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Study of Association between diabetes mellitus and left ventricular hypertrophy in a tertiary care hospital of Kanpur

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Abstract-

Introduction- Diabetes mellitus (DM) is a metabolic disease hallmarked by raised blood glucose concentration and because of its consequences, it has high morbidity rate. The studies indicate that individuals with type 2 diabetes mellitus (T2DM) frequently have left ventricular hypertrophy (LVH). Therefore, this study was planned to assess the prevalence and determinants of LVH in T2DM in order to delay or avoid the onset of cardiac complications and to give a carefully focused intervention aimed at lowering morbidity and mortality in patients with T2DM.

Material and method- The present study was a cross-sectional study done on T2DM patients with age from 30 to 60 years. The data were recorded, including vital signs, age, sex, fasting plasma glucose (FPG), glycosylated hemoglobin (HbA1C), body mass index (BMI), and duration of DM. A respiratory and systemic examination was performed. The diabetics were examined radiographically using plane chest x-rays and electrocardiograms (ECGs). By using pulsed doppler echocardiography, LVH was assessed. A pre-structured proforma was used to record all of the data, and SPSS-16 was used for analysis. The "p value was considered statistically significant if it was less than 0.05."

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Result- The current study showed mean age of 50.08±6.32years and had male preponderance. Half of the cases had albuminuria, and 49.66% of T2DM patients had LVH. Gender was significantly associated with both LVH and albuminuria. There was no correlation between gender and the severity of LVH. Even at the time of diagnosis, a high incidence of LVH was noted in normotensive and asymptomatic T2DM, and this result was positively correlated with albuminuria, age, sex, FPG, HbA1C, and duration of DM. There was no significant correlation between LVH and BMI.

Conclusion- In current research, LVH was more common in T2DM. Every patient had mild LVH. Our findings suggest T2DM patients to have good glycaemic control and further highlight the significance of screening for subclinical LVH in all T2DM patients, even to diabetics who do not have any history of hypertension or cardiac disease and particularly those who are older.

Keywords- LVH, T2DM, CVD, diabetes, etc.

Introduction-

Diabetes mellitus (DM) is a metabolic disease hallmarked by raised blood glucose concentration due to insulin insufficiency, reduced insulin action due to insulin resistance, or a combination of these all.[1] Numerous studies have shown that type 2 diabetes mellitus (T2DM) is a known risk factor for cardiovascular disease (CVD).[2] Even in the absence of atherosclerotic disease, diabetes can alter the structure and function of the heart.[3] Left ventricular hypertrophy (LVH) is one of the most prevalent ways that CVD manifests in DM patients. DM patients frequently have LVH, which is a strong predictor of CVD and an independent risk factor for heart failure, myocardial ischemia, cardiac arrhythmia, and sudden death.[4] A continuously elevated strain on the heart results in an unnatural increase in the mass of the left ventricular myocardium, or LVH. This usually happens when the heart pumps against a high afterload, like in aortic stenosis and hypertension. Another significant factor is diastolic overload, or increased left ventricular filling, which is the fundamental mechanism for LVH in patients with dilated cardiomyopathy and aortic or mitral regurgitation.[5] Myocardial fibrosis is a major factor in the development of LVH, impairing heart function. The renin-angiotensin-aldosterone system seems to be pathophysiologically associated with the development of cardiac fibrosis.[6] LVH has been linked to insulin resistance, which commonly coexists with type 2 diabetes.[7,8] According to

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several researches, DM's interactions with age and obesity may be the cause of the association between T2DM and LVH.[9] Since T2DM and insulin resistance are intimately linked to obesity, once body mass or fat mass is taken into account, the relationship between T2DM and insulin resistance and LV hypertrophy may no longer exist.[10,11] Numerous long-term epidemiologic studies have shown that T2DM is either a cause or an effect of cardiomyopathy, which includes changes in the structure and function of the left ventricle (LV) as well as changes in the geometry of the heart. It is commonly known that elevated LV mass (LVM) from hyperglycemia/T2DM results in LVH and cardiac geometry alterations. Based on the underlying metabolic and cardiac endocrinologic mechanisms, the high correlation between LVH and T2DM implies that their temporal relationship is reciprocal. These reciprocal relationships could sustain a vicious cycle whereby increased glucose causes LVM to rise, which in turn causes LVH to accelerate hyperglycemia. Therefore, early detection of LVH in T2DM patients should be achieved through screening. ECG, echocardiography, or cardiac magnetic resonance imaging (MRI) can all be used to measure LVH.[4] Out of the three tests for LVH, ECG is the most accessible, affordable, and straightforward but it has low sensitivity. Therefore the preferred test to check for LVH is echocardiography. It helps identify additional anomalies including valve disease and left ventricular failure and is far more sensitive than an ECG.[4] Neither the degree of correlation between DM and LVH nor any potential interactions with patient characteristics have been assessed.[12] The temporal link between LVH and T2DM is not well established at this time. Few studies, particularly in multiethnic cohorts, have demonstrated that DM is linked to increase LVM in the general population, regardless of other risk factors. Hence this study was planned to assess the prevalence and predictors of LVH in T2DM.

Material and Methods

The T2DM patients who visited the L.P.S Institute of Cardiology in Kanpur, India for three years between 2019 and 2021 were the subjects of the current cross-sectional study. A total of 300 patients with normal blood pressure between the age of 30 and 60years who had been diagnosed with T2DM were included in the study. According to the American Diabetes Association's (ADA) guideline, the patients were classified as diabetics who met the following criteria: fasting plasma glucose (FPG) ≥126mg/dl, random blood sugar (RBS) ≥200mg/dl during an oral glucose tolerance test (OGTT) conducted according to WHO guidelines, or patients exhibiting classic hyperglycemia or hyperglycaemic crisis symptoms with an RBS ≥200mg/dl or glycosylated

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haemoglobin (HbA1C) ≥6.5%. The "Institutes Ethics Committee" granted ethical clearance, and each participant provided informed consent. The study excluded patients with severe anaemia, chronic renal failure, valvular heart disease, ischaemic heart disease (IHD), congenital heart failure (CHF), cardiomyopathies, hemoglobinopathy, and chronic pulmonary disease in addition to those who were hypertensive and unwilling to participate. The patients had a comprehensive general examination, with particular attention paid to the presence of pallor, anasarca, and all peripheral pulses. The diabetics' vital signs, blood pressure (BP), pulse rate (PR), respiration rate (RR), and temperature were recorded. A systemic examination that included a cardiovascular and respiratory examination was also performed. Age, sex, height, body weight, body surface area, and body mass index (BMI), duration of DM were among the variables that were recorded. Analyses in laboratories included those of blood and urine. Blood analysis was done to examine the patients' fasting lipid profile, blood urea, serum creatinine, haemogram, FPG, postprandial plasma glucose (PPPG), RBS, and HbA1C. Urine was analyzed for routine and microscopic examination, as well as to determine the urinary albumin creatinine ratio (UACR). After an eight-hour fast, venous blood was drawn using aseptic procedures for blood analysis, and in the morning, a urine sample was collected in a container for urine analysis. The diabetic patients had plane chest x-ray and electrocardiography (ECG) as part of their radiographic assessment. Left ventricular hypertrophy (LVH) was detected by measuring left ventricular mass index (LVMI) using transthoracic echocardiography, according to recommendation of 'American Society of Echocardiography (ASE)'. The M Mode parameters measured were left ventricular end diastolic diameter (LVIDed), left ventricular end systolic diameter (LVIDes), ventricular septum thickness (IVSTed) and posterior wall thickness in diastole (PWTed). Left ventricular mass (LVM) was calculated by using ASE formula i.e. LVM= $0.8[1.04\{(LVIDed+PWTed+IVSTed)^3-(LVIDed)^3\}]+0.6gm$. Left ventricular mass index (LVMI) calculated by dividing LVM by BSA i.e. LVM / BSA. LVH was considered if LVMI was >45 $g/m^{2.7}$ in females and >49 $g/m^{2.7}$ in males. LVH was subdivided into mild, moderate and severe based on LVMI of the patient. Males with LVMI between 49-55$g/m^{2.7}$, 56-63$g/m^{2.7}$, and ≥64$g/m^{2.7}$ were considered to have mild, moderate and severe LVH respectively. Females with LVMI between 45-51$g/m^{2.7}$, 52-58$g/m^{2.7}$, and ≥59$g/m^{2.7}$ were considered to have mild, moderate and severe LVH respectively. A pre-structured proforma was used to record all of the data. Data were examined using SPSS-16 (Statistical Package for the Social Sciences) to determine the mean, percentage, standard

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deviation, student t-test, and fisher's exact test. To analyse quantitative and qualitative data, the t-test and Fisher's exact test were used, respectively, and "p value less than 0.05 was considered statistically significant."

Result-

The current study was done on 300 normotensive T2DM patients with age from 30-60years. The mean age of the subjects was 50.08±6.32years. As seen in table 1, age was further divided into three groups with maximum patients were in the age group of 50-60years i.e. 180(60%) followed by 40-49years and 30-39years with 108(36%) and 12(4%) patients respectively.

Table 1- Distribution of patients based on Age and LVH

Parameter		n(%)	Total
Age	30-39years	12(4%)	300 (100%)
	40-49years	108(36%)	
	50-60years	180(60%)	
LVH present	Males	116(77.85%)	159 (49.66%)
	Females	33(22.14%)	
LVH absent			151 (51.34%)

The present study showed male dominance with 180(60%) males and 120(40%) females as depicted in figure 1. Table 1 clearly shows that LVH was present in 149(49.66%) T2DM patients. Out of 149 LVH patients, 116(77.85%) were males and 33(22.14%) were females.

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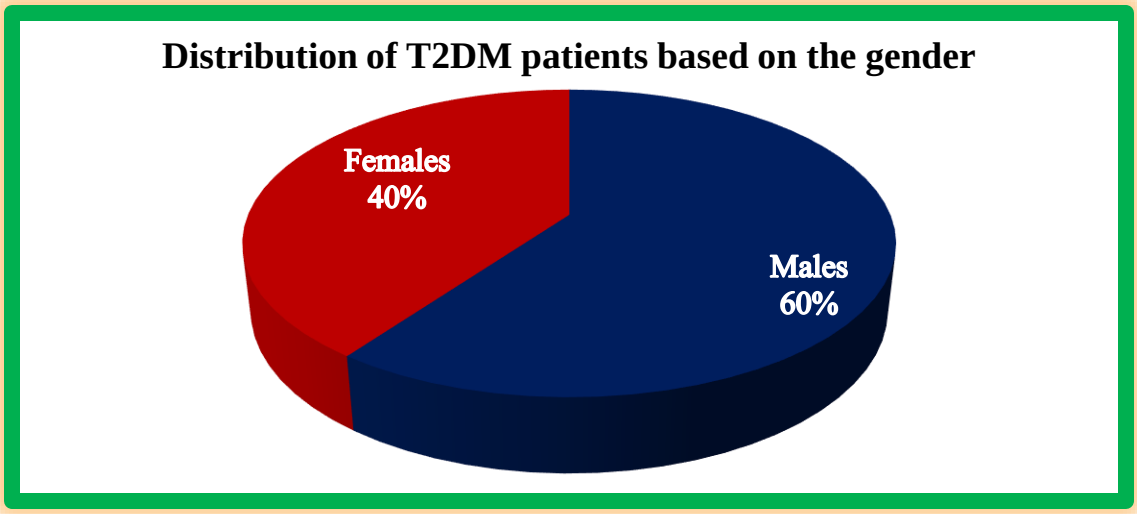

Figure 1- Distribution of T2DM patients based on the gender.

Table 2 shows mean of the study variables. The mean age of males in present study was 50.70±5.73years and of females was 48.91±6.99years. The mean FPG, HbA1c, BMI and duration of DM was 183.77±29.74mg/dl, 7.48±0.77%, 25.43±2.56 kg/m^2 and 5.91±3.46years respectively.

Table 2– Mean of the study variables.

Variable		Mean±SD
Age(years)		50.08±6.32
Mean age(years)	**Males**	50.70±5.73
	Females	48.91±6.99
FPG(mg/dl)		183.77±29.74
HbA1c(%)		7.48±0.77
BMI(kg/m^2)		25.43±2.56
Duration of DM(years)		5.91±3.46

Table 4- Sex wise distribution of T2DM patients based on different parameters. LVH was observed in 116(64.44%) males and 33(27.50%) females. However the rest 64(35.55%) T2DM males and 87(72.50%) females did not report any LVH. Further LVH on the basis of its severity

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was classified into mild moderate and severe as detected by 2D echocardiography. Mild LVH was assessed in 116(64.44%) males and 33(27.5%) females whereas moderate and severe LVH was not assessed in even a single male or female. Albuminuria was seen in half of the T2DM patients. Out of 180 males, 130(72.22%) reported the presence of albuminuria and in rest 50(27.77%) albuminuria was absent. Maximum females i.e. 100(83.33%) did not report albuminuria, whereas in 20(16.66%) females, albuminuria was found to be present. The association of sex with LVH and albuminuria was statistically significant. As far as type of albuminuria is concerned, microalbuminuria was mainly observed in our study with 102(56.66%) males and 14(11.66%) females. Whereas, macroalbuminuria was seen in 28(15.55%) males and 06(5.00%) females. The association of type of albuminuria and LVH severity with gender was not significant with p value of 0.4001 and 1.0000 respectively.

Table 3- Sex wise distribution of T2DM patients based on different parameters

Parameters		**Males n(%) n=180**	**Females n(%) n=120**	**P value**
LVH	Present	116(64.44%)	33(27.50%)	**0.0001**
	Absent	64(35.55%)	87(72.50%)	
LVH severity	Mild	116(64.44%)	33(27.5%)	1.0000
	Moderate	0(0.00%)	0(0.00%)	
	Severe	0(0.00%)	0(0.00%)	
Albuminuria	Present	130(72.22%)	20(16.66%)	**0.0000**
	Absent	50(27.77%)	100(83.33%)	
Type of albuminuria	Microalbuminuria	102(56.66%)	14(11.66%)	0.4001
	Macroalbuminuria	28(15.55%)	06(5.00%)	

Figure 2 depicts the sex wise distribution of T2DM patients based on the age group. Maximum i.e. 110(61.11%) males were from the age group of 50-60years followed by 40-49years and 30-39years with 60(33.33%) and 05(2.77%) males respectively. Females also mainly belonged to age group of 50-60years with 70(58.33%) females followed by 40-49years and 30-39years with 48(40.00%) and 02(1.66%) females respectively. However the association of age groups with sex was not statistically significant.

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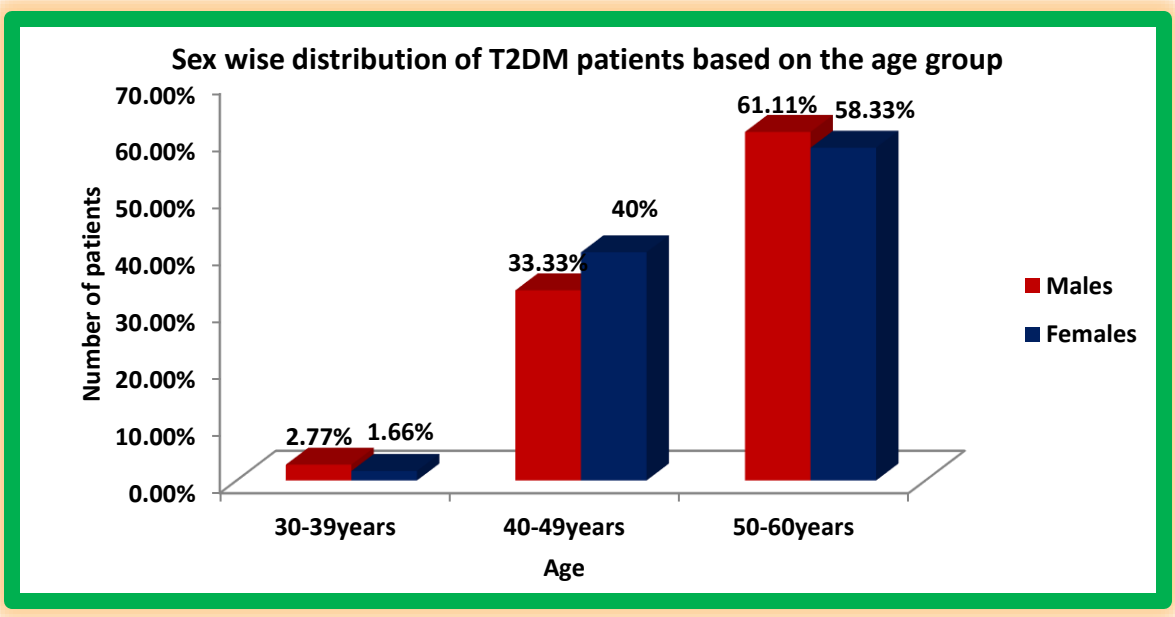

Figure 2- Sex wise distribution of T2DM patients based on the age group.

Mean FPG of population with LVH was 195.32±32.62mg/dl and that of population without LVH was 172.22±26.87mg/dl .This shows that FPG is positively associated with the incidence of LVH in population as mean of FPG of population with LVH was higher as compare to population without LVH and correlation was found extremely significant (p=0.0002) The mean HbA1C of population with LVH was higher (7.74±0.91%) as compared to population without LVH (7.22±0.63%) Correlation was found very significant between HbA1C and incidence of LVH using unpaired t test (p value =0.0011). This correlation suggests that the higher the value of HbA1C at the time of diagnosis, higher the incidence of LVH. Mean age of population with LVH was 51.91±4.53years and that of population without LVH was 49.00±6.84years. This shows that age is positively associated with the incidence of LVH in population as mean of age of population with LVH was higher as compared to population without LVH and correlation was found significant (p=0.0230) Mean BMI of population with LVH was 25.82±25.05kg/m²and that of population without LVH was 25.05±2.49kg/m². This shows that BMI was not positively associated with the incidence of LVH in population and correlation was insignificant (p=0.1473). Mean duration of diabetes of population with LVH was 7.86±4.16years and that of population without LVH was 3.96±2.76years. Correlation was found very significant between duration of diabetes and LVH using t test (p value=0.001). This correlation suggests that the higher the

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duration of DM, higher the incidence of LVH. Out of 149 LVH cases, 118(79.19%) cases had albuminuria and the rest 31(20.80%) were not associated with albuminuria. 151 T2DM patients who were not diagnosed with LVH were also evaluated for albuminuria and it was observed that 32(21.19%) cases had albuminuria and the rest 119(78.80%) were not associated with albuminuria. Our study found significant relationship between albuminuria and LVH ($p<0.0001$).

Table 4- Comparison of parameters among the patients with and without LVH.

Parameters		With LVH	Without LVH	P value
No. of Patients		149	151	-----
FPG (mg/dl)		195.32±32.62	172.22±26.87	**0.0002**
HbA1C (%)		7.74 + 0.91	7.22 + 0.63	**0.0011**
Age (years)		51.91 + 4.53	49.00 + 6.84	**0.0230**
BMI (kg/m²)		25.82 + 2.64	25.05 + 2.49	0.1473
Duration of DM (years)		7.86±4.16	3.96±2.76	**<0.001**
Albuminuria	**Present**	118(79.19%)	32(21.19%)	**<0.0001**
	Absent	31(20.80%)	119(78.80%)	

Discussion-

Diabetes Mellitus is linked to numerous microvascular and macrovascular problems. These chronic complications, which are the main causes of early mortality among diabetic patients, occur as a result of the gap between the onset and clinical diagnosis of diabetes. In this study 300 normotensive type 2 diabetic patients aged 30 to 60years, were evaluated for the prevalence of LVH and its relationship to a number of variables, including age, BMI, FPG, HbA1C, and duration of DM. The mean age of the subjects in our study was 50.08±6.32years. This finding is in harmony with the study by Gupta S et al.,[13] and Chauhan S et al.,[14] as they found nearly similar mean age of patients with type 2 diabetes mellitus. Alam KC et al.,[15] and Srinivasan MP et al.,[16] found slightly higher mean age of 53.86 ± 3.34years and 56.47 ± 5.89years respectively compared to present study. In the Asian study by Khoharo HK et al.,[17] the mean age was slightly lower than our study i.e. 47±13years. Maximum patients of our study were in the age group of 50-60years. This finding is nearly in agreement with the study by Alam KC et al.,[15] as 76% of the patients in their study belonged to the age group of 41-60years. The mean FPG, HbA1c, BMI and duration of DM in present study was 183.77±29.74mg/dl, 7.48±0.77%, 25.43±2.56 kg/m^2 and 5.91±3.46years respectively. These findings are much lower than the

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study by Alam KC et al.,[15] as they had FPG, BMI and mean duration of DM as 204.92±22.83 mg/dl, 27.04±3.87kg/m^2 and 11.27±4.19years respectively. The mean HbA1c in the study by Alam KC et al.,[15] is nearly in agreement with our study as they documented it to be 7.32±0.60%. In the study on Nigerians by Olamoyegun AM et al.,[18] the mean FPG was 154.8±100.8mg/dl. In the study by Menezes SA et al.,[19] the HbA1c values were higher (>8.5%) than our study. In the Asian study by Khoharo HK et al.,[17] the mean duration of diabetes was higher i.e. 13±7years compared to our study. In our study, incidence of LVH in T2DM without known hypertension, cardiac, cerebrovascular or peripheral vascular disease was 49.6%. In present study a positive correlation was found between prevalence of LVH and age, level of HbA1c and duration of DM but association with BMI was not significant. This outcome is strongly in harmony with the study by Sukamal Santra et al.,[20] in Kolkata as they also demonstrated higher prevalence of LVH i.e. 53% in form of high left ventricular mass (LVM) index in normotensive T2DM. The possible contribution of hyperinsulinemia and hyperglycemia to LVM have been suggested in normotensive diabetic patient. They also found a positive correlation between LVH and HbA1C but unlike our study they did not found any correlation with age and observed a positive correlation of LVH with BMI. Our finding is in concordance with the study by Haider Sobhy Al Hadad et al.,[4] as they found a significant correlation between age, BMI and LVM. According to a study conducted at a hospital in Kolkata, India, by Sukamal et al.,[21] people with diabetes mellitus have a higher risk of developing LVH the longer they have had the disease. James and Edward[22] in their study showed that LVH may be linked to natural physiological changes brought on by age, and DM may hasten these changes. However, our result is in contrast to the study by Haider Sobhy Al Hadad et al.,[4] Rothargpui et al., and Geeta et al., [23] as they failed to show an independent association of duration of DM and HbA1c with LVM in diabetics. Dawson et al.,[24] in UK found a very high prevalence of 74% which may be because they included already diagnosed cases of T2DM. The Incidence of LVH was found higher in males as compared to females and the possible reason could be the male preponderance in our study. This is in harmony with the study by Prasad NB et al.,[25] as their study also showed male dominance, however study by Alam KC et al.,[15] is in contrast to our study as they had female dominance in their study. Kazuo Eguchi et al.,[12] found that having type 2 diabetes, regardless of other factors like hypertension, was linked to a 1.5-fold higher probability of having LVM above the 75th percentile of the general population. Similar

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findings were made by Palmieri et al.,[11] who found that participants with diabetes had a 1.32-fold increased risk of LVH compared to those without the disease. Another study by Bertoni AG et al.,[26] also showed the positive association between T2DM and increased LVM in multiethnic populations. Study by Prasad NB et al.,[25] and Somratne et al.,[27] documented much lesser prevalence of LVH i.e. 34% and 37% respectively in T2DM patients. Numerous investigations have shown that in the general population, T2DM is linked to the development of LVH and cardiac geometry alterations.[28-30]

Conclusion-

In current research, LVH was more common in T2DM individuals. Every patient in our study had mild LVH and none of them had moderate or severe LVH. There was no correlation between sex and the severity of LVH. LVH was associated with poor glycemic control, a longer duration of type 2 diabetes, the presence of albuminuria, and advanced age. Our findings suggest T2DM patients to have good glycaemic control and further highlight the significance of screening for subclinical LVH in all T2DM patients, even to diabetics who do not have any history of hypertension or cardiac disease and particularly those who are older. The early detection and timely, efficient therapeutic management of LVH in diabetics can be facilitated by routine screening and monitoring for any cardiac disease. This will reduce the morbidity and will enhance the disease outcomes. Further longterm studies are needed to ascertain the relationship between LVH and T2DM and associated comorbidities.

Conflict o interest: None

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