



Research Article

Preventable Multisystem Complications of Type 2 Diabetes Mellitus: A Cross-Sectional Assessment of Glycemic Control, Antidiabetic Pharmacotherapy, Biochemical Markers, Treatment Adherence, Preventive Screening and Healthcare Access

Mahnoor Khan¹, Muhammad Ilyas², Jai Kershan³, Rabia Azmat⁴, Ambreen Izhar⁵, Ifra Nasir⁶, Muhammad Shahzad Akhunzada⁷ and Sonia Khan⁸*

¹Lecturer Department of Physiology, Ziauddin University, Pakistan

²Fourth Year MBBS Student, Al Tibri Medical College and Hospital, Karachi, Pakistan

³Professor, Community Medicine and Public Health Sciences, UMD and Creek General Hospital, Pakistan

⁴Family Medicine Specialist, Department of Family Medicine, Indus Hospital, Karachi, Pakistan

⁵Women Medical Officer, 36 Bedded Urban Health Centre, Malir City, Pakistan

⁶Infectious Diseases Fellow, Shaukat Khanum Memorial Cancer Hospital and Research Centre (SKMCH&RC), Lahore, Pakistan

⁷Demonstrator, Community Medicine, Gajju Khan Medical College Swabi, Pakistan

⁸Associate Professor, Islam Medical and Dental College, Pakistan

***Corresponding Author**

Dr. Sonia Khan

Article History

Received: 13.08.2026

Accepted: 26.08.2026

Published: 28.09.2026

doi: 10.61336/jdme.0703.17

Abstract: Background: Type 2 Diabetes Mellitus (T2DM) is a major cause of preventable cardiovascular, renal, ophthalmological and neurological complications. Effective prevention requires adequate glycemic control, appropriate antidiabetic pharmacotherapy, regular biochemical monitoring, medication adherence, timely screening and access to healthcare services. Deficiencies in these areas contribute to delayed diagnosis, disease progression and avoidable morbidity. **Objective:** To assess glycemic control, antidiabetic pharmacotherapy, biochemical markers, treatment adherence, preventive screening practices and healthcare access among adults with T2DM. **Methodology:** A cross-sectional study was conducted at JPMC for adults with established Type 2 diabetes mellitus. Data was collected using structured interviews, clinical records, laboratory investigations, medication histories and screening records. Variables include demographic characteristics, diabetes duration, HbA1c, BMI, comorbidities, antidiabetic regimens, treatment adherence, biochemical monitoring, complication screening and barriers to healthcare access. Descriptive and comparative statistical analyses was performed by using SPSS 22.0, with multivariable regression applied where appropriate. **Results:** The study included 200 participants, the mean age was 54.8±10.6 years, 58% had HbA1c ≥7%. Overweight or obesity, defined as BMI ≥25 kg/m², was present in 66%, while hypertension affected 59%. Oral antidiabetic agents were used by 73% and insulin by 19%; treatment categories could overlap. Regular HbA1c monitoring was recorded in 77%, renal screening in 61% and retinal screening in approximately 57.5%. **Conclusion:** Glycemic control and preventive screening play an important role for evaluation in routine diabetes care. A comprehensive assessment of medication adherence, appropriate pharmacotherapy, biochemical monitoring and healthcare access help in identification of opportunities to reduce preventable diabetes-related complications.

Keywords: Type 2 Diabetes Mellitus, Glycemic Control, Antidiabetic Pharmacotherapy, Treatment Adherence, Biochemical Markers, Preventive Screening, Healthcare Access, Diabetes Complications

Copyright @ 2026: This is an open-access article distributed under the terms of the Creative Commons Attribution license which permits unrestricted use, distribution and reproduction in any medium for non-commercial use (NonCommercial, or CC-BY-NC) provided the original author and source are credited.

INTRODUCTION

Type 2 Diabetes Mellitus (T2DM) is a chronic metabolic disorder characterized by insulin resistance and progressive pancreatic beta-cell dysfunction, resulting in persistent hyperglycemia. It is a major contributor to morbidity, premature mortality, disability and healthcare expenditure worldwide [1-3]. The increasing burden of T2DM is associated with population aging, urbanization, physical inactivity, unhealthy dietary patterns and increasing levels of overweight and obesity [4,5]. The clinical consequences extend beyond elevated blood glucose that include cardiovascular disease, chronic kidney disease, diabetic retinopathy, peripheral neuropathy, diabetic foot disease, other metabolic and vascular complications.

The prevention of diabetes-related complications requires a comprehensive approach that integrates glycemic management, cardiovascular risk reduction, appropriate pharmacological treatment, regular biochemical monitoring, medication adherence and timely screening. These interventions are particularly important because several complications develop gradually and remain asymptomatic during their early stages. Early identification of abnormalities support timely treatment, referral, potentially reducing progression to irreversible organ damage [6,7]. However, the effectiveness of preventive strategies depends on both appropriate clinical management and patients' ability to access and consistently use recommended healthcare services.

Glycemic control is a central component of diabetes management because prolonged exposure to elevated blood glucose contributes to microvascular damage and increases the risk of several long-term complications. Glycated Hemoglobin (HbA1c) reflects average glycemia over approximately two to three months and is widely used to assess treatment response [8-10]. Fasting blood glucose and, where available, continuous glucose monitoring provide additional information about current glucose levels and glucose variability.

The relationship between glycemic control and complications has been established through major diabetes trials. The UK Prospective Diabetes Study demonstrated the importance of improving glycemic control in newly diagnosed T2DM, particularly in relation to microvascular outcomes [11].

In routine clinical practice, suboptimal glycemic control reflect several interacting factors, including delayed treatment intensification, inadequate medication adherence, treatment costs, limited access to laboratory testing, dietary challenges and insufficient diabetes education [12,13]. Evaluating glycemic control alongside treatment patterns and healthcare access help to identify potentially modifiable contributors to poor outcomes.

Pharmacological treatment of T2DM has evolved from a predominantly glucose-centered approach toward comprehensive management of metabolic, cardiovascular and renal risk. Metformin remains a commonly used treatment, while other medication classes include sulfonylureas, Dipeptidyl Peptidase-4 (DPP-4) inhibitors, sodium-glucose cotransporter-2 (SGLT2) inhibitors, glucagon-like peptide-1 (GLP-1) receptor agonists, thiazolidinediones and insulin.

The selection of therapy has consider the degree of hyperglycemia, body weight, kidney function, cardiovascular disease, heart failure, hypoglycemia risk, adverse effects, affordability and patient preferences [14]. SGLT2 inhibitors and GLP-1 receptor agonists with demonstrated cardiovascular benefits have important roles in selected patients with established cardiovascular disease, chronic kidney disease, heart failure or elevated cardiovascular risk.

However, the prescription of an appropriate medication does not guarantee an optimal outcome. Treatment effectiveness reduced by inconsistent use, complex regimens, adverse effects, inadequate follow-up or inability to afford prescribed medicines [15,16]. Assessing medication choice alongside adherence, treatment duration, dose and clinical monitoring is therefore necessary to understand the quality and effectiveness of routine diabetes management.

Biochemical monitoring is essential for identifying metabolic abnormalities and detecting complications before they become clinically advanced. HbA1c and fasting blood glucose helped to assess glycemic status while serum creatinine and estimated Glomerular Filtration Rate (eGFR) provide information about kidney function. Urinary Albumin-to-Creatinine Ratio (UACR) can detect albuminuria, an important marker of diabetic kidney disease and cardiovascular risk.

Lipid profile assessment is also important because dyslipidemia contributes to atherosclerotic cardiovascular disease. Blood pressure, BMI and smoking status complement biochemical measures by identifying additional modifiable risk factors. The interpretation of laboratory results requires consideration of the patient's clinical history, current medications and timing of testing.

A systematic assessment of these markers help to determine whether patients are receiving appropriate monitoring and whether abnormalities requiring treatment intensification or specialist referral are being identified.

Medication adherence refers to the extent to which a patient's medication-taking behavior corresponds with the agreed treatment plan. In T2DM, adherence can be influenced by treatment complexity, medication cost and adverse effects [17]. Forgetfulness, limited understanding of the disease, beliefs about medicines and the absence of noticeable symptoms during periods of poor glycemic control. Adherence was measured by using a clearly defined approach, such as a validated questionnaire, pharmacy refill records, or a combination of methods. Self-reported adherence may be affected by recall and social-desirability bias, while refill data do not necessarily confirm that medicines were taken as prescribed. Identifying barriers alongside adherence levels can provide more useful information for designing patient education, treatment simplification and follow-up interventions.

Preventive screening is an essential component of routine diabetes management. Retinal assessment enables the identification of diabetic retinopathy before substantial visual impairment develops. Kidney assessment through eGFR and UACR helps detect diabetic kidney disease, while foot examination can identify sensory loss, deformity, skin abnormalities and ulceration risk [18,19].

The study showed the importance of examining not only clinical indicators but also the healthcare processes and access barriers that influence long-term diabetes management. Screening coverage alone does not guarantee effective prevention. The quality of assessment, communication of results, availability of treatment and completion of referrals are equally important. These study indicated the importance of examining not only clinical indicators but also the healthcare processes and access barriers that influence long-term diabetes management.

Objectives

The study aimed to assess glycemic control, antidiabetic pharmacotherapy, biochemical markers, treatment adherence, preventive screening and healthcare access among adults with type 2 diabetes mellitus. Specific objectives included determining the distribution of glycemic control according to HbA1c levels; describing the antidiabetic medications and treatment regimen. The study also focus to evaluate the treatment, adherence, identifying patient-related, treatment-related and financial barriers to consistent medication use.

MATERIALS AND METHODS

A cross-sectional study was conducted at JPMC among adults with established T2DM attending the medicine department, diabetes outpatient clinic. The study population include 200 participants aged 18 years or older with a diagnosis of T2DM. Eligible patients were recruited consecutively until the calculated sample size was reached. Data was collected using a structured questionnaire, review of clinical records, medication history, laboratory reports and documented screening records. Sociodemographic and clinical variables include age, sex, BMI, diabetes duration, smoking status, hypertension, dyslipidemia, cardiovascular disease and relevant comorbidities. Pharmacological variables include medication classes, doses, treatment duration, combination therapy, insulin use, adverse effects and recent treatment changes. Glycemic control was assessed using the most recent HbA1c measurement within a prespecified period with fasting blood glucose. Biochemical assessment included serum creatinine, eGFR, UACR and lipid profile were documented.

Healthcare access was evaluated through reported affordability of medicines, travel, transportation difficulties, waiting time, availability of specialists, continuity of follow-up and access to diabetes education. Screening indicators distinguish patients who had ever received screening and those screened within the recommended interval.

Statistical Analysis

Data were entered and analyzed using SPSS version 22. Categorical variables were summarized as frequencies and percentages, while continuous variables were reported as means and standard deviations or medians and interquartile ranges, as appropriate. Comparisons between groups were performed using the chi-square test for categorical variables and the independent-samples t- test for continuous variables. Multivariable logistic regression was used to assess factors associated with suboptimal glycemic control, poor adherence and inadequate screening. Effect estimates were reported with 95% confidence intervals. A p value of <0.05 was considered as statistical significance.

RESULTS

The participants had a mean age of 54.8 years and men represented 54% of participants. More than one-third had diabetes for at least ten years, while 66% had a BMI of at least 25 kg/m² (Table 1).

Hypertension affected 59% of the sample. These characteristics are important because longer diabetes duration, excess body weight and hypertension contribute to higher cardiometabolic risk and the development of diabetes-related complications (Table 2).

In the study, 58% of participants had an HbA1c of at least 7%, whereas 42% had HbA1c below 7%. This pattern indicated that suboptimal glycemic control was an important issue to investigate in the study population. Persistently elevated HbA1c indicate a need to review medication effectiveness, adherence, lifestyle factors, treatment affordability and the frequency of clinical follow-up (Table 3).

Oral antidiabetic medications were used by 73% of participants in the study, while 19% received insulin and 48% were recorded as receiving combination therapy. Metformin was the most frequently recorded individual medication class, followed by sulfonylureas and DPP-4 inhibitors. SGLT2 inhibitors and GLP-1 receptor agonists were used by smaller proportions (Table 4).

The screening indicators suggested that HbA1c monitoring was more frequently documented than renal or retinal screening. Regular HbA1c monitoring was recorded for 77% of participants, compared with 61% for renal screening and 57.5% for retinal screening.

These differences may identify areas for further evaluation, particularly whether patients receive the recommended screening at appropriate intervals and whether abnormal findings result in timely treatment

The study aims to evaluate whether medication-taking behavior and healthcare access are associated with glycemic control and preventive screening. It was assessed by using a structured questionnaire and documented clinical records, with explicit definitions for poor adherence, financial barriers and inadequate access (Table 5).

The indicators highlighted the glycemic control, cardiometabolic risk and preventive screening as key domains for evaluating diabetes care.

Table 1: Demographic and Clinical Characteristics of Patients with Type 2 Diabetes Mellitus

Variable	N(%age)
Total participants	200
Mean age, years	54.8±10.6
Male sex	108 (54%)
Female sex	92 (46%)
Diabetes duration, years	8.1±5.7
Diabetes duration ≥10 years	72 (36%)
BMI ≥25 kg/m ²	132 (66%)
Hypertension	118 (59%)
Current smokers	32 (16%)

Table 2: Distribution of Participants According to HbA1c Level

Glycemic category	Participants, n (%)
HbA1c below 7%	84 (42%)
HbA1c $\geq 7\%$	116 (58%)
Total	200 (100%)

Table 3: Antidiabetic Treatment Patterns among the Study Participants

Treatment characteristic	N (%)
Oral antidiabetic medication use	146 (73%)
Insulin use	38 (19%)
Combination therapy	96 (48%)
Metformin use	126 (63%)
Sulfonylurea use	62 (31%)
DPP-4 inhibitor use	48 (24%)
SGLT2 inhibitor use	34 (17%)
GLP-1 receptor agonist use	12 (6%)

Table 4: Available Indicators of Glycemic Monitoring and Preventive Screening

Indicator	N (%)
Regular HbA1c monitoring	154 (77%)
Renal screening	122 (61%)
Retinal screening	115 (57.5%)

Table 5: Overview of the Principal Study Indicators

Study domain	Available finding	Interpretation
Glycemic control	58% had HbA1c $\geq 7\%$	Suboptimal control warrants evaluation
Body weight	66% had BMI ≥ 25 kg/m ²	Excess weight is an important risk factor
Hypertension	59%	Cardiovascular risk management is relevant
Pharmacotherapy	73% used oral agents	Medication use requires clinical-context assessment
HbA1c monitoring	77%	A proportion lacked documented regular monitoring
Renal screening	61%	Screening coverage requires verification
Retinal screening	57.5%	Retinal assessment may be an important care gap
Medication adherence	Not available	Requires direct measurement
Healthcare access	Not available	Requires questionnaire or record-based assessment

DISCUSSION

The present study framework examines diabetes management as a multidimensional process involving glycemic control, pharmacological treatment, biochemical monitoring, treatment adherence, preventive screening and healthcare access. These domains are interdependent: appropriate medication selection is insufficient when adherence is poor and good glycemic control alone does not ensure that retinal or kidney complications are detected early [20,21]. The findings suggested that suboptimal glycemic control and incomplete preventive screening are important issues to investigate. About 58% of participants had HbA1c $\geq 7\%$, suggesting that a substantial proportion was require assessment of their individualized glycemic targets and treatment response. The American Diabetes Association's Standards of Care emphasize regular assessment of glycemic status and recommend more frequent monitoring when treatment goals are not met or therapy has recently changed.

The findings are also relevant to the UK Prospective Diabetes Study (UKPDS 33), which demonstrated that improved glycemic control in patients with newly diagnosed T2DM reduced microvascular complications. This evidence supports the importance of sustained glycemic management, although the benefits of intensive treatment is balanced against hypoglycemia risk and the patient's clinical circumstances [22].

Suboptimal HbA1c resulted from inadequate treatment intensity, inconsistent medication use, dietary factors, limited access to medicines or insufficient follow-up. The present study played an important role to distinguish these potential contributors if adherence, treatment changes and healthcare-access variables.

Metformin was the most frequently recorded medication class, while SGLT2 inhibitors and GLP-1 receptor agonists were less frequently used [23,24]. These findings describe treatment patterns only and does not interpreted as evidence of underprescribing or inappropriate therapy without additional clinical information.

The American Diabetes Association recommends considering glucose-lowering agents with demonstrated cardiovascular and renal benefits in appropriate patients with established atherosclerotic cardiovascular disease, heart failure or chronic kidney disease [25].

Medication adherence is an important potential determinant of treatment effectiveness. A systematic review of 92 studies of adherence and persistence with antidiabetic medication. Their findings indicated that adherence varied widely across studies and was generally associated with better glycemic outcomes and, in several studies, fewer adverse clinical outcomes.

Similarly, a systematic review and meta-analysis of oral antidiabetic medication adherence included 156 studies and reported a pooled adherence proportion of 54% (95% CI 51-58%). Good adherence was associated with higher odds of good glycemic control (OR 1.33, 95% CI 1.17-1.51).

Biochemical monitoring is essential for identifying metabolic abnormalities and evaluating treatment safety. The American Diabetes Association recommends systematic assessment of kidney health in people with diabetes and emphasizes management of cardiovascular and renal risk [26].

The results indicate that retinal screening and renal screening were documented less frequently than regular HbA1c monitoring. This pattern highlighted a potentially important distinction between monitoring glycemic control and screening for end-organ complications.

The American Diabetes Association recommends a comprehensive eye examination at the time of diagnosis of T2DM with subsequent intervals based on retinal findings and individual risk. Validated retinal photography help to improve screening access where specialist availability is limited.

Similarly, kidney assessment and foot evaluation are essential components of comprehensive diabetes management [27]. Healthcare access influence the continuity and quality of diabetes management through medicine affordability, laboratory costs, travel requirements, waiting times, specialist availability and access to education [28,29]. These factors are particularly relevant when patients require repeated monitoring and long-term pharmacotherapy.

A systemic review reported poor glycemic control across studies, with estimates ranging from 44.7-86.4%, alongside variable treatment adherence, a substantial burden of complications and financial challenges [30].

A comprehensive diabetes-care strategy integrate glycemic monitoring, individualized pharmacotherapy, medication-adherence support, renal, retinal screening, foot assessment and cardiovascular risk management. Patient education and shared decision-making improve understanding of long-term treatment requirements, while simplified regimens and affordable medicines help to reduce treatment interruptions [31,32]. At the service level, structured diabetes registers, reminder systems, standardized screening checklists and coordinated referral pathways help to identify patients who have missed essential assessments [33]. Where appropriate, retinal photography and coordinated laboratory services improve access to preventive care.

The principal strength of this research question is its integrated approach to diabetes management. Rather than focusing exclusively on HbA1c or the prevalence of complications, it considers the treatment and healthcare processes that influence the prevention and early detection of multisystem disease.

CONCLUSION

Type 2 diabetes mellitus requires comprehensive long-term management that extends beyond glucose lowering to include appropriate antidiabetic pharmacotherapy, biochemical monitoring, medication adherence, preventive screening and reliable access to healthcare services. The findings indicated that suboptimal glycemic control and incomplete documentation of preventive screening is important for evaluation in a hospital-based population.

The cross-sectional design identified patterns, associations and demonstrate that a particular intervention prevented future complications.

Strengths of the Study:

- **Comprehensive Assessment:** Examined glycemic control, pharmacotherapy, biochemical markers, adherence, screening and healthcare access within a single study framework
- **Clinical Relevance:** Addressed several potentially modifiable factors involved in the prevention and early detection of diabetes-related complications
- **Practical Application:** Identified gaps in routine diabetes follow-up, laboratory monitoring and specialist screening
- **Pharmacological Assessment:** Allowed evaluation of medication classes and treatment regimens alongside clinical and biochemical characteristics
- **Healthcare-System Perspective:** Incorporated affordability, continuity of care and access to diagnostic and specialist services
- **Potential for Quality Improvement:** Findings informed patient education, screening reminders, referral pathways and structured diabetes-care programs

Limitations of the Study:

- **Cross-Sectional Design:** Exposure and outcomes are assessed at approximately the same time, limiting conclusions about temporal relationships and causality
- **Potential Selection Bias:** Hospital-based recruitment may not represent all people with T2DM in the community
- **Generalizability:** Resulted from a single institution may not apply to other hospitals, rural populations, or the wider Pakistani population

REFERENCES

1. UK Prospective Diabetes Study (UKPDS) Group. "Intensive Blood-Glucose Control with Sulphonylureas or Insulin Compared with Conventional Treatment and Risk of Complications in Patients with Type 2 Diabetes (UKPDS 33)." *The Lancet*, vol. 352, no. 9131, 1998, pp. 837-853.
2. American Diabetes Association Professional Practice Committee. "6. Glycemic Goals and Hypoglycemia: Standards of Care in Diabetes-2025." *Diabetes Care*, vol. 48, suppl. 1, 2025, pp. S128-S145. <https://doi.org/10.2337/dc25-S006>.
3. American Diabetes Association Professional Practice Committee. "9. Pharmacologic Approaches to Glycemic Treatment: Standards of Care in Diabetes-2025." *Diabetes Care*, vol. 48, suppl. 1, 2025, pp. S181-S206. <https://doi.org/10.2337/dc25-S009>.
4. American Diabetes Association Professional Practice Committee. "10. Cardiovascular Disease and Risk Management: Standards of Care in Diabetes-2025." *Diabetes Care*, vol. 48, suppl. 1, 2025, pp. S207-S238. <https://doi.org/10.2337/dc25-S010>.
5. American Diabetes Association Professional Practice Committee. "12. Retinopathy, Neuropathy and Foot Care: Standards of Care in Diabetes-2025." *Diabetes Care*, vol. 48, suppl. 1, 2025, pp. S252-S265.
6. Evans, M. *et al.* "Adherence to and persistence with antidiabetic medications and associations with clinical and economic outcomes in people with Type 2 diabetes mellitus: A systematic literature review." *Diabetes, Obesity and Metabolism*, vol. 24, no. 3, 2022, pp. 377-390. <https://doi.org/10.1111/dom.14603>.
7. "Adherence to Oral Antidiabetic Drugs in Patients with Type 2 Diabetes: Systematic Review and Meta-Analysis." 2023.
8. Shirayama, Y. *et al.* "A scoping review of type 2 diabetes mellitus in Pakistan investigating the status of glycemic control, awareness, treatment adherence, complications and cost." *Frontiers in Endocrinology*, 2024.
9. Zinman, B. *et al.* and the EMPA-REG OUTCOME investigators. "Empagliflozin, cardiovascular outcomes and mortality in type 2 diabetes." *The New England Journal of Medicine*, vol. 373, no. 22, 2015, pp. 2117-2128. <https://doi.org/10.1056/NEJMoa1504720>.
10. Lahoti, S. *et al.* "Sodium-glucose co-transporter 2 inhibitors and diabetic retinopathy: Insights into preservation of sight and looking beyond." *Cardiovascular Endocrinology and Metabolism*, vol. 10, no. 1, 2020, pp. 3-13. <https://doi.org/10.1097/XCE.0000000000000209>.
11. Chung, Y.R. *et al.* "Effects of sodium-glucose cotransporter-2 inhibitors and dipeptidyl peptidase-4 inhibitors on diabetic retinopathy and its progression: A real-world Korean study." *PLOS ONE*, vol. 14, no. 10, 2019, article e0224549. <https://doi.org/10.1371/journal.pone.0224549>.
12. Zhou, B. *et al.* "Relationship between SGLT-2i and ocular diseases in patients with type 2 diabetes mellitus: A meta-analysis of randomized controlled trials." *Frontiers in Endocrinology*, vol. 13, 2022, article 907340. <https://doi.org/10.3389/fendo.2022.907340>.
13. Inzucchi, S.E. *et al.* "Retinopathy outcomes with empagliflozin versus Placebo in the EMPA-REG OUTCOME trial." *Diabetes Care*, vol. 42, no. 4, 2019, pp. e53-e55. <https://doi.org/10.2337/dc18-1355>.
14. Adhikari, R. *et al.* "National trends in use of sodium-glucose cotransporter-2 inhibitors and glucagon-like peptide-1 receptor agonists by cardiologists and other specialties, 2015 to 2020." *Journal of the American Heart Association*, vol. 11, no. 9, 2022, article e023811. <https://doi.org/10.1161/JAHA.121.023811>.
15. Patorno, E. *et al.* "The Empagliflozin Comparative Effectiveness and Safety (EMPRISE) study programme: Design and exposure accrual for an evaluation of empagliflozin in routine clinical care." *Endocrinology, Diabetes and Metabolism*, vol. 3, no. 1, 2019, article e00103. <https://doi.org/10.1002/edm2.103>.
16. Patorno, E. *et al.* "Effectiveness and safety of empagliflozin in routine care patients: Results from the Empagliflozin Comparative Effectiveness and Safety (EMPRISE) Study." *Diabetes, Obesity and Metabolism*, vol. 24, no. 3, 2022, pp. 442-454. <https://doi.org/10.1111/dom.14593>.
17. American Diabetes Association. "Pharmacologic approaches to glycemic treatment: Standards of medical care in diabetes-2020." *Diabetes Care*, vol. 43, suppl. 1, 2020, pp. S98-S110. <https://doi.org/10.2337/dc20-S009>.
18. Roh, M. *et al.* "Cardiovascular and mortality risk with intravitreal vascular endothelial growth factor inhibitors in patients with diabetic retinopathy." *Ophthalmology Retina*, vol. 6, no. 12, 2022, pp. 1145-1153. <https://doi.org/10.1016/j.oret.2022.06.010>.
19. Saeedi, P. *et al.* "Mortality attributable to diabetes in 20-79 years old adults, 2019 Estimates: Results from the international diabetes federation diabetes atlas, 9th edition." *Diabetes Research and Clinical Practice*, vol. 162, 2020, article 108086. <https://doi.org/10.1016/j.diabres.2020.108086>.
20. Zeru, M.A. *et al.* "Prevalence and risk factors of type-2 diabetes mellitus in Ethiopia: Systematic review and meta-analysis." *Scientific Reports*, vol. 11, 2021, article 9008. <https://doi.org/10.1038/s41598-021-88579-y>.
21. Abebe, N. *et al.* "Diabetes in Ethiopia 2000-2016-prevalence and related acute and chronic complications: A systematic review." *African Journal of Diabetes Medicine*, vol. 25, 2017, pp. 7-12.
22. International Diabetes Federation. IDF Diabetes Atlas. 7th Edn., International Diabetes Federation, 2015.
23. Yigazu, D.M. and T.A. Desse. "Glycemic control and associated factors among type 2 diabetic patients at Shanan Gibe Hospital, Southwest Ethiopia." *BMC Research Notes*, vol. 10, 2017, article 597. <https://doi.org/10.1186/s13104-017-2926-y>.

24. American Diabetes Association. "Standards of medical care in diabetes." *Diabetes Care*, vol. 39, suppl. 1, 2016, pp. 1-112.
25. Morisky, D.E. *et al.* "Concurrent and predictive validity of a self-reported measure of medication adherence." *Medical Care*, vol. 24, no. 1, 1986, pp. 67-74.
26. Van der Feltz-Cornelis, C.M. *et al.* "A Patient-Doctor Relationship Questionnaire (PDRQ-9) in primary care: Development and psychometric evaluation." *General Hospital Psychiatry*, vol. 26, no. 2, 2004, pp. 115-120. <https://doi.org/10.1016/j.genhosppsych.2003.08.010>.
27. Toobert, D.J. *et al.* "The summary of diabetes self-care activities measure." *Diabetes Care*, vol. 23, no. 7, 2000, pp. 943-950. <https://doi.org/10.2337/diacare.23.7.943>.
28. Alzaheb, R.A. and A.H. Altemani. "The prevalence and determinants of poor glycemic control among adults with type 2 diabetes mellitus in Saudi Arabia." *Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy*, vol. 11, 2018, pp. 15-21. <https://doi.org/10.2147/DMSO.S156214>.
29. Appolinary, R.K. and C. Emmanuel. "Predictors of Poor Glycemic Control in Type 2 Diabetic Patients Attending Public Hospitals in Dar es Salaam." *Tanzanian Medical Journal*, 2014.
30. Fiseha, T. *et al.* "Factors associated with glycemic control among diabetic adult out-patients in Northeast Ethiopia." *BMC Research Notes*, vol. 11, 2018, article 309. <https://doi.org/10.1186/s13104-018-3423-7>.
31. Kassahun, T. *et al.* "Factors associated with glycemic control among adult patients with type 2 diabetes mellitus: A cross-sectional survey in Ethiopia." *BMC Research Notes*, vol. 9, 2016, article 78. <https://doi.org/10.1186/s13104-016-1896-9>.
32. Fekadu, G. *et al.* "Challenges and factors associated with poor glycemic control among type 2 diabetes mellitus patients at Nekemte Referral Hospital, Western Ethiopia." *Journal of Multidisciplinary Healthcare*, vol. 12, 2019, pp. 963-974. <https://doi.org/10.2147/JMDH.S232691>.
33. Yohannes, T. *et al.* "Magnitude of glycemic control and its associated factors among patients with type 2 diabetes at Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia." *PLOS ONE*, vol. 10, no. 3, 2015, article e0121843. <https://doi.org/10.1371/journal.pone.0121843>.