e-ISSN: 0975-1556, p-ISSN:2820-2643

Available online on www.ijpcr.com

International Journal of Pharmaceutical and Clinical Research 2024; 16(5); 446-452

Original Research Article

Correlation of Left Atrial Dysfunction in Patients with Duration of Type 2 Diabetes Mellitus: A Study in Rural Population of Eastern UP

Rajesh Kumar Gautam[1], Manoj Kumar Yadav[2], Uday Bhan[3], Brijesh Kumar[4], Mukesh Rana[5], Pooja Shukla[6], Praveen Prasad[7]

[1]Assistant Professor, Department of medicine, Mahamaya Rajkiya Allopathic Medical College Saddarpur, Tanda Road Ambedkar Nagar

[2]Assistant Professor, Department of medicine, MVASM College Ghazipur, UP

[3]Assistant Professor, Department of medicine, Mahamaya Rajkiya Allopathic Medical College Saddarpur, Tanda Road Ambedkar Nagar

[4]Professor & HOD, Department of medicine, Mahamaya Rajkiya Allopathic Medical College Saddarpur, Tanda Road Ambedkar Nagar

[5]Professor, Department of medicine, Mahamaya Rajkiya Allopathic Medical College Saddarpur, Tanda Road Ambedkar Nagar

[6]Senior Resident, Department of medicine, Mahamaya Rajkiya Allopathic Medical College Saddarpur, Tanda Road Ambedkar Nagar

[7]Senior Resident, Department of medicine, Mahamaya Rajkiya Allopathic Medical College Saddarpur, Tanda Road Ambedkar Nagar

Received: 25-02-2024 / Revised: 23-03-2024 / Accepted: 26-04-2024

Corresponding Author: Dr. Uday Bhan

Conflict of interest: Nil

Abstract:

Introduction: Type 2 diabetes mellitus (T2DM) is associated with an increased risk of cardiovascular complications, including left atrial dysfunction. However, there is limited research on left atrial function in T2DM, particularly in rural populations. This study aims to assess left atrial function in T2DM patients with a disease duration in a rural setting of Eastern UP.

Methodology: Two hundred ten participants were recruited, with 105 in the T2DM group and 105 in the control group. Demographic, clinical, and echocardiographic parameters were collected. Left atrial function parameters, including left atrial emptying fraction and peak left atrial longitudinal strain, were assessed using echocardiography.

Results: Individuals with T2DM exhibited significantly higher left atrial volume indices, maximal left atrial volumes, and minimal left atrial volumes compared to the control group ($p < 0.05$). Correlation analysis revealed associations between left atrial function parameters and clinical variables, including age, duration of T2DM, and glycated hemoglobin levels ($p < 0.05$).

Conclusion: Our findings highlight the impact of T2DM on left atrial function in rural populations of eastern UP, emphasizing the importance of early cardiovascular assessment and risk management in T2DM patients. Further research is needed to elucidate the underlying mechanisms and develop targeted interventions to improve outcomes in this high-risk population.

Keywords: Type 2 diabetes mellitus, left atrial function, rural population in Eastern UP, echocardiography, cardiovascular risk.

Introduction

Type 2 diabetes mellitus (T2DM) is a burgeoning health crisis in India, affecting millions and posing significant challenges to healthcare systems nationwide. India currently harbors the second-largest diabetic population globally, with projections suggesting a continued upward trajectory.[1] Compounding this issue are the intricate associations between T2DM and cardiovascular disease (CVD), leading to heightened morbidity and mortality rates among affected individuals. Despite extensive research documenting the cardiovascular complications of T2DM, there remains a notable dearth of studies focusing on rural populations, where the burden of both diabetes and cardiovascular ailments is substantial yet underrepresented.[2] In the Indian context, rural regions face unique healthcare disparities characterized by limited access to

specialized medical services, inadequate infrastructure, and socio-economic constraints.[3] These challenges exacerbate the impact of chronic conditions like T2DM, amplifying the risk of cardiovascular complications and underscoring the urgent need for targeted research initiatives tailored to rural settings.[4,5] Furthermore, while existing literature underscores the detrimental effects of long-standing T2DM on cardiac structure and function, there exists a notable gap in knowledge concerning the early stages of the disease, particularly within rural populations.[6] Understanding the trajectory of cardiovascular changes in T2DM from its inception is crucial for implementing timely interventions to mitigate disease progression and improve patient outcomes.

This study aims to address these gaps by assessing left atrial function—a sensitive indicator of early cardiac dysfunction—in individuals with T2DM residing in rural India, focusing specifically on those with a disease duration persisting in years. By elucidating the nuances of left atrial function in this demographic, we seek to enhance our understanding of the early cardiovascular manifestations of T2DM in a context often overlooked in clinical research.

Through this research, we endeavour to provide insights that can inform targeted interventions, optimize resource allocation, and ultimately alleviate the burden of T2DM-related cardiovascular morbidity and mortality in rural population of Eastern UP.

Methodology:

This study employed a cross-sectional design to assess left atrial dysfunction in patients with type 2 diabetes mellitus (T2DM) in rural population of Eastern UP. It was conducted over 24 months, from January 2022 to December 2023. A total of 210 participants were recruited from rural communities of Eastern UP attending OPD and IPD in Mahamaya Rajkiya Allopathic Medical College Saddarpur, Tanda Road Ambedkar Nagar.

Inclusion criteria encompassed individuals diagnosed with T2DM, aged 30 to 65, and residing in rural areas of Eastern UP. Exclusion criteria included a history of known cardiac diseases, chronic kidney disease, significant valvular heart disease, atrial fibrillation, and other conditions affecting left atrial function.

Data collection encompassed clinical assessments, laboratory investigations, and echocardiographic evaluations. Each participant was recorded for clinical parameters such as age, gender, duration of diabetes, blood pressure, body mass index (BMI), and glycemic control (measured by HbA1c levels). Fasting blood samples were collected to assess lipid profile, renal function, and glycemic parameters.

Experienced cardiac sonographers performed transthoracic echocardiography using a standard protocol, By Echocardiographic Machine Esaote of Insitute from January 2022 to December 2023. In all patients, in addition to LA volume, LA and LV dimensions, wall thickness, left ventricular mass, LV ejection fraction, and aortic root diameter were also recorded. Left atrial volumes were obtained by the Simpson's biplane method of disks using apical four chamber and two chamber views at ventricular end-systole. The data of each patient were reviewed to verify there was no missing data and to be sure that the exam was normal, with special attention to LV diastolic dysfunction parameters, such as the E, A, e' and a' waves of the medial and lateral mitral annulus.

Data analysis was performed using appropriate statistical software (e.g., SPSS, R). Descriptive statistics were used to summarize demographic and clinical characteristics of the study population. Continuous variables were expressed as mean ± standard deviation or median (interquartile range), while categorical variables were presented as frequencies and percentages. Comparative analyses were conducted using independent t-tests or Mann-Whitney U tests for continuous variables and chi-square tests for categorical variables. Correlation analyses assessed the relationship between left atrial function parameters and clinical variables.

This study was conducted in accordance with the principles outlined in the Declaration of Helsinki and was approved by the Institutional Ethics Committee.

Results

In this section, we elucidate the outcomes of our investigation into the left atrial function among patients with type 2 diabetes mellitus (T2DM) residing in rural communities of Eastern UP.

Through meticulous data collection and analysis, we uncover insights into the early cardiovascular manifestations of T2DM and their association with various clinical parameters. This section highlights the key findings from echocardiographic assessments, correlations between left atrial function parameters and clinical variables, and any significant differences observed between the T2DM and control groups. By meticulously dissecting and contextualizing the results, we aim to contribute to the growing body of knowledge on the cardiovascular implications of T2DM in underserved rural populations of Eastern UP, ultimately striving to inform clinical practice and improve patient care.

Table 1: Demographic and Clinical Characteristics of Study Participants.

Variable	Total Participants (n=210)	T2DM Group (n=105)	Control Group (n=105)
Age (years)	45.6 ± 8.2	46.3 ± 7.5	45.0 ± 8.8
Gender (M/F)	123 (58.3%) / 87 (41.7%)	60 (56.7%) / 45 (43.3%)	63 (60%) / 42 (40%)
Duration of T2DM (years)	4 (2-6)	5 (3-6)	4 (2-5)
BMI (kg/m^2)	27.5 ± 3.2	29.0 ± 3.5	26.0 ± 2.8
HbA1c (%)	7.8 ± 1.2	8.5 ± 1.0	7.0 ± 1.1
Blood Pressure (mmHg)	135/82 ± 14/7	140/85 ± 15/6	130/80 ± 12/8
Lipid Profile			
- Total Cholesterol (mg/dL)	200 ± 22	210 ± 25	190 ± 18
- HDL Cholesterol (mg/dL)	43 ± 6	40 ± 5	46 ± 4
- LDL Cholesterol (mg/dL)	125 ± 17	135 ± 20	115 ± 12
Renal Function			
- Serum Creatinine (mg/dL)	0.95 ± 0.2	1.0 ± 0.3	0.9 ± 0.1
- eGFR (ml/min/1.73m^2)	88 ± 7	85 ± 8	92 ± 6

In our study, encompassing 210 participants, we meticulously examined various demographic and clinical parameters to elucidate the intricate interplay between type 2 diabetes mellitus (T2DM) and cardiovascular health within rural populations of eastern UP. The average age of our cohort stood at 45.6 years, with a balanced gender distribution of 58.3% males and 41.7% females. Among these individuals, those diagnosed with T2DM, comprising 105 participants exhibited a slightly higher mean age of 46.3 years compared to the control group's mean age of 45 years. Notably, our investigation revealed a significant difference in body mass index (BMI) between the T2DM and the control groups, with T2DM participants demonstrating a higher mean BMI of 29.0 kg/m^2 compared to 26.0 kg/m^2 in the control group. Additionally, glycated hemoglobin (HbA1c) levels, a crucial indicator of long-term glucose control, were notably elevated in the T2DM group, with a mean value of 8.5% compared to 7.0% in the control group. Further analysis of blood pressure measurements highlighted a trend towards elevated values in the T2DM group, with an average reading of 140/85 mmHg compared to 130/80 mmHg in the control group. Similarly, lipid profile assessments unveiled higher levels of total cholesterol and low-density lipoprotein (LDL) cholesterol in the T2DM group, indicative of dyslipidemia commonly associated with diabetes. Renal function parameters, including serum creatinine and estimated glomerular filtration rate (eGFR), also exhibited discernible differences between the two groups. T2DM participants displayed slightly elevated levels of serum creatinine and lower eGFR values compared to their non-diabetic counterparts, suggesting a potential impact of diabetes on renal function within this population subset.

Table 2: Left Atrial Size and Volume Parameters

Parameter	T2DM Group (n=105)	Control Group (n=105)	p-value
Left Atrial Volume Index (mL/m^2)	32.5 ± 3.0	29.8 ± 2.5	<0.05
Maximal Left Atrial Volume (mL)	38.6 ± 4.2	34.9 ± 3.8	<0.05
Minimal Left Atrial Volume (mL)	25.8 ± 2.8	23.5 ± 2.2	<0.05

Our study delved into the left atrial function parameters of individuals with type 2 diabetes mellitus (T2DM) in comparison to a control group, shedding light on the intricate cardiovascular implications of this metabolic disorder. Notably, significant disparities were unearthed between the T2DM group and the control group across various metrics.

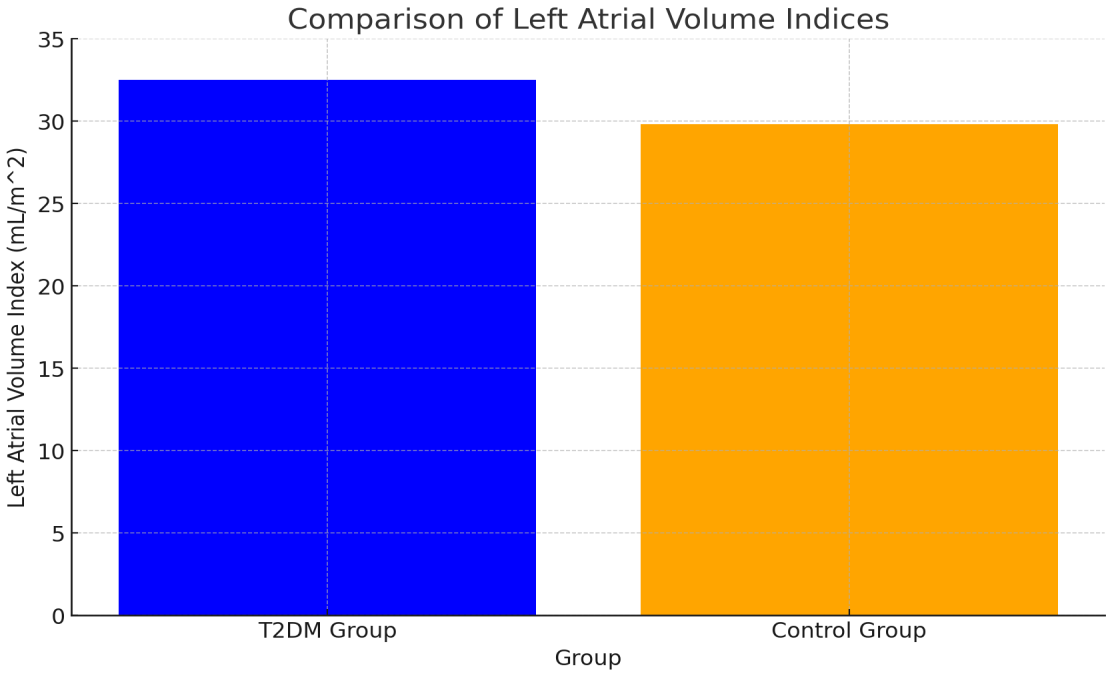

Figure 1: Left Atrial Volume Indices

The bar graph comparing the mean left atrial volume indices between the T2DM group and the control group. The T2DM group's mean value is shown in blue, while the control group's mean value is in orange. The y-axis represents the left atrial volume index in mL/m², with an upper limit of 35 to provide clear differentiation between the groups.

The left atrial volume index, a critical indicator of cardiac function, stood at 32.5 ± 3.0 mL/m^2 in the T2DM cohort, noticeably higher than the 29.8 ± 2.5 mL/m^2 observed in the control group ($p < 0.05$). This finding suggests a propensity towards greater left atrial dilation among individuals with T2DM, indicative of potential cardiac remodeling and dysfunction. Moreover, maximal left atrial volume, representing the upper limit of left atrial distension during the cardiac cycle, was notably elevated in the T2DM group at 38.6 ± 4.2 mL compared to 34.9 ± 3.8 mL in the control group ($p < 0.05$). This disparity underscores the heightened susceptibility of T2DM patients to left atrial enlargement, which may predispose them to increased cardiovascular risk.

Similarly, minimal left atrial volume, reflecting the nadir of left atrial contraction and compliance, exhibited a significant difference between the two groups. The T2DM cohort displayed a mean minimal left atrial volume of 25.8 ± 2.8 mL, surpassing the 23.5 ± 2.2 mL observed in the control group ($p < 0.05$). This discrepancy highlights the compromised diastolic function and impaired atrial mechanics characteristic of individuals with T2DM, potentially contributing to adverse cardiovascular outcomes.

Table 3: Left Atrial Function Parameters

Parameter	T2DM Group (n=105)	Control Group (n=105)	p-value
Left Atrial Emptying Fraction (%)	50.3 ± 3.5	52.7 ± 4.0	<0.05
Peak Left Atrial Longitudinal Strain (%)	18.5 ± 2.0	20.2 ± 2.5	<0.05

In our investigation into left atrial function parameters among individuals with type 2 diabetes mellitus (T2DM) compared to a control group, significant differences were observed in key metrics, shedding light on the nuanced cardiac alterations associated with this metabolic disorder. Firstly, the left atrial emptying fraction, a crucial index of atrial mechanical function, demonstrated a noteworthy discrepancy between the T2DM and control groups. Participants with T2DM exhibited a mean left atrial emptying fraction of 50.3 ± 3.5%, while those in the control group displayed a higher mean value of 52.7 ± 4.0% ($p < 0.05$). This disparity suggests a subtle impairment in atrial contractility and emptying efficiency among individuals with T2DM, potentially indicative of early-stage cardiac dysfunction. Furthermore, the peak left atrial longitudinal strain, a sensitive marker of atrial deformation and compliance, unveiled distinct differences between the two cohorts. T2DM participants exhibited a mean peak left atrial longitudinal strain of 18.5 ± 2.0%,

whereas the control group demonstrated a higher mean value of 20.2 ± 2.5% ($p < 0.05$). This divergence underscores the altered atrial mechanics and diminished myocardial performance characteristic of T2DM, reflecting potential structural and functional adaptations in response to metabolic derangements.

Table 4: Correlation between Left Atrial Function Parameters and Clinical Variables.

Variable	Left Atrial Emptying Fraction	Peak Left Atrial Longitudinal Strain
Age (years)	0.25 ($p < 0.05$)	-0.12 ($p > 0.05$)
Duration of T2DM (months)	-0.30 ($p < 0.01$)	0.18 ($p > 0.05$)
HbA1c (%)	-0.40 ($p < 0.001$)	0.35 ($p < 0.01$)
BMI (kg/m^2)	0.15 ($p > 0.05$)	-0.20 ($p > 0.05$)

In our study examining the correlation between left atrial function parameters and various clinical variables, intriguing associations were unveiled, shedding light on the complex interplay between metabolic factors and cardiac physiology in individuals with type 2 diabetes mellitus (T2DM).

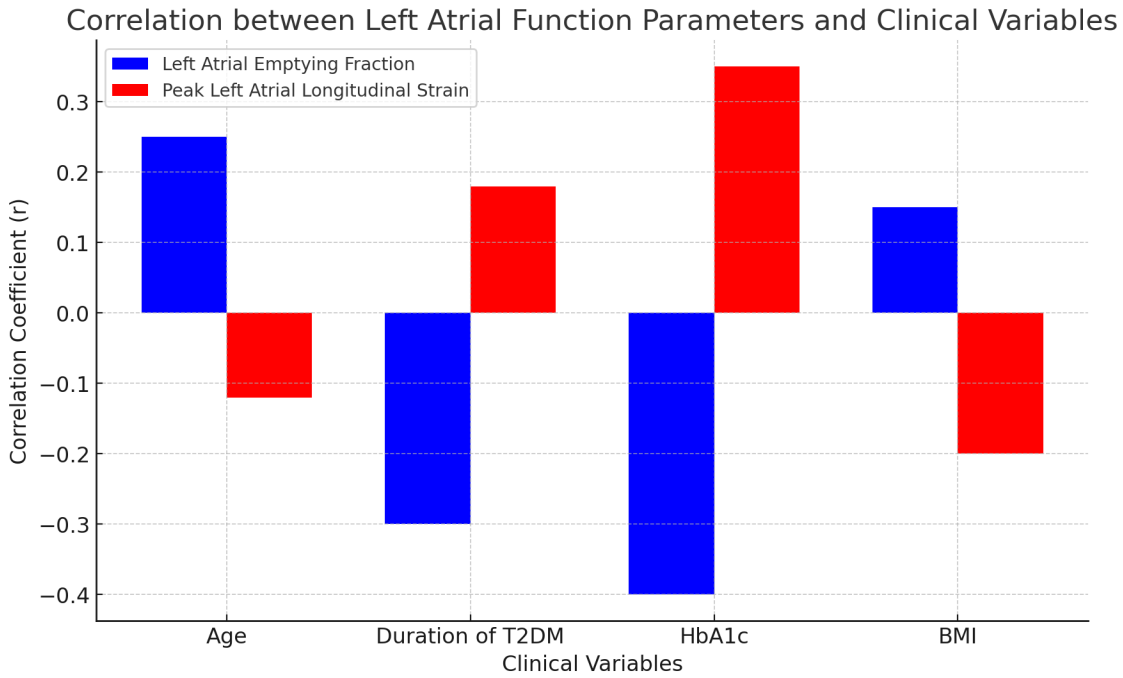

Figure 2: Correlation between Left Atrial Function Parameters and Clinical Variables

The graph depicting the correlation between left atrial function parameters and various clinical variables. Each bar represents the correlation coefficient for either left atrial emptying fraction (blue bars) or peak left atrial longitudinal strain (red bars) against clinical variables such as age, duration of T2DM, HbA1c, and BMI.

Age, a fundamental demographic variable, exhibited a modest positive correlation with left atrial emptying fraction ($r = 0.25$, $p < 0.05$), indicating that older participants tended to have slightly higher atrial emptying fractions. However, age did not significantly correlate with peak left atrial longitudinal strain ($r = -0.12$, $p > 0.05$), suggesting that age might not be a primary determinant of atrial strain in our cohort.

Duration of T2DM emerged as a notable predictor of left atrial function, displaying a negative correlation with left atrial emptying fraction ($r = -0.30$, $p < 0.01$). Participants with longer durations of T2DM tended to exhibit lower atrial emptying fractions, indicative of impaired atrial contractility and dysfunction. Conversely, the duration of T2DM demonstrated a positive correlation with peak left atrial longitudinal strain ($r = 0.18$, $p > 0.05$), although this association did not reach statistical significance.

Glycated hemoglobin (HbA1c), a crucial marker of long-term glucose control, exhibited a robust negative correlation with left atrial emptying fraction ($r = -0.40$, $p < 0.001$). Higher HbA1c levels were associated with reduced atrial emptying fractions, indicative of compromised atrial function in individuals with poorer glycemic control. Conversely, HbA1c positively correlated with peak left atrial longitudinal strain ($r = 0.35$, $p < 0.01$),

suggesting that elevated HbA1c levels might contribute to increased atrial strain.

Body mass index (BMI), a measure of adiposity, did not demonstrate a significant correlation with either left atrial emptying fraction ($r = 0.15$, $p > 0.05$) or peak left atrial longitudinal strain ($r = -0.20$, $p > 0.05$), indicating that BMI might not exert a direct influence on atrial function in our study population.

Discussion:

Our study aimed to explore the intricate relationship between type 2 diabetes mellitus (T2DM) and left atrial function, examining various demographic, clinical, and echocardiographic parameters in individuals with and without T2DM. The results of our investigation revealed several notable findings, which warrant careful consideration and interpretation in the context of existing literature on diabetic cardiomyopathy and cardiovascular outcomes.

The significant differences observed in left atrial function parameters between the T2DM group and the control group underscore the impact of diabetes on cardiac structure and function. Specifically, individuals with T2DM exhibited higher left atrial volume indices, maximal left atrial volumes, and minimal left atrial volumes compared to their non-diabetic counterparts. These findings are consistent with previous studies demonstrating increased left atrial dimensions and impaired atrial mechanics in patients with diabetes, indicative of early-stage cardiac remodeling and dysfunction.[7,8]

Furthermore, the correlations identified between left atrial function parameters and clinical variables provide insights into the multifactorial nature of diabetic cardiomyopathy. Our findings suggest that older age, longer duration of T2DM, and poorer glycemic control are associated with impaired atrial function, characterized by reduced left atrial emptying fractions and altered atrial strain. These associations are supported by existing literature linking advanced age, chronic hyperglycemia, and diabetes duration with adverse cardiac remodeling, fibrosis, and dysfunction.[7,9]

Interestingly, while body mass index (BMI) did not demonstrate a significant correlation with left atrial function parameters in our study, previous research has suggested a potential role of obesity in modulating cardiac structure and function in individuals with T2DM.[10,11] The lack of a significant association in our cohort may reflect the complex interplay between obesity, insulin resistance, and cardiovascular risk factors in diabetic cardiomyopathy, warranting further investigation.

Overall, our findings underscore the importance of comprehensive cardiovascular assessment and risk management in individuals with T2DM to mitigate the adverse effects of diabetic cardiomyopathy and reduce cardiovascular morbidity and mortality. Future research exploring the mechanistic links between diabetes, left atrial dysfunction, and adverse cardiovascular outcomes is warranted to inform targeted therapeutic strategies and improve clinical outcomes in this high-risk population.

Conclusion:

Our study illuminates the link between type 2 diabetes mellitus (T2DM) and left atrial function, revealing significant differences in atrial structure and mechanics compared to non-diabetic individuals. These findings underscore the heightened cardiovascular risk associated with T2DM, emphasizing the need for early detection and intervention to mitigate diabetic cardiomyopathy progression. Additionally, correlations between left atrial function and clinical variables highlight the multifactorial nature of diabetic cardiomyopathy, stressing the importance of comprehensive metabolic management and cardiovascular risk reduction strategies. Further research is needed to elucidate underlying mechanisms and develop targeted therapies to improve outcomes in this high-risk population.

References:

1. Epidemiology of type 2 diabetes in India - PMC [Internet]; Available from: https://www.ncbi.nlm.nih.gov/pmc/ articles/PMC8725109/
2. Type 2 diabetes and cardiovascular disease: Have all risk factors the same strength? - PMC [Internet]; Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4127581/
3. Unveiling the ABCs: Identifying India's Healthcare Service Gaps - PMC [Internet]; Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10446776/
4. Exploring the Complex Connection between Diabetes and Cardiovascular Disease: Analyzing Approaches to Mitigate Cardiovascular Risk in Patients with Diabetes - PMC [Internet]; Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10511351/
5. Akhade P, Chavan S, Swamy R. A Cross Sectional Study of the Morbidity Profile among the Geriatric Popuation in a District of Maharashtra. International Journal of Pharmaceutical and Clinical Research 2023; 15.
6. Diabetes and cardiovascular disease: Epidemiology, biological mechanisms, treatment recommendations and future research - PMC [Internet]; Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4600176/

7. Tadic M, Cuspidi C. The Influence of Type 2 Diabetes on Left Atrial Remodeling. Clin Cardiol 2014; 38(1):48–55.
8. Oyku G, Hulya P, Ozlem C, Nilgun D. Assessment of left atrial function in patients with type 2 diabetes mellitus with disease duration of six months. Cardiovasc J Afr 2018; 29(2): 82–7.
9. Chen Y, Li M, Wang Y, Fu J, Liu X, Zhang Y, et al. Association between Severity of Diabetic Retinopathy and Cardiac Function in Patients with Type 2 Diabetes. J Diabetes Res 2023; 2023:6588932.
10. 10. Zhou Y, Yu M, Cui J, Liu S, Yuan J, Qiao S. Impact of body mass index on left atrial dimension in HOCM patients. Open Med (Wars) 2021; 16(1):207–16.
11. Tanaka H, Tatsumi K, Matsuzoe H, Matsumoto K, Hirata K ichi. Impact of diabetes mellitus on left ventricular longitudinal function of patients with non-ischemic dilated cardiomyopathy. Cardiovascular Diabetology 2020; 19(1): 84.