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Body mass index and blood pressure level among adult Sudanese in Khartoum state

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Abstract

Introduction: The positive correlation between BMI and blood pressure has been established worldwide. So the increase in BMI has been considered as a risk factor for increased blood pressure.

Objectives: The objective of this study is to establish the relationship of body mass index and blood pressure level in Sudanese healthy adult living in Khartoum State.

Methods: Across sectional study was conducted in Khartoum

State on 205adultmales and female of aged between 20-80 years and not known to be hypertensive or suffering from any chronic illness. A questionnaire was filled by each participant covering (age, gender, physical activity, amount of salt intake, smoking history, and past medical history of chronic illness). Blood pressure was measured using the manual sphygmomanometer. Weight was measure using the standard scale and height was measured using a meter. BMI was calculated according to the formula:

$$\text{BMI} = \frac{\text{Weight (kg)}}{[\text{Height (m)}]^2}$$

Correlations between the variables were estimated and P value < 0.05 was considered statistically significant.

Results: There is statically significant, strong relationship between body mass index and systolic blood pressure and also positive correlation between body mass index diastolic blood pressure (p-value= 0.019)

Conclusion: The results showed a statistically significant positive correlation between blood pressure and BMI.

Introduction:

The association of obesity and hypertension has been recognized since the beginning of the 20th century, when blood pressure was first measured in populations this relationship between body weight and blood pressure was demonstrated prospectively in the Framingham Heart Study in the 1960s. The nature of the linkage between BP and body weight remained obscured until the mid-1980s when basic clinical and population-based research significantly clarified many aspects of the relationship between these two common and complex regulatory disturbances.(1)

Hypertension affects more than a quarter of the world's adult population and this proportion is likely to reach 29% by 2025. Most of this increase will occur in developing countries. Obesity is reaching epidemic proportions in the industrialized world and contributes to morbidity and mortality, although obesity is less prevalent in developed countries, it is increasing with urbanization. (2)

Globally, high blood pressure (BP) is estimated to cause 7.1 million deaths, about 13% of the total. About 62% of cerebrovascular disease and 49% of ischemic heart disease are attributable to suboptimal BP (systolic >115mm Hg). Overweight and obesity increase the risks of high BP, coronary heart disease, ischemic stroke, type II diabetes mellitus and certain cancers. Worldwide about 58% of diabetes mellitus and 21% of ischemic heart disease are attributable to BMI above 21 (3)

There is an increase in both blood pressure and body mass index in the recent years. Studies on general population have demonstrated that the prevalence of hypertension in overweight subjects is more when compared to that in normal subjects (4)

Many factors affect the normal blood pressure including, advanced age, smoking, black race, low potassium and high sodium intake, inactivity, alcohol intake, stress, some chronic illnesses, overweight and obesity.(5) A

study done on Japanese schoolchildren showed that there was significant positive relation between height, weight and blood pressure, but the relation between weight and blood pressure was stronger[6]

There is a positive association between obesity and blood pressure in both developed and less developed countries [7]

Many studies showed direct positive relation between BMI and blood pressure, increased BMI is associated with increased blood pressure, both systolic and diastolic.[8]

Obesity should be considered as a chronic medical condition, which is likely to require long-term treatment. Understanding of the mechanisms associated with obesity-related hypertension is essential for successful treatment strategies.[9]

Systematic reviews consistently reported a decrease in systemic blood pressure of about 1 mm Hg per kg of weight loss with follow-up of 2 to 3 years. There is attenuation in the longer-term, with a decrease of about 6 mm Hg in SBP per 10 kg of weight loss Intervention programs appropriate for obesity-hypertension combine diet, physical activity, and behavioral modification and aim to achieve long-term change in health-related behaviors.[1]

As the blood pressure depends on the cardiac output and the COP increases according to the body needs as in exercise, it is expected to have an increased COP with increased weight and size (BMI) to perfuse a larger mass, and consequently an increase in BP well occurs. Could this increase in BP with increased BMI be physiological and the definition of hypertension has to depend on BMI needs to be investigated and in this study its correlation of BMI and BP has been addressed so is finally to Refrains equation for the normal BP in relation BMI.

Methods

This is an analytical, cross-sectional community‑based study performed in Khartoum state capital of Sudan, in Sudanese healthy volunteer males and females aged 20-80 years who were not hypertensive, or has any chronic illness or using chronic medication, Ethical approval of this study was obtained from the National Ribat University.

The objectives of the study were explained to all individuals participating in the study.

And body mass index (BMI) was calculated by measuring weight and height by weight and height measuring devices (scale). Blood pressure was measured using the mercury sphygmomanometer.

All the data collected in this study was analyzed using the SPSS (Statistical Package for Social Sciences) computer program version 20,

P value < 0.05 was considered statistically significant.

Results

Age distribution of the participants came as follow: 143(69.8%) aged between 20-39 years, 46(22.4%) aged between 40-59 years and 16(7.8%) aged 60 years and above).

Males were 113(55.1%) and females were 92(44.9%).

BMI distribution of the participants falls under these categories: 97(47.3%) normal BMI (18.5-24.9); followed by 45(22%) overweight (25-29.9), then 40(19.5%) underweight (< 18.4) and 23(11.2%) obese (30 or more).

According to Systolic blood pressure measurement 90(43.9%) of the participants were prehypertensive, 83(40.5%) were normotensive, 26(16.7%) were hypertensive 6(2.8%) were hypotensive.

Based on the diastolic blood pressure measurement 101(49.3%) of the participants were prehypertensive, 63(30.7%) were normotensive, 37(18%) were hypertensive and 4(2%) were hypotensive.

The majority of the participants 188(91.7%) did not practice sport, 6(2.9%) practice sport 1 hour/week, 6(2.9%) 3 hours/week, 4(2%) 2hours/week and 1(0.5%) practice sport more than 3 hours/week.

The majority of the respondents 195(95.1%) did not smoke cigarettes, and those smoke cigarette were 5(2.4%) smoking 5-10 cigarettes per day, 3(1.5%) less than 5 cigarettes per days and 2(1%) more than 10 cigarettes per day .

None of the participants had history of heart disease, majority 203(99%) did not take any medications and only 2(1%) take diabetes medications.

The majority of the participants 189(92.2%) used medium amount of salt in meals, 9(4.4%) used extra amount, and 7(3.4%) used small amount (Figure 1).

Scattered plot chart showed slight direct correlation between BMI and Systolic blood pressure, but not significant correlation where R = 0.01687 (< 0.20) and P value = 0.0634 > 0.05) (Figure 2).

The mean systolic blood pressure was 114.5 in underweight subjects slightly increased to 116.8 in both normal and overweight subjects then clearly increased in obese subjects to 125.7 (Figure 3).

Scattered plot chart showed significant direct correlation between BMI and diastolic blood pressure, where R = 0.21 and P value = 0.0027 < 0.05) (Figure 4).

It's clear from the above figure that mean diastolic blood pressure increased gradually from 75 in underweight subjects to 77.4, 78.2 and 84.3 in normal, overweight and obese subjects respectively (figure 5).

The majority of females (who got pregnant) 60(84.5%) did not experience hypertension in pregnancy and 11(15.5%) reported hypertension in pregnancy.

According to total blood pressure (sys/dia) measurement hypertensive participants were 33(16.1%), prehypertenive88 (42.9%), normotensive 83(40.5%) and hypotensive 1(0.5%).

Normal BMI was found to be more common among participants aged 20-39 years(76.3%) and overweight among the participants aged 20-39 years (53.3%) and 40-59 years (37.8%) (P value = 0.003).

Over weight and obesity are found to be more common among females (60%),(60.9%) than males (40%) (39.1%) respectively (P value = 0.001).

Hypertension (systolic) was reported in 10% , 8.2% , 17.8% , and 26.7% of participants with underweight, normal, overweight and obese respectively, and prehypertensive in 40% , 48.5% , 35.6% and 47.8% respectively (P value = 0.005) (Table 1).

Hypertension diastolic was reported in 5%, 15.5%, 22.2% and 22.2% of the participants with underweight, normal, overweight and obese respectively, (P value = 0.001) (Table 2).

According to age group systolic hypertension and prehypertension are more common among the age groups 20-39 years(50%), (65.6%) and 40-60 years(38.5%), (24.4%) respectively (P value = 0.017) .

Diastolic hypertension and prehypertension According to age group are more common among the age groups 20-39 years(67.6%),(69.3%) and 40-60 years (24.3%) ,(20.8%) respectively (P value = 0.041) (Table 3).

As shown in Table (4) males showed more frequency of systolic prehypertension and hypertension (61.1%), (57.7%) than females (38.9%), (42.3%) respectively (P value = 0.001).

They showed more frequency of diastolic prehypertension and hypertension (56.4%), (62.2%) than females (43.6%), (37.8%) respectively (P value = 0.023). (Table 5)

According to BMI hypertension (sys/dia) was reported in 10% , 12.4% , 24.4% and 26.1% of the patients with underweight, normal, overweight and obese BMI respectively (P value = 0.019) (Table 6). Search for other causes is needed.

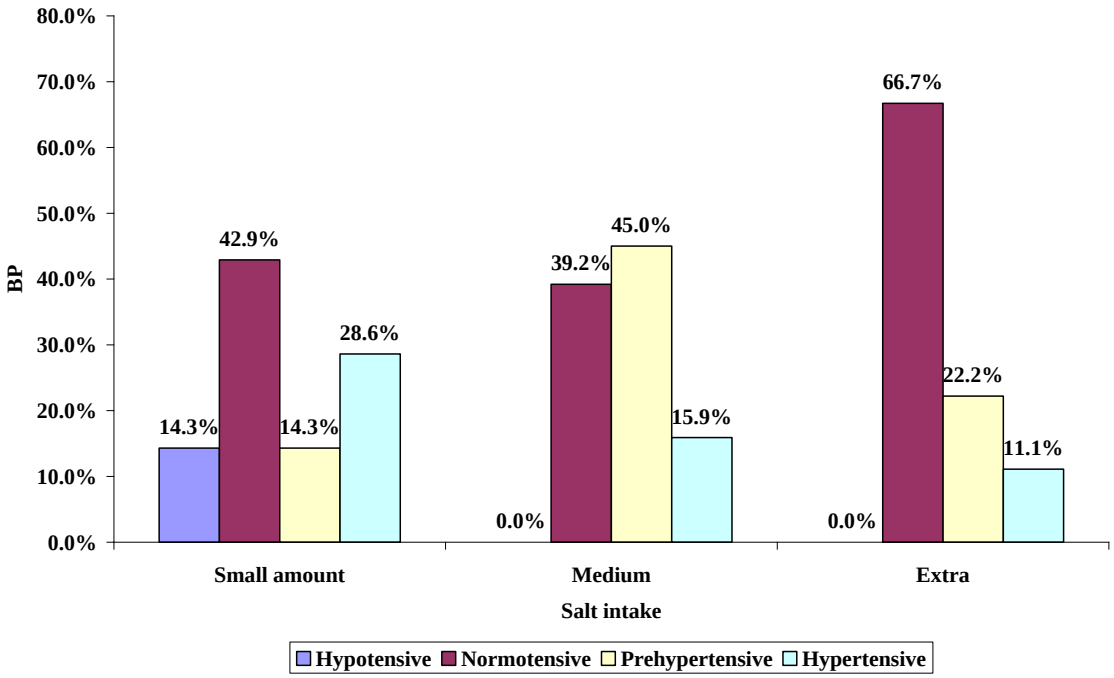

Figure (1) Correlation of salt intake and BP

(n=205)

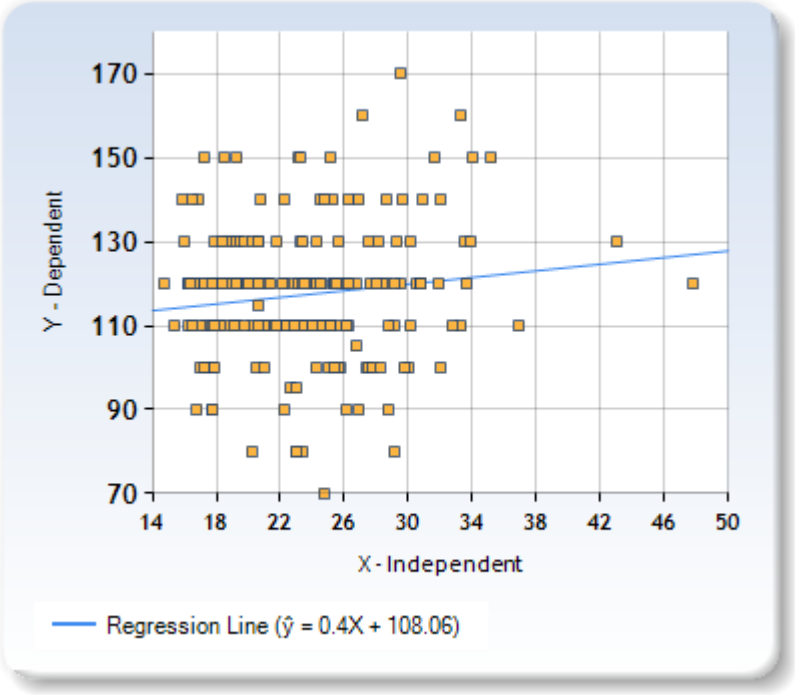

Figure (2) BMI in relation to Systolic blood pressure (both males and females)

Y = systolic blood pressure (dependent variable) and X = BMI (impendent variable)

95% Confidence Intervals

R	**0.13**
P Value	**0.0634**

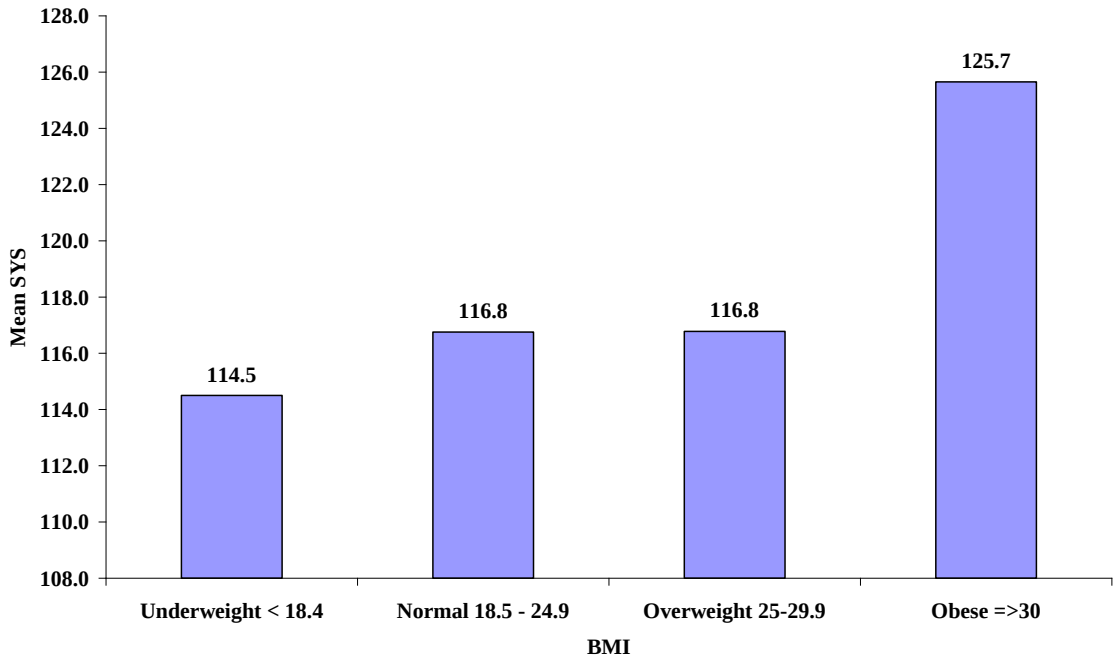

Figure (3) BMI in relation to mean Systolic blood pressure (both males and females) (Bar Chart)

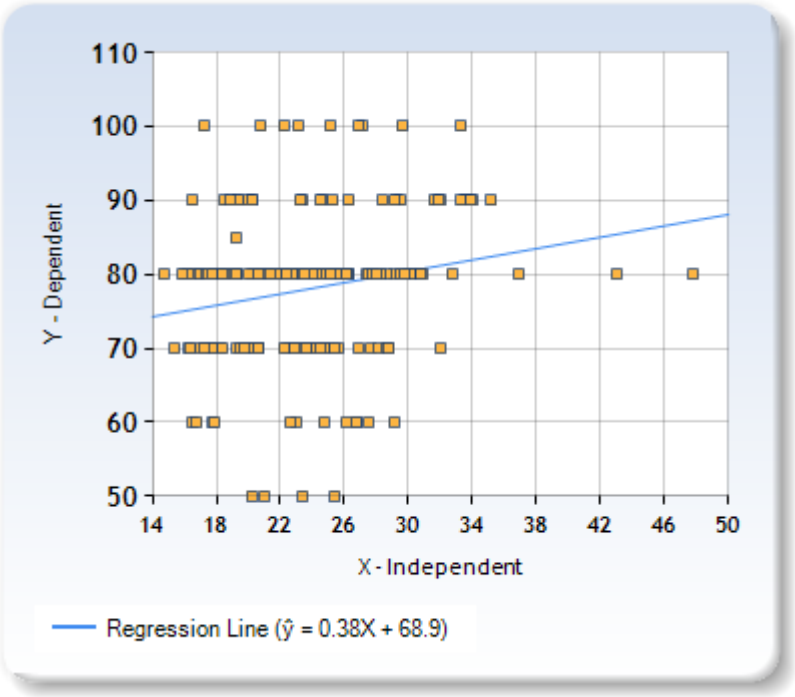

Figure (4) BMI in relation to diastolic blood pressure (both males and females)

Y = diastolic blood pressure (dependent variable) and X = BMI (impendent variable)

95% Confidence Intervals

R	**0.21**
P Value	**0.0027**

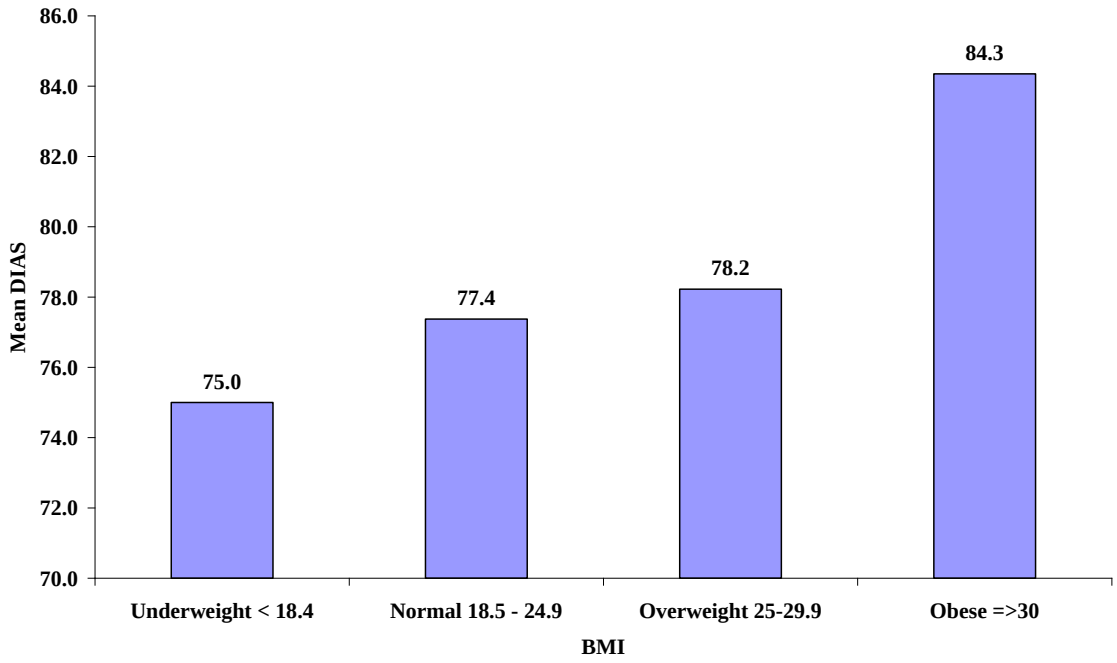

Figure (5) BMI in relation to mean diastolic blood pressure (both males and females)

(Bar Chart)

Table (1) Distribution of the participants according to correlation between systolic blood pressure and BMI

Systolic	BMI			
	Underweight < 18.4	**Normal 18.5 - 24.9**	**Overweight 25-29.9**	**Obese =>30**
Hypeotensive< 90	0(0.0%)	5(5.2%)	1(2.2%)	0(0.0%)
Normotensive 90-119	20(50.0%)	37(38.1%)	20(44.4%)	6(26.1%)
Prehypertensive 120-139	16(40.0%)	47(48.5%)	16(35.6%)	11(47.8%)
Hypertensive => 140	4(10.0%)	8(8.2%)	8(17.8%)	6(26.1%)
Total	**40(100.0%)**	**97(100.0%)**	**45(100.0%)**	**23(100.0%)**
P value = 0.005				

Table (2) Distribution of the participants according to correlation between diastolic blood pressure and BMI

	BMI			
Diastolic	**Underweight < 18.4**	**Normal 18.5 - 24.9**	**Overweight 25-29.9**	**Obese =>30**
Hypeotensive< 60	0(0.0%)	3(3.1%)	1(2.2%)	0(0.0%)
Normotensive 60-79	18(45.0%)	31(32.0%)	13(28.9%)	1(4.3%)
Prehypertensive 80-89	20(50.0%)	48(49.5%)	21(46.7%)	12(52.2%)
Hypertensive =>90	2(5.0%)	15(15.5%)	10(22.2%)	10(43.5%)
Total	40(100.0%)	97(100.0%)	45(100.0%)	23(100.0%)
P value = 0.001				

Table (3) Distribution of the participants according to correlation between diastolic blood pressure and age

	Diastolic			
Age group	**Hypeotensive < 60**	**Normotensive 60-79**	**Prehypertensive 80-89**	**Hypertensive =>90**
20-39 years	2(50.0%)	46(73.0%)	70(69.3%)	25(67.6%)
40-59 years	2(50.0%)	14(22.2%)	21(20.8%)	9(24.3%)
60 years and more	0(0.0%)	3(4.8%)	10(9.9%))	3(8.1%)
Total	**4(100.0%)**	**63(100.0%)**	**101(100.0%)**	**37(100.0%)**
P value = 0.041				

Table (4) Distribution of the participants according to correlation between systolic blood pressure and gender

	Systolic			
Gender	**Hypeotensive < 90**	**Normotensive 90-119**	**Prehypertensive 120-139**	**Hypertensive => 140**
Male	1(16.7%)	42(50.6%)	55(61.1%)	15(57.7%)
Female	5(83.3%)	41(49.4%)	35(38.9%)	11(42.3%)
Total	6(100.0%)	83(100.0%)	90(100.0%)	26(100.0%)
P value = 0.001				

Table (5) Distribution of the participants according to correlation between diastolic blood pressure and gender

Gender	Diastolic			
	Hypeotensive **< 60**	**Normotensive** **60-79**	**Prehypertensive** **80-89**	**Hypertensive** **=>90**
Male	1(25.0%)	32(50.8%)	57(56.4%)	23(62.2%)
Female	3(75.0%)	31(49.2%)	44(43.6%)	14(37.8%)
Total	**4(100.0%)**	**63(100.0%)**	**101(100.0%)**	**37(100.0%)**
P value = 0.023				

Table (6) Distribution of the participants according to correlation between blood pressure (sys/dia) and BMI

	BMI			
SYS/DIA	**Underweight < 18.4**	**Normal 18.5 - 24.9**	**Overweight 25-29.9**	**Obese =>30**
Hypotensive	0(0.0%)	1(1.0%)	0(0.0%)	0(0.0%)
Normotensive	20(50.0%)	37(38.1%)	20(44.4%)	6(26.1%)
Prehypertensive	16(40.0%)	47(48.5%)	14(31.1%)	11(47.8%)
Hypertensive	4(10.0%)	12(12.4%)	11(24.4%)	6(26.1%)
Total	**40**	**97**	**45**	**23**
P value = 0.019				

Discussion

The main goal of this study was to investigate the relationship between blood pressure and body mass index .The study covered many factors that may influence the blood pressure like physical activity, amount of salt intake, smoking, and past history of chronic illness or history of drugs

The study showed thatincreasein body mass index may increase both systolic and diastolic blood pressure and the prevalence of high blood pressure was greater in those with high body mass index [11,2]

Theincreased body weight can cause high blood pressure in a variety of ways. When there is increased weight it takes more pressure to move the blood around the body. Cardiac output is often higher in obese, due to an augmented stroke volume and an increase in heart rate.

In agreement with previous studies, there is gender differences where males have high blood pressure than females

The prevalence of obesity was greater in females (60.9%) than males (39.1%)[10]. Although females are more obese than males the prevalence of prehypertension and hypertension was higher among males according to the normal classification which was not taking the gender differences in body mass index and blood pressure.

This study showed that some cases have low body mass index but have high blood pressure, which need further investigation about the previous family history and environmental factors.

In Conclusion there is a trend of increased BP with increased BMI, which could be physiological, and a large-scale study is needed to verify this.

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