Original article

Prehypertension in young females, where do they stand?

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KEY WORDS

Exercise stress testing
Prehypertension
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A B S T R A C T

Background: To determine the prevalence of prehypertension in young females and its correlation to various parameters like body mass index (BMI), waist hip ratio (WHR), waist circumference (WC) and family history, and blood pressure (BP) response to exercise stress testing.*Methods:* One hundred and fifty apparently healthy females of age group 18–25-years were randomly selected from the student population of Jawaharlal Nehru Medical College, Sawangi (Meghe), Wardha, after satisfying all the inclusion criteria and written informed consent. Along with all the anthropometric parameters BMI, WHR, WC and family history of hypertension (HTN) and/or diabetes, resting BP, and BP response to exercise stress testing were measured in the study.*Results:* Amongst 150 subjects, 63 (42%) subjects were normotensive and 87 (58%) were prehypertensive. Body mass index, WHR, WC and family history of HTN were significantly higher in prehypertensive group. Prehypertensive group also had an exaggerated BP response to exercise stress testing and higher BP during recovery.*Conclusion:* Prevalence of prehypertension was found to be high in females, also there was a strong correlation between prehypertension and BMI, WHR and WC suggesting a positive correlation between obesity and prehypertension. Prehypertensive group also showed an exaggerated BP response to exercise stress testing.

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Introduction

Hypertension (HTN) is the most common cardiovascular disease (CVD) affecting about 20% of adult population and is a leading cause of morbidity and mortality worldwide. It is a major risk factor for heart disease, stroke and kidney disease. It is a major public health problem in both economically developing and developed countries.¹

By the year 2025, the overall prevalence of HTN is expected to be 29% in men and 29.5% in women.²

Hypertension is a powerful risk factor that increases the likelihood of developing a wide variety of CVD which cause 6–8 million deaths amongst women. Every year one-third of all deaths of women are due to CVD.

The relationship between blood pressure (BP) and cardiovascular mortality is thought to be linear with no definite lower threshold that identifies potential danger or cessation of benefit. Recent studies have documented increase in the risk of CVD and high rate of progression to HTN with a systolic BP (SBP) of 120–139 mmHg and/or diastolic BP (DBP) of 80–89 mmHg.

Prehypertension was defined according to JNC-7 criteria as having either a SBP of 120–139 mmHg and/or DBP as 80–89 mmHg in the absence of antihypertensive medication. Normal BP is defined as SBP < 120 mmHg and DBP < 80 mmHg without any antihypertensive medication.⁴

Approximately 60% of American adults (67% of men and 50% of women) had prehypertension and 27% had HTN. The prevalence of prehypertension remained constant across age groups among men but increased with age among women but prevalence of HTN was similar, which may be related to a lower awareness of HTN among men.⁴

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Overweight and obesity are important determinants of health and lead to adverse metabolic changes including high BP. Being overweight is associated with two- to six-fold increase in the risk of developing HTN. Variations in Indian population have shown strong relationship between anthropometric indicators and BP levels.⁵

Exercise is a common physiological stress used to elicit cardiovascular abnormalities not present at rest and to determine the adequacy of cardiac function. Exercise testing has been used in attempt to identify patients who have an abnormal BP response and are destined subsequently to develop HTN.^{6,7}

Thus, in our study, we have tried to find correlation of prehypertension in young females to the various anthropometric measurements and BP response to treadmill testing as possible predictors of future risk of development of HTN and associated risks.

Aims and objectives

Study of prehypertension in young females and its relation to

1. Anthropometric measurements.
2. Family history.
3. Blood pressure response to exercise stress testing.

Materials and methods

The present study was conducted in the Department of Medicine, Jawaharlal Nehru Medical College and associated Acharya Vinoba Bhave Rural Hospital, Sawangi (Meghe), Wardha (M.S.) from October 2006 to October 2008. Ethical clearance was taken from Institutional Ethics Committee (IEC).

Study design

One hundred and fifty apparently healthy females in the age group of 18–25 years were randomly selected from the students of this college, and included in the study after obtaining a written informed consent.

Exclusion criteria

The subjects were excluded from the study if they had

1. Hypertension.
2. Cardiopulmonary disease and/or diabetes mellitus (DM).
3. Using cardioactive drugs.
4. Any physical disability which precluded tread mill testing.

Study protocol

All the students were studied as per the proforma. Medical history was taken for cardiopulmonary disease and diabetes

mellitus. History of use of cardioactive drugs was recorded. Smoking status was recorded.

Parental status for HTN and DM was recorded in each student.

Anthropometric measurements

1. Weight in kilograms was recorded on standard weighing scale, without footwear.
2. Height in centimeters was measured, without footwear standing against wall mounted scale.
3. Body mass index derived from the Quetelet formula: $BMI = \text{Weight (kg)} / \text{Height (m)}^2$.

The students were classified as underweight, normal, overweight, and obese as per the World Health Organization (WHO) and International Obesity Task Force (IOTF) Classification for BMI in Asian adults. Normal range is 18.5–23 kg/m² and obesity is 25 kg/m².

4. Waist circumference (cm) was measured at the level half-way between the iliac crest and the costal margin in expiration in standing position.
5. Hip circumference (cm) was measured as the maximum circumference over the buttocks.
6. Waist hip ratio was calculated.

Clinical examination

A detailed general examination and systemic examination was done according to the proforma.

Subjects were asked to report for tread mill test (TMT) with light meal 2 hours before test, upon inclusion for study.

The TMT was performed on a motor driven with Tread Mill Software NASAN ST+ VERSION 6.0 analysed by computer.

Blood pressure recording

Blood pressure was recorded by aneroid sphygmomanometer in the left arm, at the level of heart by auscultatory method in the supine position, standing position, after hyperventilation, during the last minute of each stage of testing (3 minutes interval), peak exercise, and third minute of recovery.

The first and fifth Korotkoffs sounds were taken as SBP and DBP, respectively.

Peak exercise

While on TMT, peak exercise was defined when the subject attained predetermined heart rate (HR) (220-age in years) or exhaustion, whichever is earlier.

Hypertensive response to exercise on tread mill was defined as SBP and/or DBP at exceeded 200 mmHg and 100 mmHg, respectively.⁸

Statistical analysis

Statistical analysis was carried out using the statistical programme available in SPSS version 14.0. The following tests were applied:

1. Fisher's Z-test.
2. One way analysis of variance (ANOVA).
3. Regression analysis, using Pearson's correlation co-efficient and multiple linear regression.

Results

One hundred and fifty apparently healthy females were studied and their anthropometric measurements with their resting BP both SBP and DBP were recorded.

Amongst 150 females, 87 females had a prehypertensive response and 63 females had a normotensive response.

The mean weight of subject was 55.31 kg (SD) and mean height 158.18 cm (SD). The mean BMI calculated was $22.33 \pm 3.83 \text{ kg/m}^2$, mean WC of subjects is $72.56 \pm 10.57 \text{ cm}$. 55 (36.67%) had positive history of HTN and or DM in their parents

whereas remaining 95 (63.33%) subjects did not. Sixty-three (42%) had BP in the normotensive range and 87 (58%) in prehypertensive range.

Based on resting BP values among the subjects, they were divided into two groups and other characteristics were compared.

In the normotensive group mean age was 20.49 and in the prehypertensive group, the mean age was 20.8. The difference in two group was not significant.

Mean BMI in the normotensive group was $20.22 \pm 2.43 \text{ kg/m}^2$ and in the prehypertensive group $23.69 \pm 4 \text{ kg/m}^2$ ($P=0.000$). Mean WHR in two groups was 0.73 ± 0.04 and 0.76 ± 0.05 ($P=0.000$), respectively.

In the normotensive group the mean peak SBP and DBP on exercise were $131.52 \pm 9.08 \text{ mmHg}$ and $81.74 \pm 6.14 \text{ mmHg}$ and in the prehypertensive group were $146.02 \pm 9.06 \text{ mmHg}$ and $93.14 \pm 9.18 \text{ mmHg}$, respectively ($P=0.00$).

Mean recovery SBP and DBP recorded after 3 minutes in the normotensive group were $117.81 \pm 5.98 \text{ mmHg}$ and $72.15 \pm 4.67 \text{ mmHg}$ and in the prehypertensive group $127.08 \pm 8.05 \text{ mmHg}$ and $87.01 \pm 7.08 \text{ mmHg}$, respectively ($P=0.00$) (Figure 1 and Table 1).

Figure 1 Comparison of various parameters in subjects according to normotensive and prehypertensive groups. BMI: body mass index, DBP: diastolic blood pressure, DBPR: peak diastolic – resting diastolic, HTN: hypertension, SBP: systolic blood pressure, SBPR: peak systolic – resting systolic, SD: standard deviation.

Table 1

Comparison of various parameters in subjects according to normotensive and prehypertensive groups.

Parameters	Normotensive (n=63)	Prehypertensive (n=87)	z value	P value*
Mean BMI (kg/m ²)	20.22±2.43	23.69±4.00	6.58	0.000
Mean waist hip ratio	0.73±0.04	0.76±0.05	4.16	0.000
Mean resting SBP (mmHg)	110.84±5.11	125.33±8.74	12.73	0.000
Mean resting DBP (mmHg)	69.07±4.68	82.11±6.25	14.59	0.000
Mean peak SBP (mmHg)	131.52±7.19	146.02±9.88	10.39	0.000
Mean peak DBP (mmHg)	81.74±6.14	93.14±9.18	9.10	0.000
Mean recovery SBP (mmHg)	117.87±5.98	127.08±8.05	8.03	0.000
Mean recovery DBP (mmHg)	72.15±4.67	81.01±7.08	9.21	0.000
SBPR (mmHg)**	20.68±7.53	20.68±5.92	0.06	0.995
DBPR (mmHg)†	12.66±5.94	11.26±6.52	1.38	0.180
Family history of HTN and/or DM (+ve)	18	37	6.56	Significant
Hypertensive response	–	22	22.0	Significant

*P value <0.05 is significant, **SBPR: peak systolic – resting systolic, †DBPR: peak diastolic – resting diastolic. BMI: body mass index, DBP: diastolic blood pressure, DM: diabetes mellitus, HTN: hypertension, SBP: systolic blood pressure.

Family history of HTN and/or DM was positive in 18 subjects in group 1 and 37 subjects in group 2.

Twenty-two subjects showing hypertensive response to exercise stress testing were in the prehypertensive group.

Discussion

According to JNC-7 criteria prehypertension is SBP between 120–139 mmHg and DBP 80–89 mmHg. We found that the prevalence of prehypertension was 58%, signifying that a high percentage of females is prehypertensive at an early age.

Body mass index, WHR and WC were found to be significantly higher in prehypertensive group revealing that overweight and obesity are major accompaniments before HTN.

As much as BMI is a reflection of lifestyle, addressing it would be appropriate when subjects are found to be in that range. Associating elevated BMI with BP above the optimal range reinforces the association of obesity as a risk factor for prehypertension and future HTN.^{9,10}

Family history of HTN was significantly higher in prehypertension group which explained that HTN though being a multifactorial disease, genetic influence contributes fairly enough with other risk factors in development of prehypertension and HTN.

Though in our study, family history was obtained by the information provided by the subjects, it becomes equally important to evaluate the parents for HTN and diabetes, once the subjects are found to have prehypertension or exaggerated BP response to TMT and parents were reported to be normotensive.

Blood pressure response to TMT in young females was exaggerated in prehypertensive group. They also had delayed recovery of BP after the exercise. This response pattern in the prehypertensive subjects represent impaired cardiovascular adjustment to exercise which is not apparent at rest and may be unmasked during exercise. This may indicate a greater risk of developing HTN in future. The likely mechanism could be impaired endothelial dependant vasodilatation in hypertensive subjects.^{11–14}

Thus, from our study, we conclude that resting BP in prehypertensive range served as a simple and best tool to predict clustering of phenotypes for risk of HTN and cardiovascular risk in future. Prevalence of prehypertension is high (58%) in our study which is quoted in different studies.

Follow-up of these subjects for development of HTN and coronary artery disease (CAD) can throw further light on importance of prehypertension in healthy population.

Study can be taken as representative among young healthy females. More risk factors can be studied to validate the hypothesis that clustering of risk factors for HTN and related disorders occur at an early age among females. Suitable life style modification can help in postponing long-term complications like HTN, CAD and diabetes.

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