ORIGINAL ARTICLE

ASSOCIATION OF BODY MASS INDEX WITH PERIPHERAL VASCULAR RESISTANCE

Urooj Bhatti[1], Ramesh Kumar[1], Kavita Bai[1], Keenjhar Rani[1], Bheem Soothar[2], Zoheb Rafique Memon[1]

[1]Liaquat University of Medical and Health Sciences, Jamshoro, Pakistan, [2]Dow University of Health Science, Karachi, Pakistan

Objectives: To determine the relationship of body mass index (BMI) with peripheral circulation in healthy adults.

Methodology: This cross-sectional study was carried out at Jamshoro's Liaquat University of Medical and Health Sciences' Physiology Department. The study lasted one year (January to December 2018). One hundred and eighty healthy persons under the age of forty were chosen, including males and females. After calculating the BMI, to determine the peripheral circulation, arterial blood pressure and heart rate (pulse rate) were recorded. Data was analyzed using IBM SPSS version 23.0.

Results: A total of one hundred eighty (180) people took part in the study, 94 (52.2%) of whom were men and 86 (47.8%) of whom were women. Participants in the study had an average age of 21.83 5.88 years. The average person weighed 66.12 kg and was 2.85 m tall. Their average body mass index was 25.10±6.55. The pulse rate (beats/minute) in underweight, normal, overweight, and obese were 73.85±6.17, 73.56±6.04, 76.66±6.72, and 78.85±6.85, respectively ($p<0.01$). The mean arterial pressures in underweight, normal weight, overweight, and obese were 87.08±6.70, 85.72±8.15, 91.20±6.57 and 94.59±8.14mmHg respectively ($p<0.01$) Mean pulse pressure in BMI groups mentioned above were also statistically significant ($p<0.01$), i.e., 36.32±6.43, 39.12±8.12, 40.33±6.78 and 43.49±6.67mmHg respectively. Similarly, systolic BP (mmHg) in underweight, normal weight, overweight, and obese were 111.32±9.31, 113.17±10.41, 120.86±9.23 and 127.23±10.77 respectively ($p<0.01$).

Conclusion: Peripheral vascular resistance varies in accordance with body mass index, but no variation is noted on the basis of gender. In the present study, mean systolic and diastolic BP were significantly different on the basis of difference in BMI.

Keywords: Peripheral circulation, arterial blood pressure, pulse, BMI, overweight, obesity, healthy adults, gender

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INTRODUCTION

Obesity is a serious health issue globally, and its co-morbidities vary according to different residing areas, i.e., in Indians, hypertension is common with obesity, while in South Africa and Russia, diabetes mellitus and hypertension are frequently reported with obesity.[1]

According to the World Health Organization, obesity is defined as body mass index (BMI) ≥30 kg/m^2, and overweight is 25-29.9 kg/m^2. Obesity-related cardiovascular disorders increase the mortality rate globally.[2] The prevalence of obesity is increasing alarmingly, and there is a need to intervene to decrease the risk of non-communicable diseases.[3] In Pakistan, 15.0% of the adult population is overweight or obese;[4] in rural areas, the obesity prevalence is 9% among men and 14% among the female populace, while in urban areas, it is 22% in men and 37% in women.[5]

People with obesity and overweight are at risk for various cardiovascular disorders like hypertension-induced coronary artery disease and heart failure leading to sudden death.[6,7] Although various studies have been conducted in Western countries to evaluate the impact of overweight and obesity, only a few studies have been done in Pakistan to assess this issue in normal, healthy adults. This study is planned to

explore the association of BMI with peripheral circulation.

METHODOLOGY

This descriptive cross-sectional study was conducted at the Physiology Department, LUMHS Jamshoro, from January to December 2018. Based on the 15.0% proportion of the obese and overweight population in Pakistan,[4] taking a 95% confidence interval and 5% margin of error, the calculated sample size was 196. Among 196 participants, 16 were discarded due to incomplete data, and therefore, a total of 180 healthy participants (180) of 18 to 40 years of age (males and females) were recruited by non-probability purposive sampling technique. Non-smoker volunteers without any respiratory or cardiac diseases were included in the study. Pregnant women, smokers, diabetics, diagnosed hypertensive taking medication, known cases of anemia, known cases of cardiovascular disease, and asthma were excluded from the study. Approval was obtained from the university's ethical review committee with letter No. LUMHS/REC/118 December 4th 2017. In order to recruit volunteers matching the selection criteria, flyers were placed on different notice boards of campuses and of the LUH (Liaquat University Hospital).

The BMI scale (RGZ-160, China), which has a 160 kg capacity and a 70 to 90 cm range, was used to measure the weight and height of the volunteers. Weight was measured in kilograms, while height was measured in centimeters. Weight was measured without wearing socks and shoes while wearing light clothing. Height was taken with bare feet while standing straight.

BMI was calculated by taking weight (Kg) and then divided by the height (square meter). It was categorized as normal: 18.50 to 24.99 (kg/m^2), underweight <18.50, overweight ≥25.00-29.99, and obese ≥30.00.

Using a sphygmomanometer (Yamasu Japan) and stethoscope (Littman Company), the arterial blood pressure was taken from the right arm while the participant was sitting. The final reading was determined by taking the mean of the first three readings. Mean arterial pressure was calculated by pulse pressure (subtracting the diastolic blood pressure (DBP) from the systolic blood pressure (SBP) divided that by 3 and then the addition of diastolicbloodpressure.[7] Pulse pressure was determined by subtracting the DBP from SBP. The participant was asked to lie still for 15 minutes while the heart rate was monitored three times, with the average of the three measurements serving as the final measurement to minimize the chance of mistake. The Statistical Program for Social Sciences (SPSS) version 23.0 (IBM Armonk, NY: IBM Corp.) was employed for the data analysis. The mean and standard deviation were used to examine continuous hemodynamic data. The one-way ANOVA F-test was used to compare BMI groups, and post hoc analysis was done using Tukey's HSD test of multiple comparisons. Independent sample t-test was used to compare the means between genders. P-values less than 0.05 were considered statistically significant.

RESULTS

A total of one hundred eighty (180) people took part in the study, 94 (52.2%) of whom were men and 86 (47.8%) of whom were women. Participants in the study had an average age of 21.83 5.88 years. The average person weighed 66.12 kg and was 2.85 m tall. Their average body mass index was 25.10±6.55. The majority, or 58 (32.2%), belonged to the overweight group, followed by 47 (26.1%) in terms of obesity. A total of 41 participants (22.87%) were normal weight, whereas 34 participants (18.9%) were underweight. (As shown in Table 1).

Table 1: Descriptive statistics of study population

	Summary statistics
Total (N)	**180**
Age (in years)	21.73±5.78
Gender	
Male	94(52.2)
Female	86(47.8)
Weight (kg)	66.12± 21.3
Height (m^2)	2.85±0.33
Body mass index (kg/m^2)	25.10±6.55
Underweight	34(18.9)
Overweight	58(32.2)
Obese	47(26.1)
Normal	41(22.8)

The pulse rate in underweight, normal, overweight, and obese was 73.85±6.17, 73.56±6.04, 76.66±6.72, and 78.85±6.85 beats per minute, respectively. All BMI groups and pulse strongly correlated (p<0.01). The corresponding mean arterial pressures for people who were underweight, normal weight, overweight, and obese were 87.08±6.70, 85.72±8.15, 91.20±6.57 and 94.59±8.14mmHg respectively. Changes in mean arterial pressure were significantly correlated with changes in BMI (p<0.01). Mean pulse pressure in the aforementioned BMI groups was statistically significant (p<0.01), i.e., 36.32±6.43, 39.12±8.12, 40.33±6.78 and 43.49±6.67mmHg respectively. Mean systolic and diastolic blood pressure were significantly

different in different BMI groups. (As shown in Table 2)

When mean arterial pressure (mmHg), pulse pressure(mmHg), systolic blood pressure (mmHg), and diastolic blood pressure (mmHg) were compared between underweight and overweight, it revealed the significant difference, i.e., (p=0.06, p=0.04, p<0.01 and p <0.01, respectively). When similarly aforementioned variables were compared between underweight and obese, they revealed a significant difference, i.e., (p=0.01, p=0.01, p<0.01, p<0.01, and p <0.01, respectively). Similarly, the aforementioned variables of peripheral vascular resistance compared between overweight and normal weight, as well as between obese and normal weight, all revealed significant differences statistically. (As shown in Table 3)

Table 2: Association of peripheral resistance with body mass index

	Underweight (n=34)	Normal (n=41)	Overweight (n=58)	Obese (n=47)	P-value -
Pulse (beats/min)	73.85±6.17	73.56±6.04	76.66±6.72	78.85±6.85	<0.01*
Mean Arterial Pressure (mmHg)	87.08±6.70	85.72±8.15	91.20±6.57	94.59±8.14	<0.01*
PulsePressure(mmHg)	36.32±6.43	39.12±8.12	40.33±6.78	43.49±6.67	<0.01*
Systolic pressure (mmHg)	111.32±9.32	113.17±10.41	120.86±9.23	127.23±10.77	<0.01*
Diastolic pressure (mmHg)	75.00±6.15	73.54±8.38	81.03±7.77	86.60±8.91	<0.01*

**p<0.05 was considered statistically significant using one-way ANOVA*

Table 3. Association of peripheral vascular resistance with body mass index (Tukeys HSD test)

	Pulse (beats/min)	Mean Arterial Pressure (mmHg	Pulse Pressure (mmHg)	Systolic Blood Pressure (mmHg)	Diastolic Blood Pressure (mmHg)
Underweight vs. Overweight	73.85±6.17	87.08±6.70	36.32±6.43	111.32±9.32	75.00±6.15
	76.66±6.72	91.20±6.57	40.33±6.78	120.86±9.23	81.03±7.77
	p =0.29	p =0.06	p =0.04*	p <0.01*	p <0.01*
Underweight vs. Obese	73.85±6.17	87.08±6.70	36.32±6.43	111.32±9.32	75.00±6.15
	78.85±6.85	94.59±8.14	43.49±6.67	127.23±10.77	86.60±8.91
	p =0.01*	p =0.01*	p <0.01*	p <0.01*	p <0.01*
Overweight vs. Normal weight	76.66±6.72	91.20±6.57	40.33±6.78	120.86±9.23	81.03±7.77
	73.56±6.04	85.72±8.15	39.12±8.12	113.17±10.41	73.54±8.38
	p =0.07	p <0.01*	p =0.98	p <0.01*	p <0.01*
Obese vs. Normal weight	78.85±6.85	94.59±8.14	43.49±6.67	127.23±10.77	86.60±8.91
	73.56±6.04	85.72±8.15	39.12±8.12	113.17±10.41	73.54±8.38
	p <0.01*	p <0.01	p =0.07	p <0.01	p <0.01*

**p<0.05 was considered statistically significant using Tukey's HSD test*

When the variables above to measure peripheral vascular resistance parameters were compared based on gender, there was no significant difference statistically. (As shown in table 4)

Table 4: Gender-wise comparison of peripheral resistance

	Male Mean ± SD	Female Mean ± SD	P-value
Total (N)	**94**	**86**	**-**
Pulse (beats/minute)	75.55±6.48	76.49±7.13	0.35
Mean Arterial Pressure (mmHg)	89.55±7.84	90.62±8.41	0.37
Pulse pressure (mmHg)	40.46±6.55	39.76±8.21	0.52
Systolic blood pressure (mmHg)	120.32±10.47	117.5±12.67	0.1
Diastolic blood pressure (mmHg)	80.06±8.67	79.19±10.18	0.53

DISCUSSION

The study's findings regarding the relationship between BMI and cardiac parameters showed that there were significant differences in the means of all parameters, including pulse, arterial pressure, pulse pressure, systolic blood pressure, and diastolic blood pressure, depending on the body mass index category (p0.01 for all). In comparison to those who were underweight, overweight, and normal weight, obese people had the highest means. In the present study, mean systolic and diastolic BP were significantly different based on differences in BMI. The results of this research closely resemble the findings of the existing literature. An earlier study described that heart rate is positively correlated with obesity. Overweight had higher mean blood pressure and mean arterial pressure, while overweight had higher heart rates.[8] Similarly, in another study, obesity and blood pressure were positively correlated in both genders.[9] Hypertension in obese persons was more prevalent as compared to non-obese individuals.[10]

The contributing factor might be the increased sympathetic activity in the kidneys of overweight and obese people or the increased levels of adipokines contributing to increased blood pressure with an increase in BMI.[11] Because the mean arterial pressure, systolic and diastolic blood pressures, and heart rate have been observed to correlate favorably with BMI.[12] Additionally, the two genders had no statistically significant difference in mean arterial pressure or mean pulse rate.

According to a study, exercise can play a role in decreasing the hemodynamic variables.[13] Similar to the present study, another study from Peshawar, Pakistan, showed higher mean systolic BP as well as diastolic BP in both obesity as well as in overweight.[14] A study supporting the present research has revealed significant controlled BP after weight loss.[15] The results of an Indian study showed that mean blood pressure was elevated in overweight persons as compared to normal persons. Higher systolic BP was noted in obese women as compared to normal-weight women, while there was no noteworthy distinction observed in pulse rate and diastolic BP in obese versus normal young women.[16] Accordingly, there was higher mean BP along with elevated pulse among obese in contrast to normal-weight persons.[17]

Obese and overweight people are more prone to develop higher systolic and diastolic blood pressure even in childhood, so early intervention in weight reduction can decrease cardiovascular disease in later life. Furthermore, a study from Karachi, Pakistan, showed that overweight and obese children of school-going age had higher blood pressure as compared to normal-weight children.[18] Similarly, a study from India showed higher mean systolic, diastolic, pulse, and arterial pressure in all age groups ranging from 21 to 60 years.[19]

According to the results of a study, mean blood pressure rises considerably as the BMI increases; it was lower in underweight, normal in normal weight, and higher in obese persons.[20] In an international study, heart rate and pulse pressure were negatively correlated with BMI and positively correlated with diastolic and systolic blood pressures.[21] In contrast to the present study, one of the studies has shown no significant difference in vascular stiffness in various groups of BMI, but they measured different parameters to measure peripheral vascular resistance.[22]

Limitations: The sample size is smaller due to the smaller time scale, and it was difficult to find healthy, overweight, and obese people. Most of our participants were from urban areas.

CONCLUSION

Peripheral vascular resistance varies according to body mass index, but no variation is noted in gender. In the present study, mean systolic and diastolic BP were significantly different based on differences in BMI.

AUTHORS' CONTRIBUTION

UB and RK: Concept and design, data acquisition, interpretation, drafting, final approval, and agree to be accountable for all aspects of the work. UB, RK, KB, KR, B, and ZRM: Data acquisition, interpretation, drafting, final approval and agree to be accountable for all aspects of the work.

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Address for Correspondence:

Dr. Zoheb Rafique Memon, Lecturer, Department of Community Medicine and Public Health Sciences, Liaquat University of Medical and Health Sciences Jamshoro, Pakistan.
Email: zoheb.memon83@gmail.com