

## Research Article

# Relationship between blood pressure and BMI: a cross sectional study among government employees of Gujarat state, India

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## ABSTRACT

**Background:** For diseases like hypertension, cardiovascular disease, type II diabetes mellitus and other chronic diseases body mass index (BMI) is identified as a positive and independent risk factor associated with both morbidity and mortality. The objective of the study is to establish a relationship between blood pressure and BMI among government employees of Gujarat state.

**Methods:** This cross-sectional study was carried out among government employees of new Sachivalaya, Gandhinagar of Gujarat during April to July 2004. Total 775 employees were selected using stratified, systematic random and simple random sampling designs. Written consent of all the subjects was obtained. A structured pre-tested proforma was used for collecting information and the results of the measurements. Anthropometric measurements like height, weight, waist circumference and hip circumference were taken and BMI was calculated. To test the significance of the difference among the statistical parameters in different subsets of population F-test was applied.

**Results:** Out of 775 subjects participated in the study 676 (87.2 percent) were males and 99 (12.8 percent) were females. The highest proportion of the study subjects were in the 41-50 age groups. The mean age of the study population was 46.72 years. The mean Systolic Blood Pressure (SBP) of the total study population was 125.9 mm of Hg. The mean Diastolic Blood Pressure (DBP) of the total study population was 81.5 mm of Hg. The mean SBP and DBP shows an increasing trend with increasing age & were found statistically significant. [For SBP,  $F = 15.36$ ,  $p=0.00$ , For DBP,  $F=4.9$ ;  $p=0.007$ ]. The difference among mean SBP and DBP of the three categories of BMI were found statistically significant in male population, female population and total study population (For SBP,  $F = 14.48$ ,  $p = 0.00001$ ) (For DBP,  $F=20.14$ ,  $p=0.00000$ ).

**Conclusion:** There is significant correlation between BMI and DBP or SBP among government employees of Gujarat state situated in western part of India, thus basic measurement of weight and height to determine the BMI as a routine assessment during clinic visitation with appropriate lifestyle modification would help in controlling hypertension as well as reduce its prevalence.

**Keywords:** Hypertension, BMI, Systolic Blood Pressure, Diastolic Blood Pressure, Obesity

## INTRODUCTION

Close association between blood pressure and body mass index is established 70 years ago.<sup>1</sup> Relationship between hypertension and overweight is identified by number of

studies conducted in western world.<sup>2-5</sup> Weight reduction is having positive effect in decreasing blood pressure by many studies. A number of clinical trials have also shown that weight reduction is having significant effect in lowering blood pressure. Body weight adjusted for height

is often used as an alternative to the measurement of adipose tissue mass in the evaluation of individuals or populations for obesity. Quetelet's index is one of the most widely used index in which body weight (in kg) is divided by height (in m<sup>2</sup>).<sup>6-9</sup>

For diseases like hypertension, cardiovascular disease, type II diabetes mellitus and other chronic diseases body mass index (BMI) is identified as a positive and independent risk factor associated with both morbidity and mortality. A very strong association has been proved between BMI and mortality among Asians particularly Indians. The considerable positive relationship among BMI and both SBP and DBP has been established in studies of African-Americans, Chinese Africans and Caribbeans.

Developing countries like India are facing double burden of non-communicable diseases like hypertension, along with infection and malnutrition. Heavy financial burden is put on by hypertension on population and health systems, which already has limited resources. Several Longitudinal studies in developing countries prove strong relationship between BMI and hypertension.

In developing countries like India where clinic based care for complications are not readily available, population based preventive approach for the management of hypertension is the best strategy. The study tried to produce information that shows relationship of hypertension in reference to obesity. Information provided by the study will be very helpful for developing future preventive and control strategy for hypertension.

## METHODS

This cross-sectional study was carried out among the 4000 government employees of new Sachivalaya, Gandhinagar of Gujarat during April to July 2004. At an expected prevalence of hypertension in adults of 20 percent, with an absolute precision of 3 percent and design effect of 1 at 95 percent significance level (alpha risk of 5 percent), the required sample size was calculated as 668. Anticipating a refusal rate of 10-12 percent, the final sample size obtained was 775. Out of 22 different departments and considering 4 cadres of employees, study participants were selected using stratified, systematic random and simple random sampling designs. The necessary sanction was obtained from ethical committee of Baroda Medical College & the permission to initiate the study from Government of Gujarat before the beginning of the study. Written consent of all the subjects was obtained before the interview and no participant refuse to participate in the study. A structured pre-tested proforma was used for collecting information and the results of the measurements. Anthropometric measurements like height, weight, waist circumference and hip circumference were taken following standard procedures at the end of the interview which lasted for about 20 minutes. Hypertension was defined as systolic

blood pressure (SBP) >140 mmHg and/or diastolic blood pressure (DBP) >90 mmHg as per US Seventh Joint National Committee on Detection, Evaluation and Treatment of Hypertension (JNC VII) criteria. BMI was calculated as weight in kilograms divided by squared height in meter. Conventional BMI cutoff points were applied to classify the study populations into underweight (BMI<18.5 kg/m<sup>2</sup>), normal BMI (18.5≤BMI<25 kg/m<sup>2</sup>) and overweight (BMI≥25 kg/m<sup>2</sup>). The statistical software SPSS 17 (trial version) was use for data analysis. The mean values of weight, height, BMI and BP was determined. To test the significance of the difference among the statistical parameters in different subsets of population, suitable statistical test (F-test) was applied.

## RESULTS

Out of 775 subjects participated in the study 676 (87.2 percent) were males and 99 (12.8 percent) were females. The highest proportion of the study subjects were in the 41-50 age groups and the lowest proportion were from ≤40 age group. The mean age of the study population was 46.72 years (46.73 years for males and 46.64 for females) and the percentage of them above the age of 40 was very high (88.2 percent).

The mean Systolic Blood Pressure (SBP) of the total study population was 125.9 mm of Hg. (Table 1) The mean SBP of total female population (127.8 mm of Hg) was marginally higher than that of total male population (125.7 mm of Hg), but the difference was statistically not significant. The mean SBP shows an increasing trend with increasing age & was found statistically significant. (F = 15.36, p=0.000).

**Table 1: Age and sex wise distribution of mean SBP (In mm of Hg) in study population.**

Age Group	Male	Female	Total
≤40	118.3	117.8	118.3
41-50	125.4	128.6	125.9
>50	129.7	129.4	129.7
overall	125.7	127.8	125.9
F-Test Value	11.12	1.61	15.36
p- Value	0.000	0.20	0.000

The mean Diastolic Blood Pressure (DBP) of total female population (81.2 mm of Hg) was marginally lower than that of total male population (81.5 mm of Hg), but the difference was statistically not significant. (Table 2) The mean DBP rises with age and it was highest (82.9 mm of Hg) in the oldest age group (>50 years) and it was the lowest in the youngest age group (78.6 mm of Hg) and observed differences was statistically significant. (F=4.9; p=0.007).

**Table 2: Age and sex wise distribution of mean DBP (In mm of Hg) in study population.**

Age Group	Male	Female	Total
≤40	78.4	80.0	78.6
41-50	81.6	80.7	81.5
>50	82.9	83.3	82.9
overall	81.5	81.2	81.5
F-Test Value	4.41	0.56	4.90
p- Value	0.012	0.57	0.007

Both the male population and total study population show similar relationship between mean SBP and BMI. In both population mean SBP raises with rise in BMI value. Also the difference in mean SBP value is about 10 mm of Hg between normal and obese category of BMI. (Table 3) The difference among mean SBP of the three categories of BMI is found statistically significant in male population, female population and total study population. (F =14.48, p =0.00001).

**Table 3: Body mass index and mean systolic blood pressure (In mm of Hg) in study population.**

BMI	Mean SBP (In mm of Hg) (Standard deviation)		
	Male (N=676)	Female (N=99)	Total (N=775)
Normal	122.82(17.2) N=393	124.33(15.7) N=92	122.92(17.1) N=435
Overweight	124.1(19.7) N=242	131.0(18.6) N=43	129.4(19.5) N=285
Obese	133.3(17.2) N=41	125.9(18.4) N=14	132.0(17.8) N=55
F-Test Value	6.22	2.59	14.48
p- Value	0.002106	0.0782	0.000001

The relationship between BMI and mean DBP is almost identical as that of between BMI and mean SBP. (Table 4) However, the difference in DBP value between normal and obese category of BMI is about 6 mm of Hg, which is relatively smaller compared to corresponding category in BMI and mean SBP relationship. The difference in mean DBP among three categories of BMI is found statistically highly significant in male population and total study population. (F=20.14, p=0.00000).

**Table 4: Body mass index and mean diastolic blood pressure in the study population.**

BMI	Mean SBP (In mm of Hg) (Standard Deviation)		
	Male (N=676)	Female (N=99)	Total (N=775)
Normal	79.4(10.6) N=393	78.9(9.9) N=42	79.3(10.5) N=435
Overweight	84.1(11.9) N=242	83.6(10.1) N=43	84.0(11.6) N=285
Obese	87.4(10.7) N=41	81.5(11.3) N=14	85.7(11.4) N=55
F-Test Value	19.49	2.26	20.14
p- Value	0.00000	0.109222	0.00000

## DISCUSSION

In our study we examined the relationship between BMI and BP among government employees of Gujarat state situated in western part of India. We observed that BMI is extensively and independently associated with both SBP and DBP in the study population.

In addition to the sedentary life style, the employees of the Sachivalaya, who are working directly under the various ministries of the Government of Gujarat, are likely to have greater exposure to mental stress as a result of the nature of their work, and this in turn may affect the quality of their work besides having a negative impact on their health status.

In our study age and overweight or obesity were identified as an important determinant of hypertension among the study population. A significant positive correlation between BMI and SBP or DBP was observed in this population. Many other studies also observed similar findings in the past. Mean BP levels increase with increasing BMI categories among both sexes. The risk of hypertension is higher among population groups with overweight and obesity. It is also possible that populations with very low BMI levels could have an increased risk of hypertension, a hypothesis that needs to be tested through more analytical studies. A number of metabolic consequences of obesity have been proposed as the blood pressure-elevating mechanism. Increasing weight has been shown to increase salt retention;<sup>10,11</sup> and insulin resistance is proposed by some to be a cause of hypertension; adipose tissue produces substantial amounts of AGT, and we recently documented a correlation between BMI and AGT, and between blood pressure and AGT, independent of BMI in Nigerian and Jamaican population samples.<sup>12,13</sup> Studies suggest that urbanization is having important role for high mean SBP and DBP.<sup>14,15,16,17</sup> present study all the subjects are living in urban area and may be urbanization also played an important role in higher mean SBP and DBP among them.

The association between BMI and BP has been widely reported across populations in Asia, Latin America, United States and Canada. In a study that included five Latin American populations (urban) and seven Asian populations (four urban, three rural), significant positive relationships of similar magnitude were observed between BMI and BP, despite differences in mean BMI levels between the populations studied.<sup>18,19</sup>

In our study SBP and DBP were positively correlated with age while BMI was not or negatively correlated. Thus, BP increases with increasing age, while BMI did not change significantly. A significant correlation between SBP and age was also reported in India.<sup>20</sup> Based on the JNC VII classification of hypertension, the prevalence of undiagnosed or untreated hypertension was more among the male subjects than the female subjects, a finding similar to the pattern in rural Indians.<sup>21</sup>

## CONCLUSION

There is significant correlation between BMI and DBP or SBP among government employees of Gujarat state situated in western part of India, thus basic measurement of weight and height to determine the BMI as a routine assessment during clinic visitation with appropriate lifestyle modification would help in controlling hypertension as well as reduce its prevalence.

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