Original Research Article Journal of National Heart & Lung Society Nepal

Vol-4. No. 1, Jan-Jun 2025 DOI:10.3126/jnhls.v4i1.79808 ISSN: 2091-0657 (Online & Print)

Normative Echocardiographic Reference Values for Left Atrial and Left Ventricular Parameters

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Received: 13th February, 2025 Accepted: 16th May, 2025 Published: 30th June, 2025

ABSTRACT

Background: Amidst the various modalities of cardiac investigations, echocardiography still stands atop owing to its reliability, reproducibility, cost-effectiveness and non-invasiveness. Various diseases can have effect on heart resulting in alteration of dimensions in different parameters. Differentiating normal from abnormal is, therefore, essential for timely intervention of the pathology. International guidelines have defined the normal values which are, however, not inclusive of our population. This study has brought forward the normal ranges of different cardiac parameters in different age-groups and across genders in our population, thereby helping the practitioners and researchers to move forward for further handling of the cases in their respective field.

Methods: This was a hospital-based prospective observational study conducted at National Academy of Medical Sciences, Bir Hospital, Kathmandu, Nepal. The study duration was from March 2023 to April 2025. Eight hundred fifty-three patients above 18 years of age with normal echocardiography reports that were evaluated in the Department of cardiology, Bir Hospital using transthoracic 2D echocardiography were enrolled in the study. The dimensions of left-sided cardiac structures and the doppler study were measured using standard methods.

Results: A total of 853 patients were enrolled in the study with a mean age of (49.15 $\pm$ 13.19) years; males comprising of 52.3% of the total population. Adults were the maximum followed by the middle-aged population. The various echocardiographic parameters showed statistically significant differences among age-groups and across genders while others did not. Most of the normal reference values are, however, lower in our population as compared to those from other various international guidelines.

Conclusion: The normal reference ranges for various echocardiographic parameters for both males and females and across different age-groups in our population are towards the lower side of what have been learned from other international guidelines for echocardiography.

Keywords: echocardiographic parameters; reference ranges; Nepalese population.

INTRODUCTION

The echocardiographic quantification of cardiac chamber size and function is the most commonly used noninvasive modality to provide real-time images of the beating heart. Left atrium (LA) has a role in maintaining pressure within the heart by secreting natriuretic peptides. In diastole, the left atrium and the left ventricle, as their counterpart on the right side, form a functionally single chamber so that the pressure remains the same within this unit. Its functional analysis reflects the left ventricular diastolic function. The current standard echocardiographic parameters used to study left ventricular diastolic function include pulsed-wave Doppler mitral inflow analysis, tissue Doppler imaging measurements, and LA dimension estimation.[1] Left ventricular (LV) function is a well-known predictor of cardiac morbidity and mortality. The role of echocardiography in regard to the assessment of LV function is well established and the horizon has been expanded over the last few years

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with the development of advanced methodologies.[2] Measurements of left ventricular (LV) cavity dimensions have been essential components of echocardiographic examinations from the initial applications of the technique.[3] LV dimensions in systole and diastole and left atrial dimensions and volumes are the basic components of left ventricular functions. The measurements are taken in 2D-echoes in parasternal and apical views. These measurements indicate whether the corresponding value is within or out of the range and hence help in identifying the diseased state of the heart.[4] The normative echocardiographic values are different for gender and race. Some of the values are different for different age groups. The American Society of Echocardiography has published the reference ranges.[5]

Tissue doppler imaging has found importance in early detection of myocardial dysfunction. It uses Doppler principles to measure the velocity of myocardial motion. It is a useful echocardiographic technique to evaluate global and regional myocardial systolic as well as diastolic function.[6] The recent international guidelines on heart failure with preserved ejection fraction (HFpEF) recommend TDI for the establishment of the diagnosis.[7] One such study was done in National Heart Center, Gangalal by Prajapati D et al in 2012, which involved only the healthy staffs of the same institute. The importance attached to these parameters has prompted attempts to derive the normative values for our population to provide reference data for evaluation of cardiac function and anatomy in clinical practice and research activities.

METHODS

This was a hospital-based prospective observational study. In a population survey to produce a meaningful result, a sample size of 100 at minimum or 10% of the total population not exceeding 1000 is required with greater value in between is preferable.[8] Eight hundred- fifty-three patients above 18 years of age with normal echocardiography reports that were evaluated in the Department of cardiology, Bir Hospital by cardiologists using transthoracic 2D echocardiography having a digital commercial harmonic imaging ultrasound system with phased-array transducer (Philips Affinity 50 and Samsung V8) were enrolled in the study. The study duration was from March 2023 to April 2025.

The left atrial (LA) diameter was measured in diastole in M-mode in parasternal long-axis (PLAX) view. The LA volume was measured in apical four- and two-chamber views using the area-length method with averaged auto-calculation by the machine. The linear internal measurements of the left ventricle and its walls were also taken in PLAX view. Values were carefully obtained perpendicular to the LV long axis and measured at or immediately below the level of the mitral valve leaflet tips using the electronic calipers that were positioned on the interface between the myocardial wall and cavity and the interface between the wall and the pericardium. The proximal ventricle outflow tract (LVOT) was measured in mid-systole 0.5–1 cm below the aortic cusps in a plane parallel to the aortic annulus using the trailing-edge-to-leading-edge method from the zoomed parasternal long-axis view. Distal (LVOT) diameter is measured at the aortic valve annulus level.[9] For measuring the Tissue doppler imaging (TDI), the sample volume was placed in the ventricular myocardium immediately adjacent to the mitral annulus for both septal and lateral loci. The TDI signal over a cardiac cycle has three peaks- a positive systolic peak and two negative diastolic peaks. The positive systolic wave (s' velocity) represents myocardial contraction. The negative waves represent the early diastolic myocardial relaxation (e' velocity) and late diastolic active atrial contraction (a' velocity). Isovolumic contraction and relaxation periods can also be identified from the imaging. Mitral in-flow velocities of blood from LA to LV across the mitral valve were measured using PW doppler in apical four chamber view.

Baseline measurements included measurements of blood pressure, weight in kilograms and height in centimeters. Body surface area (BSA) was calculated from Mosteller formula:

$$\mathrm{BSA} = \sqrt{\mathrm{Weight\ in\ Kg\ x\ Height\ in\ CM}/\ 3600}$$

Left ventricular dimensions in systole and diastole, left atrial dimensions and volumes, mitral inflow velocities, left ventricular tissue-doppler parameters and left ventricular ejection fraction were taken for the study. Ethical clearance was taken from the Institutional Research Board (IRB), National Academy of Medical Sciences, Bir Hospital. Statistical analysis was performed using SPSS version 20. Continuous variables were summarized as the mean ± 1 SD. P-value ≤0.05 was considered statistically significant.

RESULTS

A total of 853 patients were enrolled in the study with maximum number of adults. Males slightly outnumbered females (Table 1). Body surface areas in males were significantly higher (p < 0.001).

Table 1. Demography of patient population.	
Age	
Range	18 – 89 (years)
Mean	(49.15 ± 13.19) years
Age-Groups	
18 - 44 (Adults)	497
45 - 64 (Middle-aged)	308
65 and above (Elderly)	48
Sex	
Male	446 (52.3%)
BSA of male (m^2)	(1.75 ± 1.67)
Female	407 (47.7%)
BSA of female (m^2)	(1.60 ± 1.65)

Gender-wise distribution also showed higher number of both males and females in adults followed by middle-aged group (Figure-1).

LA diameter, LA volume and LA volume index (LAVi- LA volume/ body surface area) for different age-groups and gender were as shown below (Table-2).

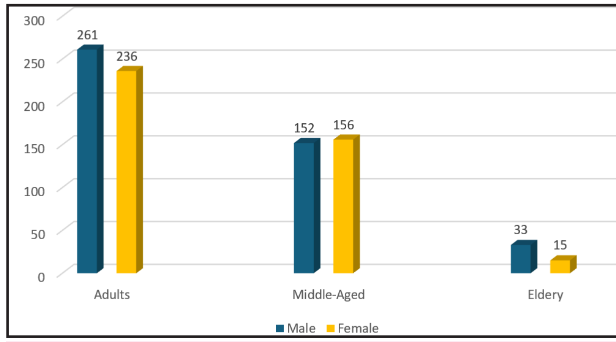

Figure 1. Gender-wise distribution in age-groups.

One-way ANOVA test was done to see whether these parameters relate with age. Among the three age-groups, LA diameter did not show statistically significant difference (p = 0.082). However, the variability in LA volume and LA volume index were statistically significant (p = 0.001 and p < 0.001 respectively).

The variation in these LA parameters was also tested across genders (Table 3). The difference in LA volume index was not statistically significant (p-value =0.081). However, a highly significant difference in LA diameter and LA volume was noticed (p-value <0.001).

The dimensions of left ventricle in both systole and diastole as obtained in M-mode have been tabulated below as per age-groups and genders (Table 3). Two-way ANOVA was used to test the statistical

Table 3. LA Parameters across genders.

Parameters	Male	Female	Total	p-value
LA diameter (cm)	3.12 ± 0.40	3.03 ± 0.42	3.07 ± 0.41	<0.001
LA Volume (ml)	38.84 ± 8.90	36.46 ± 8.00	37.70 ± 8.56	<0.001
LA Volume Index (ml/ m^2)	22.14 ± 4.86	22.71± 4.60	22.41 ± 4.74	0.81

Table 2. Left atrial parameters.

Parameters	Age Groups									p-value
	Adults			Middle-aged			Elderly			
	Male	Female	Total	Male	Female	Total	Male	Female	Total	
LA Diameter (cm)	3.09±0.39	3.01±0.42	3.05±0.41	3.20±0.38	3.01±0.42	3.05±0.41	3.01±0.46	3.01±0.47	3.01±0.46	0.082
LA Volum (ml)e	37.40±8.16	36.08±7.98	36.77±8.09	40.67±9.11	37.48±8.05	39.06±8.72	40.57±9.27	31.82±9.27	37.82±9.27	0.001
LAVi (ml/m^2)	21.11±4.34	22.49±4.48	21.77±4.46	23.35±5.14	23.22±4.82	23.29±4.97	24.67±5.33	20.76±3.24	23.45±5.08	<0.001

Table 4. Left ventricular dimensions in M-mode.

Parameters	Age Groups									p-value
	Adults			Middle-aged			Elderly			
	Male	Female	Total	Male	Female	Total	Male	Female	Total	
IVSd (cm)	0.77±0.09	0.75±0.09	0.76±0.09	0.80±0.08	0.75±0.07	0.77±0.08	0.78±0.07	0.79±0.09	0.78±0.08	0.117
LVIDd (cm)	4.6±0.37	4.3±0.40	4.5±0.40	4.5±0.41	4.3±0.43	4.4±0.43	4.4±0.42	4.2±0.39	4.3±0.42	0.005
PWd (cm)	0.78±0.09	0.74±0.08	0.76±0.08	0.80±0.08	0.76±0.07	0.78±0.08	0.79±0.07	0.78±0.08	0.78±0.07	0.079
IVSs (cm)	1.10±0.11	1.05±0.10	1.08±0.11	1.12±0.10	1.08±0.11	1.10±0.10	1.12±0.10	1.13±0.09	1.12±0.09	<0.001
LVIDs (cm)	2.97±0.35	2.79±0.32	2.89±0.35	2.86±0.42	2.73±0.36	2.79±0.40	2.75±0.33	2.63±0.40	2.71±0.35	<0.001
PWs (cm)	1.13±0.10	1.08±0.10	1.11±0.10	1.15±0.10	1.12±0.08	1.13±0.09	1.16±0.08	1.12±0.07	1.15±0.08	<0.001

Table 5. LV Dimensions in M-mode as per genders.

Parameters (cm)	Male (Mean ± SD)	Female (Mean ± SD)	Total (Mean ± SD)	p-value
IVSd	0.78± 0.09	0.75 ± 0.08	0.77 ± 0.09	<0.001
LVIDd	4.57 ± 0.39	4.34 ± 0.41	4.46 ± 0.42	<0.001
PWd	0.79 ± 0.08	0.75 ± 0.08	0.77±0.08	<0.001
IVSs	1.11 ± 0.10	1.07 ± 0.11	1.09 ± 0.11	<0.001
LVIDs	2.92± 0.38	2.76 ± 0.34	2.84 ±0.37	<0.001
PWs	1.14 ±0.10	1.10 ± 0.09	1.12± 0.10	<0.001

Table 7. LV Parameters across genders.

Parameters (cm)	Male	Female	Total	p-value
LV Length	6.94± 0.76	6.68 ± 0.71	6.82 ± 0.74	<0.001
CSA	17.37± 3.38	16.61± 3.26	17.01± 3.34	0.001
Proximal LVOT	1.97± 0.18	1.82 ± 0.17	1.89 ± 0.19	<0.001
Distal LVOT	1.82 ± 0.19	1.71 ± 0.52	1.77 ± 0.39	<0.001

Table 6. LV parameters as per age-groups and gender.

Parameters (cm)	Age Groups									p-value
	Adults			Middle-aged			Elderly			
	Male	Female	Total	Male	Female	Total	Male	Female	Total	
LV Length	6.95±0.80	6.65±0.73	6.81±0.78	6.90±0.70	6.73±0.69	6.82±0.70	7.00±0.71	6.77±0.52	6.93±0.66	0.551
CSA	17.39±3.45	16.66±3.10	17.04±3.30	17.28±3.32	16.39±2.93	16.83±3.16	17.26±3.14	15.99±2.36	16.87±2.63	0.72
Proximal LVOT	1.97±0.18	1.82±0.18	1.90±0.19	1.96±0.18	1.81±0.17	1.88±0.19	1.91±0.19	1.78±0.18	1.87±0.19	0.26
Distal LVOT	1.84±0.19	1.69±0.18	1.77±0.20	1.81±0.17	1.74±0.81	1.78±0.59	1.74±0.21	1.66±0.22	1.71±0.21	0.584

Table 8. Mitral in-flow velocities.

Parameters	Age Groups									p-value
	Adults			Middle-aged			Elderly			
	Male	Female	Total	Male	Female	Total	Male	Female	Total	
E-Wave Velocity (cm/s)	78.44 ±16.41	82.75 ±15.97	80.47 ±16.32	72.07 ±13.03	75.54 ±15.52	73.83 ±14.43	68.18 ±12.68	67.20 ±12.02	67.87 ±12.36	<0.001
A-wave Velocity (cm/s)	61.64 ±16.05	64.89 ±14.99	63.18 ±15.62	70.30 ±15.41	76.43 ±15.79	73.41 ±15.88	77.88 ±17.97	75.47 ±14.38	77.13 ±16.81	<0.001

Table 9. Mitral in-flow velocities across genders.

Parameters	Male	Female	Total	p-value
E-wave velocity (cm/s)	75.51 ±15.48	79.40 ±16.19	77.36 ±15.93	<0.001
A-Wave velocity (cm/s)	65.80 ± 16.80	69.70 ± 16.26	67.66 ±16.65	<0.001

significance of these parameters. Among age-groups, variation in IVSd and PWd were not statistically significant ($p = 0.117$ and $p = 0.079$ respectively); rest of the parameters had statistically significant difference (Table 4).

All these parameters were statistically significant across genders ($p < 0.001$ for each) (Table 5).

Table 10. Septal TDI parameters of mitral annulus.

Parameters (cm/s)	Age Groups									p-value
	Adults			Middle-aged			Elderly			
	Male	Female	Total	Male	Female	Total	Male	Female	Total	
Septal e-wave	8.90 ±1.94	8.45 ±1.92	8.69 ±1.94	6.96 ±1.21	6.89 ±1.27	7.92 ±1.24	6.43 ±0.88	6.28 ±1.31	6.38 ±1.02	<0.001
Septal a-wave	8.59 ±1.87	8.31 ±1.80	8.46 ±1.84	9.03 ±1.58	8.80 ±1.55	8.91 ±1.57	8.88 ±1.41	8.58 ±1.78	8.78 ±1.52	<0.001
Septal s-wave	8.18 ±1.41	7.75 ±1.36	7.98 ±1.40	7.84 ±1.34	7.44 ±1.11	7.64 ±1.25	7.45 ±1.19	7.10 ±1.25	7.34 ±1.20	<0.001

Table 11. Septal TDI Parameters of mitral annulus as per gender.

Parameters	Male	Female	Total	p-value
Septal e-wave	8.09 ± 2.04	7.85 ± 1.99	8.15 ± 4.12	0.043
Septal a-wave	8.81 ± 1.84	8.52 ± 1.78	8.67 ± 1.82	0.023
Septal s-wave	8.03 ± 1.44	7.62 ± 1.30	7.84 ± 1.39	<0.001

Table 13. Lateral TDI parameters of mitral annulus as per gender.

Parameters	Male	Female	Total	p-value
Lateral e-wave	11.06 ±2.94	10.75 ± 2.84	10.92 ± 2.90	0.119
Lateral a-wave	9.48 ± 2.40	9.39 ± 2.24	9.44 ± 2.32	0.589
Lateral s-wave	9.40 ± 2.11	8.76 ± 1.94	9.10 ± 2.05	<0.001

Table 12. Lateral TDI parameters of mitral annulus.

Parameters (cm/s)	Age Groups									p-value
	Adults			Middle-aged			Elderly			
	Male	Female	Total	Male	Female	Total	Male	Female	Total	
Lateral e-wave	12.18 ±2.95	11.89 ±2.82	12.04 ±2.89	9.64 ±2.06	9.21 ±1.97	9.42 ±2.02	8.82 ±2.08	8.87 ±2.34	8.83 ±2.14	<0.001
Lateral a-wave	9.11 ±2.27	9.02 ±2.23	9.07 ±2.25	10.00 ±2.55	9.91 ±2.10	9.95 ±2.33	10.02 ±2.17	9.86 ±2.77	9.97 ±2.34	<0.001
Lateral s-wave	9.71 ±2.21	9.04 ±2.10	9.39 ±2.19	9.00 ±1.90	8.36 ±1.58	8.68 ±1.77	8.88 ±1.74	8.38 ±2.05	8.72 ±1.83	<0.001

Table 14. Comparison of LA parameters from different studies.

Parameters	Our study		ASE		NORRE Study		JAMP Study	
	Male	Female	Male	Female	Male	Female	Male	Female
LA Diameter in PLAX (cm)	2.72-3.52	2.61-3.45	3.0-4.0	2.7-3.8	3.51±0.41	3.24±0.41	3.2±0.4	3.1±0.3
LA Volume (ml)	38.84±8.90	36.46±8.00			56.70±14.90	48.10 ±12.70	42±14	38±12
LA Volume Index (ml/m^2)	22.14±4.86	22.71± 4.60	27±7.0	27.3±7.9	28.90±7.0	28.3±6.5	24±7	25±8

Table 11. Comparative study of LV dimensions.

Parameters (cm)	Our study		ASE		NORRE Study		JAMP Study	
	Male	Female	Male	Female	Male	Female	Male	Female
IVSd	0.69-0.87	0.67-0.83	0.60-1.00	0.60-0.90	0.92±0.16	0.82±0.15	0.9±0.1	0.8±0.1
LVIDd	4.57±0.39	4.34±0.41	5.02±0.41	4.50±0.36	4.62±0.48	4.30±0.41	4.8±0.4	4.4±0.3
PWd	0.71-0.87	0.67-0.83	0.6-1.0	0.6-0.9	0.93±0.15	0.85±0.15	0.9±0.1	0.8±0.1
IVSs	1.01-1.21	0.96-1.18						
LVIDs	2.92±0.38	2.76±0.34	3.24±0.37	2.82±0.33	3.14±0.46	2.88±0.43	3.0±0.4	2.8±0.3
PWs	1.04-1.24	1.01-1.19						

Table 12. Comparative study of LVOT dimensions.

Parameters	Our study		NORRE Study	
	Male	Female	Male	Female
Proximal LVOT	1.97 ± 0.18	1.82 ± 0.17	2.16±0.23	1.93±0.18
Distal LVOT	1.82 ± 0.19	1.71 ± 0.52	2.23±0.21	2.00±0.17

Table 13. Mitral in-flow velocities as per gender.

Parameters	Our study		KOREAN Study[14]	
	Male	Female	Male	Female
E-wave Velocity	75.51±15.48	79.40±16.19	66.00±14.00	73.00±17.00
A-wave velocity	65.80±16.80	69.70±16.26	59.00±17.00	62.00±17.00

Table 14. TDI parameters of mitral annulus.				
Parameters	Our study		KOREAN Study[14]	
	Male	Female	Male	Female
Septal e'-wave	8.09 ± 2.04	7.85 ± 1.99	9.2±2.6	9.3±3.1
Septal a'-wave	8.81 ± 1.84	8.52 ± 1.78	9.2±1.7	8.5±1.8
Septal s'-wave	8.03 ± 1.44	7.62 ± 1.30	8.1±1.4	7.8±1.3
Lateral e'-wave	11.06± 2.94	10.75 ± 2.84	12.3±3.5	12.6±3.8
Lateral a'-wave	9.48 ±2.40	9.39 ± 2.24	9.4±2.3	9.0±2.2
Lateral s'-wave	9.40 ± 2.11	8.76 ± 1.94	10.2±2.5	9.6±2.3

LV length in diastole, mid-cavity cross-sectional area at papillary muscle level (CSA), proximal LVOT diameter and distal LVOT diameter did not show statistically significant difference across age-groups; (Table 6).

However, the variation across genders was highly significant for all the parameters (Table 7).

Mitral in-flow velocities (E-wave velocity and A-wave velocity) were also assessed. Both these parameters showed statistically significant difference across age-groups (Table 8).

Combined across the age-groups, both of these velocities were higher in females with statistically significant difference (Table 9).

Tissue-doppler study of mitral annulus was assessed across genders and age-groups. Septal e-wave, septal a-wave and septal s-wave were all significantly different across age-groups (Table 10).

The same parameters also showed statistically significant difference across genders (Table 11). All these parameters tended to be higher in males.

Lateral e-wave velocity, lateral a-wave velocity and lateral s-wave velocity all showed statistically significant difference across age-groups ($p < 0.001$) (Table 12).

Among the lateral TDI parameters, only s-wave only s-wave had statistically significant difference across genders ($p < 0.001$) but not the other two parameters ($p = 0.119$ and $p = 0.589$ respectively) (Table 13).

DISCUSSION

Several therapeutic decisions depend on proper assessment of cardiac chamber dimensions and function and normal reference values are important to avoid labelling patients with normal measurements to abnormal category and vice versa.[10] Therefore, normal reference ranges for cardiac chambers and the doppler measurements are essential for every cohort of population.

In our study, out of 853 patients, males were higher in number (52.3%). The mean age of the population was (49.15 ± 13.19) years with the age range of 18 to 89 years. Maximum number of patients were adults (58.26%) followed by middle-aged population. Body surface areas in males were significantly higher ($p < 0.001$). In a similar NORRE study to find out the echocardiographic reference ranges for normal cardiac chamber size, 734 healthy subjects with a mean age of 45.8 ± 13.3 years (range: 20-78) were enrolled; males outnumbered females (56.40%), and women had significantly smaller body surface areas.[9] In another study to find out the normal values of echocardiographic parameters in relation to age in a healthy Japanese population (The JAMP Study), a total of 700 healthy volunteers, aged from 20 to 79 years with 54.71% males were involved; the mean age of the population was 43.5±14.5 years and males had significantly higher body surface area.[11] This study also resembles to our study.

In our study, difference in LA volume index between genders was not statistically significant (p-value =0.081). However, a highly significant difference in LA diameter and LA volume was noticed between genders (p-value <0.001). Among the three age-groups, LA diameter did not show statistically significant difference ($p = 0.082$). However, the variability in LA volume and LA volume index were statistically significant ($p = 0.001$ and $p < 0.001$ respectively).

In the JAMP study, LA diameter in the parasternal long-axis acoustic view and LA volume by area-length method showed significant increase with aging. LA diameter and LA volume were statistically higher in males but not the indexed LA volume.[11] In the NORRE study, LA dimensions and volumes were larger in men than in women; and LA volumes indexed to body surface area were similar between genders. However in this study, LA volume did not correlate with age.[9]

The variation in results about the statistical significance of different parameters of LA in different studies underscores the complexity of LA shape and underappreciation of error incurred with different modalities of measurements. LA diameter, LA volume and LA volume index in our population are lower than in other international studies (Table-14).

In our study, the dimensions of left ventricle in both systole and diastole were statistically significant across genders (p <0.001 for each). However, among age-groups, variation in IVSd and PWd were not statistically significant (p = 0.117 and p = 0.079 respectively); rest of the parameters had statistically significant difference. In the study from North India, the difference in all the systolic and diastolic parameters of LV dimensions, except for the PWd, were statistically significant across age-groups [(18-40) years and (41-60) years] and genders; PWd was significantly different between females in two age-groups but not between males.[12] This finding contradicts to our study only with regard to IVSd. In the NORRE study, all the LV dimensions showed statistically significant difference between males and females but the study remained silent about the difference across age-groups.[9] In another study in young eastern Indian adults, there was no significant difference in absolute echocardiographic parameters between genders.[10] The findings are varied in different studies. On comparing the values of LV dimensions in males and females from our study with those from international studies, most of the values are lower in our population[9,13] (Table 11).

Our study revealed that the LV length in diastole, mid-cavity cross-sectional area at papillary muscle level (CSA), proximal LVOT diameter and distal LVOT diameter all showed statistically significant difference across genders; however, the variation across age-groups was not significant. The proximal and distal LVOT diameter showed statistically significant difference across genders in NORRE study.[9] The values in our population were lower than in NORRE study (Table 12). LV length and mid-cavity cross-sectional area have not been mentioned in standard researches, rather LV volume and LV mass are focused on.

Mitral in-flow velocities (E-wave velocity and A-wave velocity) showed statistically significant difference across both genders and age-groups in our study. Combined across the age-groups, both of these velocities were higher in females. In a Korean study, it was found that mitral E and A velocities were significantly higher in women compared to men.[14] This finding was similar to what was seen in our study (Table-13).

Tissue-doppler study of mitral annulus was assessed across genders and age-groups. Septal e-wave, septal a-wave and septal s-wave were all significantly different across genders and age-groups. All these parameters tended to be higher in males (Table-14). Lateral e-wave, lateral a-wave and lateral s-wave all showed statistically significant difference across age-groups (p < 0.001); however, only lateral s-wave had statistically significant difference across genders (p < 0.001) but not the other two parameters (p = 0.119 and p = 0.589 respectively). This is in partial contradiction to the finding of the above-mentioned Korean study where no significant differences in mitral septal and lateral e' velocities between men and women were observed. However, both septal and lateral s' and a' velocities were significantly higher in men compared to women.

CONCLUSION

Our study provides normative echocardiographic parameters for left sided chambers and the doppler velocities. The study is elaborative in the sense that it incorporates values for age-groups and genders. It shows the variation in parameters with age and across genders. The importance that lies behind indexing a parameter with body surface area has been illustrated. As the data was taken by the cardiologists themselves in advanced echocardiography machines with good resolution, the findings are mostly undebatable.

ACKNOWLEDGEMENTS

I am very grateful to our biostatistician Mr. Siddhartha Dhungana for his untiring help in the statistic part of this article. Rosi Adhikari, Tulasha Bhattarai, Parbati

Kuikel, Sangita Aryal and Baburaja Maharjan all deserve my gratitude for their help in data collection in the peak hours of echocardiography examinations. I am indebted to all the participants who blessed me with this article. I am grateful to my kids, Aashray and Angely, for their help in computor works and bearing me during the write-up of this article.

Limitation: The study involved the individuals visiting the hospital. It is not inclusive of all the ethnic groups. The possibility of subclinical diseases having effect on heart cannot be ruled out in every individual, particularly coronary artery disease, elevated blood pressure etc., which might have effect on the echocardiographic measurements. Inter- and intra-observer variation might have affected the measurements to some extent, if not all.

Conflict of interest: None

Funding: None

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Citation: Poudel SK, Bhatta A, Bista A, Ghimire N, Lamsal S, Maharjan K, Acharya DP, Tiwary A, Dangol B, Ghimire S, Subedi M, Gautam B, Sherpa K, Koirala PC, Mishra DK, Aryal A, Prasain G, Poudel B, Shah P, KC R, Tiwari YP, Khatri Y, Giri Y, Poudel LG. Normative Echocardiographic Reference Values for Left Atrial and Left Ventricular Parameters. JNHLS. 2025; 4(1):16-24.