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Proportion of LV Dysfunction in Normotensive Type 2 Diabetes Mellitus Patients

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ABSTRACT

The study investigates the prevalence and correlations of Left Ventricular (LV) Diastolic and Systolic Dysfunction among 52 subjects, examining various demographic and clinical factors. LV Diastolic Dysfunction is prevalent in 53.8% of the subjects, with 48% showing abnormal relaxation and 5.8% displaying a restrictive pattern. LV Systolic Dysfunction is present in 13.5% of the subjects. The study finds no significant gender difference in diastolic dysfunction prevalence, with rates of 53.1% in men and 55% in women (p-value > 0.05). However, diastolic dysfunction is more prevalent among patients from the middle socioeconomic class, which is statistically significant (p-value = 0.006), likely due to lifestyle factors and physical activity levels. Age-wise, LV Diastolic Dysfunction is most prevalent in the 50-60 years and over 70 years age groups, but this correlation is not statistically significant (p-value > 0.05). Similarly, while variations in diastolic dysfunction are observed across different BMI categories, these differences are not statistically significant (p-value > 0.05). In terms of HbA1c levels, 52% of diabetics with elevated HbA1c have LV Diastolic Dysfunction, compared to 100% of those with well-controlled HbA1c, though this association is not statistically significant (p-value > 0.05). Abdominal obesity does not significantly impact the prevalence of LV Diastolic Dysfunction (p-value > 0.05). Conversely, anemia shows a significant association with LV Diastolic Dysfunction; 68% of anemic patients have this condition compared to 40.7% of those with normal hemoglobin levels (p-value < 0.05). The study concludes that while some factors like socioeconomic status and anemia significantly correlate with LV Diastolic Dysfunction, others like BMI, gender, and abdominal obesity do not.

INTRODUCTION

Diabetes mellitus represents a persistent metabolic ailment characterized by heightened blood sugar levels, leading to extensive organ impairment involving the eyes, cardiovascular system, kidneys, nerves, and arteries over time[1]. The two predominant forms of diabetes are Type- I, where there is minimal or no insulin production by the pancreas, and Type- II, where there is insulin resistance[2,3]. The incidence of diabetes mellitus has been steadily increasing over recent decades. Between 2000 and 2016, there was approximately a 5% rise in early death due to diabetes[4]. The International Diabetes Federation discovered that there is a worldwide increase in the occurrence of diabetes mellitus, presenting a significant challenge to the healthcare system[5]. Roughly 537 million adults have diabetes globally, and by 2030, this number is expected to be 643 million, increasing to around 783 million by 2045[5]. Diabetes mellitus accounts for 1-5 million deaths annually worldwide. In India, the incidence of diabetes was 9.0% in 2011, rising to 9.6% in 2021, and is projected to reach 10.4% in 2030[6]. The primary cardiac complications of diabetes mellitus include coronary artery disease and diabetic cardiomyopathy. Subclinical echocardiographic abnormalities may exist for an extended period before these complications develop[7]. Recent research has found that the occurrence of heart failure in diabetic patients is higher even without hypertension and coronary artery disease[8]. Studies have also indicated that diabetic heart failure initially begins as diastolic dysfunction and later progresses to involve systolic function, with the incidence proportional to HBA1c levels[9].

Based on the etiology, diabetes can be categorized into various types, including Type-I diabetes mellitus, Type-2 diabetes mellitus, MODY (Maturity Onset Diabetes of the Young), GDM (Gestational Diabetes Mellitus), Neonatal Diabetes Mellitus, and Secondary Diabetes Mellitus due to endocrinopathies, medications, etc[4,10]. Insulin is secreted by beta cells located in the Islets of Langerhans in the pancreas. In Type-I Diabetes Mellitus, there is destruction of beta cells due to an autoimmune process, resulting in insulin deficiency and diabetes[2]. Polymorphisms in the MHC and HLA complex have been associated with Type-I DM. The onset of Type-I DM typically peaks around 4-6 years of age and again around 10-14 years of age, with approximately 45% of cases presenting before the age of 10[6]. In Type-II Diabetes mellitus, there is an imbalance in insulin secretion and resistance to insulin's effects[11]. The resistance to insulin's action is multifactorial. Lifestyle factors, genetic factors (familial), obesity, and aging play significant roles in the onset of Type-2 DM. Type-2 DM typically manifests later in life, although obese adolescents are at higher risk of developing Type-2 DM as they age[12]. The likelihood of developing Type-2 DM in a monozygotic twin of an affected twin is 90%[13]. Genomic studies have found that genetic loss of the TCF7L2 (Transcription Factor 7-Like 2) gene increases the risk of Type-2 DM. Other loci studied include NFS1, JAZF1, KCNQ1, and NOTCH-2[14]. MODY is a non-insulin-dependent diabetes typically diagnosed in individuals under 25 years of age, characterized by an autosomal dominant transmission with mutations in the HNF1A (Hepatocyte Nuclear Factor 1 Alpha) and Glucokinase genes. MODY is often misdiagnosed as Type-I or Type-2 DM[15]. Confirmation of MODY requires genetic testing for these specific mutations. Gestational diabetes mellitus is identified in 2-3% of pregnant women[16]. It arises due to the effect of anti-insulin hormones (prolactin, estrogen, progesterone, cortisol, and human placental lactogen) that circulate during pregnancy, reducing peripheral sensitivity to insulin and resulting in diabetes[16].

According to the American Diabetes Association, diabetes is diagnosed if any of the following criteria are met: Symptoms of diabetes (polyuria, polydipsia, polyphagia) or a hyperglycemic crisis plus a random blood sugar (RBS) of 200 mg/dl or higher. HbA1c level of 6.5% or higher. Fasting plasma glucose of 126 mg/dl or more two-hour plasma glucose of 200 mg/dl or more during a 75 gm oral glucose tolerance test (OGTT)[17].

The macrovascular Complications observed are Coronary Artery Disease, Stroke or Transient Ischemic Attacks and Peripheral Vascular Disease. These conditions primarily affect the peripheral arteries, cerebral arteries, and coronary arteries. Early stages of the disease are associated with the formation of atherosclerotic plaques, while in advanced stages, there is complete occlusion of the vessels, leading to ischemia, infarction, or gangrene of the respective organs[18].

The recent studies using MR spectroscopy have discovered that diabetic patients have elevated myocardial lipid content, independent of serum triglyceride levels. This contributes to myocardial fibrosis and diastolic dysfunction. Histopathological examination of myocardial biopsy specimens in diabetic cardiomyopathy revealed interstitial and perivascular fibrosis. This fibrosis may be responsible for the diastolic dysfunction observed in diabetics[19].

Interestingly, even normotensive patients with T2DM—those who do not exhibit elevated blood pressure—are at an increased risk for developing LV dysfunction. This phenomenon underscores the importance of recognizing cardiovascular risks in T2DM patients irrespective of their blood pressure status. Understanding the proportion of LV dysfunction in normotensive T2DM patients is crucial for early detection, effective management, and prevention of adverse cardiovascular outcomes[20]. The aim of this study is to explore the proportion of LV dysfunction in normotensive T2DM patients, examine the underlying mechanisms, diagnostic approaches, and clinical implications, and highlight the importance of comprehensive cardiovascular assessment in this population. By doing so, we aim to provide insights that can inform clinical practice and improve patient care.

MATERIALS AND METHODS

The study was designed as an interventional prospective study, focusing on proportion of left ventricular dysfunction in normotensive Type 2 Diabetes Mellitus patients to identify effective strategies for improving patient outcomes.

The study was conducted over a period of two years, from May 2018 to April 2021, involving 50 patients visiting to the Tertiary care Centre, Government Medical College, Thiruvananthapuram., Kerala University located Thiruvananthapuram, Kerala.

Study population

The study was conducted on a Normotensive type 2 diabetic patients attending medicine OP or admitted in medical wards in government medical college, Thiruvananthapuram. The ethical approval has been obtained from Institutional Human Ethics Committee..

The patients for the study were selected with the inclusion criteria: All normotensive adult patients with Type 2 Diabetes Mellitus on or off treatment. The exclusion criteria: Patients on antiplatelet and antithrombotics, Patients with previous cardiac ailments, Patients with cardiac failure, Patients with CKDdy Population.

DATA ANALYSIS

Data for the study was entered into MS Excel and analyzed using SPSS Software version 20. The findings were presented in various formats including tables, bar diagrams, and pie charts to illustrate the distributions and relationships clearly. Categorical variables were expressed as proportions and quantitative variables as mean and standard deviation Statistical test of significance - Chi-Square test for categorical variables and students t-test for quantitative variables. $p<0.05$ will be considered as statistically significant. Outcome measures were quantified using to assess the risk associated with of LV dysfunction in normotensive type 2 diabetes mellitus patients.

RESULTS

Table:1: Distribution of age

Among the study population of 52 subjects, the majority fall within the age group of 50 to 70 years, with a mean age of 59.9 years and a standard deviation of 10.9 years. Gender distribution shows that 62% of the subjects are male and 38% are female. In terms of Body Mass Index (BMI), only 42% of the subjects have a normal BMI, 1.9% are underweight, and 52% are overweight or obese. The waist-hip ratio (WHR) indicates that 59.6% of the subjects (31 out of 52) have abdominal obesity, defined as a WHR greater than 0.90 in males and greater than 0.85 in females. Additionally, anemia is more prevalent among females than males, with 48% of the total subjects affected by anemia.

Distribution of HbA1c levels among diabetics: The distribution of HbA1c levels among 52 diabetic subjects. It reveals that the vast majority, 96.2% (50 out of 52 subjects), have elevated HbA1c levels, indicating poor diabetic control with HbA1c values exceeding 7.0%. Only 3.8% (2 subjects) have well-controlled HbA1c levels. The mean HbA1c value for the study population is 9.1%, with a standard deviation of 1.85. This data highlights a significant prevalence of inadequate glycemic control among the subjects, suggesting a critical need for improved diabetes management strategies within this group.

In our study, 60% of subjects had lower levels of HDL in their blood, with a mean value of 41.04 mg/dl and a standard deviation of 10.5. Regarding serum cholesterol levels, 15% of the subjects had total cholesterol levels exceeding 220 mg/dl, with a mean cholesterol level of 194 mg/dl and a standard deviation of 28. Additionally, 58% of the patients had elevated triglyceride levels, with a mean value of 154.12 mg/dl and a standard deviation of 30.11. LDL levels were elevated (≥120 mg/dl) in about 50% of subjects, with a mean level of 123 mg/dl and a standard deviation of 27. This data underscores the prevalence of dyslipidemia among the study population, indicating a need for targeted lipid management strategies.

Table 1: Distribution of LV Diastolic and Systolic dysfunction

LV Diastolic Dysfunction	Frequency	Percentage (%)
No diastolic dysfunction	24	46.2
Abnormal relaxation	25	48
Restrictive pattern	3	5.8
Total	52	100
LV Systolic Dysfunction		
Severe	1	1.9
Borderline	1	1.9
Moderate	1	1.9
Mild	4	7.7
Normal	45	86.5
Total	52	100

The table 1 reveals that Left Ventricular (LV) Diastolic Dysfunction is prevalent in 53.8% of the subjects, with 48% showing abnormal relaxation and 5.8% displaying a restrictive pattern. Additionally, LV Systolic Dysfunction is present in 13.5% of the subjects, equating to 7 out of 52 individuals. These findings indicate a significant occurrence of both diastolic and systolic dysfunctions in the study population, highlighting the importance of monitoring and managing cardiac function comprehensively in patients. The high prevalence of diastolic dysfunction, particularly abnormal relaxation, suggests a need for targeted interventions to address these specific cardiac issues.

Table 2: Correlation between LV diastolic dysfunction and gender

Sex	LV Diastolic Dysfunction				Total		χ^2	df	p
	Yes		No						
	N	%	N	%	N	%			
Male	17	53.1	15	46.9	32	100	0.017	1	0.895
Female	11	55	9	45	20	100			
Total	28	53.8	24	46.2	52	100			

The data 2 indicates that LV Diastolic Dysfunction is present in 53.1% of diabetic men and 55% of diabetic women, with no significant association between gender and the prevalence of diastolic dysfunction, as evidenced by a chi-square value of 0.017, a p-value of 0.89, and a degree of freedom of 1. Additionally, diastolic dysfunction is more prevalent among patients from the middle socioeconomic class, which is statistically significant (p-value = 0.006). This higher prevalence may be attributed to lifestyle factors and levels of physical activity typical of this socioeconomic group. These findings suggest that while gender does not significantly influence the occurrence of diastolic dysfunction in diabetic patients, socioeconomic factors and related lifestyle choices play a critical role.

Table 3: Correlation between LV diastolic dysfunction and age

Age in years	LV Diastolic Dysfunction				Total		χ^2	df	p
	Yes		No						
	N	%	N	%	N	%			
≤50	6	60	4	40	10	100			
51 - 60	11	64.7	6	35.3	17	100			
61 - 70	6	35.3	11	64.7	17	100			
>70	5	62.5	3	37.5	8	100	3.555	3	0.314
Total	28	53.8	24	46.2	52	100			

The table 3 illustrates the correlation between age and the prevalence of Left Ventricular (LV) Diastolic Dysfunction among 52 subjects. The data shows that LV Diastolic Dysfunction is more prevalent in the age groups 50-60 years and over 70 years, with prevalence rates of 64.7% and 62.5%, respectively. In contrast, the prevalence is lower in the 61-70 years age group at 35.3% and in those under 50 years at 60%. Despite these variations, the chi-square value of 3.555 and a p-value of 0.314 with 3 degrees of freedom indicate that the association between age and LV Diastolic Dysfunction is not statistically significant (p-value > 0.05). This suggests that while there appear to be differences in prevalence across age groups, these differences are not significant enough to establish a strong correlation between age and the presence of LV Diastolic Dysfunction in this study population.

Table 4: Correlation between LV diastolic dysfunction and BMI

BMI	LV Diastolic Dysfunction				Total		χ^2	df	p
	Yes		No						
	N	%	N	%	N	%			
Under weight	0	0	1	100	1	100			
Normal	15	62.5	9	37.5	24	100			
Over weight	9	45	11	55	20	100			
Obese	4	57.1	3	42.9	7	100	2.550	3	0.466
Total	28	53.8	24	46.2	52	100			

The table 4 presents the correlation between Body Mass Index (BMI) and the prevalence of Left Ventricular (LV) Diastolic Dysfunction among 52 subjects. The data indicates that 57.1% of obese diabetics and 45% of overweight diabetics have LV Diastolic Dysfunction. Additionally, 62.5% of diabetics with a normal BMI also have LV Diastolic Dysfunction, whereas none of the underweight subjects show this condition. Despite these observations, the chi-square value of 2.550 and a p-value of 0.466 with 3 degrees of freedom indicate no significant association between BMI and LV Diastolic Dysfunction (p-value > 0.05). This lack of statistical significance suggests that the variations in LV Diastolic Dysfunction across different BMI categories may be due to other factors, such as potential false values caused by weight loss in uncontrolled diabetes, rather than BMI itself.

Table 5: Correlation between LV diastolic dysfunction and HbA1c

HbA1C	LV Diastolic Dysfunction				Total		χ^2	df	p
	Yes		No						
	N	%	N	%	N	%			
Elevated	26	52	24	48	50	100	1.783	1	0.182
Well controlled	2	100	0	0	2	100			
Total	28	53.8	24	46.2	52	100			

The table 5 shows the correlation between Left Ventricular (LV) Diastolic Dysfunction and HbA1c levels among 52 diabetic subjects. It indicates that 52% of diabetics with elevated HbA1c levels (26 out of 50 subjects) have LV Diastolic Dysfunction, while 100% of diabetics with well-controlled HbA1c levels (2 out of 2 subjects) exhibit this condition. Despite these differences, the chi-square value of 1.783 and a p-value of 0.182 with 1 degree of freedom indicate no significant association between HbA1c levels and LV Diastolic Dysfunction (p-value > 0.05). This lack of statistical significance may be attributed to the small number of subjects with well-controlled HbA1c levels, which limits the reliability of this finding.

Table 6: Correlation between LV diastolic dysfunction and Abdominal obesity

Abdominal obesity	LV Diastolic Dysfunction				Total		χ^2	df	p
	Yes		No						
	N	%	N	%	N	%			
Present	15	45.5	18	54.5	33	100	2.559	1	0.110
Absent	13	68.4	6	31.6	19	100			
Total	28	53.8	24	46.2	52	100			

The table 6 illustrates the correlation between Left Ventricular (LV) Diastolic Dysfunction and abdominal obesity among 52 subjects. The data shows that 45.5% of patients with abdominal obesity (15 out of 33) have LV Diastolic Dysfunction, while 68.4% of patients without abdominal obesity (13 out of 19) exhibit this condition. Despite these observed differences, the chi-square value of 2.559 and a p-value of 0.110 with 1 degree of freedom indicate no statistically significant association between abdominal obesity and LV Diastolic Dysfunction (p-value > 0.05). This suggests that abdominal obesity does not have a significant impact on the prevalence of LV Diastolic Dysfunction in this study population.

Table 7: Correlation between LV systolic dysfunction and Anemia

Anemia	LV Diastolic Dysfunction				Total		χ^2	df	p
	Yes		No						
	N	%	N	%	N	%			
Yes	17	68	8	32	25	100	3.881	1	0.049
No	11	40.7	16	59.3	27	100			
Total	28	53.8	24	46.2	52	100			

The table 7 shows the correlation between Left Ventricular (LV) Diastolic Dysfunction and anemia among 52 subjects. The data indicates that 68% of anemic patients (17 out of 25) have LV Diastolic Dysfunction, compared to only 40.7% of patients .

with normal hemoglobin levels (11 out of 27). This difference is statistically significant, as evidenced by a chi-square value of 3.881 and a p-value of 0.049 with 1 degree of freedom (p-value < 0.05). This suggests a significant association between anemia and the prevalence of LV Diastolic Dysfunction, implying that anemic patients are more likely to experience diastolic dysfunction than those with normal hemoglobin levels.

Table 8: Correlation between LV systolic dysfunction and BMI

BMI	LV Systolic Dysfunction				Total		χ^2	df	p
	Yes		No						
	N	%	N	%	N	%			
Under weight	0	0	1	100	1	100	0.219	3	0.974
Normal	3	12.5	21	87.5	24	100			
Over weight	3	15	17	85	20	100			
Obese	1	14.3	6	85.7	7	100			
Total	7	13.5	45	86.5	52	100			

The table 8 presents the correlation between Left Ventricular (LV) Systolic Dysfunction and Body Mass Index (BMI) among 52 subjects. The data shows that 12.5% of subjects with normal BMI, 15% of overweight subjects, and 14.3% of obese subjects have LV Systolic Dysfunction. None of the underweight subjects exhibit LV Systolic Dysfunction. Despite these percentages, the chi-square value of 0.219 and a p-value of 0.974 with 3 degrees of freedom indicate no significant association between BMI and LV Systolic Dysfunction (p-value > 0.05). This suggests that the prevalence of LV Systolic Dysfunction is not significantly influenced by BMI categories in this study population.

Table 9: Correlation between LV systolic dysfunction and HbA1c

HbA1C	LV Systolic Dysfunction				Total		χ^2	df	p
	Yes		No						
	N	%	N	%	N	%			
Elevated	7	14	43	86	50	100	0.324	1	0.569
Well controlled	0	0	2	100	2	100			
Total	7	13.5	45	86.5	52	100			

The table 9 illustrates the correlation between Left Ventricular (LV) Systolic Dysfunction and HbA1c levels among 52 subjects. It shows that 14% of patients with elevated HbA1c (7 out of 50) had LV Systolic Dysfunction, whereas none of the patients with well-controlled HbA1c (0 out of 2) exhibited this condition. Despite this observation, the chi-square value of 0.324 and a p-value of 0.569 with 1 degree of freedom indicate no statistically significant association between HbA1c levels and LV Systolic Dysfunction (p-value > 0.05). This suggests that the occurrence of LV Systolic Dysfunction is not significantly influenced by whether a patient's HbA1c is elevated or well-controlled within this study population.

Table 10: Correlation between LV systolic dysfunction and Abdominal obesity

Abdominal obesity	LV Systolic Dysfunction				Total		χ^2	df	p
	Yes		No						
	N	%	N	%	N	%			
Abnormal	2	14.3	12	85.7	14	100	0.011	1	0.916
Normal	5	13.2	33	86.8	38	100			
Total	7	13.5	45	86.5	52	100			

The table 10 shows the correlation between Left Ventricular (LV) Systolic Dysfunction and abdominal obesity among 52 subjects. The data indicates that 14.3% of subjects with abnormal abdominal obesity (2 out of 14) have LV Systolic Dysfunction, compared to 13.2% of subjects with normal abdominal obesity (5 out of 38). Despite these figures, the chi-square value of 0.011 and a p-value of 0.916 with 1 degree of freedom indicate no significant association between abdominal obesity and LV Systolic Dysfunction (p-value > 0.05). This suggests that abdominal obesity does not significantly impact the prevalence of LV Systolic Dysfunction in this study population.

DISCUSSION

This investigation aimed to identify the prevalence of left ventricular (LV) dysfunction among diabetic individuals. It is a hospital-based cross-sectional analysis performed among patients admitted to medical wards in the General Medicine department at Government Medical College, Thiruvananthapuram.

In this research, a total of 52 participants with type-2 diabetes mellitus (T2DM) were enrolled. All participants were normotensive, with no symptoms or history of previous cardiac or respiratory conditions. Among these participants, 32 were male (61.5%) and 20 were female (38.5%). In the study conducted by Sotonye T Dodiyi-Manuel et al., the mean age of patients was 50-76 ± 9.13 years[21]. In our study, the mean age is 59.96 ± 10.48 years, with the majority of patients falling within the 50-70 years age range. A majority (63.5%) of the patients belong to a lower socioeconomic status.

The mean BMI observed by Sotonye T Dodiyi-Manuel et al. was 26.88 ± 4.73 kg/m²[21]. In our study, the mean BMI is 25.08 ± 3.83 kg/m², with approximately 52% of patients having a BMI above normal (overweight and obese). The waist circumference and waist-hip ratio in the study by Ataklti Gebertsadik Woldegebriel et al. were 82.9 cm and 0.84, respectively[22]. In our study, these values were 90.5 cm and 0.93 ± 0.11, respectively. The waist-hip ratio exceeds the recommended cutoff in 63.5% of subjects. In our study, 60% of diabetic females and 70% of diabetic males had abdominal obesity. The mean fasting blood sugar (FBS) among subjects in this study is 186.8 ± 54.6 mg/dl. The mean hemoglobin was found to be 12.23 ± 1.47 g/dl, compared to 11.68 ± 0.81 g/dl in the study by Barbieri J et al[23]. In this study, the serum triglyceride level is elevated in 57.7% of diabetic patients, with a mean of 154.12 ± 30.11 mg/dl, which is slightly lower than in the study by Khandelia R et al., where approximately 80% of diabetic patients showed elevated triglyceride levels. This indicates that dyslipidemia is more prevalent among diabetics. For the study by Khandelia R et al., LDL was elevated in 48% of patients, similar to our study, where 50% of patients had elevated LDL levels[24]. This elevated LDL level contributes to accelerated atherosclerosis in diabetic patients. In our study, almost 96% of the patients had HbA1c levels greater than 7.0%, indicating poor diabetes control. Additionally, 67.3% had HbA1c values over 8.0%, and around 26.9% had HbA1c levels exceeding 10.0%. In this study, the prevalence of left ventricular diastolic dysfunction was found to be 53.4%, closely matching the study by Dodiyi-Manuel ST et al., where 65.6% had impaired diastolic function[25]. There was no significant relationship between gender and cardiac failure in this study. Similarly, no significant association was found between age and diastolic dysfunction, possibly due to the smaller sample size.

Most patients with diastolic dysfunction (78.9%) in our study belonged to the middle socioeconomic class, likely influenced by dietary habits and lifestyle factors (P=0.006). This suggests that lifestyle modifications may improve patients' health conditions. No significant association was found between BMI and diastolic dysfunction, potentially due to uncontrolled diabetes leading to a catabolic state, which might falsely influence results. Only 30% of diabetic patients with LV dysfunction in our study had elevated triglyceride levels, with no significant association between them, in contrast to the study by Khandelia R et al., where 60% of patients had elevated triglycerides[24]. This discrepancy may be due to many patients already being on statin therapy for dyslipidemia. Abdominal obesity showed no significant association with diastolic dysfunction in our study. Around 63.5% of subjects met the criteria for metabolic syndrome, slightly higher than the 58% in the study by Nsiah K et al[26].

In this study, anemia was significantly associated with LV diastolic dysfunction (P<0.05), indicating that anemia significantly affects cardiac function. The prevalence of LV systolic dysfunction in our study was 13.5%, similar to the 15.56% reported in the study by Sotonye T Dodiyi-Manuel et al[25].

CONCLUSION

This study reveals a significant prevalence of left ventricular (LV) dysfunction among normotensive type 2 diabetes mellitus (T2DM) patients, underscoring the need for comprehensive cardiovascular assessment in this population. Despite the absence of hypertension, 53.4% of the patients exhibited diastolic dysfunction, with poor glycemic control, dyslipidemia, and anemia being notable contributing factors. The findings highlight that routine cardiovascular screening and proactive management, including lifestyle modifications and targeted treatments, are essential to mitigate cardiovascular risks and improve outcomes in normotensive T2DM patients. Further research with larger cohorts is warranted to confirm these results and develop effective prevention strategies.

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