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Original Article

Prevalence and Factors Associated with Poor Glycemic Control Among Patients with Type 2 Diabetes Mellitus Attending a Tertiary Care Hospital in Khyber Pakhtunkhwa, Pakistan: A Cross-Sectional Study

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Abstract

Objective: To assess the prevalence of poor glycemic control and identify independent factors associated with poor glycemic control in T2DM patients in the diabetes outpatient clinic of a tertiary care hospital.

Methodology: This cross-sectional study was conducted in the Department of Medicine, Mardan Medical Complex, Mardan, over three months (January to March 2026). We consecutively recruited patients with T2DM diagnosed for ≥ 3 months ($n=400$). We defined poor glycaemic control as $HbA1c \geq 7\%$. We assessed physical activity, adherence, income, and follow-up. We analyzed data using SPSS 26.0 and Python. Logistic regression identified factors associated with poor glycaemic control. We assessed model performance using the Hosmer–Lemeshow test, AUC, bootstrap resampling, and 10-fold cross-validation.

Results: Poor glycaemic control was observed in 60.8% (243/400; 95% CI, 56.0–65.5%) of patients. On multivariable analysis, poor glycaemic control was independently associated with physical inactivity, poor dietary and medication adherence, overweight/obesity, insulin-containing regimens, absence of self-monitoring of blood glucose, diabetes duration >5 years, and low household income. Rural residence, hypertension, and current smoking were significant on univariate analysis but not after multivariable adjustment. The model showed acceptable discrimination, with an apparent AUC of 0.78 and an internally validated AUC of 0.74–0.75.

Conclusions: The T2DM outpatients had poor glycemic control at their last visit. The identified associated factors were mostly modifiable with structured lifestyle counseling, adherence support, interventions, and self-management education, and warrant assessment in future interventional studies.

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Introduction

Diabetes mellitus Type 2 (T2DM) is one of the biggest public health challenges of the twenty-first century. The burden of mortality and disability-adjusted life years (DALYs) due to T2DM has been increasing most rapidly in low- and low-middle sociodemographic index (SDI) countries, driven mainly by population growth and epidemiological transition[2]. HbA1c below 7% is an important biomarker to monitor long-term glycemic control. In most non-pregnant adults, the aim of glycaemic control is to keep HbA1c <7%, which may be more challenging in resource-limited healthcare settings.³ However, microvascular and macrovascular complications are significantly reduced in those with good glycaemic control[3]. A recent scoping review of the Pakistani literature found that all studies reported poor glycaemic control ranging from 44.7% to 86.4%, low levels of diabetes-related knowledge in T2DM patients, and poor adherence to treatment [4]. The patterns have been observed in hospital- and clinic-based studies in other low- and middle-income countries (LMICs). In hospital-based case-control and cohort studies in Ethiopia, factors associated with poor glycaemic control included younger age, irregular physical activity, medication non-adherence, and comorbidities [5,6]. Previous studies in Pakistan have examined individual factors affecting glycaemic control. However, few have combined socioeconomic, behavioral, anthropometric, and treatment-related factors in the same cohort of tertiary-care diabetes clinic outpatients in Khyber Pakhtunkhwa [7,8]. Patients in tertiary care referral clinics may differ systematically from those in primary care in disease severity, treatment complexity, and the number of comorbidities, which may affect the pattern of factors associated with poor control in this setting. Therefore, this study aimed to identify factors independently associated with poor glycaemic control and determine the prevalence of poor glycaemic control among patients with T2DM attending the outpatient clinic in a tertiary care hospital setting.

Materials and Methods

This analytical cross-sectional study was conducted in the Outpatient Diabetes Clinic, Department of Medicine, Mardan Medical Complex, Mardan, a tertiary-care teaching hospital of Bacha Khan Medical College, Mardan, Khyber Pakhtunkhwa, Pakistan, over 3 months from January 2026 to March 2026. The Institutional Ethical Review Committee of Bacha Khan Medical College, Mardan, approved the study (letter No. 681/BKMC dated 23/12/2025). All participants gave written informed consent before entering the study.

Data Collection

We collected data using a structured, pretested questionnaire covering sociodemographic, anthropometric, clinical, behavioral, and treatment-related variables. We recorded information on diabetes duration, physical activity, dietary and medication adherence, self-monitoring, smoking, household income, comorbidities, treatment regimen, and HbA1c levels. Pasted text

Participants

We screened patients attending the outpatient diabetes clinic consecutively during the study period. Eligible participants had confirmed type 2 diabetes mellitus for at least six months and a recent HbA1c measurement within three months. Patients with type 1, gestational, or secondary diabetes were excluded.

Sample Size

Sample size calculation was based on the assumption of a pooled prevalence of poor glycaemic control of 62% reported in similar regional literature, a 95% confidence level ($Z = 1.96$) and a margin of error of 5%, using the formula for the single-population-proportion sample size ($n = Z^2p(1-p)/d^2$). This yielded a minimum required sample of 362 patients. Patients were recruited using consecutive sampling to ensure that the number of patients analyzed (400) was sufficient to account for the number of patients to be expected due to exclusions and missing data; a total of 470 patients were assessed for eligibility over the course of the study, as shown below and in Figure 1.

Inclusion Criteria

Patients were eligible if they had a confirmed diagnosis of type 2 diabetes mellitus for at least six months, were attending the outpatient diabetes clinic, and had a documented HbA1c measurement obtained within the previous three months.

Exclusion Criteria

Patients were excluded if they had type 1 diabetes mellitus, gestational diabetes, secondary diabetes, had received a blood transfusion within the previous three months, or declined participation.

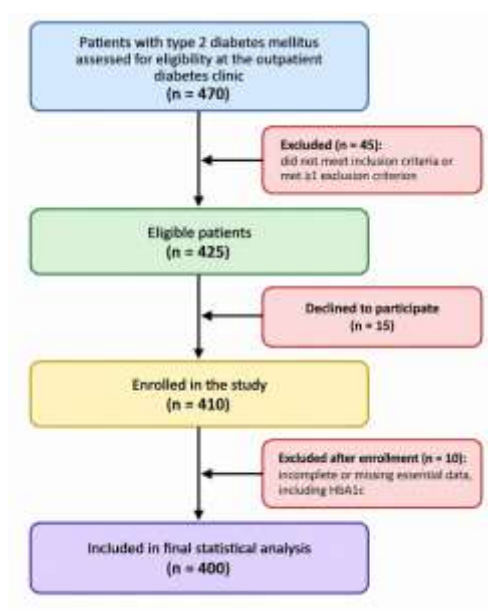
Statistical Analysis

Data were analyzed using IBM SPSS Statistics version 26.0 and Python 3 with pandas, scipy, statsmodels, and scikit-learn. Categorical variables were summarized as frequencies and percentages and compared using the chi-square test. Continuous variables were expressed as mean $\pm$ standard deviation or median (IQR) and compared using an independent-samples t-test or Mann-Whitney U test. Crude odds ratios (ORs) with 95% confidence intervals (CIs) were calculated. Variables meeting the predefined univariate screening threshold of $p < 0.25$, along with clinically relevant variables, were included in multivariable logistic regression. We reported adjusted odds ratios (aORs) with 95% CIs to identify independent factors associated with poor glycemic control. Multicollinearity was assessed using variance inflation factors (VIFs). We evaluated model calibration using the Hosmer-Lemeshow test, and discrimination using the area under the receiver operating characteristic curve (AUC). We performed internal validation using 1,000-repetition bootstrap resampling and 10-fold cross-validation, reporting Brier scores and calibration measures. We determined the optimal classification threshold using the Youden index and calculated sensitivity, specificity, positive predictive value, and negative predictive value. We considered $p < 0.05$ statistically significant.

Results

We evaluated 470 patients with type 2 diabetes mellitus (T2DM) for eligibility during the study period at the outpatient diabetes clinic. Of these, 45 were excluded for not meeting the inclusion criteria or for meeting one or more exclusion criteria, and 425 were eligible for inclusion. Of these, 410 participants declined to participate. Another 10 subjects were then excluded due to missing key information, such as HbA1c testing. Thus, the final analysis included 400 participants (Figure 1). In the final analytic dataset, no data were missing for any variables required for this study.

Figure 1: Participant Recruitment and Flow Diagram



Flow diagram illustrating participant screening, exclusions, eligibility assessment, and final enrollment of 400 patients with type 2 diabetes mellitus

Table 1. Sociodemographic and Anthropometric Characteristics of Participants by Glycemic Control Status

Variable	Poor control (n=243)	At-target control (n=157)	Crude OR (95% CI)	p-value
Age, mean ± SD, years	52.4 ± 13.0	51.6 ± 13.4	—	0.511
Age ≥50 years	139 (57.2)	85 (54.1)	1.13 (0.76–1.70)	0.547
Male sex	134 (55.1)	84 (53.5)	1.07 (0.71–1.60)	0.748
Rural residence	125 (51.4)	63 (40.1)	1.58 (1.05–2.37)	0.027
Illiterate	95 (39.1)	55 (35.0)	1.19 (0.78–1.81)	0.412
Low household income	144 (59.3)	78 (49.7)	1.47 (0.98–2.21)	0.060
BMI, mean ± SD, kg/m²	28.4 ± 5.8	26.0 ± 6.0	—	<0.001
Overweight/obese (BMI ≥25 kg/m²)	164 (67.5)	72 (45.9)	2.45 (1.62–3.70)	<0.001

Data are presented as mean ± standard deviation or frequency (%), as appropriate. OR = odds ratio; CI = confidence interval; BMI = body mass index. Crude ORs compare patients with poor glycemic control with those having at-target control. Pasted text

Table 2. Clinical, Behavioral, and Treatment-Related Factors by Glycemic Control Status

Variable	Poor control (n=243)	At-target control (n=157)	Crude OR (95% CI)	p-value
Diabetes duration, mean ± SD, years	9.1 ± 5.9	7.7 ± 5.6	—	0.022
Diabetes duration >5 years	159 (65.4)	81 (51.6)	1.78 (1.18–2.68)	0.006
Physical inactivity	153 (63.0)	61 (38.9)	2.68 (1.77–4.04)	<0.001
Poor dietary adherence	140 (57.6)	58 (36.9)	2.32 (1.54–3.50)	<0.001
Poor medication adherence	119 (49.0)	56 (35.7)	1.73 (1.15–2.61)	0.009
No self-monitoring of blood glucose	165 (67.9)	85 (54.1)	1.79 (1.18–2.71)	0.006
Current smoker	80 (32.9)	40 (25.5)	1.44 (0.92–2.25)	0.113
Comorbid hypertension	132 (54.3)	71 (45.2)	1.44 (0.96–2.16)	0.075
Positive family history of diabetes	151 (62.1)	89 (56.7)	1.25 (0.83–1.89)	0.277
Insulin-containing regimen	108 (44.4)	46 (29.3)	1.93 (1.26–2.96)	0.002
Irregular clinic follow-up	119 (49.0)	70 (44.6)	1.19 (0.80–1.78)	0.391

Data are presented as mean ± standard deviation or frequency (%). OR = odds ratio; CI = confidence interval. Crude ORs were calculated for each factor in relation to poor glycemic control. A p-value <0.05 was considered statistically significant

Table 3. Multivariable Logistic Regression Analysis of Factors Associated with Poor Glycemic Control

Factor	Adjusted OR (95% CI)	p-value
Physical inactivity	2.60 (1.64–4.12)	<0.001
Poor dietary adherence	2.58 (1.62–4.11)	<0.001
Overweight/obese (BMI ≥25 kg/m²)	2.32 (1.47–3.68)	<0.001
Insulin-containing regimen	2.12 (1.31–3.44)	0.002
Poor medication adherence	2.01 (1.25–3.23)	0.004
No self-monitoring of blood glucose	1.83 (1.14–2.91)	0.012
Diabetes duration >5 years	1.66 (1.04–2.65)	0.033
Low household income	1.61 (1.01–2.57)	0.044
Current smoker	1.47 (0.89–2.44)	0.136
Comorbid hypertension	1.38 (0.87–2.18)	0.173
Rural residence	1.44 (0.91–2.28)	0.119

Multivariable logistic regression was used to identify factors independently associated with poor glycemic control. AOR = adjusted odds ratio; CI = confidence interval; BMI = body mass index. Reference categories were good physical activity, good dietary and medication adherence, self-monitoring of blood glucose, diabetes duration ≤5 years, BMI <25 kg/m², higher household income, urban residence, and absence of hypertension.

Discussion

In the present cross-sectional study, 60.8% of patients with type 2 diabetes mellitus (T2DM) had poor glycemic control, while 39.2% achieved the predefined HbA1c target. This finding indicates a substantial burden of inadequate glycemic control among patients attending a tertiary-care diabetes clinic in Khyber Pakhtunkhwa. Similar difficulties in achieving glycemic targets have been reported in other tertiary-care and outpatient populations, where lifestyle factors, treatment adherence, disease duration, and socioeconomic conditions contribute to variation in glycemic control [9,10]. Physical inactivity was independently associated with poor glycemic control in the present study (aOR, 2.60; 95% CI, 1.64–4.12; $p < 0.001$). This finding is consistent with evidence showing that regular physical activity improves insulin sensitivity and contributes to better glycemic control among individuals with T2DM [12]. Poor dietary adherence was also independently associated with poor glycemic control (aOR, 2.58; 95% CI, 1.62–4.11; $p < 0.001$). Systematic reviews indicate that dietary interventions, including Mediterranean-style and other structured dietary approaches, can produce clinically meaningful improvements in HbA1c levels [16]. These findings emphasize the importance of integrating dietary counseling and physical activity into routine diabetes management. Overweight or obesity was another independent factor associated with poor glycemic control (aOR, 2.32; 95% CI, 1.47–3.68; $p < 0.001$). Patients with poor glycemic control had a higher mean BMI than those with at-target control. Recent evidence has demonstrated an association between higher BMI and poorer glycemic control in individuals with T2DM, supporting the importance of weight management as part of comprehensive diabetes care [13,17]. Obesity may contribute to insulin resistance and make it harder to achieve recommended glycemic targets. Poor medication adherence was independently associated with poor glycemic control (aOR, 2.01; 95% CI, 1.25–3.23; $p = 0.004$). This observation is consistent with studies demonstrating that adherence to oral antidiabetic medications is an important determinant of glycemic outcomes [18,19]. Similarly, the absence of self-monitoring of blood glucose was independently associated with poor control (aOR, 1.83; 95% CI, 1.14–2.91; $p = 0.012$). Structured self-monitoring may support treatment adjustment and patient self-management, particularly in appropriately selected patients [20]. An insulin-containing treatment regimen was associated with poor glycemic control (aOR, 2.12; 95% CI, 1.31–3.44; $p = 0.002$). Interpret this association cautiously; it does not prove that insulin therapy causes poor glycemic control. Insulin is frequently introduced or intensified in patients with more advanced disease or persistent hyperglycemia; therefore, confounding by indication and reverse causality are possible explanations. Contemporary treatment recommendations support treatment intensification, including insulin when clinically indicated, in patients who remain above their individualized glycemic targets [21]. Diabetes duration of more than 5 years was also independently associated with poor glycemic control (aOR, 1.66; 95% CI, 1.04–2.65; $p = 0.033$). Longer disease duration may be accompanied by progressive changes in pancreatic β -cell function, increasing treatment complexity and making glycemic targets more difficult to maintain [14]. However, the sensitivity analysis showed that diabetes duration was no longer statistically significant when modeled as a continuous variable. Therefore, interpret this association with greater caution than the more consistent findings for BMI and behavioral factors. Low household income remained independently associated with poor glycemic control (aOR, 1.61; 95% CI, 1.01–2.57; $p = 0.044$). Socioeconomic circumstances may influence access to healthcare, medication affordability, dietary choices, health literacy, and the ability to maintain recommended lifestyle behaviors. The observed association highlights the importance of considering socioeconomic circumstances when designing diabetes self-management

interventions. Rural residence, current smoking, and comorbid hypertension were associated with poor glycemic control in univariate analyses but were not independently significant after multivariable adjustment. These findings suggest that other measured behavioral, socioeconomic, or clinical factors may have partly explained the initial associations. Previous studies have similarly demonstrated that individual sociodemographic and clinical factors may lose statistical significance after adjustment for multiple determinants of glycemic control [9,23,24]. The present study also demonstrated a progressive increase in the proportion of patients with poor glycemic control as the number of associated factors increased. However, this pattern should be interpreted as an accumulation of associated characteristics rather than a causal dose-response relationship. Internal validation analyses showed modest optimism in the apparent model performance, with the AUC decreasing from 0.78 to approximately 0.75 after bootstrap correction and to 0.74 with 10-fold cross-validation. These findings support reasonable internal discrimination but require external validation before application to other populations. This study has several limitations. Its cross-sectional design prevents determination of temporal or causal relationships. Self-reported dietary and medication adherence may be affected by recall and social-desirability bias. The single-center tertiary-care setting may limit generalizability to primary-care and community populations. Dichotomization of continuous variables may also reduce statistical information. Confounding by indication may affect the association between insulin-containing therapy and poor glycemic control. In addition, we did not assess psychological factors, objective measures of medication adherence, or other potentially relevant determinants. Although we performed bootstrap resampling and 10-fold cross-validation, we did not externally validate the model. Overall, the findings indicate that poor glycemic control in this tertiary-care population was associated with multiple behavioral, anthropometric, treatment-related, disease-duration, and socioeconomic factors. Interventions addressing physical activity, dietary and medication adherence, weight management, self-monitoring, and socioeconomic barriers may be relevant components of comprehensive diabetes care [11,15,25].

Conclusion

Poor glycemic control affected 60.8% of patients with T2DM. Physical inactivity, poor dietary and medication adherence, overweight/obesity, insulin-containing therapy, lack of self-monitoring, longer diabetes duration, and low household income were independently associated with poor control. Structured lifestyle counseling and diabetes self-management interventions may improve glycemic outcomes.

Conflict of Interest

The authors declare no conflict of interest.

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Ethical Approval

Ethical approval was obtained from the Institutional Ethical Review Committee of Bacha Khan Medical College, Mardan (**Letter No. 681/BKMC, dated December 23, 2025**),

Authors' Contribution

Fazli Rabbi: Conceptualization, Methodology, Writing – original draft.

Muhammad Sohrab: Investigation, Data curation.

Shah Zeb: Investigation (laboratory analysis), Methodology.

Murad Ali: Formal analysis, Writing – review & editing, Supervision.

All authors read and approved the final manuscript, and each author confirms that they meet the ICMJE criteria for authorship.

References

- Genitsaridi I, Salpea P, Salim A, Sajjadi SF, Tomic D, James S, et al. 11th edition of the IDF Diabetes Atlas: global, regional, and national diabetes prevalence estimates for 2024 and projections for 2050. *Lancet Diabetes Endocrinol.* 2026;14(2):149-156. doi:10.1016/S2213-8587(25)00299-2
- He KJ, Wang H, Xu J, Gong G, Liu X, Guan H. Global burden of type 2 diabetes mellitus from 1990 to 2021, with projections of prevalence to 2044: a systematic analysis across SDI levels for the Global Burden of Disease Study 2021. *Front Endocrinol (Lausanne).* 2024;15:1501690. doi:10.3389/fendo.2024.1501690.
- American Diabetes Association Professional Practice Committee. 6. Glycemic goals, hypoglycemia, and hyperglycemic crises: Standards of Care in Diabetes-2026. *Diabetes Care.* 2026;49(Suppl 1):S132-S149. doi:10.2337/dc26-S006
- Taimur H, Ahmad I, Khan H, Shirayama Y, Okamoto M, Aung MN, et al. A scoping review of type 2 diabetes mellitus in Pakistan investigating the status of glycemic control, awareness, treatment adherence, complications and cost. *Front Endocrinol (Lausanne).* 2024;15:1441591. doi:10.3389/fendo.2024.1441591
- Mengstie MA, Abebe EC, Dejenie TA, Seid MA, Teshome AA. Frequency and correlates of poor glycemic control in patients with type 2 diabetes at Jimma Medical Center, Ethiopia: a cross-sectional study. *Pan Afr Med J.* 2024;47:7. doi:10.11604/pamj.2024.47.7.37452.
- Yahaya JJ, Doya IF, Morgan ED, Ngaiza AI, Bintabara D. Poor glycemic control and associated factors among patients with type 2 diabetes mellitus: a cross-sectional study. *Sci Rep.* 2023;13(1):9673. doi:10.1038/s41598-023-36675-3.
- Phuwilert P, Khiewkhern S, Phajan T, Wongprachum K, Wibuloutai J, Srichomphoo C, et al. Factors affecting glycemic control in patients with type 2 diabetes in Kalasin Province, Thailand: an analytical cross-sectional study. *Healthcare (Basel).* 2024;12(19):1916. doi:10.3390/healthcare12191916.
- Legese GL, Asres G, Alemu S, Yesuf T, Tesfaye YA, Amare T. Determinants of poor glycemic control among type 2 diabetes mellitus patients at University of Gondar Comprehensive Specialized Hospital, Northwest Ethiopia: unmatched case-control study. *Front Endocrinol (Lausanne).* 2023;14:1087437. doi:10.3389/fendo.2023.1087437.
- Shita NG, Iyasu AS. Predictors of poor glycemic control among patients with type 2 diabetes on follow-up care at a tertiary healthcare setting in Ethiopia. *Sci Rep.* 2022;12(1):9459. doi:10.1038/s41598-022-13673-5.
- Butt MD, Ong SC, Rafiq A, Malik T, Sajjad A, Batool N, et al. An observational multi-center study on type 2 diabetes treatment prescribing pattern and patient adherence to treatment. *Sci Rep.* 2023;13(1):23037. doi:10.1038/s41598-023-50517-2.
- Shaikh N, Qureshi N, Qureshi MJ, Mian ZR, Saeed H, Rana MA, et al. Association of antidiabetic medication regimens and medication adherence with HbA1c reduction in type 2 diabetic patients: a retrospective study. *Cureus.* 2025;17(9):e92853. doi:10.7759/cureus.92853.
- Dong C, Liu R, Huang Z, et al. Effect of exercise interventions based on family management or self-management on glycaemic control in patients with type 2 diabetes mellitus: a systematic review and meta-analysis. *Diabetol Metab Syndr.* 2023;15:232. doi:10.1186/s13098-023-01209-4.
- Deng L, Jia L, Wu XL, Cheng M. Association between body mass index and glycemic control in type 2 diabetes mellitus: a cross-sectional study. *Diabetes Metab Syndr Obes.* 2025;18:555-563. doi:10.2147/DMSO.S508365.
- Kumar J, Rehman T, Barkat R, Shah BL, Sindhu L, Husnain M, et al. A comparative analysis of clinical features of diabetes mellitus type 2 with respect to duration of diabetes. *Cureus.* 2024;16(11):e74849. doi:10.7759/cureus.74849.
- Hassen K, Abebe ST, Banjaw Z, Ibrahim M, et al. Depression and glycaemic control among adult patients with type 2 diabetes: a cross-sectional study in a comprehensive specialized hospital, Jigjiga, Ethiopia. *BMJ Open.* 2023;13(11):e073123. doi:10.1136/bmjopen-2023-073123.
- Jing T, Zhang S, Bai M, Chen Z, Gao S, Li S, et al. Effect of dietary approaches on glycemic control in patients with type 2 diabetes: a systematic review with network meta-analysis of randomized trials. *Nutrients.* 2023;15(14):3156. doi:10.3390/nu15143156.
- Newson RS, Divino V, Boye KS, Chen J, DeKoven M, Vallarino C, et al. Glycemic control and obesity among people with type 2 diabetes in Europe and Australia: a retrospective cohort analysis. *Diabetes Ther.* 2024;15(6):1435-1449. doi:10.1007/s13300-024-01583-w.
- Piragine E, Petri D, Martelli A, Calderone V, Lucenteforte E. Adherence to oral antidiabetic drugs in patients with type 2 diabetes: systematic review and meta-analysis. *J Clin Med.* 2023;12(5):1981. doi:10.3390/jcm12051981.
- Sendekie AK, Netere AK, Kasahun AE, Belachew EA. Medication adherence and its impact on glycemic control in type 2 diabetes mellitus patients with comorbidity: a multicenter cross-sectional study in Northwest Ethiopia. *PLoS One.* 2022;17(9):e0274971. doi:10.1371/journal.pone.0274971.
- Holmes-Truscott E, Baptista S, Ling M, Collins E, Ekinci EI, Furler J, et al. The impact of structured self-monitoring of blood glucose on clinical, behavioral, and psychosocial outcomes among adults with non-insulin-treated type 2 diabetes: a systematic review and meta-analysis. *Front Clin Diabetes Healthc.* 2023;4:1177030. doi:10.3389/fcdhc.2023.1177030.
- Davies MJ, Aroda VR, Collins BS, Gabbay RA, Green J, Maruthur NM, et al. Management of hyperglycemia in type 2 diabetes, 2022. A consensus report by the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD). *Diabetes Care.* 2022;45(11):2753-2786. doi:10.2337/dci22-0034.
- Ananthakumar B, Raghavan R. Social and rural determinants of glycemic control in type 2 diabetes mellitus. *Indian J Med Res.* 2026;163(2):231-236. doi:10.25259/IJMR_1884_2025.
- Zhai Z, Yang Y, Lin G, Lin W, Wu J, Liu X, et al. Hypertension and hyperlipidemia status among type 2 diabetic patients in the community and analysis of influencing factors for glycemic control. *Diabetol Metab Syndr.* 2023;15(1):73. doi:10.1186/s13098-023-01013-0.
- Sia HK, Kor CT, Tu ST, Liao PY, Wang JY. Association between smoking and glycemic control in men with newly diagnosed type 2 diabetes: a retrospective matched cohort study. *Ann Med.* 2022;54(1):1385-1394. doi:10.1080/07853890.2022.2075559.
- Chowdhury HA, Harrison CL, Siddiquea BN, Tissera S, Afroz A, Ali L, et al. The effectiveness of diabetes self-management education intervention on glycaemic control and cardiometabolic risk in adults with type 2 diabetes in low- and middle-income countries: a systematic review and meta-analysis. *PLoS One.* 2024;19(2):e0297328. doi:10.1371/journal.pone.0297328.