

## How Strongly the Body Mass Index (BMI) is Associated with Inter Arm Blood Pressure Difference

Muhammad Absar Alam, Anam Rehman\*, Javaria Manzoor\*, Zafar Ali Zafar, Shireen Jawed\*, Benash Altaf\*

Independent Medical College, Faisalabad Pakistan, \*Aziz Fatimah Medical and Dental College, Faisalabad, Pakistan

### ABSTRACT

**Objectives:** To explore the association between the body mass index (BMI) and inter arm difference (IAD) blood pressure and to understand how these factors influence blood pressure.

**Study Design:** Cross-sectional study.

**Place and Duration of Study:** Aziz Fatimah Medical and Dental College Faisalabad Pakistan, from Nov to Dec 2020.

**Methodology:** Total 100 healthy medical students aged 19-21 years were included in the study. Height in meters and weight in kilograms were documented by stadiometer (ZT-100). BMI was assessed by Quetelet's index ( $BMI = \text{weight in Kg} / \text{height in m}^2$ ). Blood pressure was recorded simultaneously in both arms by the auscultatory method. Inter arm difference in blood pressure was estimated by calculating differences in diastolic and systolic pressures between the right and left arm.

**Results:** Mean age of the participants was  $19.83 \pm 1.23$  years. Significant difference was noted in systolic and diastolic inter-arm blood pressure among obese and non-obese groups ( $p$ -values  $< 0.001$ ). BMI was positively associated with diastolic and systolic inter-arm blood pressure ( $p$ -values  $< 0.001$ ).

**Conclusion:** Body mass index is positively associated with inter arm difference in blood pressure, and both positively impact the blood pressure.

**Keywords:** Body mass index (BMI), Diastolic blood pressure, Inter arm difference (IAD), Systolic blood pressure.

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### INTRODUCTION

Due to unhealthy lifestyle, less physical activity and increasing consumption of alcoholic beverages, obesity is becoming a significant health issue among young adults.<sup>1,2</sup> According to the World Health Organization (WHO) survey, 39% of adults aged 18 and above were found overweight, and 13% were obese. Asians are more prone to obesity-related comorbidities such as diabetes and hypertension at lower body mass index (BMI) than their age and sex-matched Europeans due to greater body fat percentages in them.<sup>3,4</sup>

Various previous studies conducted in the Indo-Pak sub-continent have documented the prevalence of 45-55% of pre-hypertension among the young population of 18 years and above.<sup>5</sup> Its prevalence is increasing day by day at an alarming rate in Pakistan due to increasing trends of obesity, increased salt, saturated fat, and low fruits and vegetables consumption.<sup>6,7</sup> Being the silent killer due to the absence of symptoms, its prevalence is even increasing worldwide at a break-neck pace, and it is estimated that this rate will hike up to the level of 29%, especially the young adults. Substantial evidence is available showing the positive association of obesity with hypertension. New guidelines

by the National Institute for Care and Health Excellence (NICE) emphasize blood pressure recording in both arms due to natural inter-arm difference in blood pressure but how much difference is significant is a matter of concern.<sup>8,9</sup> The blood pressure should be measured in both arms at the first visit because differences exist, and measurement in only one arm may lead to the under-diagnosis of hypertension.

Inter arm difference (IAD) in blood pressure has caught much attention after finding its association with various peripheral vascular diseases and increasing cardiovascular morbidity. Recent studies show that  $\geq 15$  mmHg systolic IAD in blood pressure is an indicator of underlying chronic conditions like pre-hypertension and hypertension in young adults.<sup>10</sup> Established data is available regarding the association between obesity and hypertension; however, there is a paucity of data concerning the association between BMI and IAD blood pressure, which are possible hypertension associated risk factors. This study focused on the association between BMI and IAD blood pressure, possibly associated risk factors for hypertension. We also aimed to seek how these factors influenced blood pressure.

### METHODOLOGY

This was a cross-sectional study, conducted at Aziz Fatimah Medical and Dental College, Faisalabad, from November to December 2020. Open Epi sample

**Correspondence:** Dr Javaria Manzoor, Department of Physiology, Aziz Fatimah Medical and Dental College, Faisalabad, Pakistan

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size calculator was used for sample size estimation, with power 80%, CI 95%, the ratio of sample size group 2/group1 as 1 the mean values of groups 1 and 2 were  $2.64 \pm 0.36$  and  $2.86 \pm 0.42$  respectively.<sup>7,8</sup> One hundred medical students were recruited by non-probability convenience sampling technique. Before the start of study, ethical approval from the Institutional Ethical Committee (IEC) was obtained (IEC#73-20).

**Inclusion Criteria:** Medical students of age 19-21 years were included in the study.

**Exclusion Criteria:** Students with a known history of hypertension, diabetes and cardiovascular diseases were excluded from the study.

Participants were enrolled after taking informed consent. They were assured of anonymity. Height in meters and weight in kilograms were documented by a stadiometer (ZT-100). BMI was assessed by Quetelet's index:  $BMI = \text{weight in Kg} / \text{height in m}^2$ . Subjects were allowed to relax for five minutes in a comfortable environment, and the blood pressure recording was done. Blood pressure was recorded simultaneously in both arms. Three readings were taken at the one-minute

Statistical Package for Social Sciences (SPSS) version 21 was used for the data analysis. Continuous variables like blood pressure were presented as Means  $\pm$  SD. The normality of data was checked by the Shapiro Wilk test ( $p$ -value  $\geq 0.05$ ). The independent t-test was used to compare mean blood pressure among obese and non-obese. The  $p$ -value of  $\leq 0.05$  was considered statistically significant.

**RESULTS**

This study comprised 100 medical students with mean age of  $19.83 \pm 1.23$  years (Table-I).

**Table-I: Descriptive statistics of study population (n=100).**

Parameters	Mean $\pm$ Standard deviation
Age (years)	19.8 $\pm$ 1.23
Body Mass Index (Kg /m <sup>2</sup> )	23.4 $\pm$ 4.06
Height (cm)	1.69 $\pm$ 0.09
Weight (kg)	68.38 $\pm$ 15.08

Of the total population, 46% were obese, having a BMI of  $>25$  Kg/m<sup>2</sup>, and 54% of subjects were non-obese. BMI of obese subjects was high as compared to non-obese subjects. This was a significant difference ( $p$ -

**Table-II: Comparison of Blood Pressure And Body Mass Index BMI Among Obese And Non obese Group (n=100).**

Parameters ( mean)	Obese Subjects (n=46)	Non obese subjects (n=54)	$p$ -value
Body Mass Index( kg/m <sup>2</sup> )	27.07 $\pm$ 1.69	20.62 $\pm$ 2.87	<0.001*
Systolic Blood Pressure (mmHg)	123.84 $\pm$ 13.615	115.74 $\pm$ 1.36	<0.001*
Diastolic Blood Pressure (mmHg)	84.89 $\pm$ 8.529	79.81 $\pm$ 9.19	<0.001*
Pulse Pressure (mmhg)	35.36 $\pm$ 9.542	34.31 $\pm$ 0.53	0.530
Systolic Inter Arm Difference (mmhg)	12.40 $\pm$ 7.73	8.31 $\pm$ 5.917	<0.001*
Diastolic Inter Arm Difference (mmhg)	1.58 $\pm$ .866	1.19 $\pm$ .585	<0.001*

interval by sphygmomanometer of the appropriate sized cuff. As per the American Heart Association (AHA) recommendation, the subject was made to sit with the arm supporting at the heart level.<sup>11</sup> It was assured that zero apparatus error was checked prior to taking the blood pressure readings. Systolic and diastolic blood pressure was recorded with the appearance and disappearances of clear Korotkoff sounds, respectively. To avoid parallax error, the mercury level of the sphygmomanometer was noted. The inter-arm difference in blood pressure was estimated by taking systolic and diastolic differences between the right and left arms.

For comparison purposes, the study subjects were divided into two groups, i.e. obese and non-obese groups, based on BMI. According to WHO guidelines for Asians, subjects with BMI  $\geq 25$  kg/m<sup>2</sup> were considered obese, and  $\leq 25$  kg/m<sup>2</sup> were considered non-obese.<sup>12</sup>

value  $<0.001$ ) (Table-II). Statistically significant differences in mean systolic and diastolic blood pressure were noted among obese and non-obese subjects. A significant difference was noted concerning both groups' systolic and diastolic inter-arm differences ( $p$ -value  $<0.001$ ). All these blood pressure parameters were comparatively higher in obese than non-obese. Both groups' mean pulse pressure was not significantly different ( $p$ -value=0.53). Our results indicated the significant positive association of BMI with diastolic and systolic blood pressure.

**DISCUSSION**

The present study was aimed to highlight the relation between IAD blood pressure and BMI and how these associated hypertension risk factors affect blood pressure. Hypertension has become a significant health-related problem. It is documented that prevalence of hypertension is 35% in Pakistani population. Early stages of hypertension are asymptomatic. Most

of the young population remains undiagnosed until the disease becomes advanced and symptomatic.<sup>12,13</sup> It is necessary to identify hypertension associated risk factors for early recognition of high-risk populations. The variation in blood pressure among both arms is not infrequent while doing the routine clinical assessment in a general health care centre. However, the point of concern is exactly how much alteration in blood pressure is existent.<sup>14</sup>

Our study comprised 100 subjects, among them 46% were obese, and 54% were non-obese. Similar results were also found in a study done by Khan *et al*, who found 37% of the participants obese.<sup>12</sup>

We have found a significant difference in both diastolic and systolic blood pressure in our study groups. We found markedly raised blood pressure in obese subjects. Current results agreed with the results of the study from Faisalabad by Jawed *et al*, which also reported a positive impact of BMI on blood pressure.<sup>13</sup> These findings were also supported by a study conducted in Karachi that showed a similar relation in children.<sup>14</sup> Indian study conducted at Amritsar also reported similar findings.<sup>15</sup>

Significant IAD difference was observed in systolic and diastolic blood pressure of obese and non-obese subjects. IAD was significantly higher in obese subjects whose BMI was more than 25 kg/m<sup>2</sup>. The current findings were in accordance with Muñoz-Torres *et al*, study from the United States that also reported similar results.<sup>16</sup>

Current results showed a significant positive association of IAD with BMI. Similar results were also seen in a study conducted in the United States documenting a positive association of baseline adiposity, including BMI, with IAD blood pressure.<sup>16</sup> These results were similar to those reported by Kumari *et al*, study conducted at Lucknow, India. They also reported the difference in IAD systolic blood pressure in individuals who were obese. However no significant difference was found in IAD diastolic blood pressure of obese subjects.<sup>8</sup> This study also found a significant positive association between IAD and BMI. Asians and other Americans researches also showed the significant associations between BMI and IAD, strengthening our results even more.<sup>17-19</sup>

In the previous research, it was observed that there is variation in the alteration of inter-arm blood pressure. Some researchers indicated that the IAD in blood pressure is because by any underlying inherited disease like thinning of the vessels or aortic coarctation

or the acquired disease that produces compression on the main vessels, thrombus embolus and atheroma.<sup>19</sup> As extensive data is not available concerning the association of IAD and BMI, more research is needed on an extensive scale to open new horizons in the medical field as it can be taken as a non-invasive marker to provide a clue for the underlying disease.

#### LIMITATION OF STUDY

In this study, only one parameter of obesity was focused. Although BMI is a gold standard parameter of obesity as it determines the overall adiposity, it cannot measure the fat distribution in the body. The waist-hip ratio and the waist-hip circumferences are the best indicators of central obesity. As most of the normal weight subjects at risk are frequently misdiagnosed, the parameters for central obesity should be focused. Moreover, this study had the drawback of having a small sample size.

#### CONCLUSION

Body mass index is positively associated with inter arm difference in blood pressure, and both positively impact the blood pressure.

**Conflict of Interest:** None.

#### Authors' Contribution

MAA: Study design, data analysis and manuscript write up. Reviewed and approved the manuscript, AR: Data acquisition, manuscript writing, reviewed and approved the manuscript, JM: Study design, data collection interpretation of results, revising manuscript critically, ZAZ: Data analysis and interpretation and write up of results, reviewed and approved the manuscript, SJ: Study design, data collection, and revised manuscript critically for important intellectual content, BA: Data collection, drafting and formatting of final manuscript, revised and approve the final manuscript.

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