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Relationship of Blood Pressure with Body Mass Index (BMI): A Study in a Tertiary Care Hospital, Rangpur, Bangladesh

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Abstract **Original Research Article**

Introduction: Overweight and obesity is a complaint of abnormally increased body fat mostly resulting from increased energy intake relative to vitality expenditure and is a main sustenance-related syndrome worldwide. The extensive increase in its prevalence in current years and its association with reduced life expectancy has made obesity one of the most vital public health problems. Low levels of HDL and high levels of triglycerides can also increase fat build-up in the arteries, as a result, increase peripheral resistance & rise blood pressure. The purpose of the study was to understand the relationship of blood pressure with body mass index (BMI). ***Methods:*** A cross-sectional study was carried out in the Department of Physiology and Biochemistry, Rangpur Medical College, Rangpur from January 2013 to December 2013. A purposive sampling technique was followed. A total number of 90 people from 18 to 45 years old were included in the study, categorized into three groups, such as Group-A:(Control 30): Healthy subject of normal weight, Group-B:(Experimental 30): Healthy subject of overweight & Group-C(Experimental-30): Healthy subjects of obese. Verbal consent was taken before recruiting the study population. Completed data forms were reviewed, edited, and processed for computer data entry. The data analysis was performed using the "t" test, "r" test & Statistical Package for the Social Sciences (SPSS) Version 25.0 where ($p<0.05$) considered as the level of significant with 95%CI. ***Result:*** In group A, the mean BMI of people was 18.5-22.9, in group B mean BMI of patients was 23.0-24.9, and in group C, the mean BMI of patients was 25.0 or greater. The mean ± SD systolic blood pressure levels were 106 ± 7.701 mmHg in group A and 110 ± 10.667 mmHg in group B. There was no significant difference ($p>0.05$) between the two groups. The mean ± SD diastolic blood pressure levels were 68 ± 6.644 mmHg in group A and 68.33 ± 7.232 mmHg in group B. There was no significant difference ($p>0.05$) between the two groups. The mean ± SD systolic blood pressure levels were 106 ± 7.701 mmHg in group A and 131 ± 11.987 mmHg in group C and the relationship was significant($p<0.05$). Blood pressure levels were positively correlated in both groups A &B but the relationship was statistically non-significant ($p>0.05$. Blood pressure levels were positively correlated in groups A &C but the relationship was statistically non- significant ($p>0.05$).***Conclusion:*** In this current content, it is difficult to determine the particular mechanism involved in non-significantly higher blood pressure in overweight people but significantly higher blood pressure in obese. Blood pressure also rises in those who are overweight and obese as a result of increasing energy intake, increased sympathetic nervous activity, sodium retention and an upsurge in peripheral resistance.

Keywords: Obesity, Overweight, Blood Pressure, BMI.

INTRODUCTION

Obesity and overweight are defined as abnormal or excessive accumulation of fat that displays a threat to health. A body mass index over 25 is considered overweight and over 30 is obese [1]. The prevalence of obesity has reached widespread proportions in all developed nations and has become an essential health concern. Approximately 40% of an

adult human is overweight and more than 15% is obese [2]. Mostly, South Asians have higher body fat and lower BMIs compared to Caucasians. Malaysia tripped the ASEAN scale as having the highest share of the population being categorized as obese in 2019, with over 15 per cent of its population classed as obese [3]. More than 1 billion people all around the domain are obese and of t them 650 million are grownups, 340 million are teenagers and 39 million are children [4]. BMI is positively associated with both systolic blood pressure (SBP) and diastolic pressure and weight loss considerably lessens blood pressure, suggesting that BMI is not merely an indicator of issues associated with high BP but is causally associated [5, 6]. Hyperinsulinemia initiated by insulin resistance stimulates sodium reabsorption, enhances sodium retention, and increases circulating plasma volume and it also stimulates the renin-angiotensin-aldosterone system and sympathetic nervous system, causing the hastening of atherosclerosis through the hypertrophy of vascular smooth muscle cells, which contributes to grew peripheral vascular resistance [7]. Hyperlipidemia is an eminent and main danger issue for ischemic heart disease, coronary artery disease (CAD) and cardiovascular disease as elevated levels of serum triglycerides, total cholesterol, low-density lipoprotein (LDL-C) and low levels of high-density lipoprotein (HDL-C). These are predictable danger factors for atherogenesis [8]. Low levels of HDL and high levels of triglycerides can also increase fat build-up in the arteries, as a result, increase peripheral resistance & rise blood pressure. High levels of HDL cholesterol still keep the heart by helping to eliminate the build-up of LDL from the arteries [7, 8]. So the present study has been designed to assess blood pressure in overweight and obese subjects.

OBJECTIVES

To observe the relationship of blood pressure with body mass index (BMI).

METHODS

A cross-sectional study was carried out in the Department of Physiology and Biochemistry, Rangpur Medical College, Rangpur from January 2013 to December 2013. A purposive sampling technique was followed. A total number of 90 people from 18 to 45 years old were included in the study, categorized into three groups, such as Group-A:(Control 30): Healthy subject of normal weight, Group-B:(Experimental 30): Healthy subject of overweight & Group-C(Experimental-30): Healthy subjects of obese. All observations were noted in the clinical data sheet. Informed written consent of the study subjects will be taken in easily understandable Bengali phrases. To measure blood pressure, doctors used sphygmomanometer. BMI was calculated manually by dividing person's weight in kg by height in meters squared. All observations were noted in the clinical data sheet. The results were calculated and interpreted through appropriate statistical analysis with the help of a statistician and presented with a table with other illustrations. Ethical clearance was taken from the hospital. The information was kept confidential only to be used for the study purpose.

Inclusion Criteria

- Age group of 18-45 years.
- Apparently healthy subjects of normal weight, overweight & obese person.

Exclusion Criteria

- Incomplete recorded data.
- Subjects with diabetes mellitus and other chronic diseases (liver, kidney & heart).
- Previous history of familial dyslipidemia.

Data Analysis

The study coordinators performed random checks to verify data collection processes. Completed data forms were reviewed, edited, and processed for computer data entry. Frequencies, percentages were used for descriptive analysis. For statistical analysis independent sample 't' test & Pearson's Correlation Coefficient 'r' test were performed by computer-based software SPSS-17.0 version for windows. The data analysis was performed using Statistical Package for the Social Sciences (SPSS) Version 25.0.

RESULT

Among the study population, people were categorized into three groups. Group A included healthy subjects of normal weight, group B included healthy subjects of overweight, and group C included healthy subjects of obesity. All people were from 18 to 45 years old. In group A, the mean BMI of people was 18.5-22.9, in group B mean BMI of patients was 23.0-24.9, and in group C, the mean BMI of patients was 25.0 or greater **[Table 1].** The mean ± SD systolic blood pressure levels were 106 ± 7.701 mmHg in group A and 110 ± 10.667 mmHg in group B. There was no significant difference ($p>0.05$) between the two groups. The mean ± SD diastolic blood pressure levels were 68 ± 6.644 mmHg in group A and 68.33 ± 7.232 mmHg in group B. There was no significant difference ($p>0.05$) between the two groups. The mean ± SD pulse pressure levels were 38 ± 6.644 mmHg in group A and 41.67 ± 11.167 mmHg in group B. There was no significant difference ($p>0.05$) between the two groups. The mean ± SD mean pressure levels were 80.65 ± 6.271 mmHg in group A and 82.22 ± 6.630 mmHg in group B. There was no significant difference ($p>0.05$) between the two groups **[Table 2].** The mean ± SD systolic blood pressure levels were 106 ± 7.701 mmHg in group A and 131 ± 11.987 mmHg in group C & the relationship was significant ($P>0.001$) between the two groups. The mean ± SD diastolic blood pressure levels were 68 ± 6.644 mmHg in group A and 90.166 ± 8.757 mmHg in

group C. The mean diastolic blood pressure levels were compared between group A & group C& the relationship was significant (P>0.001) between the two groups. The mean ± SD pulse pressure levels were 38 ± 6.644 mmHg in group A and 41.50 ± 5.894 mmHg in group C. There was no significant difference (P>0.05) between the two groups. The mean ± SD mean pressure levels were 80.65 ± 6.271 mmHg in group A and 104.40 ± 9.765 mmHg in group C & the relationship was significant (P>0.001) between the two groups **[Table 3].** Blood pressure levels were positively correlated in both groups A &B but the relationship was statistically non-significant **[Table 4].** Blood pressure levels were positively correlated in group A &C but the relationship was statistically non-significant **[Table 5].**

Table 1: Distribution of the Study population based on mean age, sex and BMI (N=90).

Group	Age-year (L-H)	Sex	BMI kg/m^2
A n=30	(18-45)	Male =18 Female=12	18.5-22.9
B n=30	(18-45)	Male =15 Female =15	23.0-24.9
C n=30	(18-45)	Male =20 Female =10	25.0 or greater

Table-2: Distribution of the study population based on mean ± SD Blood Pressure levels in group A & group B.

Group	**Systolic blood pressure level Mean ± SD mm/Hg Range (L-H) mm/Hg**	***'t' value***	***'p' value***
A n=30	106 ± 7.701 (90-120)	1.682	>0.05^{NS}
B n=30	110 ± 10.667 (95-130)		
Group	**Diastolic blood pressure level Mean ± SD mm/Hg Range (L-H) mm/Hg**	**'t' value**	**'p' value**
A n=30	68 ± 6.644 (60-80)	0.189	>0.05^{NS}
B n=30	68.33 ± 7.232 (60-90)		
Group	**Pulse pressure level Mean ± SD mm/Hg Range (L-H) mm/Hg**	**'t' value**	**'p' value**
A n=30	38 ± 6.644 (20-50)	1.613	>0.05^{NS}
B n=30	41.67 ± 11.167 (25-55)		
Group	**Pressure level Mean ± SD mm/Hg Range (L-H) mm/Hg**	***'t' value***	***'p' value***
A n=30	80.65 ± 6.271 (73-93)	0.936	>0.05^{NS}
B n=30	82.20 ± 6.630 (72-98)		

Table-3: Distribution of the study population based on mean ± SD Systolic blood pressure levels in group A & group C.

Group	**Systolic blood pressure level Mean ± SD mm/Hg Range (L-H) mm/Hg**	***'t' value***	***'p' value***
A n=30	106 ± 7.701 (90-120)	10.512	<0.001***
C n=30	131 ± 11.987 (110-150)		
Group	**Diastolic blood pressure level Mean ± SD mm/Hg Range (L-H) mm/Hg**	**'t' value**	**'p' value**
A n=30	68 ± 6.644 (60-80)	10.772	<0.001***
C n=30	90.166 ± 8.757 (70-100)		
Group	**Pulse pressure level Mean ± SD mm/Hg Range (L-H) mm/Hg**	**'t' value**	**'p' value**
A n=30	38 ± 6.644 (20-50)	1.613	>0.05^{NS}
C n=30	41.50 ± 11.167 (25-55)		
Group	**Pressure level Mean ± SD mm/Hg Range (L-H) mm/Hg**	***'t' value***	***'p' value***
A n=30	80.65 ± 6.271 (73-93)	11.906	<0.001***
C n=30	104.40 ± 9.765 (77-116)		

Table-4: Distribution of the study variables based on Relationship with body Mass Index (BMI) in groups A & B.

Parameters	Groups			
	Group-A		Group-B	
	r value	*p value*	*r value*	*p value*
Systolic blood pressure	0.011	0.912^{NS}	0.021	0.912^{NS}
Diastolic blood pressure	0.001	0.851^{NS}	0.036	0.851^{NS}
Pulse pressure	0.009	0.625^{NS}	0.093	0.625^{NS}
Mean pressure	0.015	0.963^{NS}	0.009	0.963^{NS}

Table-5: Distribution of the study variables based on Relationship with body Mass Index (BMI) in groups A&C.

Parameters	Groups			
	Group-A		Group-C	
	r value	*p value*	*r value*	*p value*
Systolic blood pressure	0.017	0.491^{NS}	0.131	0.491^{NS}
Diastolic blood pressure	0.003	0.780^{NS}	0.053	0.782^{NS}
Pulse pressure	0.003	0.782^{NS}	0.053	0.782^{NS}
Mean pressure	0.016	0.512^{NS}	0.153	0.512^{NS}

DISCUSSION

The present study was carried out to assess the blood pressure in overweight and obese subjects. The parameters were also studied in age-matched healthy control subjects for comparison. In this current analysis all people were from 18 to 45 years of old. Another related article suggested that age was positively correlated with blood pressure and the relationship between blood pressure and age was found to be significant and was stronger in women compared to men [11]Generally, blood pressure increased as people get older. Age was known risk factors for high blood pressure [12, 13]. In this study, all types of blood pressure were significantly higher ($p<0.001$) in obese subjects than those in healthy subjects. An author observed that blood pressure was higher in overweight & subjects which might be due to increasing energy intake, a fat-rich diet, relatively less energy expenditure and less involvement in physical activity leading to accumulation of fat in the arterial wall that causes increase blood pressure [12]. From an observational study, the author found that blood pressure was higher in overweight & obese subjects which might be due to, excessive alcohol intake, increase consumption of animal fat or salted food, salted milk tea, low consumption of vegetables, smoking and hypercholesterolemia [14]. A similar analysis also suggested that blood pressure was higher in overweight & obese subjects which might be due to increasing sympathetic nervous activity, sodium retention and enhanced vascular reactivity [15]. A similar study observed that blood pressure was higher in overweight & obese subjects which might be due to dyslipidemia and metabolic syndrome [14]. Another observational analysis also depicted that blood pressure was higher in overweight &obese subjects which might be due to metabolic abnormalities and altered HDL-cholesterol [17]. A related observation showed the prevalence of hypertension in obese participants was significantly higher (72.6%) compared to in non-obese people (50.5%) [18]. Excessive weight, particularly when associated with increased visceral adiposity, is a major threat of hypertension, accounting for 65% to 75% of the risk for human primary hypertension [19]. Another similar article pointed that, the prevalence of hypertension was 50% higher than that of persons with a normal weight and 100% higher than that of underweight persons of 40 to 64 years old [20].The association of adiposity with blood pressure is less apparent in hypertensive individuals compared to the general population signifying that the blood pressure adiposity relationship in hypertensive is moderated by environmental and genetic factors. Yet, obese people have a 3.5 folds' greater likelihood of having hypertension, 60% of hypertensive adults are >20% overweight and has been estimated that 60-70% of hypertension in adults may be directly attributable to adiposity [21].

However, in our country, no published data are available regarding these types of findings for comparison. A low level of HDL-C and a high level of triglyceride can also increase fat build-up in the arteries, then increase peripheral resistance and ultimately causes an increase in diastolic blood pressure [22]. And also increase sympathetic activity & sodium retention may be involved in the development of increased systolic blood pressure. Thus, all types of blood pressure are increased in overweight &obese subjects than those healthy control subjects [23]. Being overweight or obese increase the threat of developing high blood pressure. A review from 2020 estimated that obesity accounted for around 65 to 78 percent of cases of primary hypertension. Having more fat cells can cause complex changes in the body that combine to create or worsen hypertension [24]. This current study showed a high prevalence of blood pressure in group B and group C in contrast with Group A.

CONCLUSION

Obesity has developed into a universal epidemic in the last few ages. Body mass index (BMI) is an adequate indicator for detecting obesity in people and was inversely associated with lipid levels. In this current content, it is difficult to determine the particular mechanism involved in non-significantly higher blood pressure in overweight people but significantly higher blood pressure in obese. Blood pressure also rises in those who are overweight and obese as a result of increasing energy intake, increased sympathetic nervous activity, sodium retention and an upsurge in peripheral resistance. Blood pressure was maximum in overweight & obese and this adaptation is straightly related to BMI.

RECOMMENDATIONS

A related study with a larger sample size should be performed. The measurement of waist circumference and waist/hip ratio in overweight and obese subjects should be required to get the correct analysis. There is a necessity for setting a screening docket to cover all age groups for early detection and treatment of cases. To get robust data, multicenter studies are in great need of policymakers to interpret the demonstrable scenario and to take necessary steps towards mitigating this problem.

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Conflict of Interest: None declared.

Ethical Approval: The study was approved by the Institutional Ethics Committee.

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