

# Effect of Body Mass Index on the Relationship between Blood Pressure Levels and Neurological Symptoms among Hypertensive Patients

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## ABSTRACT

**Objective:** Objective of this study was to find out the effect of BMI on relationship between blood pressure and neurological symptoms in hypertensive patients.

**Method:** A cross-sectional study, conducted from Jan to July 2019, at OPD of Medicine, tertiary care hospital in Karachi. Total 234 subjects with age 18 years or above, with self-defined history of hypertension and antihypertensive medication were included while those with history of confirmed diabetes, CVD, neurological disorders, metabolic diseases, and severe obesity were excluded. A questionnaire was utilized to collect baseline data and symptoms associated with hypertension and neurological problems. Blood pressure and BMI were measured by standard methods defined by W.H.O. SPSS version 20.0 was used for data analysis and results were expressed as frequency and percentage. Correlation analysis was used to determine the strength of the association between BMI and BP. P-value <0.05 was taken as statistically significant.

**Results:** The age of 138 (59.0%) patients was <50 years and 96 (41.0%) was >50 years, 123 (52.6%) were males while 111 (47.4%) were females; 12 (5.1%) were underweight, 73 (31.2%) were normal weight, 101 (43.2%) were overweight and 48 (20.5%) were obese; 75 (32.1%) had normal/high normal systolic blood pressure, 128 (54.7%) had grade 1 systolic hypertension while 31 (13.2%) had grade 2/grade 3 systolic hypertension; 120 (51.3%) had normal/high normal diastolic blood pressure, 101 (43.2%) had grade 1 diastolic hypertension while 13 (5.6%) had grade 2/grade 3 diastolic hypertension. Furthermore, 180 (76.9%) had headache, 140 (59.8%) had vertigo, 129 (55.1%) had vision problems, 75 (32.1%) had sleep apnea, 167 (71.4%) had fatigue while 149 (63.7%) of them were suffering from confusion.

Underweight/normal weight patients showed that both vertigo ( $p=0.014$ ) and fatigue ( $p=0.041$ ) were significantly associated with grade 1 systolic hypertension; while none of the neurological symptom was significantly associated with diastolic blood pressure. Overweight/obese patients showed that both sleep apnea ( $p<0.001$ ) and confusion ( $p=0.028$ ) were significantly associated with grade 1 systolic hypertension. While vision problems ( $p=0.030$ ) and sleep apnea ( $p=0.038$ ) were significantly associated grade 1 diastolic hypertension.

**Conclusion:** Patients with low BMI showed significant association of neurological symptoms with only Grade 1 systolic blood pressure. While patients with High BMI showed significant association of neurological symptoms with both Systolic and diastolic Grade-1 hypertension.

**Key words:** Body mass index, Neurological symptoms

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## INTRODUCTION

Multiple morbidities in a single patient is becoming common trend at global level [1,2], which share same contributing factors like sedentary ways of living,

urbanization, utilization of fast foods, increase life expectancy due to improved health facilities, and incidence of non-communicable diseases (NCDs) like diabetes. In developed countries, the frequency of multiple morbidity is 17-90% particularly in older population [1,3]. Obesity served as precursor to several chronic diseases, like chronic hypertension, metabolic diseases, cardiac disorders, respiratory syndromes, neurological diseases and cancers because of common molecular pathways [4,5], that may lead to mortality [6]. According to 2016 analytics, almost 1.9 billion people were overweight and 650 million from them were obese [7]. Multiple morbidities exist in these people [8], that are also associated with hypertension [9].

A study from Pakistan depicted that about 30% of hypertensive patients under 45 years of age were obese and in many cases, value might raise up to 60% [10], not only this, data from college students shown that overweight and obesity is prevalent in nearly 40% [11]. Hence, obesity is one of the great health concerns for Pakistan. It is a cruel universal reality that people are more prone to high levels of BMI and Blood Pressure in recent times with a positive relation among them [12], these factors lead to increased incidence of diabetes, hypertension, cardiovascular abnormalities and obesity [13]. Hypertensive patients are also susceptible to home several neurological symptoms such as sleep apnea [14,15], headache, vertigo [16], vision problems, fatigue and confusion [17]. Hypertension is significantly linked with sleep apnea in group of obese people who had central obesity and lower vital capacity [15].

BMI is the most common diagnostic tool used for the classification of overweight and obesity in both adults and children [18]. BMI have been studied in relation to hypertension [19], however, literature did not reveal how BMI impact the relations of hypertension and neurological symptoms. The objective of present study to quantify the effect of BMI levels on association between hypertension and neurological symptoms.

## MATERIALS AND METHODS

This was a cross-sectional study with study duration six months from January 2019 till July 2019, conducted at outpatient department of Medicine, tertiary care hospital located in Karachi. After taking approval from ethical committee and informed consent from patients having self-defined history of hypertension and antihypertensive medication, total 234 subjects having age 18 years or above were included in present study by convenience sampling.

A detailed questionnaire was designed to collect anthropometric data, medical history, symptoms associated with hypertension and neurological problems. Exclusion criteria include history of confirmed diabetes, cardiovascular abnormalities, neurological disorders, metabolic diseases, and severe obesity. Mercury sphygmomanometer (Yamasu, Japan) was used to record blood pressure and value of BMI was calculated and categorized as per criteria defined by W.H.O [10]. For the

data analysis, we used Statistical Package for Social Sciences (SPSS v 20.0, IBM, USA). Quantitative and qualitative data was expressed as mean plus standard deviation, and frequency plus percentage respectively. Correlation analysis was used to determine the strength of the association between BMI and BP. P-value <0.05 was taken as statistically significant.

## RESULTS

The study results showed that 138 (59.0%) of the patients were aged up to 49 years while 96 (41.0%) were aged 50 years or more; 123 (52.6%) of them were males while 111 (47.4%) of them were females; 12 (5.1%) of them were underweight, 73 (31.2%) of them were normal weight, 101 (43.2%) of them were overweight while 48 (20.5%) of them were obese; 75 (32.1%) of them had normal/high normal systolic blood pressure, 128 (54.7%) of them had grade 1 systolic hypertension while 31 (13.2%) of them had grade 2/grade 3 systolic hypertension; 120 (51.3%) of them had normal/high normal diastolic blood pressure, 101 (43.2%) of them had grade 1 diastolic hypertension while 13 (5.6%) of them had grade 2/grade 3 diastolic hypertension (Table 1).

The study results further showed that 180 (76.9%) of them had history of headache, 140 (59.8%) of them had vertigo, 129 (55.1%) of them had vision problems, 75 (32.1%) of them had sleep apnea, 167 (71.4%) of them had fatigue while 149 (63.7%) of them were suffering from confusion (Table 2).

The bivariate analysis of associations between neurological symptoms and systolic blood pressure levels among underweight/normal weight patients showed that both vertigo ( $p=0.014$ ) and fatigue ( $p=0.041$ ) were significantly associated with systolic blood pressure levels of the patients where patients with vertigo and fatigue were most likely to have grade 1 systolic hypertension; the bivariate analysis of associations between neurological symptoms and diastolic blood pressure levels among underweight/normal weight patients revealed that none of the neurological symptoms were significantly associated with diastolic blood pressure levels of the patients (Tables 3A and B).

The bivariate analysis of associations between neurological symptoms and systolic blood pressure levels among overweight/obese patients showed that both sleep apnea ( $p<0.001$ ) and confusion ( $p=0.028$ ) were significantly associated with systolic blood pressure levels of the patients where patients with sleep apnea and fatigue were most likely to have grade 1 systolic hypertension; the bivariate analysis of associations between neurological symptoms and diastolic blood pressure levels among overweight/obese patients revealed that both vision problems ( $p=0.030$ ) and sleep apnea ( $p=0.038$ ) were significantly associated with diastolic blood pressure levels of the patients where patients with vision problems and sleep apnea were most likely to have grade 1 diastolic hypertension (Tables 4A and B).

**Table 1: Participant profile.**

Variables (n=234)		Frequency (%)
Age	Up to 49 Years	138(59.0)
	50 Years or Above	96(41.0)
Gender	Male	123(52.6)
	Female	111(47.4)
Body Mass Index	Underweight	12(5.1)
	Normal Weight	73(31.2)
	Overweight	101(43.2)
	Obese	48(20.5)
Systolic Blood Pressure	Normal/High Normal	75(32.1)
	Grade 1 Hypertension	128(54.7)
	Grade 2/Grade 3 Hypertension	31(13.2)
Diastolic Blood Pressure	Normal/High Normal	120(51.3)
	Grade 1 Hypertension	101(43.2)
	Grade 2/Grade 3 Hypertension	13(5.6)

**Table 2: Clinical profile.**

Variables (n=234)		Frequency (%)
History of Headache	Present	180 (76.9)
	Absent	54 (23.1)
Vertigo	Present	140 (59.8)
	Absent	94 (40.2)
Vision Problems	Present	129 (55.1)
	Absent	105 (44.9)
Sleep Apnea	Present	75 (32.1)
	Absent	159 (67.9)
Fatigue	Present	167 (71.4)
	Absent	67 (28.6)
Confusion	Present	149 (63.7)
	Absent	85 (36.3)

**Table 3A: Bivariate analysis of associations between neurological symptoms and systolic blood pressure levels (Underweight/Normal Weight).**

Variables (n=85)		Systolic Blood Pressure			p
		Normal/High Normal	Grade 1 Hypertension	Grade 2/Grade 3 Hypertension	
		Frequency (%)	Frequency (%)	Frequency (%)	
History of Headache	Present	18(27.3)	33(50.0)	15(22.7)	0.978
	Absent	5(26.3)	10(52.6)	4(21.1)	
Vertigo	Present	8(15.7)	29(56.9)	14(27.5)	0.014
	Absent	15(44.1)	14(41.2)	5(14.7)	

Vision Problems	Present	11(20.8)	29(54.7)	13(24.5)	0.242
	Absent	12(37.5)	14(43.8)	6(18.8)	
Sleep Apnea	Present	4(13.8)	17(58.6)	8(27.6)	0.138
	Absent	19(33.9)	26(46.4)	11(19.6)	
Fatigue	Present	15(24.6)	28(45.9)	18(29.5)	0.041
	Absent	8(33.3)	15(62.5)	1(4.2)	
Confusion	Present	11(22.0)	26(52.0)	13(26.0)	0.383
	Absent	12(34.3)	43(50.6)	19(22.4)	

**Table 3B: Bivariate analysis of associations between neurological symptoms and diastolic blood pressure levels (Underweight/Normal Weight).**

Variables (n=85)		Diastolic Blood Pressure			p
		Normal/High Normal	Grade 1 Hypertension	Grade 2/Grade 3 Hypertension	
		Frequency (%)	Frequency (%)	Frequency (%)	
History of Headache	Present	29(43.9)	33(50.0)	4(6.1)	0.799
	Absent	8(42.1)	9(47.4)	2(10.5)	
Vertigo	Present	23(45.1)	25(49.0)	3(5.9)	0.85
	Absent	14(41.2)	17(50.0)	3(8.8)	
Vision Problems	Present	23(43.4)	25(47.2)	5(9.4)	0.53
	Absent	14(43.8)	17(53.1)	1(3.1)	
Sleep Apnea	Present	10(34.5)	17(58.6)	2(6.9)	0.453
	Absent	27(48.2)	25(44.6)	4(7.1)	
Fatigue	Present	27(44.3)	29(47.5)	5(8.2)	0.75
	Absent	10(41.7)	13(54.2)	1(4.2)	
Confusion	Present	23(46.0)	24(48.0)	3(6.0)	0.814
	Absent	14(40.0)	18(51.4)	3(8.6)	

**Table 4A: Bivariate analysis of associations between neurological symptoms and systolic blood pressure levels (Overweight/Obese).**

Variables (n=149)		Systolic Blood Pressure			p
		Normal/High Normal	Grade 1 Hypertension	Grade 2/Grade 3 Hypertension	
		Frequency (%)	Frequency (%)	Frequency (%)	
History of Headache	Present	36(31.6)	67(58.8)	11(9.6)	0.19
	Absent	16(45.7)	18(51.4)	1(2.9)	
Vertigo	Present	30(33.7)	48(53.9)	11(12.4)	0.062
	Absent	22(36.7)	37(61.7)	1(1.7)	
Vision Problems	Present	23(30.3)	46(60.5)	7(9.2)	0.462
	Absent	29(39.7)	39(53.4)	5(6.8)	
Sleep Apnea	Present	8(17.4)	26(56.5)	12(26.1)	<0.001
	Absent	44(42.7)	59(57.3)	Nil	

Fatigue	Present	36(34.0)	59(55.7)	11(10.4)	0.262
	Absent	16(37.2)	26(60.5)	1(2.3)	
Confusion	Present	31(31.3)	56(56.5)	12(12.1)	0.028
	Absent	21(42.0)	29(58.0)	Nil	

**Table 4B: Bivariate analysis of associations between neurological symptoms and diastolic blood pressure levels (Overweight/Obese).**

Variables (n=149)		Diastolic Blood Pressure			p
		Normal/High Normal	Grade 1 Hypertension	Grade 2/Grade 3 Hypertension	
		Frequency (%)	Frequency (%)	Frequency (%)	
History of Headache	Present	62(54.4)	46(40.4)	6(5.3)	0.759
	Absent	21(60.0)	13(37.1)	1(2.9)	
Vertigo	Present	46(51.7)	38(42.7)	5(5.6)	0.455
	Absent	37(61.7)	21(35.0)	2(3.3)	
Vision Problems	Present	35(46.1)	38(50.0)	3(3.9)	0.03
	Absent	48(65.8)	21(28.8)	4(5.5)	
Sleep Apnea	Present	19(41.3)	23(50.0)	4(8.7)	0.038
	Absent	64(62.1)	36(35.0)	3(2.9)	
Fatigue	Present	57(53.8)	43(40.6)	6(5.7)	0.589
	Absent	26(60.5)	16(37.2)	1(2.3)	
Confusion	Present	51(51.5)	42(42.4)	6(6.1)	0.26
	Absent	32(64.0)	17(34.0)	1(2.0)	

**DISCUSSION**

Obesity and particularly morbid obesity is a challenging health concern because this growing epidemic roots an unsustainable health expenditure, morbidity and mortality and also linked with multiple co-morbidities. Hypertension is frequently allied with obesity showing terrible health implications. Excess body mass initiate a cascade of pathological sequel and creates a connection between obesity and hypertension. However, the core mechanisms prevailing disparate effects of excessive body mass on cardiovascular system are multifaceted to be understood. Therefore, it is desirable to address the potential negative consequences from the perspective of both primordial prevention and treatment for those already impacted by this condition.

In our study 31.2% subjects were normal weight, 43.2% subjects were overweight while 20.5% were obese among all study hypertensive patients. Even though, they found to have a lower limit of the obesity, it is speculated that both obesity with BMI> 30.0(kg/m<sup>2</sup>) and overweight with BMI between 25.0-29.9(kg/m<sup>2</sup>) is a contributing factor for the occurrence of several pathological conditions such as diabetes, cardiovascular diseases, psychological problems, and neurological issues.

A study was conducted on 1.7 Million (1727411) Chinese adults, with mean age 55.7 years, mean BMI 24.7, mean systolic BP 136.5 mmHg, and mean diastolic BP 81.1mmHg. It was observed that subjects who were not on antihypertensive medicine; BP was increased per unit BMI ranged from 0.8 to 1.7mmHg/(kg/m<sup>2</sup>). Furthermore, for every 1-kg/m<sup>2</sup> increase in BMI, there was a 1.3–mm Hg increase for men and a 1.4–mm Hg increase for women [20]. However, a study from Western country showed that 1.4–mm Hg increase for men and a 1.2–mm Hg increase for women was observed [21]. Hence, it was concluded that the association between BMI and BP is robust that showed significant implications on public health. Literature from Pakistani studies is in accordance with previously mentioned results that higher BMI lead to hypertension in around 30% of men (age less than 45 years), and this figure rose up to 60% in various cases [10]. This percentage is also alarmingly high i.e. 40% in college going students [11]. Hypertension due to obesity is a multi-factorial and polygenic trait, which is associated with several pathological mechanisms in obese peoples such as hyperinsulinemia, increased activity of renin–angiotensin–aldosterone system, imbalanced autonomic activities, abnormal changes in levels of adipokines and cytokines [22].

According to our data it is clarified that neurological symptoms are more frequent in obese hypertensive than normal weight. We observed that patients with lower BMI, showed significant association of grade 1 systolic hypertension with vertigo and fatigue. However, patients with high BMI i.e. overweight and obesity also display significant association between grade 1 systolic hypertension and neurological symptoms particularly sleep apnea, confusion fatigue and vision problems. Out of all hypertensive patients, 76.9% of them had history of headache, 59.8% of them had vertigo, 55.1% of them had vision problems, 32.1% of them had sleep apnea, 71.4% of them had fatigue while 63.7% of them were suffering from confusion.

Based on our results, it is concluded that a strong relationship exist between hypertension and neurological symptoms in both low and high BMI patients. But obese hypertensive patients are more likely to have greater neurological effects than only hypertensive. Fletcher EC [23], described that several factors are responsible for hypertension in middle age, which are also correlates with sleep apnea including obesity and male gender. Furthermore, Chang and team study about dizziness/ vertigo, and found it has a significant correlation to BMI, HDL and waist circumference [16]. Furthermore, Elevated BMI not only enhanced the chances of occurrence of ischemic and haemorrhagic stroke but also stroke mortality [24,25]. Similar association was also publicized by other authors that the obesity is a significant risk factor and contributing to a higher incidence of hypertension and neurological problems such as sleep apnea [15,23,26].

A study [27] was conducted in China on 1327 patients with chief complaint of headache mainly categorized into chronic headache and episodic headache. Chronic headache patients were more pertinent to have high BMI ( $p < 0.05$ ) than episodic headache. However, chronic migraine and episodic tension patients were overweight with a significantly higher value of BMI (BMI;  $p < 0.05$ ) than that of episodic migraine and chronic tension type headache. Exact causal relation is not identified yet, still it is postulated that obesity and migraine follow the similar overlapping biological mechanisms [28].

Our study is unique in the sense that we have observed the effect of BMI on hypertensive patients regarding neurological symptoms. Several authors studied the association between BMI and hypertension, hypertension and neurological symptoms, BMI and neurological symptoms as we already discussed above. However, we find that all these three have great influence on each other and somehow these three factors influence each other's outcomes too. Care must take into consideration while suggesting a medication and treatment modalities.

### CONCLUSION

Obesity expressed as body mass index (BMI) of 30 kg/m<sup>2</sup> or higher; has now reached up to epidemic proportions worldwide. It has been confirmed that it increases risk for many non-communicable diseases such

as stroke, diabetes, hypertension, heart diseases, hyperlipidemias and neurological diseases. In present study, significant positive association was observed between both systolic and diastolic hypertension to neurological symptoms including sleep apnea, vertigo, vision problems and headache.

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