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Correlation of body mass index and left ventricular mass index among adult hypertensives attending tertiary care center

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Abstract

Background: Both obesity and left ventricular hypertrophy are aetiologies associated with hypertension. Hypertension is a major risk factor for coronary artery disease, stroke, heart failure, peripheral vascular disease, loss of vision, and chronic kidney disease. Present study was aimed to determine the association of BMI and LVMI among hypertensives. **Material and Methods:** Present study was single-center, cross sectional study, conducted in adult hypertensive patients in age group of 20-60 years attending cardiology department of our tertiary care center. **Results:** A total of 114 adult hypertensive participated in this study. Among the study population majority were from 61-70 years age (33.3 %) & 51-60 years age (27.2 %), were males (57 %), were overweight (49.1%), had duration of hypertension of 5 to 10 years (39.5 %) & taking regular medication (81.6 %). Mean Left ventricular mass index (LVMI) of 114 subjects was 54.5 ± 12.67 $g/m^{2.7}$. Among the subjects 60 of them have left ventricular hypertrophy. The correlation between BMI and LVMI were analysed was found to be significant with p value < 0.05. There was a significant correlation between BMI and LVMI in male hypertensives (P value 0.010). In case of female the correlation of BMI and LVMI were not statistically significant however there was negative correlation between these. For all age groups the P value was >0.05 and there was no significant correlation, of BMI and LVMI of patients with hypertension based on age, those having hypertension between 5 and 10 years have their P value <0.05. This shows there is significant correlation. For every 1 unit increase in BMI, 0.766 unit increase in LVMI is predicted. Beta values are the standardized coefficients. **Conclusion:** It is documented from this study that there is significant correlation between BMI and LVMI among hypertensives.

Keywords: Left ventricular mass index, body mass index, hypertension, obesity

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Introduction

Left ventricular mass index (LVMI) is the parameter for assessing left ventricular hypertrophy. Body mass index (BMI) is used to assess obesity. Both obesity and left ventricular hypertrophy are aetiologies associated with hypertension. Hypertension is a major

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risk factor for coronary artery disease, stroke, heart failure, peripheral vascular disease, loss of vision, and chronic kidney disease.[1,2]

Left ventricular hypertrophy is often associated with hypertension and is an adaptive mechanism to maintain or normalize wall stress, sometimes at the expense of diastolic and long-axis systolic functions.[3] This adaptive mechanism is associated with changes in left ventricular parameters and in chamber dimensions, geometry and function.[4] These changes are progressive and can ultimately lead to heart failure with systolic and/or diastolic dysfunction.[5]

Obesity is a rapidly growing disease that is characterized by an excessive accumulation of adipose tissue.[6] Obesity and overweight are major determinants of left ventricular (LV) diastolic function. [6] Several mechanisms may contribute to the pathogenesis of LV dysfunction in obese patients. In the obese, cardiac preload and afterload are increased, leading to elevated levels of peripheral resistance.[7] Increased pro-inflammatory cytokines originating from adipose tissue are suggested to be especially important contributors. Increased body mass index (BMI) has been associated with poor LV diastolic function.[8] It is documented about the association of hypertension with left ventricular hypertrophy (LVH) and obesity with hypertension. But limited studies have attempted to study about the correlation of body mass index (BMI) and left ventricular hypertrophy (LVH) among adult hypertensives. Present study was aimed to determine the association of BMI and LVMI among hypertensives.

Material And Methods

Present study was single-center, cross sectional study, conducted in department of Physiology and Cardiology department of Pushpagiri Institute of Medical Science and Research Centre, Thiruvalla, India. Study duration was of 1 year (December 2018 to December2019). Study approval was obtained from institutional ethical committee.

Sample size: Calculated considering correlation coefficient between BMI and LVMI from previous studies, where co-efficient of (r=0.26) was obtained.[12]

Type 1 error(α) as 5% and power of study is 80%, using the formula

$n = [z\alpha + z\beta/c]^2 + 3$ where $c = 0.5 \ln[1+r/1-r]$

The sample size obtained was 114

Inclusion criteria

- All adult hypertensive patients in age group of 20-60 years attending cardiology department of our tertiary care center, willing to participate in present study

Exclusion criteria

- All cases with valvular heart disease,
- known case of hypertrophic cardiomyopathy, history of renal disease, pregnancy
- known case of physical disabilities.

After getting approval from the institutional research and ethics committee, written informed consent of study participant is obtained. All the procedures done for the study was explained. Study participant's history of present illness, past illness was collected with the help of a pilot tested questionnaire. Anthropometric measurements and blood pressure were recorded. BMI was calculated by QUETLET index kilogram of body weight per meter square height(kg/m^2).

For blood pressure the systolic blood pressure was estimated by palpatory method and then systolic and diastolic pressures by auscultatory method was determined. The first and last audible sounds was considered for systolic and diastolic pressure respectively. Measurements was considered to the nearest 2 mm Hg. Three readings subsequently were at least 3 minutes apart was recorded and average was considered. Hypertension is defined according to

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European Society Criteria guidelines 2018 as having either a systolic blood pressure of ≥140 mmHg and diastolic blood pressure as ≥90 mmHg[138]

LVM is assessed by the value obtained from 2D guided M mode echocardiography, calculated later by using Devereux formula.

$LVMASS = 0.8(1.04[LVIDD+PWTD+IVSTD]^3 - [LVIDD]^3)+0.6g.$

LVIDD -Left ventricular internal diameter in diastole

PWTD - Posterior wall thickness in diastole

IVSTD - Inter-ventricular septum thickness in diastole.

According to Cuspidi et al.,[8] LVM was corrected for height by dividing LVM by height in meter^2. Left ventricular hypertrophy is defined as Left ventricular mass index ≥ 51g/m² in men and 47 g/m² in women.[9]

Data was analysed and presented as mean, standard deviation, range for continuous variable, frequency and percentage for categorical variable. Pearson correlation co-efficient was calculated between BMI and LVMI, age, duration of hypertension. Scattered plot was used for depicting pattern of correlation between BMI and LVMI for males and females.

Results

A total of 114 adult hypertensive participated in this study. Among the study population majority were from 61-70 years age (33.3 %) & 51-60 years age (27.2 %), were males (57 %), were overweight (49.1%), had duration of hypertension of 5 to 10 years (39.5 %) & taking regular medication (81.6 %).

Table 1: General characteristics

	No. of patients	**Percentage**
Age groups (in years)		
<=40	6	5.3
41-50	19	16.7
51-60	31	27.2
61-70	38	33.3
>70	20	17.5
Mean age (mean ± SD)	60.06 ± 11.52	
Gender		
Male	65	57.0
Female	49	43.0
BMI		
Under weight	1	0.9
Normal weight	38	33.3
Over weight	56	49.1
Obese	19	16.7
Mean ± SD	26.57 ± 3.95	
Duration of hypertension		
<=5 Years	44	38.6
5 - 10 Years	45	39.5
>10 Years	25	21.9
Mean ± SD	8.43 ± 5.9	
Taking Regular medication	93	81.6

Mean systolic blood pressure (SBP) of the patients was 142.4±17.01 mm of Hg. The median was 140 mmHg, minimum value was 100 mmHg and maximum value was 180 mm Hg.

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Mean diastolic blood pressure (DBP) of the subjects was 85.56 ± 10.39 mm of Hg. Median DBP was 80 mm Hg, minimum value and maximum value was 70 mm Hg and 130 mm Hg respectively.

Table 2: Descriptive statistics regarding BP of patients with hypertension

BP	Mean ± SD	Median (IQR)	Minimum	Maximum
SBP	142.4 ± 17.01	140 (130 - 150)	100	180
DBP	85.56 ± 10.39	80 (80 - 90)	70	130

Mean LVMI of 114 subjects was 54.5 ± 12.67 $g/m^{2.7}$. Among the subjects 60 of them have left ventricular hypertrophy. The correlation between BMI and LVMI were analysed was found to be significant with p value < 0.05.

Table 3: Descriptive statistics regarding LVMI of patients with hypertension

LVMI	Mean ± SD	Median (IQR)	Minimum	Maximum
LVMI	54.5 ± 12.67 $g/m^{2.7}$	53.89 (45.88 - 60.73)	27.6	92.8

There was a significant correlation between BMI and LVMI in male hypertensives (P value 0.010). In case of female the correlation of BMI and LVMI were not statistically significant however there was negative correlation between these.

Table 4: Comparison of correlation of BMI and LVMI with hypertension based on gender

Gender	r	p	Z	p
Male	0.318**	0.010	1.026	p>0.05
Female	0.129	0.376		

For all age groups the P value was >0.05 and there was no significant correlation, of BMI and LVMI of patients with hypertension based on age

Table 5: Correlation of BMI and LVMI of patients with hypertension based on age

Age	r	p	Z	p
≤ 60	0.238	0.078	0.039	p>0.05
>60	0.245	0.064		

The correlation of BMI and LVMI of patients with hypertension based on duration of hypertension is compared between ≤ 5 Years, 5 - 10 Years and >10 Years. Those patients who have hypertension ≤ 5 years and > 10 years have their respective P values >0.05, shows no significant correlation. But those having hypertension between 5 and 10 years have their P value <0.05. This shows there is significant correlation.

Table 6: Comparison of correlation of BMI and LVMI of patients with hypertension based on duration of HTN

Duration of HTN	r	p	Pair	Z	p
≤ 5 Years (A)	0.25	0.101	A vs B	0.797	p>0.05
5 - 10 Years (B)	0.406**	0.006	A vs C	0.848	p>0.05
>10 Years (C)	0.032	0.881	B vs C	1.517	p>0.05

For every 1 unit increase in BMI, 0.766 unit increase in LVMI is predicted. Beta values are the standardized coefficients.

Table 7: Influence of BMI on LVMI of patients with hypertension

Constant	B	t	p	R^2

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34.14	0.766	2.66	P<0.05	0.057

Discussion

Cardiovascular disease (CVD) is one of the leading causes of mortality all over the world and continues to be a major public health burden. Left ventricular hypertrophy is associated with increased cardiac mortality, as it leads to arrhythmias and causing sudden cardiac death. Risk increases continuously as the mass of the left ventricle (LV) increases. Hypertension is one of the commonest risk factors for left ventricular hypertrophy, and it is found to be associated in 71% of hypertensive patients.[1,9]

Hypertension is a global disease and its burden on the health of the people worldwide is well documented. 60-70% of obese subjects are hypertensive patients both hypertension and obesity frequently coexist. Obesity is a modifiable risk factor hence interventions in the form of change in behaviour, diet and weight reduction will help in achieving required body mass index (BMI). This in turn will help in improving left ventricular mass index (LVMI).

Prevalence of obesity in India is drastically increasing and 28% of the Kerala population is estimated to be associated with the risk factor of obesity.[10,11] Since obesity is a modifiable risk factor interventions in the form of change in behavior, diet and weight reduction will help in achieving required body mass index (BMI). This in turn will help in improving left ventricular mass index (LVMI). Primary prevention of obesity can be planned in hypertensive individuals at an early stage in order to prevent its progression to left ventricular hypertrophy (LVH).[12] Therefore, early risk markers are needed to identify those at risk of being overweight.

Obese and overweight subjects are at increased risk of heart diseases and constitute an important public health problem because of associated increased risk of cardiovascular morbidity and mortality.[10] Our study showed that nearly 65% of the hypertensives were in the category of overweight and obese. This observation establishes the well-known fact of obesity co-existing with hypertension. Similar results were obtained by Hall et al.,[13] in their study showing 60-76% of obese and overweight subjects were hypertensives.

The degree of increased myocardial muscle mass is also a strong and independent risk factor for cardiac morbidity and mortality.[14] In the present study out of 114 subjects the mean LVMI is found to be $54.5 \pm 12.67 g/m^{2.7}$ and 60 subjects have left ventricular hypertrophy. Similar results were shown by Cuspidi et al.[8] Our study results are also supported by Rajesh Gupta et al .[15] They found out that mean LVMI was more in hypertensives than normotensives. Individuals with left ventricular hypertrophy are at increased risk for, stroke, CHF, and sudden death. Aggressive control of hypertension can regress or reverse left ventricular hypertrophy and reduce the risk of cardiovascular disease.

Fewer studies have assessed the joint influences of BMI and LVMI on hypertension and other variables of LV geometry. On analysing correlation between BMI and LVMI the P value was found to be <0.05 suggesting significant correlation between BMI and LVMI among hypertensives. According to Conti L et al.,[16] high BMI increases LVMI , as per their study metabolic syndrome patients with BMI > 30 had highest mean LVMI (51.14 ± 22.08 $g/m^{2.7}$) than metabolic syndrome patients with BMI < 30 had least (38.35 ± 8.52 $g/m^{2.7}$). Similar study was done by Sebnem et al.,[17] they concluded that body fat percentage was associated with higher LVMI, in newly diagnosed hypertensive patients.

In present study, there is significant correlation (P<0.05) between BMI and LVMI for males. In contrast females in present study showed no significant correlation (P>0.05). This finding is in contrast to study done by Akintude et al.,[18] concluded that LVMI of obese hypertensive men and women are the same. This is similar to study conducted by Framingham[19] which showed that the effects of BMI and BP on LVMI were similar in both

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genders. Sebnem et al.,[17] concluded that females have higher LVMI than males. The observed difference in the present study may be due to a smaller number of female subjects enrolled in our study.

The age-standardized prevalence of raised blood pressure is considered as an indicator for monitoring blood pressure among persons aged above 18 years.[20] The mean age of the study population of the present study is 60.06 ± 11.52. After stratifying the study population by age and after analysing the comparison of correlation between BMI and LVMI based on age, no significant correlation is seen. In a study done by Mungreiphy et al.,[21] the association of BP with age was more significant than that of BMI with age. Fox et al.,[22] showed that there is a high prevalence of LVH in middle aged. They also suggest that as the population ages there is an apparent shift towards higher LVMI. In our study since there is less significant relation between BMI with age, the comparison of correlation between BMI and LVMI based on age is affected.

In the current study we have categorised study samples based on duration of hypertension as <5 years, 5 -10 years and >10 years. According to table 10 in our study only the subjects with duration of hypertension between 5 -10 years shows statistically significant correlation with BMI and LVMI. In contrary to these findings study done by Sebnem et al.,[17] concluded that body fat percentage was associated with higher LVMI, in newly diagnosed hypertensive patients. These difference in findings may be due to a smaller number of samples in our study, possibly due to low number of individuals in the category of below 5years and above 10 years.

According to current study for every unit increase in BMI there will be an increase in LVMI by 0.766 units. This finding can be compared with Gottdiener et al who concluded that obesity is the strongest predictor of LVMI than BP. However, they have seen no significant interaction between BMI and LVMI.[23]

Limitations of present study were echocardiographic findings, BP, BMI were taken only once and follow up of the findings in the study population could not be done. Since it was a hospital-based study, subjects only from a particular socio-economic status could be participated. Female participants were less compared to males and correlation of BMI and LVMI based on gender was inappropriate.

Large multi centric follow up studies of correlation of BMI and LVMI are recommended in hypertensive individuals. In the background of significant correlation of BMI and LVMI with hypertension, the increasing tendency of obesity in our population need further investigation and prevention techniques so that its progression to LVH is prevented.

Conclusion

It is documented from this study that there is significant correlation between BMI and LVMI among hypertensives. For every unit increase in BMI there is an increase in LVMI by 0.766 units. Prevention of obesity can be planned in hypertensives at an early stage in order to prevent its progression to left ventricular hypertrophy Clinicians can better detect hypertrophy prevalence in the obese and in this way, cardiovascular risk can be detected in a situation where two potential risk factors, obesity and hypertension, are present already. Hence, we conclude that implementation of preventive strategies of obesity like encouraging a healthy balanced diet and regular physical exercise may reduce the impact on left ventricular mass there by reducing cardiovascular mortality.

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