with neck circumference for both male and female subjects. All the obesity markers were significantly positively correlated with each other (table-3).

Table-2: Correlation between anthropometric markers and blood pressure.

Parameters	Overall (n=1653)		Male (n=655)		Female (n=998)	
	SBP	DBP	SBP	DBP	SBP	DBP
NC (cm)	+ 0.486	+ 0.352	+ 0.323	+ 0.275	+ 0.418	+ 0.383
WC (cm)	+ 0.345	+ 0.293	+ 0.288	+ 0.234	+ 0.369	+ 0.320
NHtR	+ 0.346	+ 0.301	+ 0.240	+ 0.215	+ 0.358	+ 0.328
WHtR	+ 0.216	+ 0.228	+ 0.248	+ 0.207	+ 0.347	+ 0.301
BMI	+ 0.377	+ 0.336	+ 0.306	+ 0.240	+ 0.443	+ 0.400

Pearson's correlation coefficient was calculated; $p<0.001$ in all cases

Table-3: Relationship between anthropometric indices of the study subjects.

Parameter	NC	WC	NHtR	WHtR	BMI
Overall (n=1653):					
NC	1	0.600	0.795	0.380	0.551
WC	0.600	1	0.563	0.914	0.717
NHtR	0.795	0.563	1	0.600	0.627
WHtR	0.380	0.914	0.600	1	0.704
BMI	0.551	0.717	0.627	0.704	1
Males (n=655):					
Parameter	NC	WC	NHtR	WHtR	BMI
NC	1	0.694	0.848	0.626	0.663
WC	0.694	1	0.559	0.956	0.715
NHtR	0.848	0.559	1	0.653	0.657
WHtR	0.626	0.956	0.653	1	0.732
BMI	0.663	0.715	0.657	0.732	1
Females (n=998)					
Parameter	NC	WC	NHtR	WHtR	BMI
NC	1	0.666	0.895	0.638	0.638
WC	0.666	1	0.560	0.962	0.706
NHtR	0.895	0.560	1	0.657	0.610
WHtR	0.638	0.962	0.610	1	0.714
BMI	0.368	0.706	0.610	0.714	1

Various percentile values of all anthropometric parameters were calculated and presented in table-4.

Table-4: Percentile values of obesity indices of young Indian adults.

Percentile	Anthropometric parameters				
	NC (cm)	WC (cm)	NHtR	WHtR	BMI (kg/m^2)
Males (n=655)					
50th	35.0	78.0	0.206	0.467	21.1
75th	36.0	85.0	0.218	0.511	24.0
85th	37.0	90.0	0.223	0.531	25.4
90th	38.0	93.0	0.227	0.556	26.9
95th	39.0	98.2	0.232	0.580	29.1
Females (n=998):					
50th	31.0	76.0	0.201	0.498	20.8
75th	32.4	83.0	0.211	0.540	23.1
85th	33.2	87.0	0.219	0.568	25.3
90th	34.0	90.0	0.224	0.587	26.9
95th	35.0	94.0	0.232	0.610	29.1

Prevalence of PreHT on the basis of percentile of obesity indices were given in table-5.There was a significant difference of prevalence of PreHT above and below 85th percentile of obesity indices. Thus 85th percentile of obesity indices would be consider as best cut off point for prediction of PreHT.

Table-5: Prevalence of prehypertension on the basis of percentile of obesity indices.

Parameters	<85th	<85th	>90th	>95th
Males (n=655):				
NC	22.0%	49.4%	52.3%	53.8%
WC	23.7%	43.9%	46.3%	60.0%
NHtR	22.7%	42.0%	42.4%	48.3%
WHtR	23.5%	41.8%	45.2%	53.1%
BMI	21.8%	46.2%	50.0%	50.0%
Females (n=998):				
NC	13.8%	52.0%	57.3%	64.7%
WC	14.8%	47.3%	54.8%	56.5%
NHtR	14.2%	50.7%	53.7%	60.4%
WHtR	14.5%	48.3%	52.0%	60.4%
BMI	13.5%	50.3%	51.5%	62.2%

By considering 85th percentile as cutoff point the prevalence of neck obesity, abdominal obesity and general obesity was presented in table-6. The prevalence of PreHt with neck obesity was 49.42 % for males and 52.0 % for females; for abdominal obesity prevalence was 43.9 % and 47.26 % respectively for males and females. 45.30% of overweight and obese males and 51.3 % of same category females were Prehypertensive (see table-5).

Table-6: Prevalence of obesity among males and females.

Type of obesity	Anthropometric indices	Males (n=655)	Females (n=998)
Neck obesity	NC	87 (13.28%)	150 (15.03%)
	NHtR	100 (15.27%)	146 (14..63%-
Central Obesity	WC	82 (12.52%)	146 (14.63%0
	WHtR	98 (14.96%	149 (14.93%)
General obesity	BMI	117 (17.86)	176 (17.63%)

DISCUSSION

The aim of the present study was to examine the prevalence of prehypertension and association of different body fat markers with risk of prehypertension among young Indian adults having age limit18-21years.The present study shows that the overall prevalence of PreHT was 20% and it was 25% for males and 19% for females. Prevalence of PreHT was significantly higher in male than their female counterpart.

The distribution of excess body fat play an essential role in the development of cardiovascular disease.[18] Development of cardiovascular disease vary on different body fat depot.[19] The general obesity which is detected by BMI is failed to detect regional obesity. WC which detects central or abdominal obesity reflects higher cardiovascular disease risk.[20] Combination of BMI and WC measurements are associated with a higher risk of elevated blood pressure.[21,22] WC which reflects central obesity, is a major risk factor for cardiometabolic conditions.[20] Recently NC has been proposed as a surrogate marker of central obesity in children and adults.[23,24] NC which reflects upper body subcutaneous fat[25] provides an alternative screening tool for cardio vascular disease risk as well as pre hypertension.[5]

All the obesity markers are positively correlated with BP. All the tested obesity markers were significantly associated with each other. All the indices above 85th percentile values were the best predictors for PreHT. In compared to traditional obesity markers such as BMI and WC, NC showed higher positive association with systolic as well as diastolic blood pressure.

The main advantage of measurement of NC is that it is simple, quick and low cost method that requires less effort from examiner and examinee. NC measurement is not impeded by clothing or last meal. NC is measured on a body surface that is more stable. On the other hand the values of WC vary according to the anatomic site used for the measurement or within day. In addition, the measurement of NC may be more socially accepted and convenient for overweight and obese persons. Thus out of all tested obesity markers, NC was the best indices for early prediction of PreHT risks young Indian adults.

CONCLUSION

The results of my study highlights the prevalence of PreHT, a precursor of HT and its association with obesity markers. This cross sectional study shows that upper body fat marker, NC has higher association with PreHT in compared to general (BMI) and central obesity (WC) markers. NC is also considered as a marker of

central and abdominal obesity as it is significantly associated with BMI, WC and WHtR. High NC (>37cm for males and >33.2 cm for females) is associated with parallel increase in prevalence of PreHT. For low cost, simplicity and reliability NC may be consider as best obesity marker for prediction of cardiovascular risk in large scale epidemiological study.

ACKNOWLEDGEMENTS

The author thankfully acknowledge the cooperation rendered by College authorities and students. Their kind cooperation in this investigation is highly cherished from the core of my heart. The author would also like to acknowledge Dr. Kuntal Bhattacharya (Assistant professor of Zoology), Mrs Sutapa Mondal (Assistant professor of Chemistry), Dr. Tuhin Ghosh (Assistant professor of Chemistry), Sanjoy Kumar Roy (Associate Professor of Commerce), Debasish Maitra (Associate Professor of Commerce) and Dr. Debnath Palit (Associate Professor of Botany) for their help and support in data collection.

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