

## Study of BMI, haemoglobin and blood pressure in subjects visiting OPD's of a medical college in Lucknow, Uttar Pradesh

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### Abstract

**Introduction:** Prevalence of obesity, hypertension and anaemia is expected to rise in India. There appears a link between obesity, haemoglobin levels and blood pressure. Keeping in view the public health importance of trio the present study was undertaken.

**Material and Methods:** 336 subjects (235 males and 101 females) were included in the present study. Age, BMI, Hb, blood pressure (both systolic and diastolic) and BMI were measured. Data was analysed using appropriate statistical tests.

**Results:** Mean age, systolic and diastolic blood pressure and haemoglobin were higher in males as compared to females. Mean BMI ( $\text{Kg/m}^2$ ) was higher in females ( $22.38 \pm 4.28$ ) than males ( $21.98 \pm 4.25$ ). Significantly higher numbers of male were hypertensive than females whereas anaemia was found more in latter. With increase in BMI blood pressure was significantly higher and with decrease in Hb or with increase in severity of anaemia it was significantly reduced. Positive significant correlation of BMI and Hb with blood pressure was observed.

**Conclusion:** There appears a positive association between Hb levels and both systolic and diastolic blood pressure. BMI correlated with blood pressure.

**Keywords:** Hypertensive, Normotensive, BMI, Anaemia, Gender, Prevalence and obesity.

### Introduction

Hypertension is a major public health problem. By 2025 burden of hypertension will be 22.9% and 23.6% respectively in males and females in India.<sup>1,2</sup> Hypertension is a tip of ice berg phenomenon resulting in complications having deleterious and debilitating effect on the health.<sup>3</sup> The data of obesity is alarming and as per WHO, 1 in every 6th person in the world is obese and it is associated with high mortality rates.<sup>4</sup> Similarly, the prevalence of anaemia is also on rise. Presently 39.8% population is expected to be suffering from anaemia.<sup>5</sup> In recent years association between inflammation, anaemia and metabolic syndrome has been found which has attracted the attention of researchers worldwide.<sup>6</sup> Haemoglobin (Hb) is an independent risk factor for both systolic and diastolic blood pressure.<sup>7</sup> It is estimated that body mass index (BMI) is important marker of obesity. Abdominal obesity is a risk factor for future cardiovascular complications including hypertension.<sup>8</sup> Obesity as well as hypertension are major risk factor for mortality worldwide.<sup>9</sup> Obesity is associated with sympathetic activation and is the leading risk factor for development of hypertension.<sup>10</sup> Keeping in view the public health importance of anaemia, hypertension and obesity the present study was undertaken to find the BMI, Hb and Blood Pressure levels in subjects visiting the OPDs of a private medical college in Lucknow, Uttar Pradesh.

### Materials and Methods

It was a cross sectional study conducted in different OPD's of Integral Institute of Medical Sciences and Research, Lucknow between January to June 2018. A total of 336 subjects willing to participate (both male and female

between 18-60 years of age) were enrolled in the study. While those not giving consent and pregnant females were excluded from the study. Permission of Institutional Research and Ethical Committees were obtained before the start of study. Blood sample was collected under aseptic condition by using a disposal syringe. Hb (gm/dl) estimation was done using Automated Analyser (Beckman Coulter) in central pathology of IIMS&R, Lucknow. Blood pressures both systolic (SBP) and diastolic (DBP) were measured using sphygmomanometer by standard methods. BMI was calculated as per the formulae  $\text{Kg/m}^2$  after estimation of weight and height by standard technique. For categorizing the subjects as per BMI, blood pressure and severity of anaemia (Hb levels) the WHO (World Health Organization) and JNC (Joint National Committee) 8 classifications were used respectively.<sup>11,12</sup>

### Statistical Analysis

The data was presented as mean  $\pm$  S.D. and analysed using Statistical Package for Social Science software (21.0) IBM. Statistical tests Chi square, ANOVA, correlation and unpaired t test were applied. P value < 0.05 was taken as significant.

### Results

The present study included 336 subjects (235 males and 101 females) from various OPDs of IIMS&R, Integral University, Lucknow, Uttar Pradesh. The results indicated (Table 1) that the mean values of age, systolic and diastolic blood pressure, haemoglobin were higher in males as compared to females. Mean value of BMI ( $\text{Kg/m}^2$ ) was higher in females ( $22.38 \pm 4.28$ ) than males ( $21.98 \pm 4.25$ ).

**Table 1: Differences between males and females**

Parameter	Male(n=235) Mean ± SD	Female(n=101) Mean ± SD	P value
Age(years)	47.63±14.07	39.33±13.64	P<0.001
BMI(Kg/m <sup>2</sup> )	21.98±4.25	22.38±4.28	0.426
Hb (gm/dl)	14.08±1.78	11.80±1.84	<0.001
SBP(mm Hg)	129.85±20.70	120.08±18.24	<0.001
DBP(mm Hg)	84.48±18.08	78.69±16.02	0.006

**Table 2: Number and % of male and female as per the severity of various study variables and statistical comparison**

Parameter	Male		Female		P value
	Number	%	Number	%	
<b>SBP(mm Hg)<sup>#</sup></b>					
Normal	62	26.40	52	51.50	20.508
Prehypertensive	101	43.00	32	31.70	df=3
Stage I	40	17.00	09	8.90	P<0.001
Stage II	32	13.60	08	7.90	(significant)
#101/235(43%) males and 32/101(31.70%) females were prehypertensive. 72/235(30.64%) males and 17/101(16.83%) females were hypertensive.					
<b>DBP(mm Hg)<sup>±</sup></b>					
Normal	81	34.50	60	59.40	18.383
Pre hypertensive	74	31.50	20	19.80	df=3
Stage I	29	12.30	06	5.90	p<0.001
Stage II	51	21.70	15	14.90	(significant)
#74/235(31.50%) males and 20/101(19.80%) females were prehypertensive. 80/235(34.04%) males and 21/101(21%) females were hypertensive.					
<b>BMI(Kg/m<sup>2</sup>) category<sup>**</sup></b>					
Normal	71	30.20	37	36.60	
Underweight	59	25.10	18	17.80	3.277
Overweight	38	16.20	20	19.80	df=3
Obese	67	28.50	26	25.70	P=0.351(non significant)
<sup>**</sup> 105/235(44.68%) males and 46/101(45.54%) females were either overweight or obese.					
<b>Anaemia as per Hb (gm/dl)</b>					
Normal	190	80.90	42	41.60	58.236
Mild	30	12.80	26	25.70	df=3
Moderate	12	5.10	30	29.70	P<0.001
Severe	03	1.30	03	3.00	(significant)

\*Significantly higher numbers of male were hypertensive than females. Significant numbers of females were found to be anaemic than males. Overall 133/336(39.58%) and 94/336(27.98%) were prehypertensive in systolic and diastolic category respectively. 89/336(26.48%) and 101/336(30.06%) subjects were found to have elevated systolic and diastolic blood pressure respectively. 151/336 i.e. 44.94% were overweight and obese.

**Table 3: SBP and DBP as per the BMI and Hb (anaemia severity) in all study subjects**

Parameter range	SBP	DBP	P value
<b>BMI(Kg/m<sup>2</sup>)</b>			
Normal	120.46 ±17.27	78.57 ±13.44	
Underweight	118.13± 17.80	74.46 ±12.60	<0.001
Overweight	126.83 ±17.46	82.51± 15.36	
Obese	141.74 ±19.80	94.58 ±20.72	
<b>Anaemia as per Haemoglobin(gm/dl) range</b>			
Normal	132.40± 20.58	86.86 ±18.39	
Mild	118.14± 14.22	74.82± 13.36	<0.001
Moderate	111.42± 12.65	72.38± 8.67	
Severe	105.00 ±10.48	70.00± 10.95	

\*With increase in BMI blood pressure is significantly higher. With decrease in Hb or with increase in severity of anaemia blood pressure is significantly reduced.

**Table 4: Correlation between BMI and SBP and DBP in females**

BMI Category	SBP		DBP	
	r	p	r	p
Overall (n=101)	0.632	<0.001	0.527	<0.001
Underweight (n=18))	0.353	<0.001	0.315	0.001
Normal (n= 37)	0.031	0.759	-0.149	0.136
Overweight (n= 20)	0.018	0.859	-0.132	0.187
Obese (n=26)	<0.001	0.999	.557	<0.001

**Table 5: Correlation between BMI and SBP and DBP in males**

BMI Category	SBP		DBP	
	r	p	r	p
Overall (n=235)	0.411	<0.001	0.401	<0.001
Underweight (n=59))	0.228	<0.001	0.257	<0.001
Normal (n= 71)	-0.035	0.596	-0.159	0.015
Overweight (n= 38)	0.064	0.327	0.056	0.395
Obese (n=67)	0.066	0.310	0.364	<0.001

**Table 6: Overall correlation between study variables (both male and females)**

Parameter	SBP		DBP	
	r	p	r	p
BMI*	0.449	<0.001	0.400	<0.001
Hb*	0.551	<0.001	0.469	<0.001

\*Positive significant correlation of BMI and Hb with blood pressure

## Discussion

The present study was undertaken with the objective of comparing BMI, Hb and blood pressures (both systolic and diastolic) levels and find a correlation between them. The results indicated that the mean age, systolic and diastolic blood pressure and haemoglobin were higher in males as compared to females. Researches have shown that the blood pressure levels are higher in males as compared to females.<sup>13</sup> The mean value of DBP was found to be higher in males as compared to females. DBP shows a decline after the age of 45 years as indicated by study done by JD Lin et al., 2016.<sup>14</sup> The inter gender variations observed can also be explained on the basis of influence of male sex hormone testosterone which increases fat free mass, cause retention of salt and water in body which in turn is responsible for higher blood pressure in males.<sup>15</sup> Results of present study indicate higher percentage of males as compared to females having prehypertension. Results are in accordance with study done by Dua S et al., 2014.<sup>16</sup> Prevalence of hypertension was found to be more in males than female which was in accordance with earlier study done by Sing S et al., 2017.<sup>17</sup>

In present study higher percentage of females suffering from anaemia than males may be attributed to stimulatory and inhibitory effects of androgens and estrogen on erythropoietin in bone marrow and kidney in males and females respectively.<sup>18</sup> Differences in BMI observed in

present study can be attributed to positive influence of male hormones on fat free or lean body mass. But the influence of socio economic conditions and calorie consumption on body composition needs to be studied.<sup>19</sup> Researches have shown that genetic factors in males and environmental factors in females have an influence on variations in height, weight and BMI.<sup>11</sup>

In our study blood pressure increased with increasing BMI. The results are in accordance with earlier studies which have shown that blood pressure is within normal range in subjects with normal BMI and increases with increase in BMI.<sup>20</sup> Shuger SL et al., 2008 have shown that weight is an independent risk factor for development of hypertension.<sup>21</sup> Result of our study show that blood pressure was higher in overweight and obese subjects and direct association was found between BMI and systolic blood pressure in both overweight and obese subjects. The results are in accordance with the study of Moafi A et al., 2011.<sup>22</sup> BMI is an independent risk factor for various chronic diseases notably hypertension, cardiovascular diseases and metabolic syndromes including diabetes mellitus. Higher BMI is a risk factor for hypertension.<sup>23</sup> In our study there was a positive correlation of BMI with both systolic and diastolic blood pressure in all subjects (both males and females) which could possibly be explained on the basis of earlier researches which have shown that reduction in weight is associated with blood pressure normalization. Multiple studies have shown correlation between BMI and systolic and diastolic blood pressure.<sup>24,25</sup>

In our study positive association was found between blood pressure and BMI in underweight subjects in both males and females respectively. The contrasting results may be explained on the basis of recent researches which have shown that underweight subjects may have elevated blood pressure. There appears an association between malnutrition, pro inflammatory and anti-endothelial mechanisms that contribute to blood pressure elevation.<sup>26</sup> Interestingly, in hypertensive subjects there appears to be higher levels of pro inflammatory cytokines like IL 1, 2, 8, lower levels of anti-inflammatory IL 10 and higher levels of VEGF, TNF  $\alpha$  and EGF.<sup>27</sup>

The results of the study indicated significant positive association between Hb levels and blood pressure in both males and females. Studies have shown that systolic and diastolic blood pressures have positive association with Haemoglobin levels. Sympathetic nervous system is an important stimulant for renin secretion from peritubular capillaries of the kidney. This in turn stimulates the Angiotensin Aldosterone. The system is known to influence the secretion of erythropoietin and also exerts an influence on the blood pressure. Positive association between Hb, blood pressure and BMI have been reported in earlier studies.<sup>28-30</sup> Elevated levels of RBC and Hb are expected to result in hypertension due to increase in viscosity and nitric oxide scavenging effects of Hb.<sup>29,31</sup> Blood pressure is expected to fall in anaemia because of vasodilatation and decrease in vascular resistance and viscosity.<sup>32</sup> In our study (both in males and females) more subjects were found to be normotensive when Hb levels decrease was mild and with increase in severity of anaemia, blood pressure decreased. The results of our study are in contrast with those done by Yoon H et al., 2018 in which with decrease in Hb levels there was increase in systolic and decrease in diastolic blood pressure.<sup>33</sup> But our results are in accordance with Chinese study done by Ren L et al., 2014 in which both systolic and diastolic blood pressure were found to be increasing with increase in Hb levels.<sup>34</sup>

### Limitations

Selection bias may not be ruled out completely. Effect of socioeconomic conditions, dietary habits, lifestyle and other factors which influence BMI, blood pressure and Hb levels were not analysed.

### Conclusion

Obesity and anaemia both appear to be risk factors for number of diseases affecting overall health. Interestingly, there appear to be a common link between hypertension, anaemia and obesity. Various conclusions can be drawn on the basis of the analysis of results in the present study. There appears a positive association between Hb levels and both systolic and diastolic blood pressure. Similarly, BMI correlated with blood pressure in study subjects. It is recommended that all the subjects visiting OPD's must be evaluated for BMI, anaemia and blood pressure so that the future complications arising due to them may be addressed at early stage.

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**Conflict of Interest:** None.

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