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Prevalence and Glycaemic Indices of Left Ventricular Diastolic Dysfunction in Type 2 Diabetes Mellitus: A Cross-Sectional Study in a Tertiary Care Centre

Revathy. E*, K. Suresh, Sheik Anwar Hussain, Baskaran Sreenivasa

Department of General Medicine, Sri Venkateshwaraa Medical College Hospital and Research Centre, Ariyur, Puducherry

*Corresponding Author: Dr. Revathy. E

E mail ID: drrevathysudhakarreddy@gmail.com

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ABSTRACT

Type 2 Diabetes Mellitus (T2DM) is a progressive metabolic disorder marked by persistent hyperglycaemia, which significantly elevates the risk for various systemic complications, particularly cardiovascular disease. Among these, diabetic cardiomyopathy is a unique condition characterized by ventricular dysfunction in the absence of hypertension or coronary artery disease. Diastolic dysfunction, an early manifestation of diabetic cardiomyopathy, may remain asymptomatic yet poses a serious risk for future heart failure. This study was designed to evaluate the prevalence of left ventricular diastolic dysfunction (LVDD) in patients with T2DM and to explore the relationship between LVDD and glycaemic parameters such as fasting blood glucose, postprandial glucose, and HbA1C levels. A hospital-based cross-sectional study was conducted in a tertiary care centre at Puducherry, over one year (October 2022 to September 2023). A total of 100 normotensive T2DM patients aged over 18 years were enrolled based on ADA diagnostic criteria. Data collection included clinical assessment, laboratory investigations, and tissue Doppler echocardiography. The prevalence of diastolic dysfunction was found to be 91%, with Grade I dysfunction being the most common (41%). A strong positive correlation was observed between glycaemic indices and the severity of LVDD. These findings underscore the importance of early cardiac screening in diabetics and suggest that better glycaemic control could play a role in preventing cardiac dysfunction in this population.

INTRODUCTION

Diabetes mellitus is a chronic metabolic disease characterized by a hyperglycemic state, which may result either from an absolute deficiency of insulin or from the inability of cells to respond to insulin effectively (1)(2)(3). In 2019, the global prevalence of diabetes was estimated at 9.3%, and this figure is projected to rise to 10.2% by 2030—that is, 10 out of every 100 people are expected to be affected by diabetes. The number of individuals living with diabetes, which stood at 463 million in 2019, is projected to reach 700 million by 2045 (4)(5). According to the World Health Organization, the number of people with diabetes is increasing rapidly in low and middle income countries. It is believed that diabetes has already reached epidemic proportions in countries such as India and China (6)(7)(8).

As the incidence of diabetes mellitus rises, so does the number of individuals suffering from its complications. These complications are broadly categorized into microvascular and macrovascular complications. Microvascular complications include retinopathy, neuropathy, and end-stage renal disease, while macrovascular complications encompass stroke, cardiovascular disease, and peripheral vascular disease. Recent studies have also linked diabetes with other complications such as age-related disorders, liver diseases, infections, and cancers (9)(10).

Vascular complications involve pathological changes in the myocardium, arterial walls, central nervous system vasculature (e.g., stroke), and renal glomeruli. These complications are more common in individuals with diabetes, as they can be initiated by even subtle changes in blood glucose and lipid levels. One of the key reasons for this is that vascular cells are constantly exposed to the altered metabolic environment seen in diabetes, including elevated levels of glucose, lipids, and their toxic derivatives (11).

Cardiovascular disease (CVD) is the leading cause of mortality among people with diabetes, with myocardial infarction and heart failure being the most common manifestations (12). Research shows that individuals with diabetes are at twice the risk of developing cardiovascular diseases compared to non-diabetics (13). In addition, diabetes has been associated with a distinct form of cardiomyopathy, termed diabetic cardiomyopathy, which presents as ventricular dysfunction in the absence of other common causes such as hypertension or coronary artery disease (12).

The development of cardiovascular complications in diabetes is not solely due to hyperglycemia. Other factors, including insulin resistance, hypertension, dyslipidemia, systemic inflammation, and thrombosis, play significant roles in the pathogenesis of these conditions (14)(15). Elevated blood sugar, combined with abnormal lipid profiles and the production of toxic metabolites, can cause direct cellular and tissue damage, leading to complications (16).

Diastolic dysfunction refers to the inability of the heart muscles to relax and stretch adequately to accommodate venous return. When diastolic dysfunction occurs in the absence of hypertension or myocardial infarction, it is referred to as diabetic cardiomyopathy (DCM) (17). This condition was first described by Rubler et al. in 1972 through autopsies of four patients who

showed dilated left ventricles without any identifiable cardiac pathology. The hallmark of DCM is cardiac hypertrophy, which may initially be a compensatory response but can eventually progress to heart failure, stroke, or even sudden cardiac death (18).

Diastolic dysfunction can arise due to chamber stiffening or abnormal relaxation, which are consequences of alterations in the extracellular matrix and calcium-handling proteins. Changes in glucose and fatty acid metabolism of the myocardium further contribute to the condition. Morphological changes commonly seen with diastolic dysfunction include myocyte hypertrophy, increased collagen deposition, interstitial fibrosis, and microangiopathy (19). Among all factors, hyperglycemia stands out as the principal initiator, triggering maladaptive responses that lead to collagen deposition and myocardial fibrosis (18).

The present study aims to estimate the prevalence of diastolic dysfunction in individuals with type 2 diabetes mellitus and to examine the correlation between left ventricular diastolic dysfunction and glycaemic parameters in this population. No similar studies have been conducted in this particular setting. By investigating the relationship between glycaemic control and cardiac function, this study seeks to determine whether better management of blood glucose can help prevent the development of left ventricular diastolic dysfunction.

MATERIALS AND METHODS

A cross-sectional comparative study was conducted over one year (Oct 2022–Sep 2023) in the Departments of General Medicine, Cardiology, and Diabetology in a tertiary care hospital at Puducherry. The study included 100 normotensive patients aged 18 years and above, diagnosed with Type 2 Diabetes Mellitus based on ADA criteria. Patients with hypertension, cardiac disease, chronic illnesses, or on cardiotoxic drugs were excluded. Data were collected using a pre-tested semi-structured questionnaire, followed by clinical examination and biochemical tests (FBS, PPBS, HbA1C). All participants underwent tissue Doppler echocardiography to assess parameters related to left ventricular diastolic function. LVDD was diagnosed based on echocardiographic criteria such as E – Peak velocity of early mitral flow, A- Peak velocity of late mitral flow, e‘- early mitral flow, average E/e‘ ratio, LAVI – Left atrial volume index, E/A ratio, IVRT- Isovolumic relaxation time, PHT- Pressure half time, LVID d- Left ventricular diameter in diastole, LVID s- Left ventricular diameter in systole, and EF- Ejection fraction. The diagnosis of Left Ventricular Diastolic Dysfunction was confirmed when there was evidence of reduction in E velocity, increase in A velocity, E/A < 1, average E/e‘ >10 and LAVI >40 ml/m2

STATISTICAL ANALYSIS

Data were analyzed using SPSS version 26. Quantitative variables were summarized using mean and standard deviation; qualitative variables using frequencies and percentages. Chi-square test assessed associations between categorical variables, and ANOVA with post hoc Scheffé test was used for comparing means. A p-value < 0.05 was considered statistically significant. Charts and graphs were used for visual representation.

RESULTS

Distribution of the participants according to age, sex, duration of diabetes mellitus, regularity of treatment, presence of diabetic complications, height, weight, BMI, systolic blood pressure (mmHg), diastolic blood pressure (mmHg), pulse rate (Beats per minute), fasting blood sugar (in mg/dl), post prandial blood sugar (in mg/dl), and HbA1C (%) were given in table 1.

In the current study, 36% of the participants were of age 51 to 60 years followed by 25% of age 61 to 70 years. The mean age among the participants was 53.23 ± 9.45 years. Among which, 56% were males and 44% were females. In the present study, 37% were having diabetes for 6 to 10 years followed by 32% for less than or equal to 5 years. The mean duration of diabetes among the participants was 9.57 ± 6.69 years; 74% reported to be regularly under treatment for diabetes; 30% of diabetic patients had complication (microvascular and macrovascular).

Among the participants, 57% height was between 151 to 160 cms followed by 33% of height more than 160 cms. The mean height among the participants was 158.52 ± 6.12 cms. Among the participants, 28% weighed 61 to 70 kgs and 71 to 80 Kgs, respectively. 21% weighed 51 to 60 kgs. The mean weight among the participants was 67.77 ± 12.29 Kgs.

In the current study, 52% were overweight and 18% were obese. The mean BMI among the participants was 26.68 ± 4.12 Kg/m^2.

In the present study, 39% had systolic blood pressure of 120 mmHg followed by 31% with systolic blood pressure of 110 mmHg. The mean systolic blood pressure was 118.70 ± 8.48 mmHg, 48% had diastolic blood pressure of 80 mmHg followed by 36% with diastolic blood pressure of 70 mmHg. The mean diastolic blood pressure was 73.90 ± 6.80 mmHg. 51% had pulse rate between 80 and 89 beats per minute followed by 27% with pulse rate of 70 to 79 beats per minute. The mean pulse rate among the participants was 79.60 ± 7.53 beats per minute. 100% were normal on systemic examination.

In the present study, 44% had FBS values between 81 to 100 mg/dl followed by 18% with FBS values between 111 to 140 mg/dl. The mean FBS value was 146.76 ± 64.73 mg/dl, 30% had PPBS values between 111 to 170 mg/dl followed by 26% with PPBS values between 171 to 230 mg/dl. The mean PPBS value was 241.71 ± 102.71 mg/dl.

In the present study, 38% had HbA1C values between 6 to 6.9% followed by 16% with HbA1C values between 7 to 7.9%. The mean HbA1C was 7.54 ± 1.81 %.

Table 1: Distribution of participants by Demographic, Clinical, and Biochemical Parameters

Variables	Frequency (n=100)
Age group (in years)	
35-40	15
41-50	24
51-60	36
61-70	25
Sex	

Male	56
Female	44
Duration of diabetes mellitus (in years)	
≤ 5	32
6-10	37
11-15	15
16-20	9
21-25	7
Regularity of treatment	
Regular	74
Irregular	26
Complications	
Present	30
Absent	70
Height (in cms)	
≤ 150	10
151-160	57
>160	33
Weight (in kgs)	
46-50	9
51-60	21

61-70	28
71-80	28
>80	14
BMI	
Normal weight	30
Over weight	52
Obesity	18
Systolic blood pressure (mmHg)	
100	4
110	31
120	39
130	26
Diastolic blood pressure (mmHg)	
60	11
70	39
80	50
Pulse rate (Beats per minute)	
60-69	15
70-79	27
80-89	51
90-99	7

Fasting blood sugar (in mg/dl)	
81-110	44
111-140	18
141-170	9
171-200	7
201-230	13
>230	9
Post prandial blood sugar (in mg/dl)	
111-170	30
171-230	26
231-290	14
291-350	14
351-410	7
411-470	7
>470	2
HbA1C levels (%)	
5-5.9	14
6-6.9	38
7-7.9	16
8-8.9	13
9-9.9	6
≥ 10	13

Distribution of the participants according to MV E, MV A, E/A, average Mitral E/e', values, LAVI, EF, and Diastolic dysfunction were shown in table 2. 45% had MV E value of 61 to 80 vel/msec followed by 28% with MV E values of 81 to 100 vel/msec. 53% had MV A values of 61 to 80 vel/msec followed by 26% with MV A values of 81 to 100 velmsec. The mean MV E value was 72.03 ± 17.06 vel/msec and the mean MV A value was 73.34 ± 16.59 vel/msec.

Among the participants, 65% had E/A values of 0.8 to 1.5 followed by 23% with E/A values of less than 0.8. The mean E/A value were 1.01 ± 0.39. 49% had mitral E/e'of less than 10 and for 40%, it was 10 to 14. The mean mitral E/e'was 11.13 ± 2.98. Among the participants, 40% had LAVI of 35 to 42 followed by 38% with LAVI of 42 to 48. The mean LAVI was 42.09 ± 6.77. 37% had EF of 66 to 70 % and 24% had EF of 60 to 65%. The mean Ejection fraction was 61.46 ± 5.21%. 41% had diastolic dysfunction of grade I followed by 38% with diastolic dysfunction of grade II.

Table 2: Distribution of participants based on key echocardiographic parameters

Variables	Frequency (n=100)
MV E (Vel/msec)	
21-40	2
41-60	21
61-80	45
81-100	28
>100	4
MV A (Vel/msec)	
21-40	2
41-60	13
61-80	53
81-100	26
>100	6
E/A values	
<0.8	23
0.8-1.5	65
>1.5	12
Average Mitral E/e'	
<10	49
10-14	40
>14	11
LAVI	
16-35	10
35-42	40
42-48	38
>48	12
EF	
50-55	23
56-60	16

61-65	24
66-70	37
Diastolic dysfunction	
0	9
I	41
II	38
III	12

DISCUSSION

Diabetes mellitus is a chronic metabolic disorder marked by a hyperglycaemic state, either due to insulin deficiency or cellular resistance to insulin. (2,3) With the global increase in diabetes prevalence, complications such as cardiovascular diseases (CVDs) are also rising. (9,10) CVDs, particularly myocardial infarction and heart failure, are leading causes of mortality among diabetics. (12) In addition to hyperglycaemia, factors like insulin resistance, hypertension, dyslipidaemia, systemic inflammation, and thrombosis contribute significantly to these complications. (14,15) Vascular changes involving the myocardium, CNS vasculature, and kidneys are common. (11) Diabetics are also prone to diabetic cardiomyopathy—a condition characterized by diastolic dysfunction in the absence of hypertension or coronary artery disease. (12,18)

Diastolic dysfunction results from impaired myocardial relaxation or stiffening of the ventricular chamber. (17,19) The current study aimed to estimate the prevalence of diastolic dysfunction in Type 2 Diabetes Mellitus (T2DM) and evaluate its association with glycaemic parameters. Conducted over one year, it found that 91% of participants had diastolic dysfunction, with 41% having Grade I, 38% Grade II, and 12% Grade III.

This finding aligns with Ashaan S et al. (2024), who reported 77% prevalence of diastolic dysfunction (20), and Lumori BAE et al. (2022), who reported 86%.(21) A systematic review by Palanisamy S and Kumaresan S (2024) supported the association of T2DM with LVDD.(22)

Males in the current study had a higher prevalence of LVDD, though literature on sex-specific risk remains limited. A positive association between the duration of diabetes and LVDD was observed, similar to findings by Ashaan S et al., Rajput R et al., and Ashour K et al. (2018). This suggests that prolonged hyperglycaemic exposure leads to myocardial damage over time. (20,23,24)

Systolic and diastolic blood pressures were significantly higher in those with Grade III LVDD. This supports prior findings by Ashaan S et al., Kidawara Y et al., and Sagara R et al., who reported that uncontrolled or non-dipping hypertension increases the risk of LVDD in T2DM. (20,25,26)

The study also found poor treatment adherence and the presence of diabetic complications to be significantly associated with LVDD ($p < 0.05$). Patients with higher fasting and postprandial blood glucose and HbA1C had more severe dysfunction. These results were consistent with those of Ashaan S et al., and Ashour K et al., who emphasized that higher HbA1C levels are linked to worsening diastolic dysfunction. (20,24)

Patients with poor glycaemic control—evidenced by elevated fasting/postprandial glucose and HbA1C—had significantly more severe LVDD. HbA1C levels were highest in Grade III dysfunction, supporting prior findings by Ashour K et al. (24). These results emphasize the role of hyperglycaemia in myocardial remodeling and dysfunction.

This study aimed to assess the prevalence of LVDD in patients with Type 2 Diabetes Mellitus (T2DM) and its association with glycaemic control. Conducted at a tertiary care hospital over one year, the study found a high prevalence of LVDD (91%), with Grade I being the most common (41%). These findings are comparable to those of Ashaan S et al. and Lumori BAE et al., who also reported high rates of diastolic dysfunction in diabetics. (20,21)

Furthermore, both systolic and diastolic blood pressures were significantly higher in advanced LVDD grades. Studies by Kidawara Y et al. and Sagara R et al. support the role of subclinical or nocturnal hypertension in worsening diastolic function. (25,26)

In conclusion, the study reinforces that longer diabetes duration, poor glycaemic control, presence of complications, and elevated blood pressure are key risk factors for diastolic dysfunction in T2DM. Early screening and strict control of blood glucose and blood pressure are essential to prevent progression to diabetic cardiomyopathy.

REFERENCES

- Friedrisch JR, Friedrisch BK. Prophylactic Iron Supplementation in Pregnancy: A Controversial Issue. Biochem Insights. 2017;10:1–8.
- Committee ADAPP. 2. Classification and Diagnosis of Diabetes: Standards of Medical Care in Diabetes—2022. Diabetes Care [Internet]. 2022 Jan 1 [cited 2024 Mar 20];45(Supplement_1):S17–38. Available from: https://dx.doi.org/10.2337/dc22-S002
- Complications D. Diabetes-Related Complications. 2008;88(11).
- Forouhi NG, Wareham NJ. Epidemiology of diabetes. Med (United Kingdom) [Internet].2019;47(1):22–7. Available from: https://doi.org/10.1016/j.mpmed.2018.10.004
- Saeedi P, Petersohn I, Salpea P, Malanda B, Karuranga S, Unwin N, et al. Global and regional diabetes prevalence estimates for 2019 and projections for 2030 and 2045: Results from the International Diabetes Federation Diabetes Atlas, 9th edition. Diabetes Res Clin Pract. 2019 Nov 1;157:107843.
- 9th edition | IDF Diabetes Atlas [Internet]. [cited 2024 Mar 20]. Available from: https://diabetesatlas.org/atlas/ninth-edition/
- The top 10 causes of death [Internet]. [cited 2024 Mar 20]. Available from: https://www.who.int/news-room/fact-sheets/detail/the-top-10-causes-of-death
- Pradeepa R, Mohan V. Epidemiology of type 2 diabetes in India. Indian J Ophthalmol [Internet]. 2021 Nov 1 [cited 2024 Mar 20];69(11):2932–8. Available from:
- https://journals.lww.com/ijo/fulltext/2021/11000/epidemiology_of_type_2_diabe tes_in_india.6.aspx
- Harding JL, Pavkov ME, Magliano DJ, Shaw JE, Gregg EW. Global trends in diabetes complications: a review of current evidence. Diabetologia. 2019;62(1):3–16.
- Tomic D, Shaw JE, Magliano DJ. The burden and risks of emerging complications of diabetes mellitus. Nat Rev Endocrinol. 2022;18(9):525–39.
- Chou E, Suzuma I, Way KJ, Opland D, Clermont AC, Naruse K, et al. Decreased cardiac expression of vascular endothelial growth factor and its receptors in insulin-resistant and diabetic States: a possible explanation for impaired collateral formation in

cardiac tissue. Circulation [Internet]. 2002 Jan 22 [cited 2024 Apr 3];105(3):373–9. Available from: https://pubmed.ncbi.nlm.nih.gov/11804995/
- Heather LC, Gopal K, Srnic N, Ussher JR. Redefining Diabetic Cardiomyopathy: Perturbations in Substrate Metabolism at the Heart of its Pathology. Diabetes [Internet]. 2024 Feb 22 [cited 2024 Apr 4]; Available from: https://dx.doi.org/10.2337/dbi23-0019
- Fox CS, Coady S, Sorlie PD, Levy D, Meigs JB, D'Agostino RB, et al. Trends in Cardiovascular Complications of Diabetes. JAMA [Internet]. 2004 Nov 24 [cited 2024 Apr 4];292(20):2495-9. Available from : https://jamanetwork.com/journals/jama/fullarticle/199831
- Gubitosi-Klug RA. The diabetes control and complications trial/epidemiology of diabetes interventions and complications study at 30 years: summary and future directions. Diabetes Care [Internet]. 2014 Jan [cited 2024 Apr 3];37(1):44–9. Available from: https://pubmed.ncbi.nlm.nih.gov/24356597/
- Holman RR, Paul SK, Bethel MA, Neil HAW, Matthews DR. Long-term follow- up after tight control of blood pressure in type 2 diabetes. N Engl J Med [Internet]. 2008 Oct 9 [cited 2024 Apr 3];359(15):1565–76. Available from: https://pubmed.ncbi.nlm.nih.gov/18784091/
- Baynes JW, Thorpe SR. Role of oxidative stress in diabetic complications: a new perspective on an old paradigm. Diabetes [Internet]. 1999 Jan [cited 2024 Apr 3];48(1):1–9. Available from: https://pubmed.ncbi.nlm.nih.gov/9892215/
- Janssens J V., Raaijmakers AJA, Weeks KL, Bell JR, Mellor KM, Curl CL, et al. The cardiomyocyte origins of diastolic dysfunction: cellular components of myocardial ―stiffness.‖ https://doi.org/101152/ajpheart003342023 [Internet]. 2024 Mar 1 [cited 2024 Apr 4];326(3):H584–98. Available from: https://journals.physiology.org/doi/10.1152/ajpheart.00334.2023
- Parim B, Sathibabu Uddandrao V V., Saravanan G. Diabetic cardiomyopathy: molecular mechanisms, detrimental effects of conventional treatment, and beneficial effects of natural therapy. Heart Fail Rev. 2019;24(2):279–99.
- Ahsan S, Roshan R, Raza N, Alam M. A case-control perspective study on exploring diastolic dysfunction in asymptomatic type 2 diabetes mellitus patients with preserved systolic function, bihar, india. Student's J Heal Res Africa [Internet]. 2024 Mar 23 [cited 2024 Apr 6];5(3):7. Available from: https://www.sjhresearchafrica.org/index.php/public-html/article/view/1048
- Lumori BAE, Nuwagira E, Abeya FC, Araye AA, Masette G, Mondo CK, et al. Association of body mass index with left ventricular diastolic dysfunction among ambulatory individuals with diabetes mellitus in rural Uganda: a cross-sectional study. BMC Cardiovasc Disord [Internet]. 2022;22(1):1–7. Available from: https://doi.org/10.1186/s12872-022-02718-2
- Palanisamy S, Kumaresan S. Systematic Review of Diastolic Dysfunction in Newly Diagnosed Type 2 Diabetes Mellitus. 2024;1568–71.
- Rajput R, Mohan JC, Sawhney JPS, Dalal J, Mullasari A, Vasnawala H, et al. Prevalence of cardiac abnormalities and heart failure in unselected out-patients with type 2 diabetes mellitus and associated clinical factors: Real-world evidence from an Indian registry. Indian Heart J [Internet]. 2023 Nov 1 [cited 2024 Apr 8];75(6):436–42. Available from: https://pubmed.ncbi.nlm.nih.gov/37884126/
- Ashour K. Early Detection of Diastolic Dysfunction in Diabetic Patients (Single Center Cross Sectional Study). J Hear Cardiovasc Res. 2018;02(01):1–6.
- Kidawara Y, Kadoya M, Igeta M, Morimoto A, Miyoshi A, Kakutani-Hatayama M, et al. Nocturnal Hypertension and Left Ventricular Diastolic Dysfunction in Patients With Diabetes With the Absence of Heart Failure: Prospective Cohort HSCAA Study. Hypertens (Dallas, Tex 1979) [Internet]. 2024 Jan 1 [cited 2024 Apr 8];81(1):172–82. Available from: ttps://pubmed.ncbi.nlm.nih.gov/37990873/
- Sagara R, Inoue T, Sonoda N, Yano C, Motoya M, Umakoshi H, et al. Association between cortisol and left ventricular diastolic dysfunction in patients with diabetes mellitus. J Diabetes Investig [Internet]. 2022 Feb 1 [cited 2024 Apr 7];13(2):344–50. Available from: https://pubmed.ncbi.nlm.nih.gov/34465012/