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PREVALENCE OF LEFT VENTRICULAR DYSFUNCTION AMONG PATIENTS WITH TYPE TWO DIABETES MELLITUS IN MOSUL CITY

[*1]Ali Jasim Mohammed, [2]Atyaf Kamal Tawfeq, [3]Zakaria A. Kassim

[1]M.B.Ch.B./ C.A.B.M. (Internal Medicine).
[2]M.B.Ch.B./ D.M. (Family Medicine).
[3]M.B.Ch.B./ F.A.B.H.S. (Family Medicine).

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***Corresponding Author: Ali Jasim Mohammed**
M.B.Ch.B./ C.A.B.M. (Internal Medicine).

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ABSTRACT

Background: Diabetes mellitus is a chronic condition that can be caused by a variety of genetic and/or environmental factors. Heart conditions, particularly coronary artery disease, congestive heart failure, and arterial hypertension, are closely connected to type 2 diabetes mellitus. Left diastolic dysfunction is the first functional abnormalities which might impact patients newly diagnosed with type 2 DM within less than one year. **Objectives:** To assess the prevalence of left ventricular diastolic dysfunction in patients with asymptomatic type 2 diabetes mellitus at Mosul general Hospital in Mosul/ Iraq. **Methods:** This is a cross sectional study conducted at Mosul General Hospital during the period from the 1st of November 2022 to the end of December 2024. The patients were diagnosed with diabetes mellitus (DM) using the American Diabetes Association's diagnostic criteria. All type 2 diabetes patients over the age of 18 and who gave their consent were included in the trial. The study excluded patients with clinically noticeable cardiovascular conditions, as well as patients with severe anemia, thyroid issues, hemoglobinopathies, severe renal insufficiency and pregnancy were further exclusion criteria. The questionnaire includes four parts, part one for sociodemographic information of the study participants. Part two for anthropometric information. Part three for diabetes questions and part four for echocardiography details. **Results:** The study includes 200 patients with type 2 diabetes mellitus. The mean age ± standard deviation of the study participants was 56.46 ± 6.92 years. Of them, 112 (56%) patients were females and 88 (44%) were males, with male to female ratio of 1:1.27. Left diastolic dysfunction was present in 101 (62.3%) patients. Moreover, grade 1 was present in 87 (53.7%) patients while grade 2 was present in 13 (8%) patient and only one (0.6%) patient. Statistically significant difference between patients with left ventricular dysfunction and those without dysfunction regarding their means of ages, presence of overweight and obesity, diabetes for more than or equal to five years, glycated hemoglobin, presence of albuminuria, retinopathy, their mean of blood urea and serum creatinine (P value < 0.05). On the other hand, no statistically significant difference between the two groups regarding their gender, active smoking, and received drugs. **Conclusion:** Asymptomatic patients with type 2 diabetes have a higher prevalence of left ventricular diastolic dysfunction, with Grade I being the most common type. Higher prevalence of diastolic dysfunction was significantly linked to advance age, overweight and obesity, longer duration of diabetes, poor control of diabetes and presence of microvascular complication.

KEYWORDS: Diabetes, Dysfunction, Heart function, Iraq, Mosul, Type II.

1. INTRODUCTION

Diabetes mellitus is a chronic condition that can be caused by a variety of genetic and/or environmental factors.[1] Type 2 Diabetes Mellitus (T2DM) certainly has emerged as a new and extremely important health concern during the past 20 years, impacting even children.[2] Frequent urination, excessive thirst and hunger, weight loss, fatigue, blurred vision, nausea, vomiting, stomach pain, recurrent infections like candidiasis, male balanitis, female vulvovaginitis, delayed wound healing, and tingling in the extremities are some of the symptoms that type 2 diabetes mellitus

commonly manifests as. It's crucial to remember that some people could not exhibit any symptoms.[3]

Heart conditions, particularly coronary artery disease, congestive heart failure, and arterial hypertension, are closely connected to the majority of health problems associated with type 2 diabetes mellitus.[4] Many people with established coronary artery disease have type 2 diabetes mellitus or its precursor forms, suggesting a link between the two conditions.[5] Approximately 20-30% of those with acute coronary syndromes have type 2 diabetes, and more than 40% have impaired glucose tolerance.[6]

Studies showed that the risk of death from an acute myocardial infarction is higher for those with diabetes than in non diabetic patients.[7-9] Moreover, type 2 diabetes mellitus, in addition to coronary artery disease, is a substantial risk factor for arrhythmias and cardiac dysfunction.[10]

Diabetic cardiomyopathy begins with left ventricular diastolic dysfunction and progresses to systolic function. Early ventricular function evaluation is crucial for patients with diabetes.[11] Left diastolic dysfunction is the first functional abnormalities which might impact patients newly diagnosed with type 2 DM within less than one year.[12]

Diabetic cardiomyopathy may be diagnosed using many imaging modalities that analyze morphological parameters and measure cardiac function. Echocardiography is the most often used technique to assess the heart's structure and function, including shape and contractions. This is mostly due to its accessibility and affordability.[13] Diastolic function is assessed using pulse wave doppler, tissue doppler imaging, and left atrial volume. It evaluates diastolic function and tracks disease progression, from mild dysfunction (impaired relaxation) to more severe stages (pseudonormalization or limitation).[14] Two-dimensional, doppler, and speckle tracking echocardiography provides a thorough assessment of heart function in patients with diabetes. Stress echocardiography and coronary flow reserve assessment provide extra prognostic value.[15]

The aim of this study was to assess the prevalence of left ventricular diastolic dysfunction in patients with asymptomatic type 2 diabetes mellitus at Mosul general Hospital in Mosul/ Iraq.

2. PATIENT AND METHOD

The study was conducted at Medical outpatient consulting clinic at Mosul General Hospital with the aid of Echocardiography unit in the same hospital, From the 1st of November 2022 to the end of December 2024. The patients were diagnosed with diabetes mellitus (DM) using the American Diabetes Association's diagnostic criteria, which include the following.

I. Fasting plasma glucose (FPG) > 126 mg/dL (7.0 mmol/L). Of note; fasting is defined as consuming no calories for at least 8 hours.
II. 2-hour Plasma Glucose > 200 mg/dL (11.1 mmol/L) during an Oral Glucose Tolerance Test (OGTT), the test employs a glucose load of 75 g of anhydrous glucose dissolved in water.
III. HbA1c $\geq$ 6.5.
IV. Random plasma glucose level > 200 mg/dL (11.1 mmol/L). In addition to the following symptoms; polyuria, polydipsia, and unexplained weight loss, or hyperglycemic crises.

Participants in this descriptive cross-sectional study, must not have any clinically noticeable cardiovascular conditions, such as exertional dyspnea or chest pain. In addition, all participants must have a normal resting electrocardiogram (ECG) and be normotensive, meaning their blood pressure should be less than 130/80 mmHg. Diabetic patients aged less than 18 years old were excluded from the study. Moreover, the study excluded patients with significant valvular heart disease, coronary artery disease as indicated by symptoms, electrocardiogram results, or evidence of regional wall motion abnormalities on coronary angiography or echocardiography, hypertensive heart disease, congestive heart failure, and cardiomyopathies including dilated or hypertrophic cardiomyopathy, presence of severe anemia, thyroid issues, hemoglobinopathies, atrial fibrillation, or other arrhythmias, those with severe renal insufficiency and pregnancy were further exclusion criteria. Lastly, the study excludes those with inadequate transthoracic echocardiographic windows or those with abnormal ECG findings.

Two hundred newly diagnosed type 2 diabetes were enrolled in to this study. In addition to Echocardiography, the patients evaluated for pulse rate and blood pressure using manual sphygmomanometers. BMI was calculated by dividing weight (kg) by height (m) squared. All of the enrolled patients did ECG, blood urea, serum creatinine and glycated hemoglobin. They were sent for ophthalmologist for retinal checking. Of note only 162 did echocardiography due to the presence of hypertension (23) patient, sever anemia (less than 7 g/dl) in (4) patients, atrial fibrillation (7) patients and thyroid problem (4) patients.

The questionnaire was utilized to gather information on the patient's age, gender and smoking state. Diabetes characteristic, including time of diagnosis glycated hemoglobin, presence of proteinuria, retinopathy, nephropathy, and treatment received. Echocardiographic finding of left ventricular dysfunction with its grading.

The collected data were coded, entered, and analyzed using the available data base software program statistical package of IBM SPSS-29 (IBM Statistical Packages for Social Sciences- version 29, Chicago, IL, USA). Data were presented in simple measures of percentage, mean,

standard deviation, median and interquartile rang. Student's t-test was used to compare numerical variables between the two groups with application of chi square test for categorical variables. Fisher's exact was used when applicable. Statistical significance was considered whenever the P value was equal or less than 0.05.

3. RESULTS

The study includes 200 patients with type 2 diabetes mellitus. The mean age ± standard deviation of the study participants was 56.46 ± 6.92 years. Of them, 112 (56%) patients were females and 88 (44%) were males, with male to female ratio of 1:1.27.

Table 1 shows distribution of the study participants according to their age. The majority of patients were belonging to the age category of 50-59 years followed by 40-49 years and more than 60 years, while only minority of patients were belonging to the age category of 30-39 and 18-29 years.

Table 1: Distribution of patients with type 2 diabetes mellitus according to their ages. (number = 200).

Age category (years)	Number	Percent
18-29	1	0.5%
30-39	4	2%
40-49	31	15.5%
50-59	43	21.5%
More than 60	22	11%

Table 2 shows distribution of the study participants according to their smoking state. Active (current) smoking was present in 67 (33.5%) patients, passive smoking in 33 (16.5%) patients and x-smoking in 12 (6%) patients. On the other hand, 88 (44%) patients were report no smoking history.

Table 2: Distribution of patients with type 2 diabetes mellitus according to their smoking state. (number = 200).

Smoking state	Number	Percent
Non smoker	88	44%
Active smoker	67	33.5%
x-smoker	12	6%
Passive smoker	33	16.5%

Table 3 shows distribution of the study patients according to their body mass index. The majority of the study patients were obese with different grades and less extent they were overweight and normal body mass index.

Table 3: Distribution of patients with type 2 diabetes mellitus according to their body mass index. (number = 200).

Body mass index (Kg/ meter ^{2})	Number	Percent
Under weight (Less than 18.5)	0	0%
Normal (18.5-24.9)	28	14%
Overweight (25-29.9)	54	27%
Obesity grade I (30-34.9)	57	28.5%
Obesity grade II (35-39.9)	41	20.5%
Obesity grade III (more than 40)	20	10%

Table 4 shows distribution of the study participants according to their blood pressure and pulse. The majority of patients were normotensive and having normal pulse rate.

Table 4: Distribution of patients with type 2 diabetes mellitus according to their Blood pressure and pulse rate. (number = 200).

Variable	Number	Percent
Blood pressure:		
- Hypotension (less than 90/60 mmhg)	11	5.5%
- Normal (90-119/60-79 mmhg)	99	49.5%
- Prehypertension (120-139/80-89 mmhg)	52	26%
- Hypertension stage 1 (140-159/90-99 mmhg)	21	10.5%
- Hypertension stage 2 (160-179/100-109 mmhg)	8	4%
- Hypertension stage 3 (more than 180/110 mmhg)	9	4.5%
Pulse:		
-less than 60 beat per minute	13	6.5%
- 60-100 beat per minute	124	62%
- More than 100 beat per minute	63	32.5%

Table 5 shows distribution of the study participants according to their basic diabetes characteristics. The majority of patients had diabetes for less than 5 years, moderate to poor control diabetes, on oral hypoglycemic drugs, had positive albuminuria and retinopathy.

Table 5: Distribution of patients with type 2 diabetes mellitus according to their Blood pressure and pulse rate. (number = 200).

Variable	Number	Percent
Diabetes duration:		
-Less than five years	121	60.5%
-More than or equal to five years	79	39.5%
Glycated hemoglobin:		
-4-5.7%	38	19%
-5.8-6.4%	86	43%
-More than 6.5%	76	38%
Received treatment:		
-Oral hypoglycemic drug	171	85.5%
-Insulin	15	7.5%
-Both	14	7%
Presence of Albuminuria:		
-Yes	108	54%
-No	92	46%
Presence of retinopathy:		
-Yes	111	55.5%
-No	89	45.5%
Blood urea, mean ± standard deviation	31.3 ± 9.3 mg/d	
Serum creatinine, mean ± standard deviation	0.77 ± 0.17 mg/dl	

Table 6 shows distribution of the study participants according to their echocardiographic findings. Left diastolic dysfunction was present in 101 (62.3%) patients. Of them, grade 1 was present in 87 (53.7%) patients while grade 2 was present in 13 (8%) patient and only one (0.6%) patient.

Table 6: Distribution of the patients with type 2 diabetes mellitus according to their echocardiography findings. (number = 162).

Echocardiography findings	Number	Percent
Normal	61	37.6%
Presence of left diastolic dysfunction:		
-Grade I	87	53.7%
-Grade II	13	8%
-Grade III	1	0.6%

Table 7 shows comparison between with left diastolic dysfunction and those without dysfunction according to different variables included in the study. Statistically significant difference between them regarding their means of ages, presence of overweight and obesity, diabetes for more than or equal to five years, glycated hemoglobin, presence of albuminuria, retinopathy, their mean of blood urea and serum creatinine (P value < 0.05). On the other hand, no statistically significant difference between the two groups regarding their gender, active smoking, and received drugs (P value > 0.05).

Table 7: Comparison between patients with left diastolic dysfunction and those without dysfunction according to different variables included in the study. (number = 162).

Variable	Diastolic dysfunction = 101	No diastolic dysfunction = 61	P-value
Age (year), mean ± standard deviation	59.64 ± 6.79	50.21 ± 7.12	**<0.001**
Male/ female	42/ 59	26/35	0.819
Active smoking	38 (37.6%)	21 (34.4%)	0.248
Overweight and obesity	96 (95%)	41 (67.2%)	**<0.001**
Diabetes duration of more than or equal to five years	61 (60.4%)	11 (18%)	**<0.001**
Glycated hemoglobin, mean ± standard deviation	9.5 ± 2.7	7.3 ± 0.6	**<0.001**
Received treatment:			

-Oral hypoglycemic drug -Insulin -Both	87 (86.2%) 10 (9.9%) 4 (3.9)	57 (91.9%) 4 (6.5%) 1 (1.6%)	0.728
Presence of Albuminuria	94 (93.1%)	12 (19.3%)	**<0.001**
Presence of retinopathy	94 (93.1%)	13 (21%)	**<0.001**
Blood urea (mg/d), mean ± standard deviation	32.1 ± 9.3	30 ± 3.2	**0.017**
Serum creatinine (mg/dl), mean ± standard deviation	0.81 ± 0.21	0.75 ± 0.15	**0.021**

4- DISCUSSION

In this study the mean age of type 2 diabetes mellitus was (56 years). This is higher than what was found by recent pooled analysis showing a global average of around (45 years).[16] However, this is depending on the population and screening measures used. As its crucial to distinguish between age at diagnosis and age at onset, as onset can occur years before diagnosis. Anyhow, comparable findings were found in Saudi patients (58 years)[17], Pakistan (56 years)[18] and China (54.6 years).[19] Moreover; the study found type 2 diabetes affect females more than males. This might due to, women undergoing significant hormone fluctuations, particularly during pregnancy (gestational diabetes) and menopause, which can increase their risk of developing type 2 diabetes. In addition to the fact that women generally carry a higher burden of obesity which is a significant risk factor for type 2 diabetes.[20] consistent finding obtained from other studies.[21-22] Additionally; the study found that active smokers, passively smokers and x-smokers collectively affect by type 2 diabetes more than non smokers. Which indicates that active smokers face a significant increase in risk, while former smokers also carry an elevated risk that gradually decreases over time after quitting. Furthermore, exposure to secondhand smoke also raises the risk of developing the condition, highlighting the public health importance of reducing both active and passive smoking. Consistent finding found by a meta-analysis conducted by Qin et al.[23] In same way, the study found that type 2 diabetes linked with overweight and obesity more than normal or underweight. As obesity increases the risk of insulin resistance, which interferes with blood sugar regulation and leads to high glucose levels, characteristic of type 2 diabetes. While not everyone who is obese develops type 2 diabetes, and not all people with type 2 diabetes are obese, excess body weight is a major risk factor and a leading contributor to the condition. Which runs with other studies.[24-25]

The study found that there is considerable portion (19.5%) of type 2 diabetic patients had hypertension, this high rate of co-occurrence is due to shared pathophysiological mechanisms and lifestyle factors, and managing hypertension in type 2 diabetics is crucial for preventing serious complications like cardiovascular disease, stroke, and kidney disease. As noted by Petrie et al study results.[26] On the other hand, about one third of the study population (32.5%) had sinus tachycardia, this finding highlights a significant association between type 2 diabetes and cardiac autonomic neuropathy, causing a persistently elevated heart rate, aligning with Shihab et al study findings.[27]

Regarding diabetes characteristics, the study found that most of patients had diabetes for less than 5 years, having uncontrol diabetes in spite of treatment, with the presence of albuminuria, retinopathy but normal mean of blood urea and serum creatinine levels. The simultaneous presence of complications like albuminuria and retinopathy despite a short disease duration and normal blood urea and serum creatinine levels suggests that significant microvascular damage is occurring early, despite seemingly normal markers of advanced kidney disease. These finding were similar to Suleman et al study findings.[28]

The main finding of this study was more than 62% of the study patients had diastolic dysfunction. Additionally, this diastolic dysfunction associated with advance age, overweight and obesity, longer duration of diabetes, poor control of diabetes and presence of microvascular complication. As diastolic dysfunction is common in people with type 2 diabetes and it consider as a preclinical form of heart failure leading to heart failure, which is comparable to other studies' findings.[28-29]

The limitations of the study were; its cross-sectional, having small sample size, additionally, other variables as hyperlipidemia was not included in this study, due to limited resources in the study setting. However, more studies with larger sample size were need for confirmation of the exact prevalence of left ventricular diastolic dysfunction in patients with asymptomatic type 2 diabetes mellitus in Mosul/ Iraq.

5. CONCLUSION

Asymptomatic patients with type 2 diabetes have a higher prevalence of left ventricular diastolic dysfunction, with Grade I being the most common type. Higher prevalence of diastolic dysfunction was significantly linked to advance age, overweight and obesity, longer duration of diabetes, poor control of diabetes and presence of microvascular complication.

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REFERENCES

1. Beulens JW, Pinho MG, Abreu TC, den Braver NR, Lam TM, Huss A, Vlaanderen J, Sonnenschein T, Siddiqui NZ, Yuan Z, Kerckhoffs J. Environmental risk factors of type 2 diabetes—an exposome approach. Diabetologia, 2022 Feb; 65(2): 263-74.
2. Goyal S, Vanita V. The rise of Type 2 diabetes in children and adolescents: An emerging pandemic. Diabetes/Metabolism Research and Reviews, 2025 Jan; 41(1): e70029.
3. Khan AS, Soleja AJ, Shaikh A, Sajid M, Khan AA, Anwar A. Prevalence of overall clinical features in Type 2 Diabetes Mellitus.
4. Ma CX, Ma XN, Guan CH, Li YD, Mauricio D, Fu SB. Cardiovascular disease in type 2 diabetes mellitus: progress toward personalized management. Cardiovascular diabetology, 2022 May 14; 21(1): 74.
5. Zakir M, Ahuja N, Surksha MA, Sachdev R, Kalariya Y, Nasir M, Kashif M, Shahzeen F, Tayyab A, moazzam Khan MS, Junejo M. Cardiovascular complications of diabetes: from microvascular to macrovascular pathways. Cureus, 2023 Sep 24; 15(9).
6. Kolakalapudi P, Omar B. Diabetes mellitus and the cardiovascular system. Journal of Endocrinology and Metabolism, 2015; 5(6): 313–320.
7. Lopez-de-Andres A, Jimenez-Garcia R, Hernández-Barrera V, de Miguel-Yanes JM, Albaladejo-Vicente R, Villanueva-Orbaiz R, Carabantes-Alarcon D, Zamorano-Leon JJ, Lopez-Herranz M, de Miguel-Diez J. Are there sex differences in the effect of type 2 diabetes in the incidence and outcomes of myocardial infarction? A matched-pair analysis using hospital discharge data. Cardiovascular Diabetology, 2021 Apr 22; 20(1): 81.
8. Kim YH, Her AY, Rha SW, Choi CU, Choi BG, Kim JB, Park S, Kang DO, Park JY, Park SH, Jeong MH. Comparison of clinical outcomes after non-ST-segment and ST-segment elevation myocardial infarction in diabetic and nondiabetic populations. Journal of Clinical Medicine, 2022 Aug 29; 11(17): 5079.
9. Mesri Alamdari N, Lotfi Yagin N, Ghaffari S, Roshanravan N, Zarrintan A, Mobbaseri M. The different effects of admission blood glucose levels on the outcomes of ST elevation myocardial infarction patients with and without diabetes. Scientific Reports, 2025 Jul 29; 15(1): 27682.
10. Rawshani A, McGuire DK, Omerovic E, Sattar N, McMurray JJ, Smith U, Redfors B, Bergfeldt L, Eliasson B, Borén J, Bhatt DL. Cardiac arrhythmias and conduction abnormalities in patients with type 2 diabetes. Scientific reports, 2023 Jan 21; 13(1): 1192.
11. Urlic H, Kumric M, Vrdoljak J, Martinovic D, Dujic G, Vilovic M, Ticinovic Kurir T, Bozic J. Role of echocardiography in diabetic cardiomyopathy: from mechanisms to clinical practice. Journal of cardiovascular development and disease, 2023 Jan 26; 10(2): 46.
12. Antakly-Hanon Y, Ben Hamou A, Garçon P, Moeuf Y, Banu I, Fumery M, Voican A, Abassade P, Oriez C, Chatellier G, Dupuy O. Asymptomatic left ventricular dysfunction in patients with type 2 diabetes free of cardiovascular disease and its relationship with clinical characteristics: The DIACAR cohort study. Diabetes, Obesity and Metabolism, 2021 Feb; 23(2): 434-43.
13. Wamil M, Goncalves M, Rutherford A, Borlotti A, Pellikka PA. Multi-modality cardiac imaging in the management of diabetic heart disease. Frontiers in Cardiovascular Medicine, 2022 Nov 3; 9: 1043711.
14. Sato R, Dugar S. Left Ventricular Diastolic Function. InEchocardiography and Ultrasonography in the ICU: A Comprehensive Text, 2025 Aug 27 (pp. 193-210). Cham: Springer Nature Switzerland.
15. Alizadehasl A, Mokhayeri M, Sohani Z, Zamanian MY, Shahbazi P, Borzouei S. A Comprehensive Review of Two-Dimensional Speckle-Tracking Echocardiography in Assessing Right and Left Ventricular Function in Diabetic Patients. Clinical Cardiology, 2025 May; 48(5): e70153.
16. Carrillo-Larco RM, Guzman-Vilca WC, Xu X, Bernabe-Ortiz A. Mean age and body mass index at type 2 diabetes diagnosis: Pooled analysis of 56 health surveys across income groups and world regions. Diabet Med, 2024 Feb; 41(2): e15174.
17. Alsenany S, Al Saif A. Incidence of diabetes mellitus type 2 complications among Saudi adult patients at primary health care center. J Phys Ther Sci, 2015 Jun; 27(6): 1727-30.
18. Yaqub S, Kashif W, Hussain SA. Non-diabetic renal disease in patients with type-2 diabetes mellitus. Saudi J Kidney Dis Transpl, 2012 Sep; 23(5): 1000-7.
19. Hu C, Lin L, Zhu Y, Zhang Y, Wang S, Zhang J, Qi H, Li M, Zhu Y, Huo Y, Wan Q. Association between age at diagnosis of type 2 diabetes and cardiovascular
diseases: A nationwide, population-based, cohort study. Frontiers in Endocrinology, 2021 Oct 4; 12: 717069.
20. Kautzky-Willer A, Leutner M, Harreiter J. Sex differences in type 2 diabetes. Diabetologia, 2023 Jun; 66(6): 986-1002. doi: 10.1007/s00125-023-05891-x. Epub 2023 Mar 10. Erratum in: Diabetologia, 2023 Jun; 66(6): 1165.
21. Higher prevalence of type 2 diabetes in men than in women is associated with differences in visceral fat mass. Nordström A, Hadrévi J, Olsson T, Franks PW, Nordström P. J Clin Endocrinol Metab, 2016; 101: 3740–3746.
22. Nawaz T, Nawaz V, Khurram T, Munsif SM, Waheed S, Moin S, Anwar A, Hashmi AA. Comparative Analysis of Clinical Features of Type 2 Diabetes Mellitus Between Men and Women. Cureus, 2025 May 20; 17(5): e84472.

23. Qin GQ, Chen L, Zheng J, Wu XM, Li Y, Yang K, Liu TF, Fang ZZ, Zhang Q. Effect of passive smoking exposure on risk of type 2 diabetes: a systematic review and meta-analysis of prospective cohort studies. Frontiers in Endocrinology, 2023 Jul 31; 14: 1195354.
24. Boye KS, Lage MJ, Thieu V, Shinde S, Dhamija S, Bae JP. Obesity and glycemic control among people with type 2 diabetes in the United States: a retrospective cohort study using insurance claims data. Journal of Diabetes and its Complications, 2021 Sep 1; 35(9): 107975.
25. Garg C, Daley SF. Obesity and Type 2 Diabetes. [Updated 2025 Jun 12]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing, 2025 Jan.
26. Petrie JR, Guzik TJ, Touyz RM. Diabetes, Hypertension, and Cardiovascular Disease: Clinical Insights and Vascular Mechanisms. Can J Cardiol, 2018 May; 34(5): 575-584.
27. Shihab A, Jawad S. The Prevalence of Cardiovascular Autonomic Neuropathy among Long Term TypeII Diabetes Mellitus. The Medical Journal of Tikrit University, 2024 Dec 31; 30(2): 210-20.
28. Suleman MA, Khalaf MA. Left Ventricular Diastolic Dysfunction in Asymptomatic Type 2 Diabetes Mellitus.
29. Hassan Ayman KM, Abdallah Mahmoud A, Abdel-Mageed Eman A, Marwa S, Soliman Mona M, Kishk Yehia T. Correlation between left ventricular diastolic dysfunction and dyslipidaemia in asymptomatic patients with new-onset type 2 diabetes mellitus. The Egyptian Journal of Internal Medicine, 2021 Dec; 33(1): 8.