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Research Paper

Effect of gender difference on left ventricular and left atrial parameters in patients with essential hypertension

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ABSTRACT

Background: Arterial hypertension causes structural and functional cardiac changes, including alterations in left ventricular (LV) and left atrial (LA) parameters. These changes may vary by sex due to physiological and clinical differences.
Objective: To determine whether differences exist in LV and LA parameters between male and female patients with hypertension.
Methods: This cross-sectional analytic study was conducted at the Echocardiographic Consultation Unit of Al-Furat Teaching Hospital, Al-Najaf Governorate, from 1 September 2023 to 20 April 2024. A total of 68 hypertensive patients aged 18–60 years, including both males and females, were enrolled. All participants underwent clinical evaluation, anthropometric measurements, and Doppler echocardiography. LV parameters and LA volumes and functional indices were assessed. Statistical comparisons between sexes were performed, with significance set at $P<0.05$.
Results: Significant differences were observed between males and females in anthropometric variables, including weight, height, age, and body surface area (BSA) (all $P<0.05$). LV structural parameters interventricular septal thickness (IVS), left ventricular posterior wall thickness (LVPW), and left ventricular mass (LVM) also differed significantly between sexes (all $P<0.05$). Additionally, certain LA functional parameters, including passive volume and conduit function, showed significant differences between male and female groups ($P<0.05$).
Conclusion: LV parameters appear to be influenced by sex-related differences in hypertensive patients. In contrast, LA parameters are more strongly associated with factors such as age, ethnicity, treatment type, and treatment adherence rather than sex alone.

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1. INTRODUCTION

Arterial hypertension causes structural and functional changes in the heart, collectively named hypertensive heart disease [1]. The heart is normally smaller in females than in males from puberty onwards [2], largely due to differences in body size and composition [3]. Current guidelines therefore recommend sex-specific threshold values for optimal detection of hypertensive heart disease by echocardiography [4]. The hallmark of hypertensive heart disease and a potent prognostic indicator in hypertension is left ventricular hypertrophy, or LVH. In females compared to males, hypertension LVH is more common and less treatable with antihypertensive medication [5]. Regardless of attained blood pressure levels, persistent LVH is specifically linked to elevated arterial stiffness, an increased risk of CV events, and mortality during follow-up. An additional prevalent indicator of hypertension heart disease is a dilated left atrium (LA). Increased CVD, specifically atrial fibrillation, heart failure (HF), and ischemic stroke, is linked to LA dilatation [6], [7]. Another study reported that in middle-aged subjects with obesity without known CVD, LA dilatation was significantly more prevalent in females than in males, and particularly associated with co-presence of hypertension and increased arterial stiffness [8]. Stated that the hemodynamic load has a major influence on left ventricular features, including cardiac remodeling, because males and females have different blood pressure variations and hemodynamic loads. For instance, males with hypertension usually have greater systolic blood pressure than females do, which may lead to greater ventricular hypertrophy and higher LVM. State that variations in how men and women respond to antihypertensive medications and other forms of treatment may have an impact on the structure and functionality of the heart.

2. RELATED WORK

The results of Gerdts and colleagues showed that females exhibit higher LV myocardial function and ejection fraction than males [5]. Another study by losi and colleagues showed that LA dilatation is more common in females. In older subjects with hypertension and LVH, LA dilatation was significantly more prevalent in females [9]. Another study reported that in middle-aged subjects with obesity without known CVD, LA dilatation was significantly more prevalent in females than in males, and particularly associated with co-presence of hypertension and increased arterial stiffness [10]. Stated that the hemodynamic load has a major influence on left ventricular features, including cardiac remodeling, because males and females have different blood pressure variations and hemodynamic loads. For instance, males with hypertension usually have greater systolic blood pressure than females do, which may lead to greater ventricular hypertrophy and higher LVM. State that variations in how men and women respond to antihypertensive medications and other forms of treatment may have an impact on the structure and functionality of the heart. Compliance with therapies and efficacy differences between the sexes may be the cause of differences in LV mass and dimensions. Found that there were larger heart cavities and LVM in the male participants. These gender differences vanished when body surface area (LVMI) was used to index LVM. In terms of obesity, 38% of women and 26% of men were affected. The outcomes verified that obesity has an impact on LVM. The LA parameters are not significantly affected by gender ($p>0.05$) due to the following reasons. Who studies and increasing arterial stiffness, both of which have a role in the development of hypertension [11]. Those who are taller typically have higher blood pressure than those who are shorter. This association is explained by the fact that in taller individuals, there is a greater hydrostatic pressure generated between the heart and the brain, necessitating higher blood pressure in order to provide appropriate cerebral perfusion. A higher body mass index.

3. METHODOLOGY

3.1. Study Population

This study uses cross-sectional analysis. The study samples were collected between September 1, 2023, and April 20, 2024, from the Echocardiographic Consultation Unit of Al-Furat Teaching Hospital in the Al-Najaf Governorate. There are documented cases of hypertension patients between the ages of 18 and 60. There are both male and female patients. This study excluded patients with diabetes mellitus, coronary artery disease, significant valvular disease, a history of atrial or ventricular arrhythmias, prior cardiac surgery, an implanted device, or any other chronic diseases (e.g., chronic kidney failure, chronic liver disease, etc.). The same physician collected the echocardiographic parameters apart from the clinical information. With SPSS V21, the statistical analysis is performed. All subjects had their ECGs and anthropometric measurements (weight and height) taken. Each patient's body surface area (BSA) was computed.

3.2. Echocardiography

Every individual had a pulsed wave Doppler and 2D vivid E9 echocardiogram conducted utilizing a transducer that was connected to the ultrasound equipment. The echocardiography evaluation was conducted while a continuous three-lead ECG was being obtained. The American Society of Echocardiography's recommendations have been adhered to for conventional Doppler echocardiographic examinations [8]. To acquire a four-chamber apical image, the transducer was positioned with the indicator pointing toward the left flank at the apex beat level at the fifth intercostal space at the mid-clavicular line. As a result, measurements were made of LAMax, LAMin, pre-atrial volume, E/A, DT, and E/é. The following parameters were measured using a parasternal long-axis view: IVS, LVEDV, and LVPW. The transducer was positioned between the nipples with the indication pointing toward the right shoulder. Following the guidelines provided by the American Society of Echography (ASE), the left ventricular mass (LVM) was measured and computed using Devereux's formula. A body surface area indexed LVM (LVMI) of greater than 115 g/m2 in men and greater than 95 g/m2 in women was considered left ventricular hypertrophy (LVH). It was feasible to differentiate between the concentric LVH if RWT ≥ 0.42 and the eccentric LVH if RWT < 0.42 based on the relative wall thickness (RWT), which was determined by the 2 LVPW/LVEDV.

3.3 Statistical Analysis

In this cross-sectional study, statistical analysis was performed using the statistical package SPSS for Windows (version 21, SPSS Inc., Chicago, IL, USA). Data analyzed as per group I for females (total: n=40) compared with group II for males (total: n=28) were shown as mean ± SD. Continuous variables were compared using independent sample t-tests. A P value < 0.05 was adopted to indicate statistical significance [10].

4. RESULTS AND DISCUSSION

4.1. Demographic Characteristics

Demographic characteristics of the population are given in Table 1. The mean age of subjects was 47.85 years and the results show a significant difference in age between the hypertensive people (p=0.00001). Weight, height, and BSA also show a significant difference between hypertensive people (p= 0.002, 0.0003, and 0.000001 respectively).

SD: standard deviation, BSA: body surface area, Symbol *: significant.

Table 1. Demographic Data

Demographic Data	Hypertensive Patients (N=68) Mean ± SD	P- Value
Age (years)	47.85±8.95	0.00001*
Height (cm)	164.26±8.74	0.0003*

Weight (kg)	87.94±15.68	0.0020*
BSA	1.99±0.20	0.000001*

On the other hand Table 2 revealed that mean of IVS in male group (11.39±1.449) was higher than the mean of female group (10.15±1.511), so there was a significant increase ($p<0.05$) in IVS thickness in the male group compared with the female group. The mean of LVPW thickness in the male group (10.93±1.245) was higher than the female group (10.03±1.561), so there was a significant increase ($p<0.05$) in LVPW thickness in the male group compared with the female group. The mean of relative wall thickness (RWT) of left ventricle in the male and the female group were (0.50±0.06) and (0.46±0.09), which was not significantly different between the two groups ($p>0.05$). The mean of LVMI in the male and female group were (104.31±23.49) and (96.44 ±20.89), which was not significantly different between the two groups ($p>0.05$). The mean of LVM was (219.43 ±54.25) in male group higher significantly than the mean of LVM (185.69± 45.83) in female group, ($p<0.05$).

LV: left ventricle, LVM: left ventricular mass, LVMI: left ventricular mass index, SD: standard deviation, IVS: interventricular septum, LVPW: left ventricular posterior wall, RWT: Relative wall thickness, Symbol *: significant.

Table 2. LV Parameters According to Gender Specification

LV Parameters	Female Group (N=40) Mean±SD	Male Group (N=28) Mean±SD	P- Value
IVS	10.15±1.511	11.39±1.449	0.001*
LVPW	10.03±1.561	10.93±1.245	0.013*
RWT	0.46 ±0.09	0.50± 0.06	0.109
LVMi	96.44 ±20.89	104.31±23.49	0.151
LVM	185.69 ± 45.83	219.43 ±54.25	0.007*

Table 3 shows all volumes were not significantly different between male and female groups ($p>0.05$). Conduit function was higher significantly in males than in females ($p<0.05$).

LA: left atrium, SD: standard deviation, symbol *: significant.

Table 3. LA Parameters Related to Gender Specification

LA Parameters	Female Group (N=40) Mean±SD	Male Group (N=28) Mean±SD	P- Value
Maximum volume	57.43±10.107	62.21±16.231	0.139
Minimum volume	16.00±5.729	15.79±5.750	0.880
Pre P volume	30.80±8.392	29.00±7.921	0.376
Reservoir volume	41.43±8.221	46.43±13.287	0.060
LA contractile volume	14.80±5.766	13.21±6.286	0.286
Passive emptying volume	26.63±8.095	33.21±11.571	0.007*
Reservoir function	41.43±8.221	46.43±13.287	0.060
Conduit function	26.63±8.095	33.21±11.571	0.007*
Booster function	14.80±5.766	13.21±6.286	0.286
Passive emptying function	56.88 ±10.11	61.74 ±16.24	0.134
Active emptying function	30.27 ±8.400	28.44 ±7.96	0.369
Total emptying fraction (EF)	57.14 ±10.09	61.95 ±16.23	0.137

4.2. Discussion

The demographic data of our study differ significantly in hypertensive patients and this means that these parameters play an important role in developing hypertension. Age-related physiological changes include endothelial dysfunction and increasing arterial stiffness, both of which have a role in the

development of hypertension [11]. Those who are taller typically have higher blood pressure than those who are shorter. This association is explained by the fact that in taller individuals, there is a greater hydrostatic pressure generated between the heart and the brain, necessitating higher blood pressure in order to provide appropriate cerebral perfusion. A higher body mass index (BMI) and body weight are linked to a higher risk of hypertension. Being overweight causes a number of physiological alterations, including insulin resistance, endothelial dysfunction, and an increase in sympathetic nervous system activity, all of which have a role in the development of hypertension [12]. BSA has a positive correlation with blood pressure and is determined using height and weight. Blood pressure is often greater in people with larger BSAs than in people with smaller BSAs [13].

Table 2 shows that the association demonstrated a significant difference ($p<0.05$) in IVS, LVPW, and LVM between male and female hypertensive patients. Compared to females, males had higher values of these factors. This clarifies how the values for these factors differ in men and women on average. As a result, women's LV reacts differently to continuous pressure overloaded in hypertension. [14], [15] explain the reason of this [16] the form and function of the cardiovascular system can be influenced by the levels of estrogen and testosterone, two hormones that are different in men and women. For example, vasodilation and the inhibition of cardiac hypertrophy have been associated with the cardio protective effects of estrogen, which could account for the differences in LVPW, LVM, and IVS between the sexes. Urbina, Ferranti [15] stated that the hemodynamic load has a major influence on left ventricular features, including cardiac remodeling, because males and females have different blood pressure variations and hemodynamic loads. For instance, males with hypertension usually have greater systolic blood pressure than females do, which may lead to greater ventricular hypertrophy and higher LVM. [14] State that variations in how men and women respond to antihypertensive medications and other forms of treatment may have an impact on the structure and functionality of the heart. Compliance with therapies and efficacy differences between the sexes may be the cause of differences in LV mass and dimensions. [17] Found that there were larger heart cavities and LVM in the male participants. These gender differences vanished when body surface area (LVMI) was used to index LVM. In terms of obesity, 38% of women and 26% of men were affected. The outcomes verified that obesity has an impact on LVM. The LA parameters are not significantly affected by gender ($p>0.05$) due to the following reasons. [18] Who studied the effect of gender difference on LA parameters and suggested that although women have lower diastolic compliance and higher systolic chamber function than men do, there are gender differences in left ventricular chamber function as well, although these differences do not directly affect the LA parameters. Research has demonstrated that left atrial volumes, irrespective of gender, rise markedly with age. [19] Explained that although age and ethnicity have been taken into consideration when establishing reference values for left atrial volumes, emptying fractions, these data do not show a substantial influence of gender on LA parameters.

5. CONCLUSION

There is a significant difference in LV parameters between males and females while this difference doesn't find in LA parameters except of conduit function and passive emptying volume, the reason behind this, is these parameters affected by age, ethnicity, compliance to the treatment of hypertension and the type of treatment rather than the gender while conduit function and passive emptying volume depend directly on the left ventricular filling pressure. Estrogen, which could account for the differences in LVPW, LVM, and IVS between the sexes. [15] Stated that the hemodynamic load has a major influence on left ventricular features, including cardiac remodeling, because males and females have different blood pressure variations and hemodynamic loads. For instance, males with hypertension usually have greater systolic blood pressure than females do, which may lead to greater ventricular hypertrophy and higher LVM. [14] State that variations in how men and women respond to antihypertensive medications and other forms of treatment may have an impact on the structure and functionality of the heart. Compliance with therapies and efficacy differences between the sexes may be the cause of differences in LV mass and dimensions. [17] Found that there were larger heart cavities and LVM in the male participants. These

gender differences vanished when body surface area (LVMI) was used to index LVM. In terms of obesity, 38% of women and 26%

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Author Contributions Statement

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Dhuha Qasim Mohammed	✓		✓		✓		✓		✓		✓		✓	✓
Asaad Hasan Noaman Al-Aboodi		✓		✓		✓		✓		✓		✓	✓	✓

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

Conflict of Interest Statement

The authors declare that there are no conflicts of interest regarding the publication of this paper.

Informed Consent

All participants were informed about the purpose of the study, and their voluntary consent was obtained prior to data collection.

Ethics Approval

The Department of Physiology, Faculty of Medicine, University of Kufa and department of Echocardiography, Al-Furat Teaching Hospital, Najaf, Iraq, authorized the study design, and all patients had provided informed consent.

Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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