

Correlation of Anthropometric Measurements with Blood Pressure among Medical students in Karnataka.

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ABSTRACT

Introduction: The prevalence of obesity is increasing at an alarming rate. One of the regions with rapidly increasing rate of overweight and obesity is the South Asian region. Obesity is an important risk factor for cardiovascular diseases caused due to hypertension and diabetes. This study calls attention to the importance of Anthropometric measurements in assessment of Blood Pressure among medical students.

Methods: 170 medical students were included in this cross sectional observational study. Blood pressure and various anthropometric measurements like Body Mass Index (BMI), Waist Circumference (WC), Hip Circumference (HC), Waist to Hip ratio (WHR) and Waist to Height Ratio (WHtR) were measured. The students were categorized into various categories based on Asian Guidelines for Classification of Obesity. Also they were categorized into Blood Pressure classes based on SBP and DBP values.

Results: Out of 170 medical students including 110 males and 70 females, it was found that 11.8 % students were overweight and 18.3 % students were obese. 63.5 % students had normal Blood Pressure (<120/<80 mmHg), 22.9 % had elevated Blood Pressure (120-129/<80mmHg) and 13.5% students were found to have Hypertension Stage 1 (130-139/80-89 mm Hg). There was no significant difference between males and females with regards to mean of BMI, WC, HC, WHR, WHtR, SBP and DBP. A statistically significant correlation of SBP was found with BMI ($r=0.436$, $p=0.001$), WC ($r=0.498$, $p=0.001$), WHtR ($r=0.350$, $p=0.001$), WHR ($r=0.417$, $p=0.001$). BMI, WC, WHtR and WHR were found to be significantly higher in group of students in Hypertension stage 1 compared to normal and elevated stages.

Conclusion: Obesity prevalence in our study was found to 18.3 %. The prevalence of Stage 1 Hypertension was found to be 13.5%. The values of systolic and diastolic blood pressure were found to be different across anthropometric indices (BMI, WC, WHR, WHtR).

Keywords: Anthropometric measurements, Body Mass Index (BMI), Waist Circumference, Hip circumference, Hypertension, Obesity, Waist to Hip Ratio, Waist to Height ratio, Medical Students.

1. INTRODUCTION

Lifestyle diseases, also called as chronic diseases have risen to become one of the emerging causes for loss of lives in the world. To combat this Government of India came up with various programmes like 'National programme for prevention and control of cancer, diabetes, cardiovascular diseases and stroke (NPCDCS)', population level screening of hypertension and 'India Hypertension Control Initiative (IHCI)'. Most of these programmes cater to the age group of middle and older group. In the past couple of years hypertension prevalence is silently growing in the younger generation. Hypertension occurring in individuals less than 40 years is called young hypertension. One of the challenges found in this age group is the awareness regarding status of Blood Pressure amongst this age group. The idea that chronic diseases appear in old age has become a myth now. Added to this is the low awareness and acceptance among the young population regarding these diseases appearing in their population. Hence, to reduce the incidence and prevalence of hypertension, spreading awareness and systematic screening is a must.¹ It is estimated that keeping hypertension in check will prevent about 20-30 % of approximately 1.5 million deaths due to high blood pressure in India.²

There are a number of studies which state that obesity is an important factor responsible for causing hypertension. Even the prevalence of obesity is increasing at an alarming rate. In fact, one of the studies states that the overall prevalence of obesity in India is 40.3 %.³ One of the regions with rapidly increasing rate of overweight and obesity is the South Asian

region.⁴ The World Health Organization recently estimated that among individuals aged more or equal to 18 years, the percentage of those who were overweight is 39% and those who are obese is 13%.⁵

Our population in the age group of 18-25 years are prone for various lifestyle disorders due to a desk bound lifestyle and consumption of processed food. It has been implicated that having a BMI of greater than 30 kg/m² had more prevalence of hypertension.⁶

In a secondary analysis by Singh, Geetu et al., in 15 year period the total prevalence of Overweight / Obesity increased from 12.6% to 24% among women aged between 15-49 years and increased from 9.3% to 22.9% among men aged between 15 and 49 years old.⁷

Obesity is an important risk factor for cardiovascular diseases caused due to Hypertension and Diabetes. Those Young adults who are obese Hypertensive are at elevated risk of acquiring cardiovascular diseases. A study done among young adults in China revealed that there was 6.265 times risk for hypertension among obese individuals for Hypertension compared to 2.325 times risk for hypertension among overweight individuals.⁸ Hence, it becomes all the more important to gauge obesity as among young adults to prevent future cardiovascular risk determinants like Hypertension. Various anthropometric measurements have been used to determine obesity like Body Mass Index, Waist circumference, Hip Circumference, Waist Height ratio, Waist Hip ratio. In this study Blood pressure measured in Medical students is categorized as Normal, Elevated, Pre-Hypertension, Stage 1 Hypertension and Stage 2 Hypertension.⁹ The anthropometric measurements have been studied among medical students in different classes of Blood pressure to get a better picture of the same.

2. MATERIALS AND METHODS

This cross sectional study was conducted at KAHER's JGMM Medical College, Hubballi in Southern India from August 2023 to July 2024 among Medical students of first and second year. This study was started after securing permission from Institutional Ethics Committee, JGMMMCIEC/036/2023.

Sample size was calculated taking the combined prevalence of overweight and obesity as 27.1% according to a study done by Singh BK et al amongst medical students in a medical college in Bihar.¹⁰ Using this prevalence and 95% confidence interval with 5 % error margin, the sample size was found to be 152. To this a 10 percent non response rate was added which gave us a sample size of 167. This was rounded off to 170, which was taken as the final sample size.

Students were explained regarding the study in detail and their doubts were also cleared. They were made a part of this study only after they agreed and gave informed consent for the study.

Two readings of Blood Pressure were measured in seated position in 5 minutes gap using a mercury sphygmomanometer. Height in cm was measured using a stadiometer and was recorded to the nearest 0.1 cm. Participants were asked to remove footwear. Weight was measured using analogue weighing scale after setting it to zero. Height and weight were measured according to guidelines set by National Health and Nutrition Examination Survey (NHANES).¹¹ For measuring Waist circumference, the measuring tape was kept at the level of the umbilicus and Hip circumference was measured at the level of hip where maximum protrusion was seen. The average of three measurements was taken as the final value.¹²

Body Mass Index was calculated using the weight in kg and height in square metres. The participants were categorized into various groups in BMI based on Asian Classification of BMI wherein, normal-(18.5--22.9 kg/m²), overweight (23--24.9 kg/m²), and Obesity (≥ 25 kg/m²). Waist height ratio was calculated using Waist circumference and Height in cms. In case of Waist Circumference a value of more than 90 cm in males and more than 80 cm in females were taken as having abdominal obesity. A Waist Hip Ratio of more than 0.90 in males and more than 0.85 in females was considered as truncal obesity.¹² A value of less than 0.49 was considered normal among participants.¹³

The data was first entered into excel and cleaned. It was then exported to SPSS version 21 (IBM Corp., Illinois, Chicago) where it was analysed. The mean and Standard deviation was analysed for quantitative data. T Test was used to study statistically significant difference in means of different groups based on gender. Pearson correlation was used to study correlation between Systolic Blood Pressure, Diastolic Blood Pressure and various anthropometric measurements. One way Anova was used to analyse difference in means of BMI, WC, HC, WHR and Waist Height ratio among different categories of Blood Pressure. A p-value <0.05 was considered as statistically significant.

3. RESULTS

In this cross-sectional study, Anthropometric measurements and Blood pressure measurements were studied among 170 medical students. According to the Asian classification of BMI students were classified into various categories. 11.8 % students were found to be overweight and 18.3 % were found to be obese.

The mean age of 170 students enrolled in this study was found to 20.5 $\pm$ 2.0 years. Maximum students were below 20 years old (35%).

In anthropometric measurements, the mean values of anthropometric measurements were found to be BMI- 21.75 $\pm$ 3.58 kg/m², WC- 76.41 $\pm$ 10.21 cm, HC-92.85 $\pm$ 7.39 cm, Waist Hip Ratio- 0.827 $\pm$ 0.124 and Waist Height ratio- 0.476 $\pm$ 0.006. Mean value of Systolic Blood Pressure was 111.92 $\pm$ 11.78 mm Hg and Diastolic Blood Pressure was 73.02 $\pm$ 7.78 mm Hg. 63.5 % students had normal Blood Pressure (<120/<80 mmHg), 22.9 % had elevated Blood Pressure (120-129/<80 mmHg) and 13.5% students were found to have Hypertension Stage 1(130-139/80-89 mm Hg).

On analysing the difference in mean of BMI, WC, HC, WHR and Waist Height ratio, no statistically significant difference was found between male students (n=110) and female students (n=60).

Table 1: Anthropometric measurements and indices (Mean±SD) in total participants, males and females

Parameters	Total (n=170)	Males (n=110)	Females (n=60)	P value
BMI	21.75±3.58 kg/m ²	22.09±3.58	21.15±3.53	0.680
WC	76.41±10.21cm	77.18±10.03	75±10.48	0.45
HC	92.85±7.39 cm	91.97±7.18	94.48±7.56	0.291
Waist Hip Ratio	0.827±0.124 cm	0.842±0.120	0.798±0.127	0.359
Waist Height Ratio	0.476±0.006 cm	0.475±0.058	0.476±0.066	0.103
SBP	111.92±11.78 mm Hg	111.90±11.35	111.98±12.6	0.678
DBP	73.02±7.78 mm Hg	73.54±6.72 mmHg	72.08±9.42 mmHg	0.243

*p significant at <0.05

Table 2: Pearson correlation (r value) of SBP and DBP with various anthropometric measurements and indices

	BMI (r value)	WC(r value)	HC(r value)	Waist Height Ratio(r value)	Waist Hip Ratio(r value)
SBP	0.436*	0.498*	0.035	0.350*	0.417*
DBP	0.065	0.078	0.065	0.026	0.099

*p significant <0.05

SBP showed statistically significant positive correlation with BMI (r=0.436, p=0.001). In the same way SBP had positive significant correlation with WC (r=0.498, p=0.001), Waist Height ratio (r=0.350, p=0.001) and Waist Hip Ratio (r=0.417, p=0.001). No statistically significant correlation was found between Hip Circumference and SBP (r=0.035, p=0.652) and DBP (r=0.065, p=0.396).

A one-way ANOVA was conducted to examine the effect of classes of Hypertension on anthropometric measurements. Only three classes were identified in the study population that is Optimal, Normal and Pre Hypertension. A significant difference in BMI was found among the three groups (F= (2,167) =19.362, p = 0.001), post-hoc tests using the LSD method revealed that the group with Pre Hypertension had higher BMI (M= 24.88, SD=3.20) compared to the other two groups (Normal (M= 20.66±/ 3.21, Elevated=22.945±/ 3.37). Similarly, Waist Circumference, Waist Hip Ratio, Waist Height ratio was found to be significantly different in three groups. They were found to be higher (WC (M=83.0±/ 9.5), WHR ratio (M=0.89±/ 0.10) WHtR (M=0.5052±/ 0.056) in Pre Hypertension group compared to Optimal and Normal groups. There was no significant difference in Hip circumference between different groups of Hypertension.

4. DISCUSSION

In this study, Anthropometric measurements of 170 Undergraduate Medical Students of a Medical College aged between 18-23 years have been captured, to find out the relationship with Blood pressure with the Anthropometric measurements. The mean level of Body Mass Index (BMI), Waist Circumference (WC), Waist Hip Ratio (WHR), Hip Circumference (HC) and Waist Height Ratio were 21.75±3.58 kg/m², 76.41±10.21 cm, 0.827±0.124, 92.85±7.39 cm and 0.476±0.006 respectively. Means of Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP) measured were 111.92±11.78 mmHg and 73.02±7.78 mmHg, respectively. No significant difference in values of means between males and females was found in this study. In a study by Lahole et al. conducted in Wardha, the mean SBP was 115.7 ± 12.6 mmHg and the DBP 73.6 ± 8.9 mmHg.¹⁴ Another study by Chhabra et al. in Delhi, showed the mean SBP as 116 mmHg for boys and 107 mmHg for girls.¹⁵

In this study 11.8% students were obese, 52 students 18.3% were overweight, with combined prevalence of 30.1%. This is based on the WHO classification of BMI for Asians. A similar study by Binod et al. in North Eastern Part of India reported a combined prevalence of obesity of 27.1%.¹⁰ Chenji et al. in South India reported a combined prevalence of 25.6%.¹⁶ Another study by Dantu et al. reported the combined prevalence of overweight and obesity to be 19.6%.¹⁷ In the Western part of India, a study from Pune, by Fernandez et al, reported the combined prevalence to be 13.2%.¹⁸

In this study, Medical students with Hypertension Stage 1, mean BMI was 24.88 ± 3.2 kg/m² and was significantly higher compared to BMI in Normal Blood Pressure – 20.66 ± 3.21 kg/m² and Elevated Blood Pressure levels 22.945 ± 3.37 kg/m². As the BMI increased the Blood pressure also showed an increase. Hence, a significant difference in BMI was found among the three groups. Similar to this study, in study by Vuvor et al. about 32.5% of the respondents were having hypertension and significant difference existed between high and normal Systolic Blood Pressure of the respondents (P = 0.01).¹⁹ It was concluded in this study that rise in BMI was positively correlated with increase in Blood pressure among their population. On the other hand, Aftab et al. found 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.²⁰

In this study, the mean Waist Circumference was more in students with raised Blood pressure than in participants with normal Blood pressure. These findings were similar to the findings by Sah et al. and in a study by Patil et al. the Waist

circumference in the persons with hypertension was significantly higher as compared with Normotensive study subjects.^{21,22}

In this study, it was found that, the mean Waist Hip Circumference and Waist Height ratio was higher in students with raised blood pressure than for those with lesser Blood Pressure. Similar findings were reported in the study by Gandhi et al. among medical students in a Medical college in Northern part of India.²³ Whereas, the mean waist hip circumference in the study by Sah et al. was identical in males and females.²¹

BMI and obesity are most commonly used indicators for prediction of a cardiovascular event by correlating with Blood pressure. It is an established fact that cardiovascular events seldom have a singular cause and almost always are due to Multi-factorial causation. In this study, many other parameters such as, Stress levels, Sleep habits, Physical inactivity, screen time etc., have not been assessed.

5. CONCLUSION

In conclusion, several anthropometric measurements showed a positive correlation with increase in Blood pressure in this study. This is one of the definitive risk factors for a cardiovascular event in future. The high prevalence of obesity among the Medical students along with increased Blood pressure may be due to the fact that, the Medical students are more likely to partake junk food more frequently as they stay away from their families in a hostel. This indicates a need for devising a screening program, lifestyle modification sessions to be introduced for the students in the curriculum. Addressing other contributors of increased Blood pressure also will help in mitigating the long term risks of cardiovascular diseases in young adults. This study was conducted in Medical students between the age group of 18 to 23 years and its results cannot be generalized to the general population.

REFERENCES

1. Yuvaraj Krishnamoorthy, Sathish Rajaa, Sudheera Sulgante, Palanivel Chinnakali, Nidhi Jaswal, Sonu Goel, Prevalence of hypertension and determinants of treatment-seeking behaviour among adolescents and young adults in India: an analysis of NFHS-4, *Journal of Public Health*, Volume 45, Issue 1, March 2023, Pages e48–e56, <https://doi.org/10.1093/pubmed/fdac006>.
2. Gupta R, Xavier D. Hypertension: the most important noncommunicable disease risk factor in India. *Indian Heart J* 2018; 70:565–572.
3. Venkatrao M, Nagarathna R, Majumdar V, Patil SS, Rathi S, Nagendra H. Prevalence of Obesity in India and Its Neurological Implications: A Multifactor Analysis of a Nationwide Cross-Sectional Study. *Ann Neurosci*. 2020 Jul;27(3-4):153-161. doi: 10.1177/0972753120987465. Epub 2021 May 29. PMID: 34556954; PMCID: PMC8455012.
4. Pradeepa R, Anjana RM, Joshi SR. et al. Prevalence of generalized and abdominal obesity in urban and rural India: The ICMR-INDIAB study (phase-I) [ICMR-INDIAB-3]. *Indian J Med Res* August 1, 2015; 142: 139–150.
5. World Health Organization. Obesity and overweight. Available from: www.who.int/newsroom/fact.sheets/detail/obesity.
6. Rabkin SW, Leiter L, Reeder BA, Chen Y, Liu L. Risk factor correlates of body mass index. *Canadian Medical Association Journal*. 1997 Jul 1;157(1): S26.
7. Singh, Geetu; Agrawal, Renu; Tripathi, Neelika; Verma, Arti. Overweight and obesity, the clock ticking in India? A secondary analysis of trends of prevalence, patterns, and predictors from 2005 to 2020 using the National Family Health Survey. *International Journal of Noncommunicable Diseases* 8(1):p 31-45, Jan–Mar 2023. | DOI: 10.4103/jncd.jncd_58_22.
8. Whelton, P. K., Carey, R. M., Aronow, W. S., Casey, D. E., Collins, K. J., Dennison Himmelfarb, C., ... Wright, J. T. (2017). 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA Guideline for the Prevention, Detection, Evaluation, and Management of High Blood Pressure in Adults: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *Hypertension*, 71(6), e13–e115. doi:10.1161/hyp.0000000000000065
9. Liu X, Xiang Z, Shi X, Schenck H, Yi X, Ni R, et al. The risk factors of high blood pressure among young adults in the Tujia-nationality settlement of China. *Biomed Res Int* 2017;2017:8315603.
10. Singh, B. K., Ram, A., Kumar, A., & Kumar, M. (2024). Association of Obesity Indices with Blood Pressure Among Undergraduate Medical Students of a Tertiary Care Teaching Hospital: A Cross-Sectional Study. *International Journal of Pharmaceutical Sciences Review and Research*, 84(1). <https://doi.org/10.47583/ijpsrr.2024.v84i01.021>.
11. National Health and Nutrition Examination Survey (NHANES)- Anthropometry Procedures Manual, January 2007.
12. Report of a WHO expert consultation on waist circumference and waist hip ratio. Available from: <https://www.who.int/publications/i/item/9789241501491>.
13. Eslami M, Pourghazi F, Khazdouz M, Tian J, Pourrostami K, Esmaeili-Abdar Z, Ejtahed H-S and Qorbani M (2023) Optimal cut-off value of waist circumference-to-height ratio to predict central obesity in children and adolescents: A systematic review and meta-analysis of diagnostic studies. *Front. Nutr.* 9:985319. doi: 10.3389/fnut.2022.985319
14. Lahole S, Rawekar R, Kumar S, Acharya S, Wanjari A, Gaidhane S, et al. Anthropometric indices and its association with hypertension among young medical students: A 2 year cross-sectional study. *J Family Med Prim Care* 2022;11:281-6.

15. Chhabra P, Grover VL, Aggarwal K, Kannan AT. Nutritional status and blood pressure of medical students in Delhi. *Indian J Community Med* 2006;31:248-51.
16. Chenji SK, Rao CR, Sivanesan S, Kamath V, Kamath A. Cross-sectional analysis of obesity and high blood pressure among undergraduate students of a university medical college in South India. *Family Medicine and Community Health*. 2018 May 1;6(2):63-9.
17. Dantu P, Ujwala U. Influence of certain factors on overweight and obesity among undergraduate medical students at Vizianagaram. *Int J Recent Trends Sci Technol* 2012; 5:38–42.
18. Fernandez K, Singru SA, Kshirsagar M, Pathan Y. Study regarding overweight/obesity among medical students of a teaching hospital in Pune, India. *Med J DY Patil Univ* 2014; 7:279–83.
19. Vuvor F. Correlation of body mass index and blood pressure of adults of 30–50 years of age in Ghana. *J Health Res Rev* 2017;4:115-21.
20. Aftab RK, Ijaz F, Jawed S. Correlation of obesity with hypertension in medical students. *Annals of King EdwaqrMedicalUniverssity*.2018;24:637-342.
21. Sah NK, Zhang OT, Li YG, Yin XY, Li LH. Gender-specific associations of anthropometric measures of adiposity with blood pressure and hypertension in young Chinese Medical College Students. *J Cardiol Cardiovasc Med* 2020;5:17-23.
22. Patil CR, Sahoo DP, Dhoble M, Kherde A, Inamdar A. Prevalence of hypertension and its associated risk factors in young adults attending a tertiary care institute of Nagpur: A cross sectional study. *Int J Community Med Public Health* 2017;4:3630-5.
23. Gandhi S, Sorout J, Raina R, Raina A, Miglani U, Manchanda K, Reddy S. Association between Blood Pressure and Obesity Indices in Medical Students. *Journal of Clinical & Diagnostic Research*. 2020 Aug 1;14(8):18-26.