ORIGINAL ARTICLE

Body Mass Index and Blood Pressure Profile of Newly Enrolled Health Sciences Students in a Medical University of Karachi, Pakistan

Pardeep Kumar[1], Kiran Abdul Sattar[1*], Gati Ara[2], Abida Munir Badini[3], Muhammad Talha Khan[4] and Marie Andrades[5]

[1]*Institute of Family Medicine, Jinnah Sindh Medical University, Karachi, Pakistan*
[2]*Department of Community Medicine, Dow University of Health Sciences, Karachi, Pakistan*
[3]*Department of Family Medicine, Aga Khan University Hospital, Karachi, Pakistan*
[4]*Dow University of Health Sciences, Karachi, Pakistan*
[5]*Holy Family Hospital, Karachi, Pakistan*

Abstract

Objectives: To measure the Body Mass Index (BMI) and Blood pressure (BP) of newly enrolled undergraduate students in a medical university in Karachi, Pakistan, and to assess any association between BMI and BP levels among them.

Methods: A cross-sectional study was conducted on pre-existing three-year data of 1403 students. The age, gender, BMI, and BP were recorded. The BMI of students was classified according to the Asian cutoff and BP was categorized using the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC) classification. Data was analyzed using SPSS version 24. Descriptive statistics were used to present quantitative and qualitative variables. The association was measured using the Chi-square test of significance. A p-value of < 0.05 was taken as significant.

Results: Total 1403 students with a mean age of 19 + 1.4 years students were enrolled including 397 (28.3%) males and 1006 (71.7%) females. A total of 667 (47.5%) students had a normal weight while 216 (15.4%) students were underweight, and 512 (36.5%) were either overweight or obese. Mean systolic BP was 111.42 + 10.7 mmHg and mean diastolic BP was 73.45 + 7.96 mmHg. Most students had normal systolic BP 901 (64.2%) while 501 (35.7%) had prehypertension or stage- I or II hypertension (HTN). The majority of the students had normal diastolic BP 1357 (96.7%) and 45 (3.3%) had stage- I or II HTN. There was a significant association between BMI and BP (p<0.001).

Conclusion: A significant number of the students are either under or overweight. There is a significant relationship between BMI and BP levels.

Keywords: *Underweight, overweight, obesity, hypertension, blood pressure, medical students.*

INTRODUCTION

Non-communicable diseases (NCDs) comprise a wide range of disorders, including obesity, hypertension, chronic heart, kidney and lung diseases, diabetes, and numerous other systemic and metabolic abnormalities. Worldwide, NCDs account for 74% of all fatalities [1].

Pakistan ranks fifth by population among the countries of the world and nearly half of the population of Pakistan suffers from one or more of these chronic illnesses. NCD mortality now exceeds the mortalities due to communicable diseases.

Hypertension (HTN) and Body Mass Index (BMI) derangements are among the most important NCDs worldwide. Hypertension is defined as a blood pressure of ≥ 140/90 mm Hg [2]. In Pakistan, HTN is the most common NCD and is the foremost attributable risk factor of NCD mortalities [3]. According to a published meta-analysis in 2018, the prevalence of hypertension in Pakistani young adults was found to be 26.34% [4]. In comparison, the pooled prevalence of hypertension among adolescents in India is 7.6% [5]. Childhood BP is a strong indicator of adult blood pressure, hence, early intervention is important [5]. Obesity remains a major risk factor for hypertension, specifically in Pakistan, and is closely linked to the occurrence of cardiovascular diseases (CVDs) and mortalities [6]. Therefore, health screening at a younger age is essential to predict health and disease in later life.

The BMI is the most widely used technique for determining relative weight and categorizing obesity. It is a valuable predictive measure for assessing the risk of various disorders, particularly those associated with underweight, overweight, and obesity [7]. Both, lower-than-normal body weight and overweight have negative impacts on an individual's physical performance and fitness, but obesity and overweight have greater adverse effects than underweight does and are responsible for more demises worldwide.

Across Pakistan, the high prevalence of underweight and malnutrition combined with the high prevalence of overweight or obesity is a main pressing issue and requires serious thought to control the occurrence of diseases. In Pakistan, as indicated by the National Nutritional Survey 2018 report, among women of reproductive age (15-49 years), 24.2% were overweight

**Corresponding author: Kiran Abdul Sattar, Institute of Family Medicine, Jinnah Sindh Medical University, Karachi, Pakistan, Email: kiran.zeeshan@jsmu.edu.pk*
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and 13.9% were obese [8]. Biological factors, imbalanced diet, and physiological and social stress are major risk factors for the development of obesity in the younger generation [9]. Even though there has been more research on health disorders and the obesity epidemic recently, a limited number of these studies especially focus on college-aged students and young adults. Some studies depict that hypertension is strongly correlated with overweight and obesity and is a prevalent issue in the younger generation of Pakistan [10-12].

This study plans to examine the BMI and BP of young students, newly enrolled in a public sector medical university in Pakistan, and to find out a particular relationship between BMI and elevated BP among these students.

This study will eventually make a way for effective public health initiatives custom-made to the special challenges presented by the conjunction of obesity and hypertension in this demographic.

MATERIAL AND METHODS

This cross-sectional study was conducted over three months on a secondary dataset at Jinnah Sindh Medical University of Karachi in 2023 after approval from the Institutional Review Board at JSMU (Ref. letter no.: JSMU/IRB/2022/686). The secondary data used for the study was collected each year from 2020 to 2023 for newly enrolled students. Students' identity was hidden using pseudo-anonymization and confidentiality was maintained. Secondary data was available for the total number of 1403 students who were inducted in various undergraduate courses in health sciences. The students inducted in Medical, Dentistry, DPT (Department of Physical Medicine), BSN (Bachelor of Science in Nursing), and Pharmacy all routinely go through medical assessment upon induction and their data was available and included in the study in a consecutive method. All students were mentally sound. Well-oriented in time, place, and person and not diagnosed or treated for any chronic illness like cancer or TB.

The student's age, gender, weight, height, BMI, and BP were recorded at Family Medicine clinic of the University right after admission. This is routinely done for all students, staff, and patients who visit the clinic by the clinic nurse. Recording of BP was taken by the registered nurse after making the student comfortably sit on the assessment chair. The blood pressure was recorded by manual sphygmomanometer apparatus. The height and weight were measured by the clinic registered nurse with a stadiometer having a manual weighing scale too. Students were instructed to take off their shoes and outer clothing, such as coats before stepping on the stadiometer. Students were asked to stand with heels, buttocks, and upper back against the stadiometer and to look straight ahead. The measuring bar of the calibration rod was positioned horizontally on top of the student's head forming a 90° angle with the calibration rod and height was recorded to the nearest half inch from the lower border of the measuring rod at eye level. Weight was measured to the nearest half pound that was zero balanced before each student was weighed.

The BMI of students was calculated using the formula weight in kg/square of height in meters and they were classified according to the Asian cutoff for underweight <18.5 kg/m^2 normal >18.5-22.9 kg/m^2, overweight 23-24.9 kg/m^2, obesity I: 25-29 kg/m^2, obesity II:>30 kg/m^2 [13].

The systolic and diastolic blood pressures of students were categorized into normal (<120mmHg systolic and <80 mmHg diastolic), pre-hypertension (systolic 120-139 or 80-89mmHg diastolic), stage-I hypertension (140-159 mmHg systolic or 90-99mmHg diastolic) and stage-II hypertension (>160 mmHg systolic or >100mmHg diastolic) using JNC classification [14].

Data was analyzed using SPSS version 24. Descriptive statistics like mean and standard deviation were used to present continuous variables like age and blood pressure. The qualitative variables like gender, obesity classification, and diagnosis of hypertension were presented as frequency and percentage. Simple linear regression was used to test if BMI significantly predicted systolic and diastolic blood pressures. The association between BMI category and blood pressure was measured using a Chi-square test of significance (p-value of < 0.05).

RESULTS

The sample consists of n= 1403 students with a mean age of 19 + 1.4 years students among whom males were 28.3% (n=397) and females were 71.7% (n=1006). Most of the students were from the course of MBBS n=902 (64.3%) followed by students from BDS n=180 (12.8%), DPT n=165 (11.8%) BSN n=97 (6.9%) and Pharmacy n= 59 (4.2%).

The mean BMI of students was 22.17 + 4.33 Kg/m^2. The BMI categories [12] are shown in Table **1**.

Mean Systolic Blood pressure was 111.42 + 10.7 mmHg and Mean Diastolic Blood pressure was 73.45 + 7.96 mmHg. The results are shown in Table **2**.

There was a significant difference in the BMI status of various courses (p-value 0.0001). The association of

Table 1: BMI of enrolled students.

BMI of enrolled students			
Classification	**Asian BMI cutoff value**	**Frequency**	**Percentage**
Underweight	<18.5 Kg/m^2	216	15.4
Normal	18.5-22.9 Kg/m^2	667	47.5
Overweight	23-24.9 Kg/m^2	203	14.5
Obesity – I	25- 29.9 Kg/m^2	228	16.3
Obesity – II	≥30 Kg/m^2	81	5.8

Table 2: BP status of students.

Blood pressure status of students based on Diastolic readings			
Classification	**Cutoff in mmHg**	**Number**	**Percentage**
Normal	<80	1357	96.7
Prehypertension	80-89	0	0
Stage-I hypertension	90-99	33	2.4
Stage-II hypertension	≥100	12	0.9
Blood pressure status of students based on Systolic readings			
Normal	<120	901	64.2
Prehypertension	120-139	466	33.2
Stage-I hypertension	140-159	32	2.3
Stage-II hypertension	≥160	3	0.2

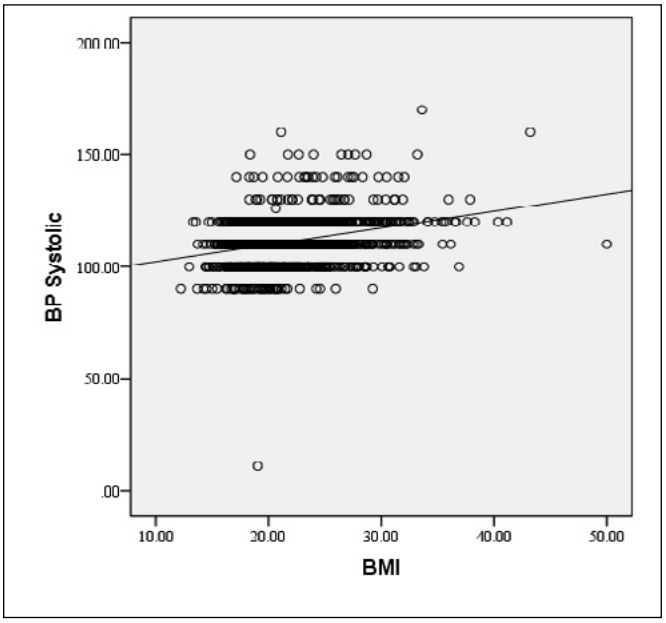

Fig. (1): Association of BMI with Systolic Blood Pressure Levels.

BMI with demographic factors failed to show a significant association (**Table 3**).

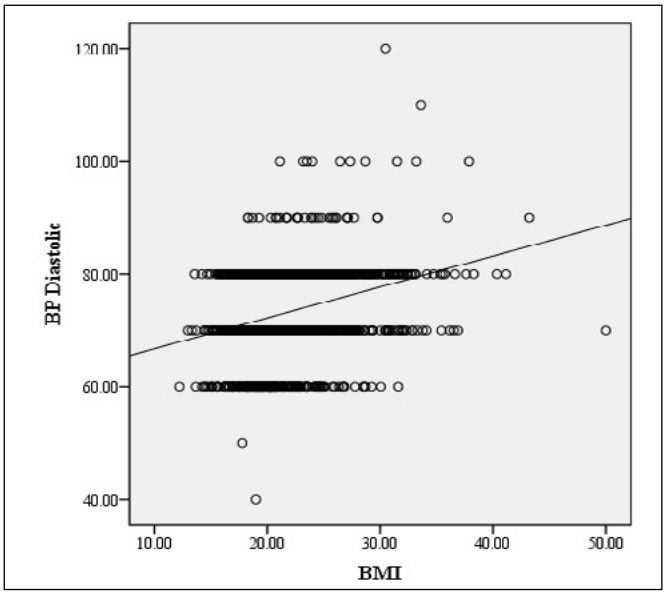

Fig. (2): Association of BMI with Diastolic Blood Pressure Levels.

There was a significant association between BMI and blood pressure levels of students. Results showed that 37.4% of the overweight population was pre-hypertensive, while 3.4% suffered from stage-I hypertension. The prevalence of hypertension increased with the increase in BMI. 49.1% of the students, classified as obesity grade-I, were pre-hypertensives, while 4.8% suffered from stage-I hypertension. Furthermore, 55.6% of the students having their BMI ≥ 30 kg/m^2, suffered from pre-hypertension, 4.9% had stage-I hypertension and 2.5% had stage-II hypertension (**Table 4**).

Simple linear regression was used to test if BMI significantly predicted systolic blood pressure (**Fig. 1**). The fitted regression model was 94.8+0.75 (BMI). The overall regression was statistically significant (R^2 = 0.092, F(1,1392)=140.2, p<0.001). It was found that

Table 3: Association of BMI with various demographic factors.

Variable n		Low <18.5 Kg/m^2		Normal 18.5-22.9 Kg/m^2		Overweight 23-24.9 Kg/m^2		Obese I 25-29.9 Kg/m^2		Obese II >30 Kg/m^2		Total		p-value
		n	%	n	%	n	%	n	%	n	%	n	%	
Gender	Male	58	14.8	172	43.8	64	16.3	76	19.3	23	5.9	393	100	0.185
	Female	158	15.8	495	49.4	139	13.9	152	15.2	58	5.8	1002	100	
Age	<20 years	199	15.6	615	48.2	184	14.4	207	16.2	71	5.6	1276	100	0.661
	≥20 years	17	14.3	52	43.7	19	16	21	17.6	10	8.4	119	100	
Year of induction	2020	47	13.4	168	48	46	13.1	65	18.6	24	6.9	350	100	0.743
	2021	94	16.4	275	48.1	87	15.2	88	15.4	28	4.9	572	100	
	2022	75	15.9	223	47.3	70	14.9	74	15.7	29	6.2	471	100	

Table 4: Association of BMI and Systolic Blood pressures of students

BMI	Normal BP		Pre hypertension		Stage I Hypertension		Stage-II Hypertension		Total		p-value
	n	%	n	%	n	%	n	%	n	%	
<18.5	167	77.3	47	21.8	1	0.5	0	0	216	100	<0.001
18.5-22.9	477	71.3	180	27	9	1.3	1	0.1	667	100	
23-24.9	120	59.1	76	37.4	7	3.4	0	0	203	100	
25-29.9	105	46.1	112	49.1	11	4.8	0	0	228	100	
≥30	30	37	45	55.6	4	4.9	2	2.5	81	100	

BMI significantly predicted systolic BP (β= 0.747, CI (0.624,0871), p<0.001).

Simple linear regression was applied to test if BMI significantly predicted diastolic blood pressure. The fitted regression model was 61.3+0.55(BMI). The overall regression was statistically significant (R^2 = 0.088, F (1,1392)= 135.08, p<0.001). It was found that BMI significantly predicted diastolic BP (β=0.547, 95%CI (0.455,0.640), p<0.001) (**Fig. 2**).

DISCUSSION

The current study showed a double burden concerning BMI. Less than half of our sample population had a normal BMI (47.5%). The rest of the sample were either underweight (15.4%), overweight (14.5%), or obese I or II (16.3%, and 5.8% respectively). This makes a total of 52% sample with other than abnormal BMI category (**Table 1**). Around 15% underweight is also a concern. They are part of an urban population who seek a college education and are assumed to have better economics than the poor masses.

According to a systemic review, the prevalence of obesity among young adults in developing countries ranges from 2.3 to 12% [15]. But our study showed a higher prevalence of overweight (14.5%) and obesity (21.1%) among young enrolled adults. The same trend has been indicated by numerous other recent studies as well. Asghar *et al.* conducted a study in four medical colleges in Karachi and found the prevalence of overweight and obesity to be 33.2% [16]. A study from one of the private medical colleges in Karachi reported that 36% of the students had pre-obesity and 15.4% had obesity [17]. Similarly, a study by Chandio *et al.* found that 36.33% of students have an obese BMI [18].

It is thus important to note that Pakistan, like many other countries, has witnessed a rise in the prevalence of obesity over the past few decades. This increase in obesity rates has been mirrored by an increase in the prevalence of hypertension. Several studies have highlighted the growing burden of hypertension in Pakistan's population [4].

According to our study, 96.7% of the students had normal diastolic BP, while only 64.2% had normal systolic BP. 2.4% and 0.9% of students suffered from stage-I and stage II diastolic hypertension, respectively. The ratio increased while measuring systolic BPs. In contrast to none being pre-hypertensive for diastolic BP, 33.2% of students suffered from systolic pre-hypertension, while 2.3% and 0.2% had stage-I and stage-II systolic hypertension, respectively (**Table 2**).

We also compared BMI with various demographic factors such as gender, age, and year of induction (**Table 3**). The results showed low body weight to be associated more with females than males, 15.8% and 14.8% respectively, while overweight and obesity showed a greater association with male gender than female gender. 16.3% of males while 13.9% of females were overweight and 25.2% of males while 21% of females were obese. The same tendency was found in the results of Khan *et al.*, [19]. This is contrary to many other studies which show a greater prevalence of obesity among females [18, 20], which indicates that the trend of obesity has been inconsistent with gender.

The results also showed that the ratio of underweight and normal weight was greater in students of age <20 years, while students of age >20 years showed a higher tendency to be overweight and obese than students of younger age. We didn't find any significant difference in the BMI in three different years.

Our study found a positive correlation between hypertension with obesity. Hypertension at this age can lead to many severe consequences, most importantly cardiovascular diseases which can cause strokes and thus disability for life [21, 22]. Strong associations between obesity and hypertension have been proved by numerous other studies within the country [11, 12] as well as globally [23-26].

One of the limitations of the study is that while BMI is a widely used tool to measure obesity, it cannot assess the body fat percentage of the individual [27]. Further studies using waist circumference along with BMI should be done to increase the accuracy of the calculation. Also, the time readings of blood pressure may not reflect true status since BP is affected by many other factors that have to be controlled, this may lead to bias. Furthermore, a longitudinal study should be conducted to observe the long-term changes in BP concerning BMI.

CONCLUSION

There is a double burden of malnutrition. A significant number of the students are either under or overweight. BMI is associated with both systolic and diastolic hypertension. Screening initiatives, targeting the younger population for both obesity and hypertension, must be established. Incorporating lifestyle adjustments, dietary guidance, and justified medical treatment from early on is vital.

ETHICAL APPROVAL

Ethical approval was obtained from the Institutional Review Board of Jinnah Sindh Medical University, Karachi (REF letter No. JSMU/IRB/2022/686). All procedures performed in studies involving human participants were following the ethical standards of the institutional and/ or national research committee and the Helsinki Declaration.

CONSENT FOR PUBLICATION

Written informed consent was taken from the participants.

AVAILABILITY OF DATA

The data set may be acquired from the corresponding author upon a reasonable request.

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Declared none.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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AUTHORS' CONTRIBUTION

All the authors contributed equally to the publication of this article.

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