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Original research article

Left ventricular diastolic dysfunction in primary hypertension evaluation by Doppler echocardiography

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Abstract

Background: Cardiovascular diseases (CVDs) are the most prevalent cause of death and disability worldwide; more people die annually from CVDs than from any other cause. An estimated 17.7 million people died from CVDs in 2015, representing 31% of all global deaths. This transition is characterized by rapid urbanization and its accompanying adverse lifestyle changes (e.g., drug and alcohol addictions, unhealthy diet, physical inactivity and increasing psychosocial ailments) and by increasing longevity. India is experiencing an alarming increase in heart disease, which seems to be linked to changes in lifestyle and diet, rapid urbanization, and possibly an underlying genetic component.

Objectives and Aims: To evaluate application of Doppler echocardiography in determining left ventricular diastolic dysfunction in primary hypertension. Proportions of hypertensive patients having left ventricular diastolic dysfunction.

Materials and Methods: This study was carried out in the Department of General Medicine at Swami Dayan and Hospital, Delhi. This is the Cross sectional Observational Study. Study of diastolic function in hypertensives in tertiary care centre was observed.

The study observed that 44% had abnormal diastolic function in hypertensive patients. Taking this value as reference, the minimum required sample size with 10% margin of error and 5% level of significance is 95 patients. So total sample size taken was 100.

Observations and Results: Sample size was of 100 cases, the variable Age (Years) was not normally distributed (p = <0.001). The Age ranged from 26-67 years. The mean Age was 49.64 years (11.45). The median Age was 50 years (15.50). Maximum patients were between age of 50-59 years (comprises 30%) followed by age group 40-49 year (comprises 26%).Only 10.0% of the patients had age less than 30 Years. Diastolic Dysfunction was present in 56 patients out of 100 (56%). Majority of patients (42%) had mild diastolic dysfunction and only 4% had severe diastolic dysfunction.

Conclusion: The prevalence of diastolic dysfunction is high among the population of patients with hypertension as reported in this study. There is a linear increase in the prevalence of DD with the increase in age. There is no difference in the prevalence of DD among males and females. LV diastolic dysfunction is significantly correlated with presence of high blood pressure, LVH and high BMI. The higher prevalence of left ventricular diastolic dysfunction and left ventricular hypertrophy among hypertensives in our study support the need for improved attainment of blood pressure goals in these patients. Every effort needs to be put in for early detection of LVDD as it has important diagnostic, prognostic and therapeutic implications.

Keywords: Diastolic dysfunction, hypertension, left ventricular hypertrophy, high blood pressure, LV diastolic dysfunction, LVH, BMI, LVDD, doppler echocardiography

Introduction

Cardiovascular diseases (CVDs) are the most prevalent cause of death and disability worldwide; more people die annually from CVDs than from any other cause. An estimated 17.7 million people died from CVDs in 2015, representing 31% of all global deaths [1].

This transition is characterized by rapid urbanization and its accompanying adverse lifestyle changes (e.g., drug and alcohol addictions, unhealthy diet, physical inactivity, and increasing psychosocial ailments) and by increasing longevity.

India is experiencing an alarming increase in heart disease, which seems to be linked to changes in lifestyle and diet, rapid urbanization, and possibly an underlying genetic component.

Hypertension is the most common risk factor and the principal precursor of heart failure [2].

The risk for developing heart failure in hypertensive compared with normotensive individualsis about twofold in men and threefold in women [3].

Hypertension is directly responsible for 57% of all stroke deaths and 24% of all coronary heart disease

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(CHD) deaths in India [4].
Hypertension is highly prevalent in India. About 33% urban and 25% rural Indians are hypertensive. Of these, 42% urban and 25% rural Indians are aware of their hypertensive status [5].
Till the recent past, all the importance was being given to the systolic function of the heart even in the genesis of congestive heart failure.
But it is in this last decade that clinicians and researchers have discovered that reversible and irreversible abnormalities of left ventricular diastolic function contribute significantly to symptoms in individuals with a variety of cardiac disorders, including those with normal or near normal systolic function.
In its simplest form, left ventricular diastolic dysfunction is defined as impairment in the capacity of the left ventricle to accept blood without a compensatory increase in left atrial pressure [6].
The causes of diastolic dysfunction may be subdivided into a decrease in passive myocardial diastolic compliance, and impairment in active LV relaxation. Abnormalities in diastolic function may occur in the presence or absence of a clinical syndrome of heart failure and with normal or abnormal systolic function.
Diastolic function is known to be influenced by several interacting factors including age, sex, blood pressure, LV hypertrophy and BMI [7].
DD is prevalent in the hypertensive population, being highly affected by age. DD is seen more commonly among elderly patients than in younger age group.
High BMI is associated with several alterations in cardiac structure and function including left ventricular hypertrophy and diastolic dysfunction. [8] .Morbidly obese carried the highest risk compared to those with normal BMI.
It has been concluded that high BMI is associated with increased risk of diastolic dysfunction even in metabolically healthy patients. It is now well established that LVH determined by echocardiography is a strong predictor of poor prognosis in cardiovascular disorders independent of traditional risk factors. [9-11].
Echocardiography serves as an essential and excellent non-invasive diagnostic tool in assessing the structural and functional changes in the heart.[12]. Diastolic dysfunction increases the risk of HF development and all-cause mortality, even after controlling for age, sex, and LVEF. Mild diastolic dysfunction has been associated with eight times the risk of mortality compared with normal cardiac function, and 10 times the risk with moderate to severe diastolic dysfunction.[12] .Thus diastolic dysfunction (DD) can be used as an early indicator, as it is a precursor to increased left ventricular mass, left ventricular hypertrophy and clinical left ventricular failure. Its early detection may help in the risk stratification of hypertensive patients.

Materials and Methods

Study set up: The patients were recruited from outpatient and inpatient department of general medicine at Swami Dayan and Hospital, Delhi.

Study design: Cross sectional Observational Study.

Sample size: Study of diastolic function in hypertensives in tertiary care centre was observed by Nagabhushana S *et al*. The study observed that 44% had abnormal diastolic function in hypertensive patients. Taking this value as reference, the minimum required sample size with 10% margin of error and 5% level of significance is 95 patients. So total sample size taken was 100.

Formula used is:-

$N \geq ((p(1-p))/(ME/z_{\alpha})^2$

Where Z_{α} is value of Z at two sided alpha error of 5%, ME is margin of error and p is prevalence rate.

Statistical Analysis

Categorical variables were presented in number and percentage (%) and continuous variables were presented as mean ± SD and median. Normality of data was tested by Kolmogorov-Smirnov test. If the normality is rejected then non parametric test were used. Statistical tests were applied as follows-

1. Quantitative variables were compared using unpaired t-test/Mann-Whitney Test (when the data sets were not normally distributed) between the normal and abnormal diastolic function patients.
2. Qualitative variables were correlated using Chi-Square test /Fisher's exact test.
3. Univariate and multivariate logistic regression were used to find out the significant risk factors of abnormal diastolic function.

The data was entered in MS EXCEL spreadsheet and analysis was done using Statistical Package for Social Sciences (SPSS) version 21.0.

Study duration: 18 months, from March 2018 to August 2019.

Inclusion criteria

1. Patients >18 years of age

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2. Patients with primary hypertension

Exclusion criteria

1. Hypertensives with atrial fibrillation, ventricular fibrillations and acute coronary syndromes
2. Patients with known valvular lesions, RHD and congenital heart diseases.
3. Documented or suspected cardiomyopathies.
4. Athletes who are playing at State/National level tournaments.
5. Patients with abnormal EF, EF< 50%.
6. Patients with renal disease, diabetes mellitus, secondary hypertension.

Methods

- This cross sectional study was conducted in Swami Dayan and Hospital, Delhi over a period of 18 months, from March 2018 to August 2019.

Observations and Results

Table 1: Distribution of the Participants in Terms of Age (Years) (n = 100)

Age (Years)	
Mean (SD)	49.64 (11.45)
Median (IQR)	50 (15.5)
Range	26 – 67

The variable Age (Years) was not normally distributed (Shapiro-Wilk Test: p = <0.001).
The Age ranged from 26-67 years.
The mean Age was 49.64 years (11.45).
The median Age was 50 years (15.50).

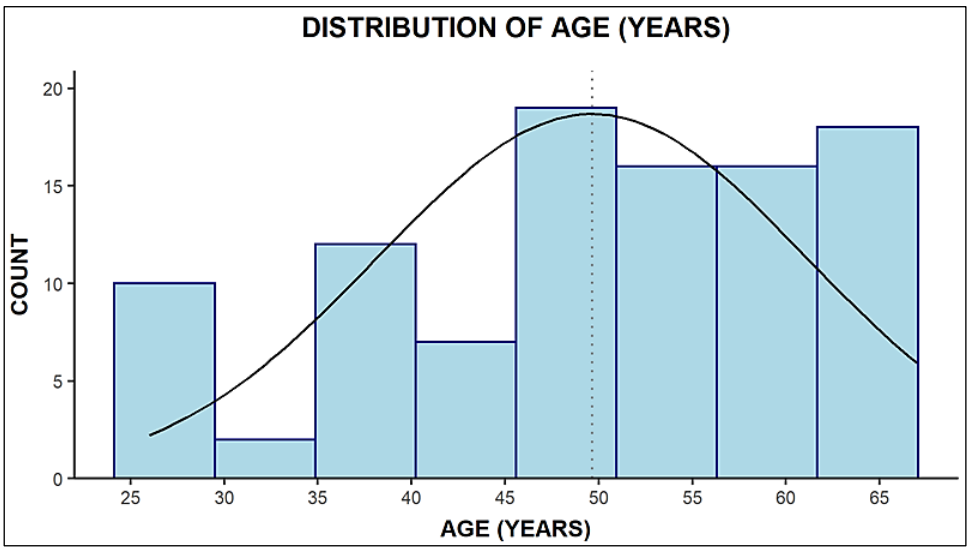

Fig 1: Distribution of the Participants in Terms of Age (Years) (n = 100)

Table 2: Distribution of the Participants in Terms of Age (n = 100)

Age	Frequency	Percentage
<30 Years	10	10.0%
30-39 Years	14	14.0%
40-49 Years	26	26.0%
50-59 Years	30	30.0%
>60 Years	20	20.0%
Total	100	100.0%

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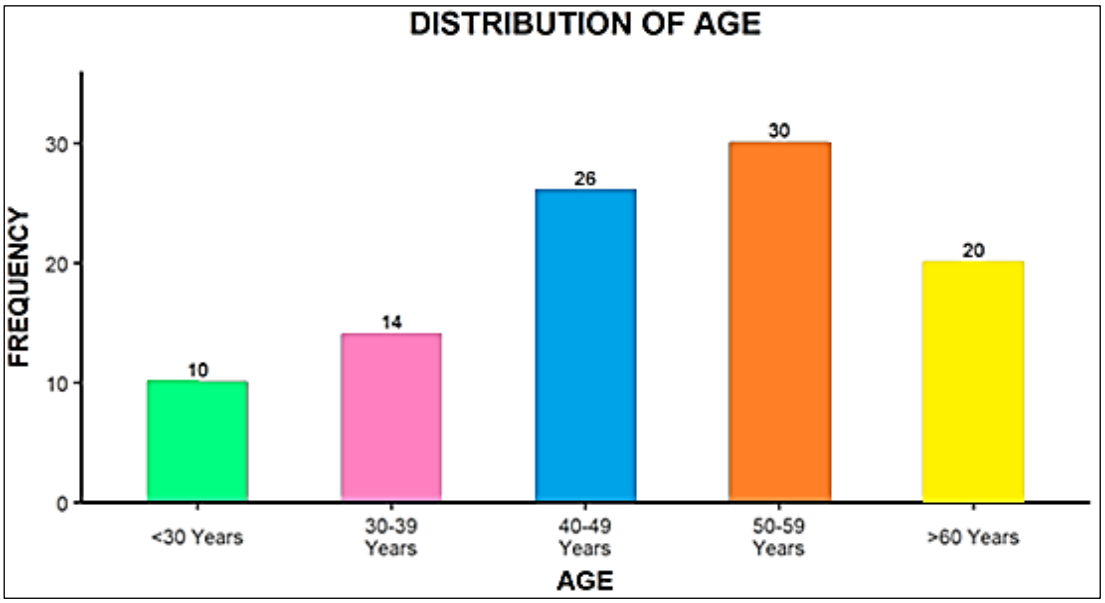

Fig 2: Distribution of the Participants in Terms of Age (n = 100)

Maximum patients were between age of 50-59 years (comprises 30%) followed by age group 40-49 year (comprises 26%).Only 10.0% of the patients had age less than 30 Years.

Table 3: Distribution of the Participants in Terms of Gender (n = 100)

Gender	Frequency	Percentage
Male	60	60.0%
Female	40	40.0%
Total	100	100.0%

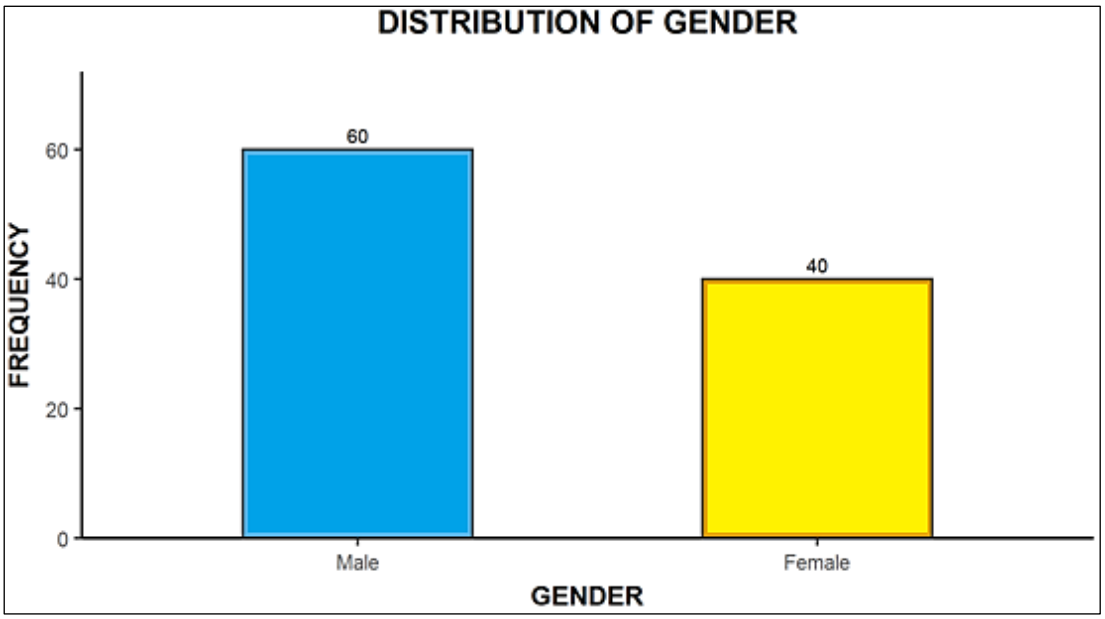

Fig 3: Distribution of the Participants in Terms of Gender (n = 100)

Out of 100 patients of primary hypertension, majority of them were males (60%).

Table 4: Distribution of the Participants in Terms of Hypertension Stage (n = 100)

Hypertension Stage	Frequency	Percentage
High Normal	19	19.0%
Hypertension Stage 1	49	49.0%
Hypertension Stage 2	32	32.0%
Total	100	100.0%

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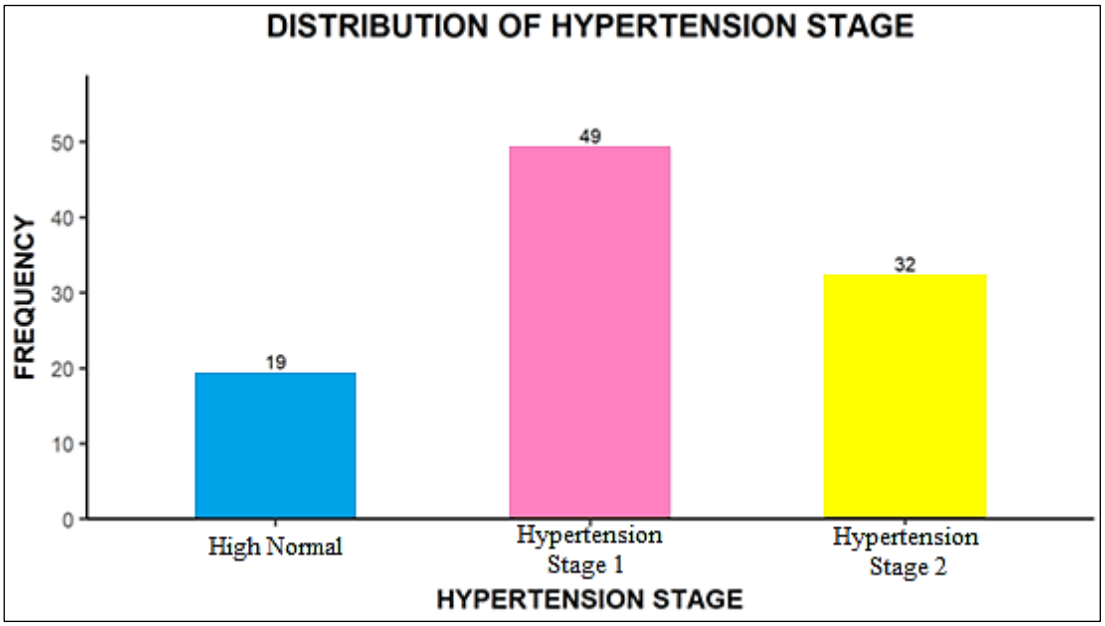

Fig 4: Distribution of the Participants in Terms of Hypertension Stage (n = 100)

Out of 100 patients studied, 19.0% of the patients had High Normal BP whereas majority (49%) of them were in Hypertension Stage 1.

Table 5: Distribution of the Participants in Terms of BMI (n = 100)

BMI (Kg/m^2)	Frequency	Percentage
18-22.9	27	27.0%
23-24.9	42	42.0%
≥25	31	31.0%
Total	100	100.0%

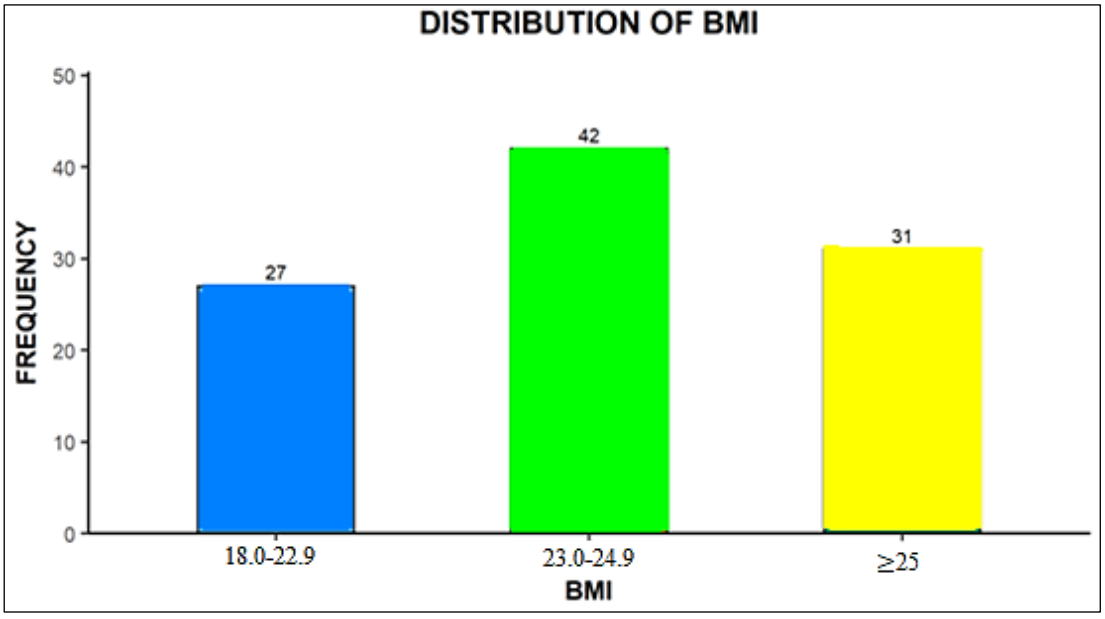

Fig 5: Distribution of the Participants in Terms of BMI (n = 100)

Majority of the patients (42%) were overweight with BMI between 23-24.9 Kg/m^2.

Table 6: Distribution of the Participants in Terms of Left Ventricular Hypertrophy (n =100)

Left Ventricular Hypertrophy	Frequency	Percentage
Present	78	78.0%
Absent	22	22.0%

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Total	100	100.0%

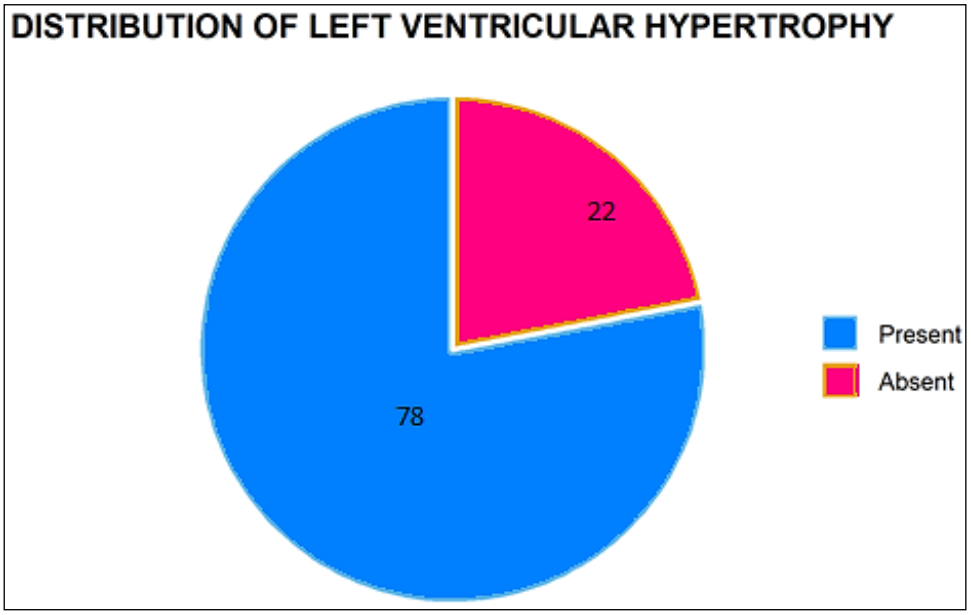

Fig 6: Distribution of the Participants in Terms of Left Ventricular Hypertrophy (n =100)

78.0% of the patients had Left Ventricular Hypertrophy.

Table 7: Distribution of the Participants in Terms of Diastolic Dysfunction (n = 100)

Diastolic Dysfunction	Frequency	Percentage
Absent	44	44.0%
Mild	42	42.0%
Moderate	10	10.0%
Severe	4	4.0%
Total	100	100.0%

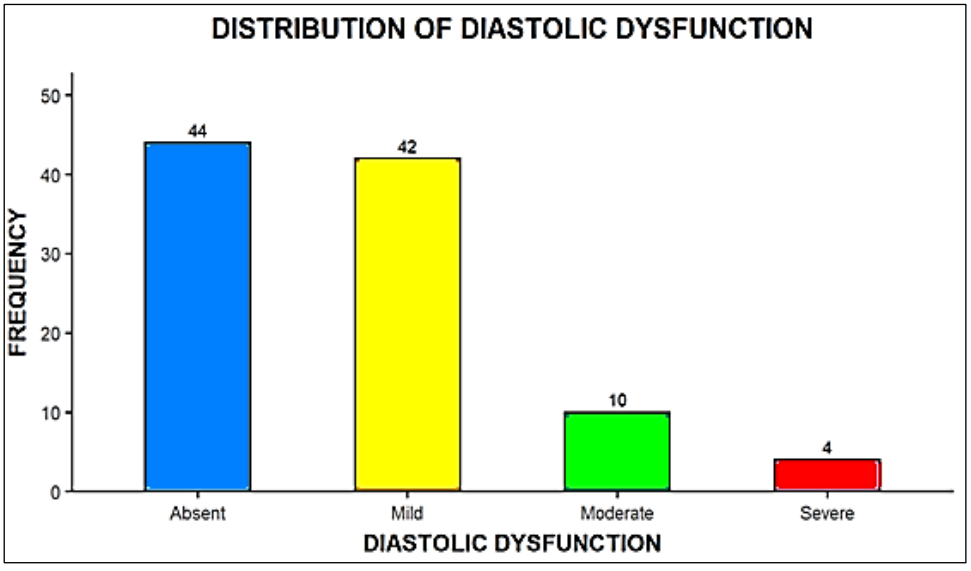

Fig 7: Distribution of the Participants in Terms of Diastolic Dysfunction (n = 100)

Diastolic Dysfunction was present in 56 patients out of 100 (56%). Majority of patients (42%) had mild diastolic dysfunction and only 4% had severe diastolic dysfunction.

Table 8: Comparison of the 4 Subgroups of the Variable Diastolic Dysfunction in Terms of Age (Years) (n = 100)

Age (Years)	Diastolic Dysfunction				Kruskal Wallis Test	
	Absent	Mild	Moderate	Severe	X^2	p value
Mean (SD)	43.77 (10.66)	52.38 (10.22)	58.60 (6.92)	63.00 (3.16)	28.450	<0.001
Median (IQR)	46 (14.25)	55.5 (12.5)	59.5 (6.5)	63.5 (4)		

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Range	26 – 67	28 – 66	45 - 66	59 - 66		

Pairwise Comparison of Subcategories of Diastolic Dysfunction	Adjusted P Value
Absent – Mild	0.003
Absent – Moderate	0.001
Mild – Moderate	0.410
Absent – Severe	0.002
Mild – Severe	0.203
Moderate – Severe	0.960

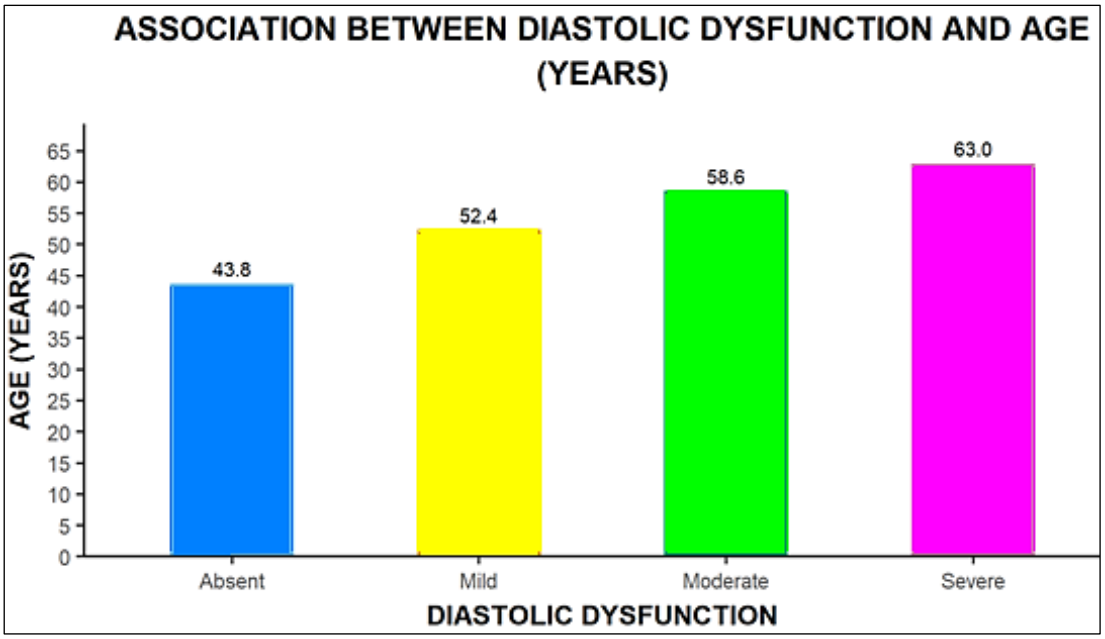

Fig 8: Comparison of the 4 Subgroups of the Variable Diastolic Dysfunction in Terms of Age (Years) (n = 100)

There was a significant difference between the 4 groups in terms of Age (Years) (X^2 = 28.450, p<0.001). The severity of diastolic dysfunction increased with increase in age.
The median Age (Years) being highest in patients with severe Diastolic Dysfunction.

Table 9: Association between Diastolic Dysfunction and Age (n = 100)

Age	Diastolic Dysfunction					Chi-Squared Test	
	Absent	Mild	Moderate	Severe	Total	X^2	P Value
<30 Years	8 (18.2%)	2 (4.8%)	0 (0.0%)	0 (0.0%)	10 (10.0%)	29.359	0.003
30-39 Years	9 (20.5%)	5 (11.9%)	0 (0.0%)	0 (0.0%)	14 (14.0%)		
40-49 Years	15 (34.1%)	9 (21.4%)	2 (20.0%)	0 (0.0%)	26 (26.0%)		
50-59 Years	10 (22.7%)	16 (38.1%)	3 (30.0%)	1 (25.0%)	30 (30.0%)		
>60 Years	2 (4.5%)	10 (23.8%)	5 (50.0%)	3 (75.0%)	20 (20.0%)		
Total	44 (100.0%)	42 (100.0%)	10 (100.0%)	4 (100.0%)	100 (100.0%)		

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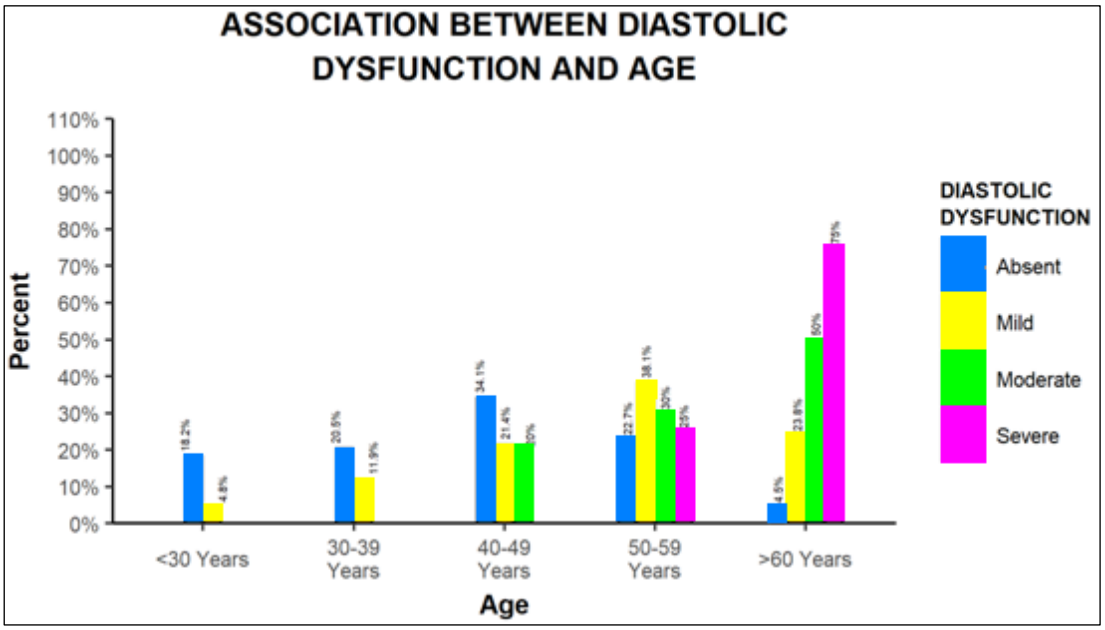

Fig 9: Association between Diastolic Dysfunction and Age (n = 100)

Chi-squared test was used to explore the association between 'Diastolic Dysfunction' and 'Age'.
There was a significant difference between the various groups in terms of distribution of Age (X^2 = 29.359, p = 0.003).
The prevalence of diastolic abnormalities varied according to age: from 20% in individuals aged <30 years to 90% among those older than 60 years. Also the severity of DD increased as the age increased.

Table 10: Association between Diastolic Dysfunction and Gender (n = 100)

Gender	Diastolic Dysfunction					Fisher's Exact Test	
	Absent	Mild	Moderate	Severe	Total	X^2	P Value
Male	26 (59.1%)	26 (61.9%)	6 (60.0%)	2 (50.0%)	60 (60.0%)	0.245	0.968
Female	18 (40.9%)	16 (38.1%)	4 (40.0%)	2 (50.0%)	40 (40.0%)		
Total	44 (100.0%)	42 (100.0%)	10 (100.0%)	4 (100.0%)	100 (100.0%)		

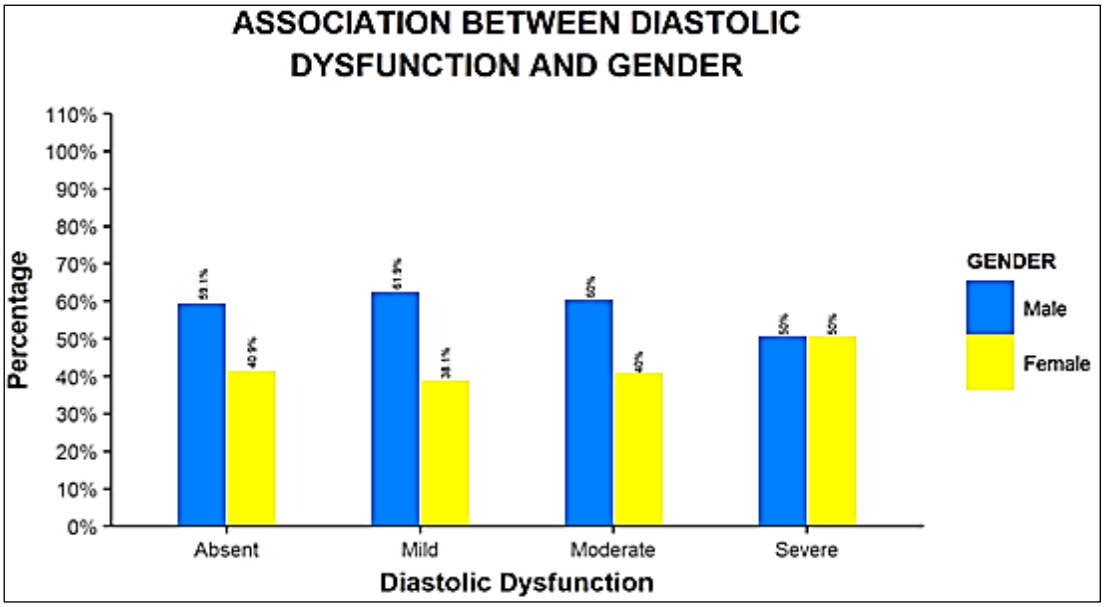

Fig 10: Association between Diastolic Dysfunction and Gender (n = 100)

Fisher's exact test was used to explore the association between 'Diastolic Dysfunction' and 'Gender'.
There was no significant difference between the various groups in terms of distribution of Gender (X^2 = 0.245, p = 0.968).

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Table 11: Association between Diastolic Dysfunction and Hypertension Stage (n = 100)

Hypertension Stage	Diastolic Dysfunction					Fisher's Exact Test	
	Absent	Mild	Moderate	Severe	Total	X^2	P Value
High Normal	18 (40.9%)	1 (2.4%)	0 (0.0%)	0 (0.0%)	19 (19.0%)	47.205	<0.001
Hypertension Stage 1	25 (56.8%)	20 (47.6%)	4 (40.0%)	0 (0.0%)	49 (49.0%)		
Hypertension Stage 2	1 (2.3%)	21 (50.0%)	6 (60.0%)	4 (100.0%)	32 (32.0%)		
Total	44 (100.0%)	42 (100.0%)	10 (100.0%)	4 (100.0%)	100 (100.0%)		

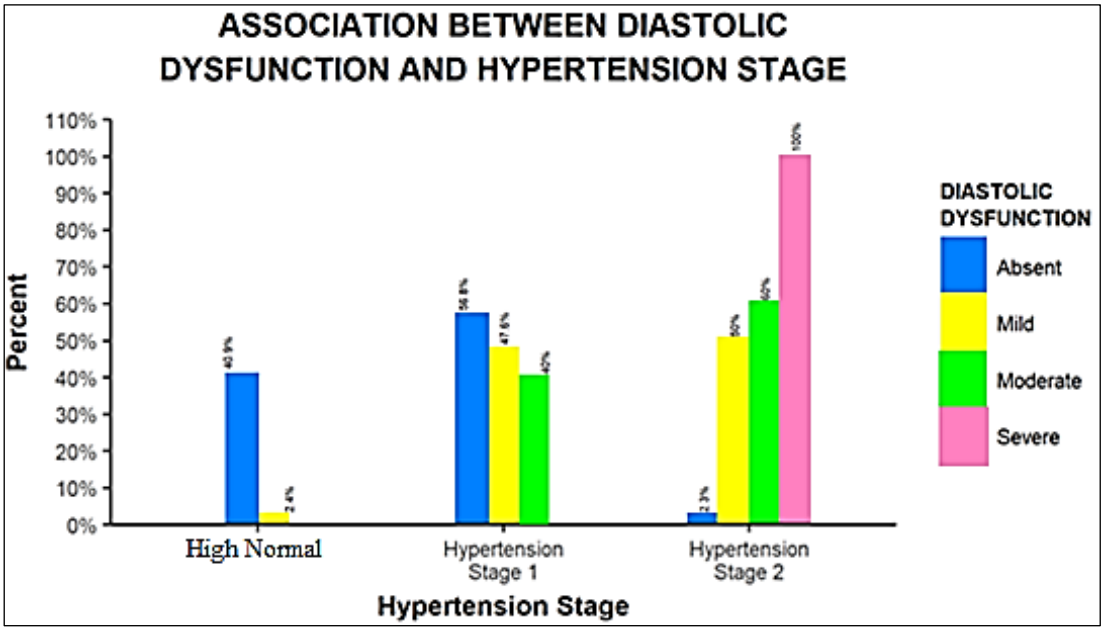

Fig 11: Association between Diastolic Dysfunction and Hypertension Stage (n=100)

There was a significant difference between the various groups in terms of distribution of Hypertension stage (X^2 = 47.205, p = <0.001).

The grading of diastolic dysfunction increased with increase in Blood Pressure. More severe diastolic dysfunction is seen with increasing stage of hypertension.

Stage II Hypertensives had more LVDD(I+II+III): 31/32-96.8% than Stage I Hypertensives 24/49-48.9%) and High Normal category of patients (1/19-5.2%).

Table 12: Association between Diastolic Dysfunction and BMI (n = 100)

BMI (Kg/m^2)	Diastolic Dysfunction					Fisher's Exact Test	
	Absent	Mild	Moderate	Severe	Total	X^2	P Value
18-22.9	23 (52.3%)	4 (9.5%)	0 (0.0%)	0 (0.0%)	27 (27.0%)	45.732	<0.001
23-24.9	18 (40.9%)	22 (52.4%)	2 (20.0%)	0 (0.0%)	42 (42.0%)		
≥25	3 (6.8%)	16 (38.1%)	8 (80.0%)	4 (100.0%)	31 (31.0%)		
Total	44 (100.0%)	42 (100.0%)	10 (100.0%)	4 (100.0%)	100 (100.0%)		

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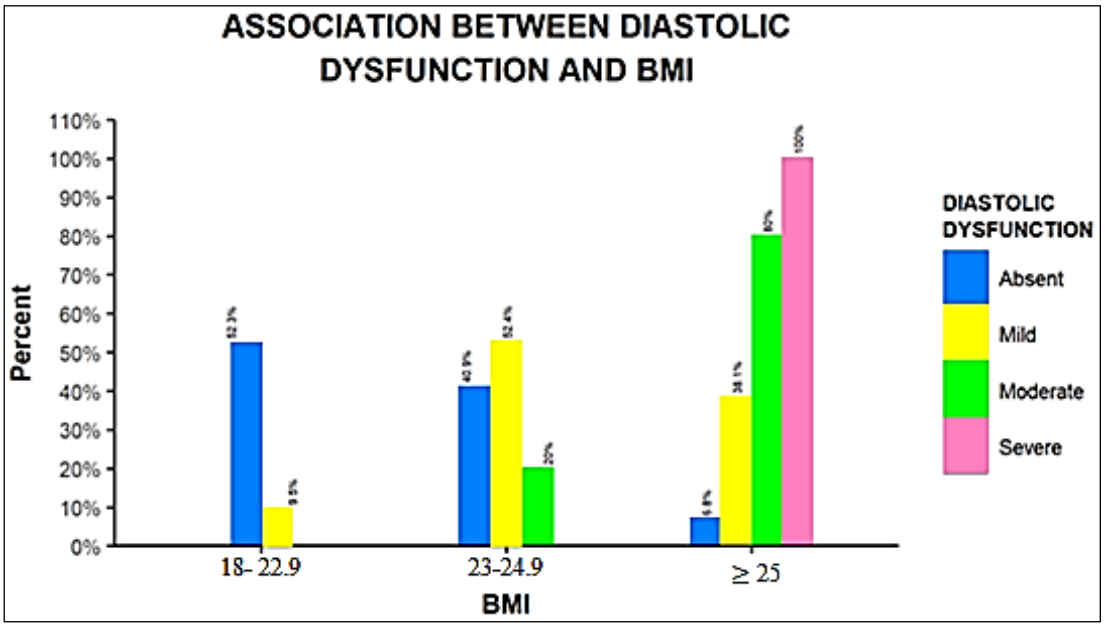

Fig 12: Association between Diastolic Dysfunction and BMI (n = 100)

Fisher's exact test was used to explore the association between 'Diastolic Dysfunction' and 'BMI'.
There was a significant difference between the various groups in terms of distribution of BMI (X^2 = 45.732, p = <0.001).
Severity of DD increased with increase in BMI.
DD was seen in 28 patients out of 31 (90.3%) with BMI ≥ 25 as compared to 4 patients out of 27 (14.8%) with normal BMI.

Table 13: Association between Diastolic Dysfunction and Left Ventricular Hypertrophy (n = 100)

Left Ventricular Hypertrophy	Diastolic Dysfunction					Fisher's Exact Test	
	Absent	Mild	Moderate	Severe	Total	X^2	P Value
Present	26 (59.1%)	38 (90.5%)	10 (100.0%)	4 (100.0%)	78 (78.0%)	16.927	<0.001
Absent	18 (40.9%)	4 (9.5%)	0 (0.0%)	0 (0.0%)	22 (22.0%)		
Total	44 (100.0%)	42 (100.0%)	10 (100.0%)	4 (100.0%)	100 (100.0%)		

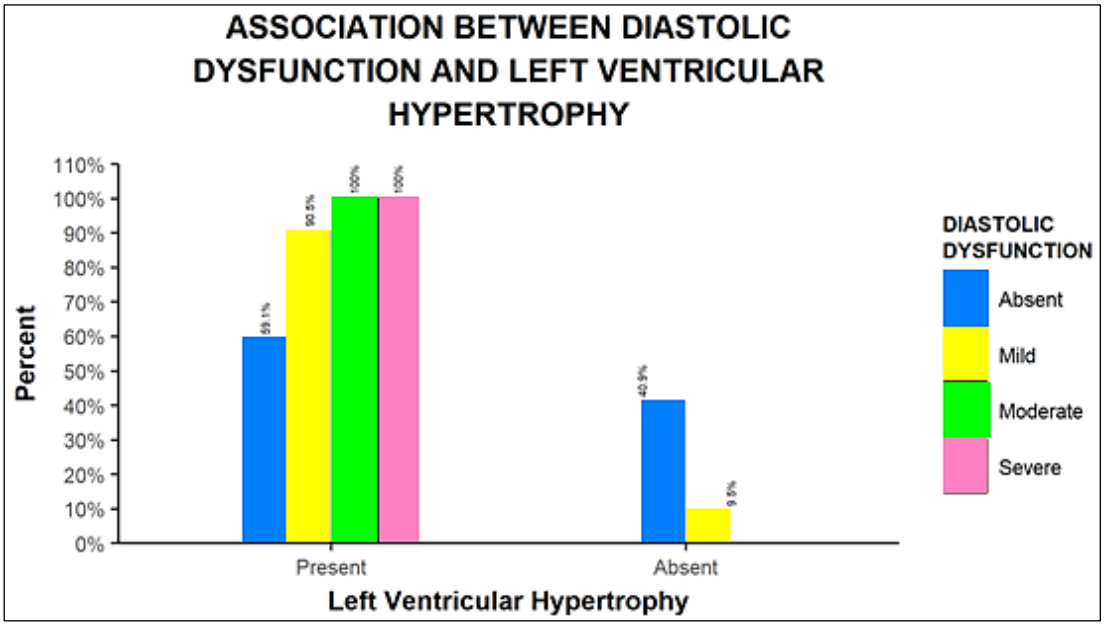

Fig 13: Association between Diastolic Dysfunction and Left Ventricular Hypertrophy (n = 100)

Fisher's exact test was used to explore the association between 'Diastolic Dysfunction' and 'Left Ventricular Hypertrophy'.
There was a significant difference between the various groups in terms of distribution of Left Ventricular

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Hypertrophy (X^2 = 16.927, p = <0.001).
Left ventricular hypertrophy was found in 78% of the hypertensive patients.
LVH was found in 38 patients out of 42 (90.47%) with mild DD, where as LVH was present in 100% of patients with moderate to severe DD.

Discussion

This study was undertaken among hypertensive patients who attended outpatient and inpatient department of general medicine at Swami Dayan and Hospital, Delhi. The study was conducted to evaluate diastolic dysfunction in 100 patients of essential hypertension. The aim of the study was to evaluate application of Doppler echocardiography in determining left ventricular diastolic dysfunction in essential hypertension. Diastolic function is known to be influenced by several interacting factors including age, sex, duration of blood pressure, and LV hypertrophy [7], all of which may potentially influence arterial compliance. Hypertension is one of the most common diseases afflicting humans throughout the world [7]. The prevalence of hypertension in Indian population as per Fourth District Level Household Survey is 25.3% with greater prevalence in men (27.4%) than women (20.0%). About 33% urban and 25% rural Indians are hypertensive.

Hypertension affects the heart causing systolic, & diastolic dysfunction, left ventricular hypertrophy, heart failure and contributes to atherosclerotic vascular problems, such as coronary artery disease. The participants of this study were aged between 26 and 67 years. Mean age of the patients were 49.64 ± 11.45 years. The maximum patients were between age of 50-59 years (30%) followed by age group 40-49 years (26%). Out of 100 patients of essential hypertension, majority of them were males (60%). A prevalence of diastolic dysfunction 56% were reported among hypertensive patients.

Fifty six percent (56/100) of study participants had diastolic dysfunction in this study, of which 75% (42/56) had mild diastolic dysfunction with 25% (14/56) having moderate to severe diastolic dysfunction. The overall prevalence of LVDD in our study was 56% which was comparable with the studies conducted by Verdechia *et al*., [13-15] 1990, Zanchetti *et al*., [16] 2007, Sciarretta *et al*., [17-20] 2009 who observed prevalence of 46%, 46% and 66% respectively.

Table 14: Prevalence of LV diastolic dysfunction in hypertensive populations

Study, Reference, Year	N	Women (%)	Mean Age, (years)	Prevalence of LVDD (%)	Prevalence of LVH (%)
Verdechia *et al*., 1990 [21]	145	47	52	46	15
Wachtell *et al*., 2000 [22]	750	44	65	84	100
De Simone *et al*., 2005 [23]	1384	53	54	20	27
Zanchetti *et al*., 2007 [24]	2545	51	70	46	46
Sciarretta *et al*., 2009 [25]	1073	48	59	66	n/a
Ching Siew Mooi *et al*., 2012 [26]	359	58	59	68	24
Santos *et al*., 2016 [27]	3001	62	76	67	n/a
Present Study	100	40	50	56	78

The previous studies listed in the above table demonstratethat the prevalence of LVDD is substantial in hypertensive patients [21-27]. However, great heterogeneity in the frequency of LVDD has been reported in hypertensive cohorts in previous studies, with values ranging from 20% to 84%. The prevalence varies widely as the characteristics of the studied population, choice of imaging modalities, and criteria used to diagnose LVDD varied in the previous studies. In our study 11 (42.3%) out of 26 cases between age group 40-49 year had DD, 20 (66.6%) out of 30 cases between 50-59 year had DD and 18 (90%) out of 20 cases more than 60 year old had DD. There was linear increase in the prevalence of DD with the increase in age group which was statistically significant (p=0.003). This was similar to the study done by Ingle VV *et al*. [20], Rosa Eduardo Cantoni *et al*., [42] & Klein AL *et al*. [43]. Our study showed that out of 40 female cases 22(55%) had DD and out of 60 male cases 34(56.66%) had DD but this was not statistically significant (P=0.968).

The role of gender appears more uncertain: while we found a similar prevalence among men and women, Fischer *et al*. [29] reported a higher prevalence in men. Another study done by A. Zanchetti *et al*. [23] found that Diastolic Dysfunction was more prevalent among females (56%) compared to males (44%).

No significant differences in prevalence between genders were found in two other population studies by Redfield MM *et al*., Abhayaratna WP *et al*. [45, 44].

Left ventricular hypertrophy is a cardinal manifestation of pre-clinical cardiovascular disease that strongly predicts cardiovascular events in hypertensive patients as well as in the general population. Prevalence of left ventricular hypertrophy from this study was 78% (78/100).

These findings compares to those of Wachtell *et al*. [46] in the LIFE multicentre study group which

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reported prevalence of LVH to be 42-78%. It is now well established that LVH determined by echocardiography is a strong predictor of poor prognosis in cardiovascular disorders independent of traditional risk factors [47-49]. The findings of higher prevalence of cardiac hypertrophy (78%) among hypertensive patients in our study support the need for improved control of blood pressure goals in these patients. Screening for end organ damage should be warranted in this population.

LVH is a recognized marker of HT-related target organ damage, and a strong and independent risk factor for adverse cardiovascular (CV) outcomes. CV risk increases with increasing LVM, and decreases with regression of LVH in response to antihypertensive treatment [50].

In my study, 24 out of 49 patients of Stage 1 hypertension had diastolic dysfunction and 31 out of 32 patients of stage 2 hypertension had diastolic dysfunction. Also the severity of diastolic dysfunction increased with increase in blood pressure.

This was comparable to a study by Laudari S *et al*. [51-52] where Stage II Hypertensives had more LVDD-95.12% than stage I Hypertensives (39/53-73.58%).

Similar results were found in the cross-sectional observational study by Zanchetti *et al*. (APROS Diadys Project), on elderly (age >65 yrs) hypertensives without systolic dysfunction, where, 2545 patients were studied to establish the prevalence of echocardiographic signs of diastolic dysfunction. It was found that the diastolic dysfunction was significantly more prevalent in patients with uncontrolled BP (treated SBP >140mmHg or DBP > 90mmHg).

In our study, prevalence of diastolic dysfunction was 57% and 90% in patients with overweight (BMI 23–24.9) and obese (BMI ≥ 25) patients respectively as compared to 15% in patients with normal BMI. In addition, the severity of LVDD was progressively higher as BMI increased.

Similar results were seen in the study by Antoine Kossaify and Nayla Nicolas [53], where LVDD was encountered in 59.3% patients with normal BMI, 78.1% in overweight patients and 87% obese patients (P= 0.043).

In the study of a cohort consisting of 7057 individuals by Zach Rozenbaum *et al*., [27] Patients in higher BMI groups more commonly demonstrated abnormalities in most echocardiographic parameters associated with diastolic dysfunction. Also, morbidly obese carried the highest risk compared to those with normal BMI.

Other studies by Seo JS *et al*., [54] Chadha DS *et al*. [55], Wang YC *et al*. [56] demonstrated an association between body mass index (BMI) and diastolic dysfunction in a metabolically healthy population.

It was concluded that high BMI is associated with increased risk of diastolic dysfunction even in metabolically healthy patients.

High BMI is associated with several alterations in cardiac structure and function including left ventricular hypertrophy and diastolic dysfunction. The influence on diastolic function and hemodynamics seems to be multifactorial, and may result from effects of adipose tissue, as well as from comorbidities which are associated with obesity, such as diabetes mellitus, dyslipidemia and hypertension [8].

Additionally, weight loss led to considerable improvements in LV mass and systolic and diastolic function in morbidly obese patients [90], which added evidence to the cause and- effect relation of obesity and abnormal ventricular structure and function.

Many substances (angiotensin 2, Leptin, Resistin, Adiponectin etc.) are secreted by adipocytes and exert a direct or indirect detrimental effect on the myocardium, and predispose an individual to both LVDD and diastolic heart failure [57].

Adiponectin deficiency in obesity contributes to myocyte apoptosis, precipitating abnormal relaxation, and can lead to adiposity-related DD [58]. Similarly, angiotensin 2 and leptin exert a fibrotic effect on the intercellular matrix leading to DD [59-61].

The current findings have potential relevance in clinical practice for evaluation of hypertensive patients as diastolic dysfunction may be an early manifestation of cardiac involvement in hypertension.

Conclusion

The prevalence of diastolic dysfunction is high among the population of patients with hypertension as reported in this study.

There is a linear increase in the prevalence of DD with the increase in age.

There is no difference in the prevalence of DD among males and females.

LV diastolic dysfunction is significantly correlated with presence of high blood pressure, LVH and high BMI.

The higher prevalence of left ventricular diastolic dysfunction and left ventricular hypertrophy among hypertensives in our study support the need for improved attainment of blood pressure goals in these patients.

Every effort needs to be put in for early detection of LVDD as it has important diagnostic, prognostic and therapeutic implications.

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