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Impact of Gender and Age on the Relationship between Body Mass Index and Hypertension among Middle-Aged Inhabitants of Kolkata, India

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Abstract: More than one billion people are hypertensive worldwide. This makes hypertension an issue of community health. Therefore, it should be our chief concern to identify the risk factors of hypertension and suggest essential preventive measures to reduce this public health burden. Diverse inquiries have uncovered the positive correlation between being overweight, obesity, and dyslipidemia with hypertension. Research suggests that Body Mass Index (BMI) and hypertension demonstrate a significant positive correlation. Excessive weight gain or visceral fat gain is the dominant risk factor for hypertension. Apart from this, several other factors like abdominal adiposity, family history, smoking etc. may be responsible for hypertension. In light of this context, the current article explores the relationship between adult residents of Kolkata's BMI and their hypertension levels. The study was performed among two age groups viz. 35 to 44 years and 45 to 54 years, as the problem is mostly uncommon for the young generation. The sample size of the present investigation was 200, having equal representation from both age and gender groups. The subjects were from middle socio-economic status families as inferred from their occupations. Systolic blood pressure (SBP), diastolic blood pressure (DBP), height, and weight were quantified. BMI was estimated from the measured height and weight. Descriptive statistics, correlation coefficients and 't' tests were calculated. Impact of age and gender was determined on BMI and hypertension scores of the subjects. The results of the present study exhibit a constructive and significant association between the relevant variables. The correlation coefficient between body mass index (BMI) and SBP was 0.74, while that between BMI and DBP was 0.734. Both correlations were statistically significant at the 0.01 level of significance. The outcomes of the t-Test indicate that significant differences exist between the BMI, SBP, and DBP scores within the gender groups. The calculated t-values for BMI, SBP, and DBP were 7.946, 7.973, and 5.296, respectively, with all of them being significant at the 0.05 level of significance. Age was found to have no substantial impact on any of the three variables. These findings can aid in identifying individuals at risk and developing preventive strategies to mitigate the prevalence of obesity or overweight and subsequently reduce blood pressure levels among adults.

Introduction

The rising rates of diabetes and hypertension pose a serious threat, especially to the health of rural populations of developing countries like India, prompting calls for better screening, treatment, and preventative measures (Fottrell et al., 2018; Mohanty et al., 2022). So, the prevalence of overweight and obesity is a formidable challenge our nation faces in this era. Obesity stands as a crucial determinant of risk for several chronic illnesses, including but not limited to hypertension, dyslipidemia,

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and type-II diabetes mellitus (Sun et al., 2018; Min et al., 2018). The treatment of overweight and obesity requires a multidisciplinary approach including dietary management, physical activity and restriction of sedentary activity. Landi et al. (1976) opined that blood pressure (SBP and DBP) increase with the level of BMI. The study also indicated that BMI had a remarkable impact on the blood pressure of adults independent of other clinical risks. Linderman et al. (2018) stated a substantial relationship exists between BMI, hypertension and cardiovascular diseases. The study showed obesity tends to increase hypertension and cardiovascular disease. The study also showed that weight loss could significantly reduce SBP and DBP, eventually lowering the probability of cardiovascular disease sufferers. A study on the Punjabi community of India revealed that the relationship between fat percentage, BMI, SBP and DBP were statistically significant (Dua et al., 2014). Occurrence of hypertension among overweight and obese people implied early detection of hypertension as a preventive measure, lifestyle modification, and weight management. The changing lifestyle factors in India are a leading cause of the increase in BMI and hypertension. This is true, especially among India's urban population (Srikanth et al., 2011). The findings of Kaufman et al. (1997) evince a significant linear association between body mass index (BMI) and hypertension exclusively among women and not men. A study on the South Asian population across Bangladesh, Nepal and India shows that hypertension increased with age in men rather than women. The association of hypertension with BMI was consistent across variables such as age, gender and socioeconomic status (Hossain et al., 2019). Outcomes of the study by Tang et al. (2022) revealed that BMI is the primary cause of dyslipidemia and hypertension among adults in China. There was a significant impact of age on hypertension that increased with the increase in age. It was also clear from the study that there was no significant impact of gender on the relationship between hypertension and BMI. Khalid et al. (2020) opined that males have a significant negative correlation in-between BMI and Hypertension, whereas in females, the correlation between the two variables was insignificant. In a study by Channanath et al. (2015), it was unveiled that at the onset of hypertension, there is an inverse relationship between age and body mass index (BMI) in men as compared to women. Therefore, keeping in view the health perspective of the community or the society, it is of utmost importance to identify the population at risk. The current study intends to look at the prevalence of obesity and overweight in middle-aged people and the relationship between their BMI and hypertension levels.

Materials and Methods

The current investigation aimed to identify the relationship between middle-aged Bengali Hindu residents of Kolkata's BMI and hypertension (SBP & DBP). The research also examined how participants' BMI and blood pressure were affected by age and gender.

Population of the study

The sample size was 200, comprising 35 to 54-year-old middle-aged residents of Kolkata. They were divided into two age groups (35 to 44 years and 45 to 54 years). There was equal representation of males and females in each age group. There were 100 subjects from 35 to 44 years and 100 from 45 to 54 years. Equal numbers of subjects were included in each stratum of the sample from various parts of Kolkata- east, west, north, south and central. The subjects belonged to middle socio-economic status Hindu families of Kolkata, considering their occupations as reported by them and, in some cases, confirmed by their family members.

Anthropometric Measurements

For the purpose of assessing the variables, anthropometric measurements such as height, weight, SBP and DBP were collected to serve the purpose of data collection. In the present investigation, the height and weight of the subjects were used to calculate BMI of the subjects as WHO (1995) recommended. In addition to this, the anthropometric measurements protocol was also maintained (Lohman et al., 1998).

Variables Selected

Based on the survey of research literature and in keeping with the goal of fulfilling the objectives of the investigation, BMI, SBP and DBP, age and gender were selected as variables for the study. Age and gender were considered as independent variables. BMI, SBP and DBP were considered as dependent variables.

Hypothesis of the Study

The alternative hypothesis of the study can be stated as follows:

i. A statistically significant relationship exists between body mass index (BMI) and SBP among residents aged 35 to 54 years in Kolkata.
ii. A statistically significant association is observed between BMI and DBP among residents aged 35 to 54 years in Kolkata.

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iii. Age significantly impacts the BMI, SBP, and DBP among residents aged 35 to 54 years in Kolkata.
iv. Gender significantly impacts the BMI, SBP, and DBP among residents aged 35 to 54 years in Kolkata.

Table 1. Means and Standard Deviations of the Height and Weight

Independent Variables		Height (ft)		Weight (Kg)	
		Mean	Standard Deviation	Mean	Standard Deviation
Age	35-54 years	5.56	0.27	77.11	6.97
	35-44years	5.56	0.27	76.94	7.14
	45-54 years	5.55	0.28	77.2	6.83
Gender	Male	5.78	0.17	78.44	6.74
	Female	5.33	0.13	75.78	6.98

Table 2. Means and Standard Deviations of the BMI, SBP and DBP

Independent Variables		BMI (Kg/m²)		SBP (mmHg)		DBP (mmHg)	
		Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Age	35-54 years	27.74	3.13	143.02	22.9	92.02	9.09
	35-44 years	27.63	3.2	142.49	23.24	92.25	9.32
	45-54 years	27.79	3.19	143.29	22.61	91.71	8.91
Gender	Male	26.17	2.77	131.31	14.33	88.83	8.11
	Female	29.31	2.79	154.74	23.91	95.21	8.93

Data Analysis

After collecting the anthropometric measurements, they were tabulated in Microsoft Excel. Subsequently, a statistical analysis of the recorded data was performed using Microsoft Excel software. Calculations were performed to determine measures of central tendency, namely means and measures of variability, specifically standard deviations. Furthermore, product-moment correlation coefficients were computed to assess the magnitude and direction of the associations between the variables of interest. Additionally, a 't'-test was conducted to evaluate the influence of age and gender on BMI, SBP, and DBP measurements among the participants.

Results and Discussion

Means and Standard Deviations

At the outset, the descriptive statistics, such as the mean and standard deviation for the age groups and the gender groups within each age group and also the entire sample, were calculated. The resulting values have been tabulated in Tables 1 and 2 for reference.

The statistical analysis depicted in Table 1 indicated that there are no significant discrepancies in mean scores across different age or gender categories. Furthermore, the standard deviation values reported in Table 1 indicate moderate homogeneity among the samples under investigation. These findings imply that age and gender are unlikely to be major factors influencing the observed outcomes.

The mean scores reported in Table 2 do not appear to differ much with the change in age. Both the mean of the SBP and DBP is higher in females than males. The standard deviation values reported in Table 2 indicate moderate levels of homogeneity.

Correlation Coefficients

To probe the relations among the pertinent variables of the investigation, correlation coefficients between pairs of these variables were computed for the entire sample and the two age groups separately. The correlations between pairs of the relevant variables for the entire sample (N = 200) are graphically represented in Figures 1 to 6.

Table 3. Age Wise Depiction of Correlation Coefficients Among Relevant Variables (p <0.01)**

Age Group	Correlation between BMI and SBP	Correlation between BMI and DBP
35 - 54 years	0.740**	0.734**
35 - 44 years	0.708**	0.745**
45 - 54 years	0.773**	0.716**

Table 4. Gender Wise Depiction of Correlation Coefficients Among Relevant Variables (p<0.01)**

Gender Group	Correlation between BMI and SBP	Correlation between BMI and DBP
Male	0.603**	0.690**
Female	0.715**	0.688**

Table 3 shows that the relationship between BMI, SBP and DBP for the entire population and the separate age groups is positive and significant. Therefore, the first and the second alternative hypothesis were accepted. This was also true according to the study's findings on the association of BMI with blood pressure by Linderman et al. (2018). The findings are in lieu with the investigation outcomes by Ravisankar et al. (2005).

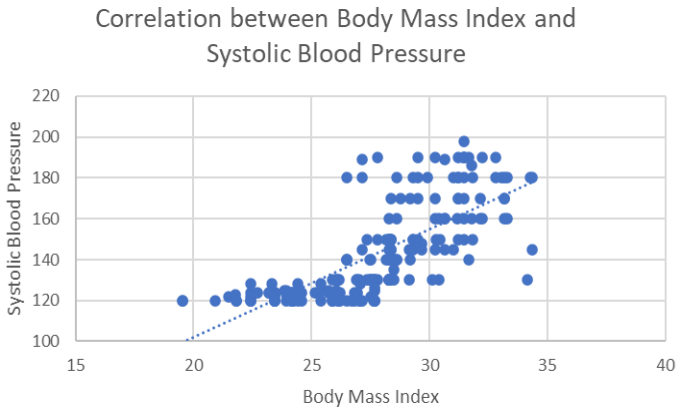

Figure 1. Scatter plot illustrating the association between BMI and SBP among Kolkata's middle-aged residents aged 35-54

Table 4 indicates a noteworthy and favourable association between BMI, SBP and DBP among both genders. As a result, the initial and secondary alternative hypotheses are confirmed. These findings are consistent with those obtained by Khalid et al. (2020) and Ravisankar et al. (2005), who also discovered the same correlation in their research.

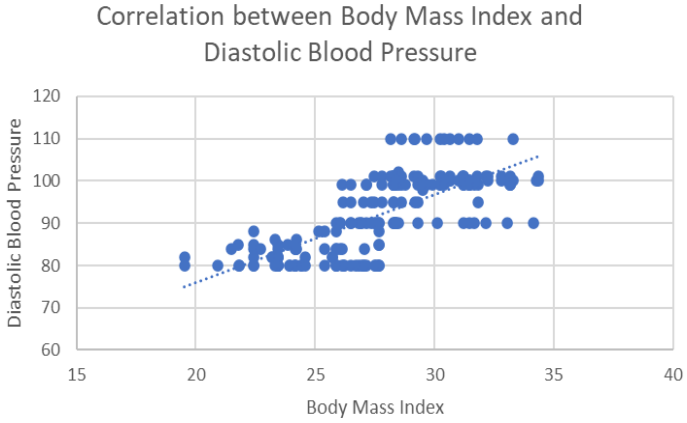

Figure 2. Scatter plot illustrating the association between BMI and DBP among Kolkata's middle-aged residents aged 35-54

The graphical representation in Figure 1 clearly demonstrates a direct and meaningful correlation between the BMI and SBP of the middle-aged inhabitants of Kolkata. This relationship appears to be linear, with the two variables exhibiting a strong positive association. In other words, as the BMI increases, there is a corresponding rise in SBP. These results have significant implications for managing and preventing hypertension, a condition closely linked to obesity and high blood pressure.

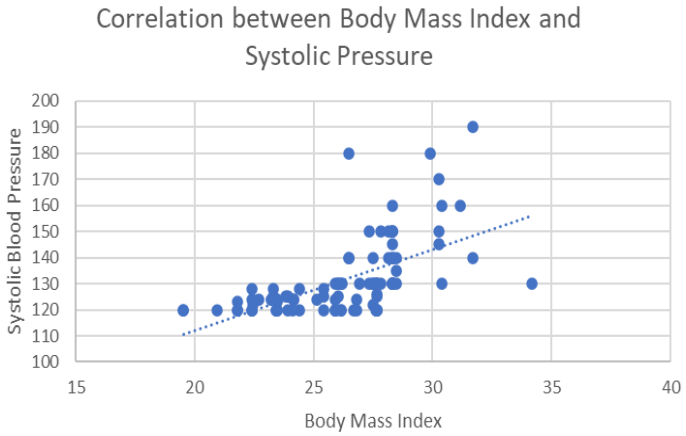

Figure 3. Scatter plot showing the association between BMI and SBP of 35-54 years old, Male Residents of Kolkata

The visual representation provided in Figure 2 reveals a notable and meaningful linear correlation between the BMI and DBP of middle-aged individuals residing in Kolkata. Specifically, the data suggests that there is a direct and strong positive relationship between the two variables. As the BMI increases, the DBP also tends to increase proportionally. These findings are significant, as

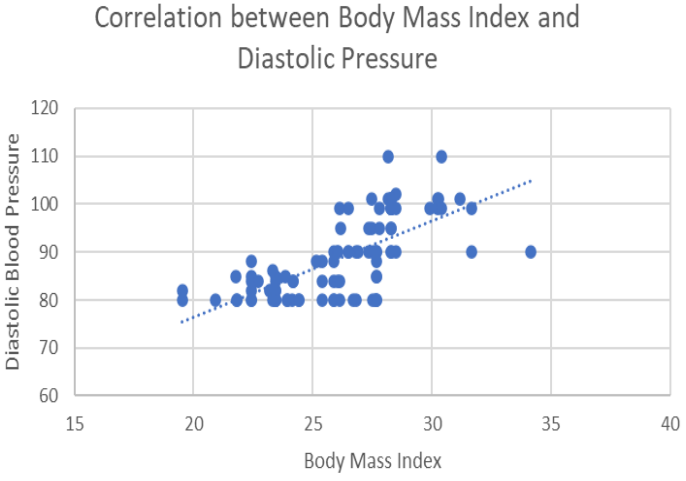

Figure 4. Scatter plot showing the association between BMI and DBP of 35-54 years old Male Residents of Kolkata

they highlight the important connection between obesity and hypertension, a condition that is a major risk factor for cardiovascular disease and other related health complications. Understanding this relationship can inform the development of effective prevention and management strategies for individuals at risk of

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developing hypertension. The graphical representation presented in Figure 3 provides evidence of a clear and meaningful linear correlation between BMI and SBP among middle-aged males residing in Kolkata. The data reveals that there is a direct positive relationship between the two variables. Specifically, as BMI increases, SBP tends to increase in a proportional manner. These findings are significant and add to the existing body of research demonstrating the link between obesity and hypertension, particularly in males. The identification of this correlation is important for the development of targeted prevention and management interventions for middle-aged males at risk of developing hypertension. This condition can have severe and life-threatening consequences.

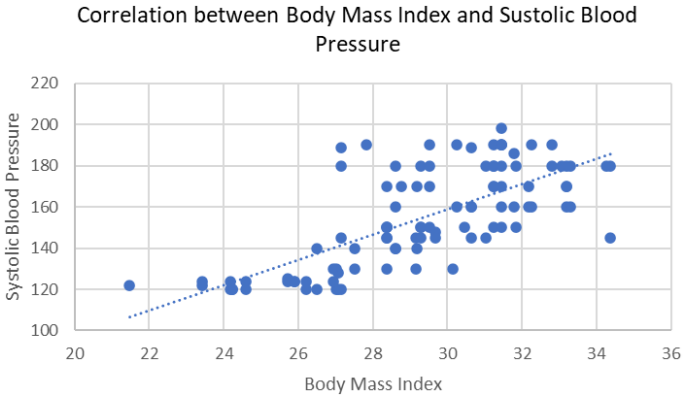

Figure 5. Scatter plot showing the Correlation between BMI and SBP of 35-54 years old, Female Residents of Kolkata

The graphical representation presented in Figure 4 demonstrates a clear and discernible linear association between the Body Mass Index (BMI) and the DBP of middle-aged males residing in Kolkata. The observed correlation between these two variables is positively directed, indicating that as BMI increases, so does the DBP. Moreover, the strength of this correlation is substantial, indicating that this relationship is statistically significant.

Figure 5 portrays a conspicuous linear association between the anthropometric indicator of BMI and SBP among middle-aged female inhabitants of Kolkata. The positive and statistically significant correlation between these two variables evinces an affirmative relationship, signifying that a proportional escalation in the hemodynamic indicator of SBP accompanies a direct rise in the anthropometric parameter of BMI. These findings suggest that maintaining a healthy BMI could help regulate SBP among middle-aged Kolkata women.

Figure 6 illustrates a direct correlation between body mass index (BMI) and DBP among middle-aged female residents of Kolkata. The affirmative and statistically significant correlation that exists between these two variables denotes that an upsurge in the anthropometric indicator of body mass index (BMI) is concurrent with a proportional increment in the hemodynamic marker of DBP. These findings emphasize the importance of maintaining a healthy BMI in regulating DBP among middle-aged women in Kolkata.

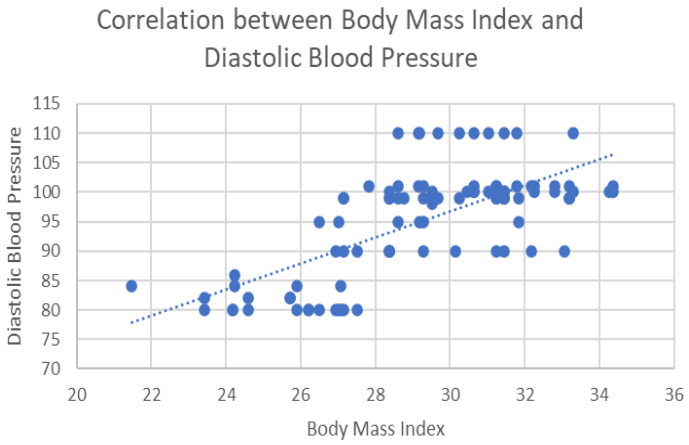

Figure 6. Scatter plot showing the Correlation between BMI and DBP of 35- 54 years old, Female Residents of Kolkata

The above tables and figures help conclude that the pertinent variables' relationship is positive and significant. This is true not only through the age groups but also through the gender groups. The investigation by Thapa et al. (2022) discussed that BMI and blood pressure have a significant correlation through different age groups. A similar finding was also highlighted in a study by Koh et al. (2022). In a study by Vuvor (2017), the results also revealed similar results.

't' – Test

To determine whether the two samples significantly differ in their mean BMI, SBP and DBP scores, the 't' – test was conducted. The results of the 't'–test is reported in Table 5.

Table 5 shows that the difference in the mean BMI, SBP and DBP scores of the two age groups is nonsignificant. The difference is significant at 0.05 level of significance for the two gender groups. Therefore, the third null hypothesis is accepted, rejecting the alternative hypothesis. Moreover, the fourth alternative hypothesis is accepted in the present study. This was also revealed in a study by Karlsson et al. (2020) which stated that there is no association between age and BMI. However, environmental factors can drive BMI and can be modifiable. Jarrett, B. L. (2009) also stated that the effect of age on BMI was non-significant. The investigation by Gurven et al. (2012) depicts similar outcomes regarding the impact of age and gender on SBP and DBP of adults. In a study by Rockwood and Howlett (2011) results revealed that there was no significant influence of age on blood pressure also.

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The positive impact of gender on BMI has also been depicted in an investigation by Reas et al. (2007). Similar outcomes regarding gender and its impact on blood pressure have been discussed in a study by Reckelhoff (2001) where she explains that women are more prone to higher blood pressure after menopause compared to their similar aged counterparts. that women seem to have higher blood pressure compared to men. This may be due to the premenopausal and post-menopausal impact. This may also be due to complicated comorbid conditions like obesity, diabetes, cardiovascular diseases, polycystic ovary syndrome and adrenal virilizing tumours. According to the present study, the association between BMI and blood pressure is

Table 5. Result of 't'-Test for the difference in mean scores of BMI, SBP and DBP

Dependant Variables	Independent Variables	't' cal.	df	't' crit. 0.05	Inference
BMI	**Age**	0.433	98	1.66	The difference is non - significant at 0.05 level of significance
	Gender	7.946	98	1.66	At a significance threshold of 0.05, the difference is significant.
SBP	**Age**	0.308	98	1.66	The difference is non - significant at 0.05 level of significance
	Gender	7.973	98	1.66	At a significance threshold of 0.05, the difference is significant.
DBP	**Age**	0.577	98	1.66	The difference is non - significant at 0.05 level of significance
	Gender	5.296	98	1.66	At a significance threshold of 0.05, the difference is significant.

Conclusion

The influence of BMI on an individual's physical and psychological health is profound. BMI is significantly related to hypertension, one of the major factors of severe health issues. The conditions underweight, overweight and obese have a global impact on public health consequences. The present investigation has tried to reflect the effect of BMI on Hypertension (Systolic and Diastolic). As the study tries to uncover the relationship between BMI and hypertension in middle-aged (35-54 years) residents of Kolkata, it also tries to find out the influence of age and gender on the pertinent variables. The study helps us to understand that there is a positive and significant correlation between BMI and hypertension in middle-aged residents of Kolkata. This finding is true for the entire sample and also for the two age groups (35-44 years and 45-54 years) independently. The result is at par with the results of the previous investigation, where a positive and linear significance is depicted among adults' blood pressure and BMI. The study predicts that BMI may directly impact blood pressure independent of other comorbid factors. The result from the 't'-Test revealed that there was no significant impact of age on BMI, SBP and DBP of middle-aged Bengali Hindu residents of Kolkata. Gender seems to significantly impact the scores of the variables mentioned. Instead of the findings, the researchers stated that the relationship between BMI and blood pressure was influenced by gender and not by age. Results reveal strong in the population. Low body weight is a defensive factor for hypertension, whereas the risk factors of hypertension are overweight, obesity and dyslipidemia. Therefore, community health measures to reduce BMI in the community or society would help reduce the risk of hypertension.

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Conflict of Interest

There is no conflict of interest in this present study.

Statement of Ethical Consent

The present study adhered to the ethical standards of the research. Participants' consent was taken, and they were informed accordingly about the study.

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