Original Article

Anthropometric indices and its association with hypertension among young medical students: A 2 year cross-sectional study

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Abstract

Introduction: Obesity, defined on the basis of anthropometric measures is a global epidemic and threatening to healthy population worldwide. A research from China among young adults (20--44 years) recorded six and two times the risk of hypertension (HTN) in individuals who were obese and overweight, respectively, relative to normal weight individuals. This study highlights about anthropometric indices and its association with HTN among young medical students at rural medical college. **Methods:** In this cross-sectional study, 1,000 medical students had been enrolled. Anthropometric indices like body mass index (BMI), waist circumference (WC), waist to hip ratio (WHR), neck circumference (NC) as per South East Asian guidelines were measured in all students. **Results:** Among young medical students, the prevalence of obesity defined by BMI, WC, WHR, and NC was 46.5%, 32.4%, 57.3%, and 8.4%. Among males, there was significant positive correlation of BMI with SBP ($P < 0.0001$) and DBP ($P < 0.0001$), whereas WC ($P < 0.0001$) and WHR ($P = 0.012$) had positive and significant correlation with SBP but not with DBP. Correlation of NC with SBP and DBP was negative but did not reach statistical significance ($P = 0.266$ and $P = 0.670$, respectively). Among females, there was significant positive correlation of BMI with SBP ($P < 0.0001$) and DBP ($P < 0.0001$), WC had significant positive correlation with SBP ($P < 0.0001$,) and DBP ($P < 0.0001$). Correlation of WHR was significant with DBP ($P = 0.002$) but not with SBP ($P = 0.055$). **Conclusion:** The prevalence of HTN in this study was 9.8% in young medical students overall and varies according to anthropometric indices. The prevalence rate varies in males and females depending on the anthropometric measures.

Keywords: Anthropometric indices, body mass index, hip circumference, hypertension, obesity, waist circumference, waist to hip ratio

Introduction

In number of countries, obesity is a global epidemic which is threatening to healthy population. Obesity is abnormal accumulation of body fat, usually ≥20% over an individual's ideal body weight.[1,2] In developed countries, faulty dietary habits and sedentary life style leads to disturbance in balance between energy intake and expenditure, leading to obesity.[1,2]

Globally, the prevalence of obesity has nearly tripled in past three decades. Recent estimates from the World Health Organization indicate that among adults aged ≥18 years, 13% are obese and 39% are overweight.[3] The observed prevalence of obesity, both generalized and central, in a study conducted by ICMR was 11--31.3% and 16.9--36.3%.[4] In another study from North

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India, prevalence of overweight was 14.8% and obesity was 55.5% in adults.[5]

Recent industrialization has forced the young students to depend upon fat rich, cheap and ready-to-eat food available foods which are poor in nutrients. Introduction of food applications on mobile, no time spent for outdoor activities, increased and hectic jobs of parents increases problem.[6] The global obesity epidemic is a leading risk factor for high BP of a shift in high blood pressure distribution among young adults.[7]

In multiple logistic regression analysis, the ICMR-INDIAB studies identified that diabetes, physical inactivity, female gender, hypertension (HTN), urban residence, higher socioeconomic status were significantly associated with obesity.[4] Therefore, there is intricate association between the obesity and HTN. The Framingham Heart Study estimated that excess body weight (involving obesity and overweight) accounted for roughly 28% and 26% cases of HTN among women and men, respectively.[8,9]

Obesity is defined on the basis of anthropometric measures. Body mass index (BMI), which is an estimate of body weight adjusted for height [weight in kilogram/height (m^2)]. The World Health Organization and National Institutes of Health have both adopted BMI as a criterion for defining obesity. Obesity is defined as a BMI ≥30 kg/m^2, overweight between 25.0 and 29.9 kg/m^2 and Healthy body weight between 18.5 and 24.9 kg/m^2.[10] Categorization of participants by BMI as per South East Asia Guidelines as Normal BMI is 18.5--22.9 kg/m^2 overweight as those with a BMI of 23--24.9 kg/m^2 and obesity as those with BMI of ≥25 kg/m^2.[11]

A research from Gupta *et al.*[12] from India recorded odds ratios of 4.5 and 3.1 for truncal obesity in adults aged 20--29 years and 2.6 and 4.8 for HTN in males and females, respectively. A research from China among young adults (20--44 years) recorded 6.265 and 2.325 times the risk of HTN in individuals who were obese and overweight, respectively, relative to normal weight individuals.[13] The evaluation of obesity in young adults is therefore significant as it leads to multiple CV risk factors such as HTN.

In view of the relative lack of Central Indian research investigating the relationship of obesity with hypertension in young adults, we planned this study to determine association of anthropometric measures of obesity with hypertension in young (18--30 years) college students.

Methods

This cross-sectional study was conducted at Medicine department at Jawaharlal Nehru Medical College at Wardha in central India from October 2018 to June 2020 after obtaining permission from the institutional ethics committee, DMIMS (DU)/IEC/2018-19/7548.

As per complete enumeration technique, sample size was calculated. Complete counts are a complete enumeration (census) of individuals within a sampling unit. Thus, a random sample of quadrats might be drawn, and all the individuals counted on each of the quadrats.

Details of this study were clearly explained to each potential participant and each query was answered in native language till the satisfaction before enrolment as study participant. Only after signing the voluntary informed consent, students were enrolled as study participant. Students were requested to visit the medicine OPD in batches of 10 each as per convenience of both students and the investigator. In the OPD, data of eligible participants was recorded in approved case record form (CRF).

Demographic data such as name, age, sex, address, and telephone number were noted in a pre-structured Performa. Each participant was carefully asked for personal history such as alcohol consumption, smoking/tobacco use, duration of physical activity, family history of cardio metabolic disorders such as HTN, diabetes, dyslipidemia.

A standard mercury sphygmomanometer was used to measure the blood pressure in sitting position at the level of the heart in a quiet and calm room on two different occasions, with at least 10-min. gap and the average was noted. WHO criteria were strictly followed.

Height (cm) of each participant was measured using standard height measuring instrument. Footwear was prohibited during height measurement (Frankfurt plane). Categorization of participants by BMI as per South East Asia Guidelines were Normal (18.5--22.9 kg/m^2), overweight (23--24.9 kg/m^2), and Obesity (≥25 kg/m^2).

Statistical analysis - Data of participants was entered in Microsoft excel sheet and was analyzed using the same. Categorical variables are presented as percentages and frequency, whereas continuous variables are presented as standard deviation (SD) and mean. Chi-square test has been used to determine statistical differences in categorical parameters and Student *t*-test has been used to determine statistical differences in continuous variables. P value < 0.05 was considered significant in all comparisons.

Result

In this cross-sectional study of medical student, we included total 1,000 students for the evaluation of HTN and anthropometric measures. In below section, we describe the results and observation obtained during the study. Among young medical students, the prevalence of obesity defined by body mass index (BMI), waist circumference (WC), waist to hip ratio (WHR), and neck circumference |(NC) was 46.5%, 32.4%, 57.3%, and 8.4%.

In total 1,000 students enrolled in the study, mean age was 21.3 ± 2.0 years and majority of them were in the age group of <20 years (39%) followed by 21 to 22 years (36.7%), 23 to 25 years (19.8%), and >25 years (4.5%). Among anthropometric measures, mean level of BMI, WC, WHR, and NC were 24.7 ± 5.5 kg/m^2, 82.0 ± 7.3 cm, 0.85 ± 0.07 and 30.8 ± 3.1 cm, respectively. Mean systolic and diastolic BP measured was 115.7 ± 12.6 mmHg and 73.6 ± 8.9 mmHg, respectively. Other baseline characteristics are shown in Table 1.

Mean BMI in males and females did not differ significantly (24.4 ± 5.5 vs. 24.9 ± 5.5, respectively; $P = 0.145$). By BMI category, 12.6% of participants were overweight and 46.5% were obese. Distribution of different BMI categories among males and females did not differ significantly ($P = 0.535$). Among them, 44.9% of males and 47.8% were obese ad defined by BMI of 25 kg/m^2 or higher. Mean WC also did not differ significantly in males and females (82.0 ± 7.4 cm vs. 82.1 ± 7.3 cm, respectively; $P = 0.829$). However, obesity prevalence defined by WC of >90 cm in males and >80 cm in females was significantly higher in females than males (45% vs. 4.6%, respectively; $P < 0.0001$). Similarly, mean WHR did not differ significantly in males and females ($P = 0.984$). However, obesity prevalence defined by WHR criteria was significantly higher in females than in males (52.4% vs. 30.2%, respectively; $P < 0.0001$) as shown in Table 2.

BMI had significant positive correlation with systolic ($P < 0.0001$) and diastolic ($P < 0.0001$) BP. Similarly, WC significant correlation with SBP ($P < 0.0001$) and DBP ($P < 0.0001$). Also, WHR showed similar results with SBP ($P = 0.002$) and DBP ($P = 0.020$). Among males, there was significant positive correlation of BMI with SBP ($P < 0.0001$) and DBP ($P < 0.0001$). Similarly, WC ($P < 0.0001$) and WHR ($P = 0.012$) had positive and significant correlation with SBP but not with DBP ($P = 0.115$ for WC, and $P = 0.981$ for WHR). Among females, there was significant positive correlation of BMI with SBP ($P < 0.0001$) and DBP ($P < 0.0001$). Similarly, WC had significant positive correlation with SBP ($P < 0.0001$) and DBP ($P < 0.0001$). Correlation of WHR was significant with DBP ($P = 0.002$) but not with SBP ($P = 0.055$). Correlation of NC with SBP and DBP was positive but did not reach statistical significance ($P = 0.089$ and $P = 0.153$, respectively) as shown in Table 3.

Table 1: Baseline parameters of study participants

Parameters	Frequency	Percentage
Age (years)	21.3±2.0	
<20	390	39.0
21-22	367	36.7
23-25	198	19.8
>25	45	4.5
Gender		
Male	437	43.7
Female	563	56.3
Anthropometric measures		
Body mass index (Kg/m^2)	24.7±5.5	
Waist circumference (cm)	82.0±7.3	
Waist: hip ratio	0.85±0.07	
Blood Pressure (mmHg)		
Systolic	115.7±12.6	
Diastolic	73.6±8.9	
Family history of cardiometabolic disorders		
Dyslipidemia	110	11.0
Hypertension	108	10.8
Diabetes	94	9.8

Table 2: Anthropometric measures in overall study participants and two genders

Parameters	Total (*n*=1000)	Males (*n*=437)	Females (*n*=563)	*P*
Body mass index (Kg/m^2)	24.7±5.5	24.4±5.5	24.9±5.5	0.145
Underweight (≤18.00)	123 (12.3)	54 (12.4)	69 (12.3)	0.535
Normal weight (18.01-22.99)	286 (28.6)	135 (30.9)	151 (26.8)	
Overweight (23.00-24.99)	126 (12.6)	52 (11.9)	74 (13.1)	
Obesity (≥25.00)	465 (46.5)	196 (44.9)	269 (47.8)	
Waist circumference (cm)	82.0±7.3	82.0±7.4	82.1±7.3	0.829
Obesity (M >90 cm; F >80 cm)	324 (32.4)	20 (4.6)	304 (54.0)	<0.0001
Waist: hip ratio	0.85±0.07	0.85±0.08	0.85±0.08	0.984
Obesity (M ≥0.90; F ≥0.85)	573 (57.3)	132 (30.2)	295 (52.4)	<0.0001

Table 3: Correlation of blood pressure with anthropometric parameters

Anthropometric parameters	Systolic blood pressure		Diastolic blood pressure	
	Pearson correlation	*P*	Pearson correlation	*P*
Total				
Body mass index	0.369	<0.0001	0.361	<0.0001
Waist circumference	0.132	<0.0001	0.132	<0.0001
Waist hip ratio	0.097	0.002	0.074	0.020
Males				
Body mass index	0.320	<0.0001	0.337	<0.0001
Waist circumference	0.144	0.003	0.076	0.115
Waist hip ratio	0.120	0.012	0.001	0.981
Females (*n*=563)				
Body mass index	0.404	<0.0001	0.379	<0.0001
Waist circumference	0.124	0.003	0.175	<0.0001
Waist hip ratio	0.081	0.055	0.130	0.002

Discussion

In this analysis, we had tried to find out the relationship of anthropometric measurements with HTN in medical students.

In this study, among anthropometric measurements, mean level of BMI, WC and WHR and were 24.7 ± 5.5 kg/m^2, 82.0 ± 7.3 cm, and 0.85 ± 0.07, respectively. Mean systolic and diastolic BP measured was 115.7 ± 12.6 mmHg and 73.6 ± 8.9 mmHg, respectively. Family history of cardio metabolic diseases such as dyslipidemia, HTN, and diabetes were reported by 11%, 10.8%, and 9.8% of the participants, respectively. In consistency with our findings, Cheah *et al.*[15] also reported that the mean systolic blood pressure was 119.1 ± 14.4 mmHg and mean diastolic blood

pressure was 72.0 ± 9.7 mmHg in study participants. Also, in a study by Chhabra *et al.*,[16] the mean systolic BP was 116 mmHg for boys and 107 mmHg for girls.

In this study, participants with HTN, mean BMI was 31.8 ± 3.4 kg/m^2 and was significantly higher compared to BMI in high-normal BP levels 28.6 ± 3.4 kg/m^2 and normal BP levels 23.5 ± 5.1 kg/m^2. Among different BMI category, all the participants with HTN were in obese category, whereas 96% of high-normal BP was obese and only 35.7% with normal BP were obese. The distribution was statistically significant.

Compared to BMI in normal BP participants 23.4 ± 5.2 kg/m^2, mean BMI of males was significantly higher in participants with HTN 31.1 ± 3.0 kg/m^2, and high-normal BP 29.0 ± 3.6 kg/m^2. The difference in BMI of participants with high-BP and HTN was non-significant. Among different BMI category, all the males with HTN were in obese category, whereas 96.9% of high-normal BP was obese and only 35.7% with normal BP were obese. The distribution was statistically significant. Among females, similar pattern was observed as seen in males. Mean BMI of females with HTN 32.2 ± 3.6 kg/m^2 and high-normal BP 28.3 ± 3.1 kg/m^2 was significantly higher than females with normal BP 23.6 ± 5.0 kg/m^2. There was also a significant difference between BMI of females with high-normal BP and hypertension. All females with hypertension were in obese BMI category, whereas 95.4% of females with high-normal BP and 36.2% of normal BP were obese. The distribution of BMI categories in three BP levels was statistically significant.

In accordance with this study, study by Aftab *et al.*,[17] reported that HTN was present in 14 (35.9%) obese I and 7 (17.9%) obese II subjects, 6 (15.4%) overweight, 12 (30.8%) normal weight students. Also, in a study by Chhabra *et al.*,[16] a significant relation between BP and BMI was observed which was consistent with our study findings.

In contrast with our study, in study by Vuvor *et al.*,[18] about 32.5% of the participants were hypertensive and significant difference existed between high and normal SBP of the participants (P = 0.01). They concluded that rise in BMI was positively correlated with BP among these study adults' population.

The mean WC was slightly more in participants with HTN than in people with high-normal and normal BP. This was specifically defined when the proportion of WC participants in the obese group was seen in slightly higher percentages in hypertensive participants (53.1%) than in high-normal (28.4%) and regular BP participants (30.4%). In both men and women, a similar trend was seen. Mean WC was substantially higher in males among participants with HTN than those with high-normal and normal BP. This was specifically known because the proportion of WC male participants in the obese group was dramatically higher in hypertensive participants (22.2%) than in average BP participants (3.3%). The mean WC of participants with HTN among females was substantially higher than that of those with high-normal and normal BP. This was specifically identified when the proportion of female WC participants in the obese group was slightly higher in hypertensive participants (71.0%) than in high-normal (48.8%) and regular BP participants (52.2%). These results were similar to the results of the research by Sah *et al.*[19] In a study by Patil *et al.*,[20] the WHR among hypertensive patients was substantially higher relative to the normotensive study population.

The mean WHR was slightly higher for participants with HTN than for those with moderate BP, but not in the high-normal range. This was specifically defined as a proportion of WHR participants in the obese group that was seen in slightly higher percentages of hypertensive participants (60.2%) than in high-normal (41.3%) and regular BP (40.7%) participants. There was no substantial gap between males in the mean WHR compared to participants with high-normal and normal BP, participants with hypertension. There was also no statistically meaningful difference in the distribution of the proportion of male WHR participants among obese hypertensive participants (38.9%), high-normal (34.4%), and regular BP participants (29.0%). The mean WHR of participants with HTN was slightly higher among females than among those with high-normal and normal BP. This was specifically determined as the number of female WHR participants in the obese group was slightly higher in hypertensive participants (72.6%) than in high-normal (46.5%) and regular BP (50.2%) participants. These results were in comparison to the findings of the research by Sah *et al.*,[19] in which both male and female WHR were identical.

The mean NC was not substantially higher in participants with HTN than in those with moderate BP than in the high-normal band. There was no statistically meaningful change, but the proportion of participants with NC in the obese group was larger in participants with HTN (14.3%) than in high-normal (8.0%) and moderate BP (7.7%) participants. Among males, there was no significant difference in mean NC of participants with HTN compared to participants with high-normal and normal B.P. This study results are contrast to study done by Kumar *et al.*[21]

Limitations

In this study, we did not assess the glycemic profiles of the participants which would have provided more insights in to the overall cardio metabolic profile of college students. The study was not designed for any interventions among the obese or dyslipidemic participants. A prospective interventional study would provide more clues to the management protocols employed in obese dyslipidemic individuals. We did not evaluate 10-year or long-term cardiovascular risk in study participants which would have helped to risk categorize the participants.

Conclusion

The prevalence of HTN in this study was 9.8% in young medical students overall and varies according to anthropometric indices.

The prevalence rates of HTN vary in males and females depending on the anthropometric measures. Duration of physical activity, family history of cardiometabolic disorders did not differ in BP categories. Except for NC, a significant association between BMI, WC, and WHR with HTN was observed. This clearly indicates increasing obesity is a risk factor for HTN in young adults.

Now a days due to industrialisation cheap and junk food which are easily available but poor in nutrients that leads to increase BMI and thus comorbidities like hypertension.

Medical students now a days are in stress, they are coming from affluent society, they are taking junk food, these can lead to HTN. This can be aware in General Medical practice because they are primary treating physician of society. That's why we want to highlight this study in Primary health care.

What our study adds

Young medical students had a high awareness about the healthy lifestyle were not practicing it.

Knowledge of nutrition and healthy diet should be of concern as it is the index of the health of the future primary-care physicians.

A mitigation to bridge the gap between the knowledge and the effective practice of it among the students is necessary and demand of the time.

Summary of key points

- In total 1000 students enrolled in the study, mean age was 21.3 ± 2.0 years and majority of them were in the age group of <20 years (39%). The proportion of males was slightly lower than females (43.7% vs 56.3% respectively).
- Among anthropometric measures, mean level of BMI, WC, WHR, and NC were 24.7 ± 5.5 kg/m^2, 82.0 ± 7.3 cm, and 0.85 ± 0.07 and 30.8 ± 3.1 cm, respectively.
- Mean systolic and diastolic BP measured was 115.7 ± 12.6 mmHg and 73.6 ± 8.9 mmHg, respectively.
- Mean WC also did not differ significantly in males and females (82.0 ± 7.4 cm vs. 82.1 ± 7.3 cm, respectively; $P = 0.829$). However, obesity prevalence defined by WC of >90 cm in males and >80 cm in females was significantly higher in females than males (45% vs. 4.6%, respectively; $P < 0.0001$).
- Mean WHR did not differ significantly in males and females ($P = 0.984$). However, obesity prevalence defined by WHR criteria was significantly higher in females than in males (52.4% vs 30.2%, respectively; $P < 0.0001$).
- Mean level of NC also did not differ significantly in males and females ($P = 0.659$). However, obesity defined by NC criteria was observed in females only (14.9%).
- BMI had significant positive correlation with systolic ($P < 0.0001$) and diastolic ($P < 0.0001$) BP. Similarly, WC significant correlation with SBP ($P < 0.0001$) and DBP ($P < 0.0001$).
- Also, WHR showed similar results with SBP ($P = 0.002$) and DBP ($P = 0.020$). Among males, there was significant positive correlation of BMI with SBP ($P < 0.0001$) and DBP ($P < 0.0001$).
- Similarly, WC ($P < 0.0001$) and WHR ($P = 0.012$) had positive and significant correlation with SBP but not with DBP ($P = 0.115$ for WC, and $P = 0.981$ for WHR).
- Among females, there was significant positive correlation of BMI with SBP ($P < 0.0001$) and DBP ($P < 0.0001$).
- Similarly, WC had significant positive correlation with SBP ($P < 0.0001$) and DBP ($P < 0.0001$). Correlation of WHR was significant with DBP ($P = 0.002$) but not with SBP ($P = 0.055$).

Take home message

- In younger adults especially in the medical college students, rates of obesity can be higher than expected. These should be evaluated at least yearly with different anthropometric measures.
- Neck circumference can be a useful measure to determine the obesity.
- Screening of BP levels to detect hypertension should be done even in young adults.
- Appropriate interventional strategies to manage the duo of obesity and hypertension are necessary in younger adults to improve the long-term CV risk.

Novelty or new Knowledge from this study

As there was incidence of HTN depending upon Anthropometric assessment this study highlights about increased awareness about physical activity and Lifestyle modification from beginning even in educated medical students. As they are going to be doctor for general population in future and so to increase awareness about the same among them.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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