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Echocardiographic Measurements in Type 2 Diabetes Mellitus: A Case–Control Study in Jazan, Saudi Arabia

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Abstract

Background: Type 2 diabetes mellitus (T2DM) is a major cardiovascular risk factor, yet echocardiographic data from the Jazan region of Saudi Arabia are scarce. ***Methods:*** This retrospective case-control study included Adults 168 patients with T2DM and 160 non-diabetic controls, (age- and gender are matched), who underwent transthoracic echocardiography at two hospitals in Jazan in period from (October 2024 to April 2026). Clinical, demographic, and echocardiographic data were retrieved from electronic medical records. ***Results:*** The results showed The results showed significant differences in echocardiographic measurements in DM and control group (IVSD/S/CM, IVIDS, LVIDS/CM, LVPWD/CM, ESV/ ML, %FS, AOD/ CM, AOR.AREA/CM², MV E/A ratio), P value <0.001, while insignificant differences in EDV/ ML, LV EF%, LAD/ CM among both groups (P value>0.05). insignificant correlation between HA1c and measurements in DM excepts for AOD (aortic diameter) and AOR.AREA/CM², P<0.05 **Conclusion*:*** Significant differences were noticed in myocardial function measurements among DM and control group, supported that the DM causes deterioration of myocardial function. Diabetic patients with abnormal findings exhibited larger IVS thickness and posterior wall thickness, indicating early concentric remodeling, while controls generally unveiled lower values.

Keywords: Type 2 Diabetes Mellitus; Echocardiography; Cardiac Abnormalities; Left Ventricular Hypertrophy; Diabetes Duration.

INTRODUCTION

Diabetes mellitus (DM) is among the most prevalent chronic metabolic disorders, and its incidence has markedly risen globally in recent decades. According to the World Health Organization, Saudi Arabia has the second highest rate of diabetes in the Middle East and the seventh highest rate in the world, with a prevalence of 25.4% in age group ≥ 30 years [1]. Age plays a significant role in the amplified prevalence of DM, reaching 40.2% for the aged ≥45 years (1) and are therefore susceptible to developing diabetes complications. Cardiovascular disease (CVD) is the primary cause of mortality within the diabetic population [2,3,4]. Diabetes is associated with heart alterations, including myocardial thickness and primarily diastolic dysfunction, known as diabetic cardiomyopathy. Numerous studies have reported a high prevalence of diastolic dysfunction among this patient population. [5,6]. patients with type 2 diabetes are also may affected with additional cardiac pathologies that impact prognosis, including left ventricular hypertrophy, reduced left and right ventricular ejection fraction, dilated left atrium, and valvular disorders [7-10].

Echocardiography is a very important tool for diagnosing cardiomyopathy. It is the gold standard to assess the structure and function of the heart [11,12]. It is also a useful tool for making an early diagnosis It is a safe and non-invasive imaging tool. Few studies have examined the impact of DM on echocardiographic measurements; this gap underscores the need for more studies in the region.

The main objective of the present study is to assess impact of DM on myocardial function and to assess the correlation between HbA1c and echocardiographic measurements in DM patients

MATERIALS AND METHODS

Study Design

This is a retrospective study of 168 Type 2 DM and 160 non-diabetic patients at King Fahad Central Hospital and Prince Mohammed bin Nasser Hospital-Jazan (age- and gender-matched). These groups underwent an echocardiographic study. Approval for this study was obtained from the Jazan Health Cluster – Research Ethics Committee (Approval number:2462).

Data Collection Process

The data for this study were obtained through a systematic process of retrieving information from EMRs using a structured data clinical sheet, which included demographic data, clinical history and body mass index, laboratory parameters (HBA1c).

Inclusion Criteria

This study included adult men and women aged between 14 and 90, (168 Type 2 DM and 160 non-diabetic patients) diagnosed based on ADA guidelines, who underwent an echocardiographic study from Oct 2024 to April 2026.

Exclusion Criteria:

1. Patients with Type I Diabetes Mellitus.
2. Patients with diabetic end-stage renal disease
3. Patients with rheumatic, valvular heart disease
4. Patients with pregnancy, UTI, and any other condition causing proteinuria.
5. Patients with congenital heart disease.
6. Patients under age 14. This was documented in the patient's medical records.

Echocardiographic Evaluations

Transthoracic echocardiographic imaging was performed using a PHILIPS EPIQ 5C Ultrasound system (Philips, Amsterdam, The Netherlands),Exams done by cardiologist Patients were positioned supine and turned to the left lateral ,using high frequency Probe Examinations were performed using parasternal long, short-axis (PLAX & PSAX) and apical window (PA2CH, PA4CH (Two and four chambers) views were taken , final diagnosis was made by specialists in echocardiography based on the diagnostic criteria of the American Society of Echocardiography and the European Association of Cardiovascular Imaging.

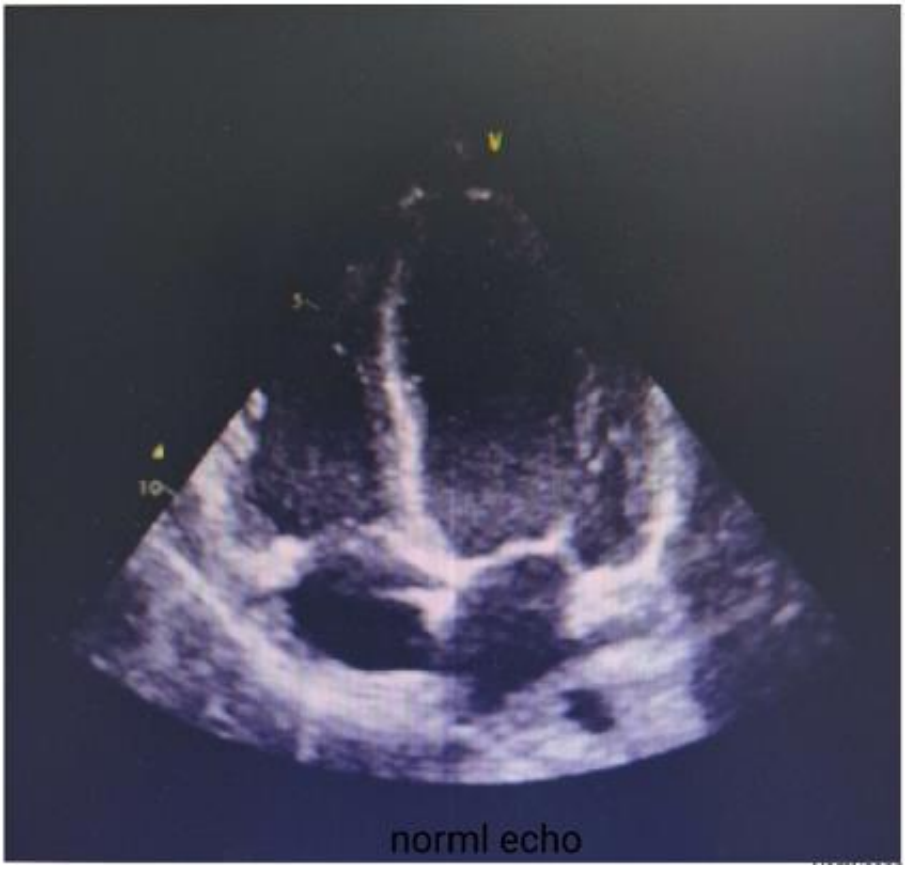

Image 1: Showed Apical 4 Chamber view of 2D echocardiography with normal findings

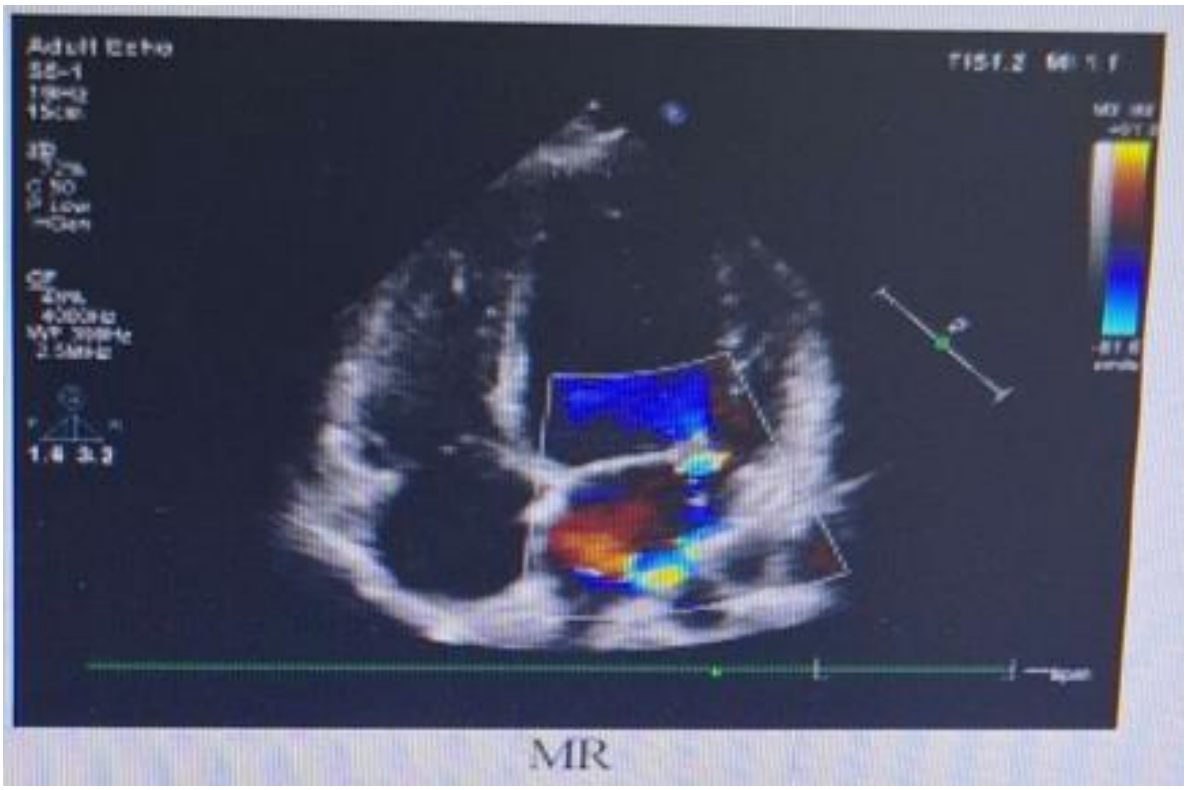

Image 2: Showed MR finding

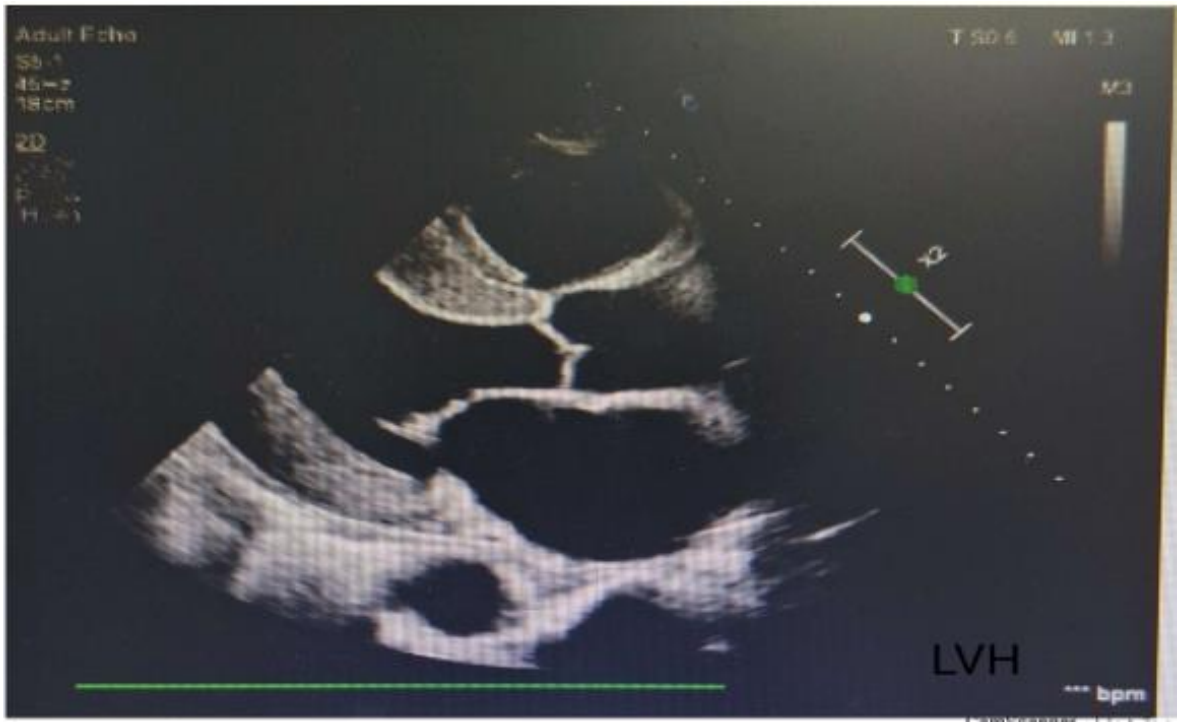

Image 3: Showed LVH finding

Statistical Analysis

An analysis was performed using IBM SPSS Statistics version 27. Descriptive statistics are presented as frequency and percentage. With comparison of echocardiography parameters among both groups were obtained using Man Whitney U test as the Shapiro test confirmed that measurements were abnormally distributed (p value < 0.05, table 2). for comparison and correlation analysis P-value of less than 0.05 was considered significant.

RESULTS

The Results includes demographic characters of both study groups& comparison of cardiac measurements of Type 2 diabetic patients with the normal subjects as following:

Table 1: Demographic characters of DM and control

		Study groups		Total	P value
		DM	Control		
Age group	14-24	12	5	17	0.000
	25-40	26	90	116	
	41-60	81	58	139	
	More than 60	49	7	56	
Gender	Female	75	75	150	0.384
	Male	93	85	178	
Total		168	160	328	

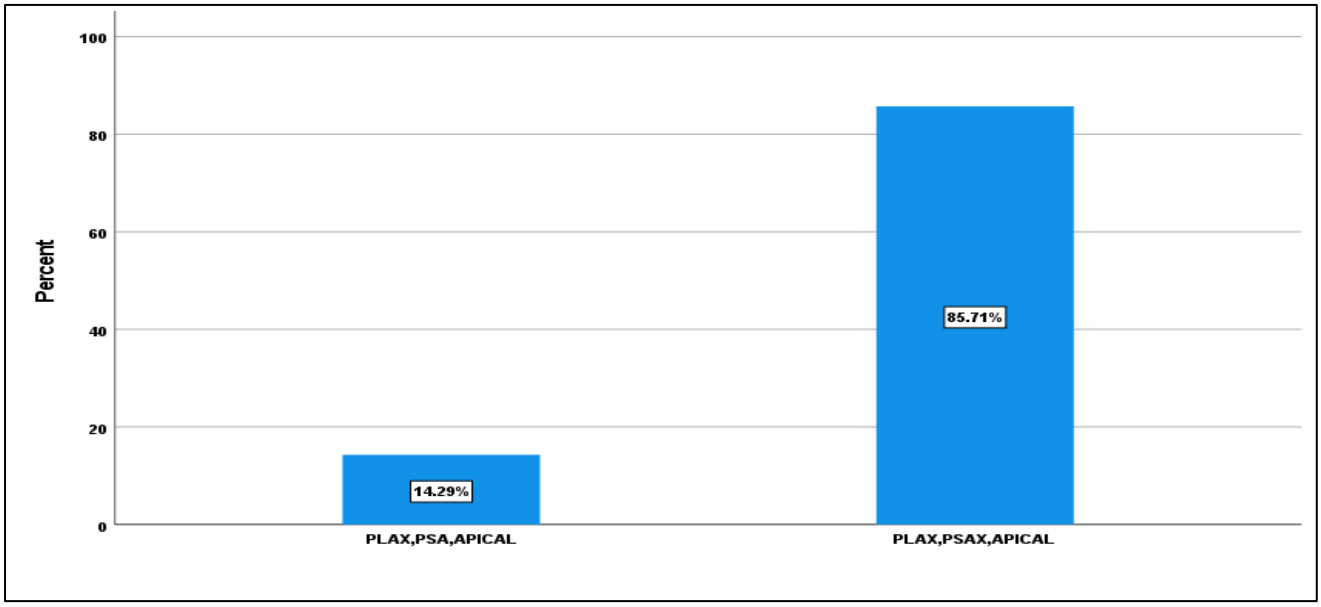

Figure 1: Cardiac views taken

Table 2: a.b correlation HBA1c duration with measurements

a.

		HBA1C	IVSD	IVIDS	LVIDSS	LVIDDS	LVPWD
HBA1C	Correlation	1.00	0.05	-0.06	-0.08	-0.07	0.07
	p		.495	.469	.289	.366	.369

b.

		HBA1C	ESV	EDV	LVEF	FS	AOD	LADD	Area	MV E/A Ratio
HBA1C	Correlation	1.00	0.09	0.05	0.06	-0.04	0.16	0.11	0.17	-0.07
	p		.25	.514	.414	.592	.039	.144	.032	.347

Table 3: Compares mean measurements between DM and Control group

Measurements	**Groups**	**Median**	**95% CI**	**Mean ± SD**	**Mean rank**	**U**	**P value**	**r**
IVSD/S/CM	DM	1.3	1.35 - 1.46	1.4 ±0.38	181.75	10542.0	.001	0.19
	Control	1.2	1.23 - 1.38	1.31 ±0.48	146.39			
IVIDS	DM	1.11	0.79 - 3.78	2.28±9.84	176.83	11369.00	0.016	0.13
	Control	1	10.23 - 20.84	15.54±33.98	151.56			
LVIDS/CM	DM	3.75	3.62 - 4.01	3.81 ±1.28	192.71	8701.50	<.001	0.31
	Control	3.2	2.92 - 3.21	3.06±0.93	134.88			
LVIDD/CM	DM	5	4.66 - 5.54	5.1 ±2.9	181.00	10668.50	.001	0.18
	Control	4.6	4.31 - 4.63	4.47 ± 1.05	147.18			
LVPWD/CM	DM	1.1	0.68 - 2.57	1.63 ± 6.19	184.84	10023.00	<.001	0.22
	Control	1	0.39 - 2.79	1.59 ±7.68	143.14			
"ESV/ ML""	DM	62.25	60.74 - 71.23	65.98 ±34.44	196.81	8012.00	<.001	0.35
	Control	46	43.55 - 46.82	45.19 ±10.5	130.58			
"EDV/ ML"	DM	120.1	115.66 - 130.41	123.04 ±48.4	163.97	13350.50	.917	0.01
	Control	118	116.54 - 123.34	119.94±21.78	165.06			
LV EF%	DM	60.9	55.86 - 59.81	57.84 ±12.97	161.85	12995.00	.605	0.03
	Control	62	60.44 - 62.01	61.23 ± 5.02	167.28			
%FS	DM	30	27.9 - 30.33	29.11 ±7.97	150.79	11137.00	.007	0.15
	Control	31	30.51 - 32.17	31.34 ± 5.3	178.89			
"AOD/ CM"	DM	2.9	2.88 - 3	2.94 ±0.41	115.23	5162.00	<.001	0.53
	Control	3.3	3.31 - 3.4	3.35 ± 0.29	216.24			
"LAD/ CM"	DM	3.8	3.65 - 4.28	3.97 ±2.05	169.26	12640.00	.352	0.05
	Control	3.55	3.61 - 4.51	4.06 ± 2.88	159.50			
AOR.AREA/CM²	DM	6.1	5.85 - 6.36	6.1 ± 1.7	194.80	8349.50	<.001	0.33
	Control	4.9	4.9 - 5.3	5.1 ±1.3	132.68			
MV E/A ratio	DM	1.21	1.13 - 1.34	1.24±0.69	136.94	8810.00	<.001	0.30
	Control	1.23	0.56 - 3.54	2.05±9.55	193.44			

Table 4: Compares mean measurements between DM with abnormalities, DM with normal echoes and Control group

Parameters	Groups	Measurements			P - value
		Mean	Median	95% CI	
IVSD/S/CM	DM normal	1.15	1.2	1.09 - 1.21	<.001
	DM abnormal	1.45	1.4	1.39 - 1.52	
	Control normal	1.3	1.2	1.23 - 1.38	
IVIDS/CM	DM normal	4.97	1	-3.21 - 13.16	<.001
	DM abnormal	1.84	1.18	0.66 - 3.03	
	Control normal	15.45	1	10.17 - 20.72	
LVIDD/CM	DM normal	3.47	3.45	2.82 - 4.12	<.001
	DM abnormal	3.88	4	3.68 - 4.09	
	Control normal	3.05	3.2	2.91 - 3.2	
LVPWD/CM	DM normal	4.95	5	4.58 - 5.32	.037
	DM abnormal	5.12	5	4.61 - 5.64	
	Control normal	4.48	4.6	4.31 - 4.64	
IVIDS	DM normal	0.93	0.94	0.83 - 1.03	.867
	DM abnormal	1.75	1.1	0.64 - 2.86	
	Control normal	1.59	1	0.4 - 2.78	
""ESV/ ML"	DM normal	52.53	46	37.17 - 67.89	<.001
	DM abnormal	68.28	68.2	62.69 - 73.87	
	Control normal	45.28	46	43.64 - 46.92	
""EDV/ ML"	DM normal	120.97	117.45	101.58 - 140.35	.747
	DM abnormal	123.32	122.2	115.2 - 131.44	
	Control normal	120.01	118	116.63 - 123.4	
LV EF%	DM normal	57.68	60.65	52.97 - 62.4	.011
	DM abnormal	57.88	61.9	55.68 - 60.09	
	Control normal	61.19	62	60.4 - 61.97	
%FS	DM normal	30.75	32.15	28.16 - 33.34	.006
	DM abnormal	28.84	30	27.48 - 30.21	
	Control normal	31.32	31	30.5 - 32.15	
"AOD/ CM"	DM normal	3.08	3.15	2.85 - 3.31	<.001
	DM abnormal	2.91	2.9	2.85 - 2.98	
	Control normal	3.35	3.3	3.31 - 3.4	
"LAD/ CM"	DM normal	4.89	4	2.7 - 7.07	.37
	DM abnormal	3.82	3.8	3.71 - 3.93	
	Control normal	4.06	3.5	3.61 - 4.5	
AOR.AREA/CM²	DM normal	5.4	5	4.58 - 6.22	<.001
	DM abnormal	6.22	6.3	5.95 - 6.49	
	Control normal	5.11	4.9	4.91 - 5.31	
MV E/A ratio	DM normal	1.2	1.21	1.13 - 1.28	.555
	DM abnormal	1.24	1.21	1.12 - 1.37	
	Control normal	2.04	1.23	0.56 - 3.52	

DISCUSSION

This study characterises the echocardiographic profile of patients with type2 DM in the Jazan Region and compare Finding with non-diabetic Control group, the results highlight the importance of regular echocardiographic screenings for diabetic patients to detect myocardial dysfunctions. Most of type II DM had structural and functional heart changes, with mitral regurgitation, left ventricular hypertrophy, and tricuspid regurgitation being the most common findings. These findings add to the literature by identifying how diabetes duration and other clinical characteristics affect cardiac health and reinforce the importance of early detection and intervention to reduce the risk of adverse outcomes in this high-risk group.

Diabetes mellitus can have a harmful impact on the myocardium. This impact leads to a deterioration in cardiac diastolic function and muscle contractility due to the damage caused by hyperglycemia (elevated blood sugar levels). Furthermore, studies indicate that Index of myocardial performance (IMP) levels are elevated in patients with type 2 diabetes mellitus. This elevation may serve as an early indicator of diabetic cardiomyopathy in individuals with diabetes [15]. The results showed significant differences in echocardiographic measurements in DM and control group (IVSD/S/CM, IVIDS, LVIDS/CM, LVPWD/CM, ESV/ ML, %FS, AOD/ CM, AOR.AREA/CM^2, MV E/A ratio), This results was similar to Alwan et al who mentioned significant differences in DM and controls group , in IVRT, ET, E, A, E/A, EF%, IMP, LVIDs, PWTd and IVSTd <0.001 and for FS%, while insignificant differences in IVCT and LVIDd [15].

Another study found a notable differences in echocardiographic measurements between a symptomatic DM type II and control group including E/A ratio, LVESD. The two groups revealed significant disparities in EF%'. When comparing DM to control, DM unveiled a markedly lower EF. In DM, the LVESD was significantly larger. In the comparison of the two groups, the LVEDD shows insignificant differences. In DM, the E/A ratio measurement was noticeably higher, [16]. Another study mentioned that altered myocardial metabolism may contribute to LV diastolic dysfunction in patients with well-controlled and uncomplicated DM type 2, with no significant differences were found in LV mass and systolic function between DM and controls. However, E/A ratio, all diastolic function indices, were significantly lower in DM type 2 related to control group [17].

Hassan Ayman et al similar to our study and found insignificant differences between DM and control in EF% in newly diagnosed cases of DM related to control [18].

Another study similar to our results except for FS% found that the echocardiographic measurements (IVST, LVEDD, PWTD, Dd, LAd, and left atrial diameter fraction-shortening values) were higher in type II DM compared to control group (Non diabetic patients) [19]

Our results show insignificant differences between HAIc level and echocardiographic measurements in DM type II patients except for aortic area measurements weak significant correction was noticed (p=0.032)

In our study DM with abnormal echo- finding is associated with increased wall thickness, altered chamber geometry, elevated systolic volumes, and reduced systolic performance, whereas controls consistently demonstrated more satisfactory cardiac structural and functional profiles. Across the three groups (DM normal echocardiography), DM with abnormal echocardiography findings and Control, many of cardiac structural and functional parameters demonstrated significant variation, mainly between diabetic patients and controls. Diabetic patients with abnormal findings consistently showed more interventricular septal thickness and posterior wall thickness, indicating early concentric remodeling, while controls generally unveiled lower values. Systolic and diastolic chamber dimensions varied markedly, with controls showing the highest systolic diameters and the smallest diastolic diameters, whereas DM with abnormal echo demonstrated increased LVIDD and higher end-systolic volumes, reflecting impaired systolic emptying. Although end-diastolic volume insignificantly differs among groups, both ejection fraction and fractional shortening were reduced in diabetic groups compared with controls, supporting subtle systolic dysfunction. Aortic measurements showed significant differences between three groups, with DM with abnormal echo showing a largest aortic area, while control group shows smallest diameter. Insignificant difference was noted in left atrial diameter (LAD)and mitral E/A ratio among DM normal, DM with cardiac abnormalities and control group

This study has several limitations that should be considered. A retrospective study means the design may introduce selection bias that cannot be controlled. Additionally, the records may be incomplete. This adds to the inability to create a cause-and-effect scenario. Also, the study was conducted in only 2 hospitals in the Jazan region; therefore, there are likely limitations on how the rest of the country and/or the rest of the world can generalize these findings. Although some important clinical and demographic variables were factored in, variables such as medication history, lifestyle, comorbidities, and other associated factors were not addressed and will likely affect the results and, therefore, the conclusions drawn from any echocardiographic analysis. Because there is a lack of longitudinal data, there is no way to know how heart abnormalities may change over time, or how their clinical importance may

change. Specialists may have performed the echocardiographic assessments, variances in assessments done by different specialists were not factored in, and this is a critical. Prospective studies that account for many variables and planned studies with follow-up are needed.

CONCLUSION

This study demonstrated significant differences in several echocardiographic parameters between diabetic and non-diabetic individuals indicate that the DM cause alteration in cardiac structural and functional profiles. DM with abnormal echo- finding is associated with increased wall thickness, altered chamber geometry, elevated systolic volumes, and reduced systolic performance, whereas controls consistently demonstrated more reasonable cardiac structural and functional profiles

Overall, these findings emphasize the importance of early cardiovascular evaluation using echocardiography in patients with type 2 diabetes mellitus. Regular screening, along with effective management of modifiable risk factors such as glycemic control and disease duration, is essential to reduce the burden of cardiovascular complications and improve long term outcomes in this high-risk population.

In conclusion, these results underscore the need for regular echocardiographic screening and thorough risk assessment in individuals with T2DM. Future research should focus on prospective, multi center studies that encompass a wider array of clinical factors and longitudinal follow up to enhance the understanding of the course and outcomes of cardiac complications in this high-risk population.

AI declaration:

The authors declare that AI-based tools, including Microsoft Copilot and Ahrefs AI, were used solely for language editing and text refinement. All data collection, statistical analyses, and interpretation of the findings were performed exclusively by the authors.

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