Original Article

Medication Adherence and Treatment Outcomes among Patients with Type 2 Diabetes Mellitus on Oral Hypoglycemic Agents: An Observational Study

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ABSTRACT

Background: Adherence to oral hypoglycemic agents (OHAs) is essential for achieving glycemic targets in type 2 diabetes mellitus (T2DM). Poor adherence contributes to persistent hyperglycemia and higher acute-care utilization.
Objectives: To estimate adherence levels and barriers in adults with T2DM receiving OHAs and to examine the association between adherence and short-term glycemic outcomes.
Methods: A hospital-based observational study was conducted at Sri Siddhartha Medical College and Hospital, Tumkur, Karnataka, from February 2025 to August 2025. One hundred adults with T2DM on OHAs were enrolled by consecutive sampling. Adherence was measured using a validated self-report scale and categorized as high, medium, or low. HbA1c, fasting plasma glucose (FPG), and post-prandial plasma glucose (PPPG) were recorded; glycemic control was defined as HbA1c <7%. Group comparisons used chi-square and one-way ANOVA, and predictors of low adherence were explored using multivariable logistic regression.
Results: Mean age was 54.2 ± 10.6 years and 58% were men. High, medium, and low adherence were observed in 32%, 38%, and 30%, respectively. Mean HbA1c was $7.8 \pm 1.4\%$, and 29% achieved HbA1c <7%. HbA1c increased across adherence categories ($7.0 \pm 0.9\%$ vs $7.7 \pm 1.0\%$ vs $8.8 \pm 1.5\%$; p<0.001). Diabetes-related emergency visit/hospitalization in the prior 6 months was higher in the low-adherence group (23.3%) than in the high-adherence group (3.1%) (p=0.01). Forgetfulness (46%) and medication cost (34%) were the most frequently reported barriers.
Conclusion: Low adherence affected nearly one-third of OHA-treated adults and was strongly associated with poorer glycemic control and greater acute-care use. Strategies addressing affordability, regimen complexity, and follow-up continuity are warranted.

Keywords: Type 2 diabetes mellitus; oral hypoglycemic agents; medication adherence; HbA1c; barriers; observational study.

INTRODUCTION

Type 2 diabetes mellitus (T2DM) is a chronic, progressive metabolic disorder that requires sustained lifestyle modification and long-term pharmacotherapy. Oral hypoglycemic agents (OHAs) remain the backbone of treatment for many adults, either as monotherapy or in combination regimens[1]. Clinical outcomes, however, depend not only on the choice and titration of OHAs but also on whether medicines are taken as prescribed. Medication adherence is conceptualized as a

dynamic behavior that includes initiation, correct implementation, and persistence over time [2]. Across chronic diseases, poor adherence is frequent and undermines the effectiveness of otherwise appropriate treatment [1,2].

In diabetes care, inadequate adherence to OHAs is a major contributor to suboptimal glycemic control. Systematic reviews have documented wide variability in adherence estimates, reflecting differences in measurement methods, populations, and health-system context [3]. Population-based and managed-care studies have shown that lower adherence to oral antidiabetic therapy is associated with higher HbA1c and poorer glycemic control [4–6]. Evidence also links nonadherence with greater health-care utilization and costs, reinforcing its clinical and economic relevance [8].

Barriers to adherence are multifactorial. Patient-related barriers include forgetfulness, limited understanding of long-term benefit, and concerns about adverse effects such as hypoglycemia. Treatment-related barriers include regimen complexity, dosing frequency, and polypharmacy, which can intensify as diabetes duration and comorbidity burden increase [9]. Socioeconomic barriers, particularly out-of-pocket expenditure, can precipitate cost-related nonadherence. Health-system factors also contribute: missed follow-up visits reduce opportunities for reinforcement, dose adjustment, and early identification of adverse effects or therapeutic inertia. Qualitative work further highlights the importance of beliefs, motivation, and social support as determinants of medication-taking behavior in T2DM [9].

Measurement of adherence can be undertaken using pharmacy refill metrics, pill counts, and validated self-report tools. Self-report instruments are practical in outpatient settings and have been used to link adherence with glycemic control, including Morisky-derived measures [6,7,10]. Guidance on selecting feasible adherence measures for clinical practice is also available [11]. Nevertheless, adherence behavior and its determinants are context-specific, influenced by socioeconomic conditions, local prescribing patterns, and continuity of care. Indian data on adherence and its relationship with recent glycemic outcomes in OHA-treated adults remain valuable for designing feasible, clinic-level interventions.

Objectives: This study aimed (1) to quantify medication adherence levels among adults with T2DM receiving OHAs at a tertiary teaching hospital; (2) to describe commonly reported barriers to adherence; (3) to identify predictors of low adherence; and (4) to evaluate the association between adherence level and short-term glycemic outcomes (HbA1c, fasting plasma glucose, post-prandial plasma glucose) and recent diabetes-related acute care visits.

MATERIALS AND METHODS
Study design and setting: This hospital-based observational study was conducted in the Department of Pharmacology in collaboration with General Medicine at Sri Siddhartha Medical College and Hospital, Tumkur, Karnataka, India, from February 2025 to August 2025.

Participants: Adults (≥18 years) with physician-diagnosed T2DM receiving OHAs for at least 3 months were eligible. Patients on exclusive insulin therapy, those with gestational diabetes, severe acute illness at the time of interview, cognitive impairment limiting reliable responses, or unwillingness to provide consent were excluded. Participants were enrolled by consecutive sampling from outpatient and inpatient services until the required sample size was achieved (n = 100).

Data collection: After written informed consent, trained investigators collected socio-demographic variables (age, sex, residence, education), clinical variables (duration of T2DM, comorbidities), treatment regimen (OHA classes, number of daily pills across all medications), and self-reported barriers to adherence. Medication adherence was assessed using a validated self-report adherence scale derived from the Morisky approach [10]. The approach has been widely used in clinical practice and research to quantify self-reported adherence behavior [11]. Participants were categorized into high, medium, and low adherence levels using standard scoring conventions; this aligns with contemporary adherence measurement frameworks emphasizing implementation and persistence [2]. Barriers were recorded using a structured checklist, allowing multiple responses.

Outcome measures: Glycemic outcomes included HbA1c (%), fasting plasma glucose (FPG, mg/dL), and post-prandial plasma glucose (PPPG, mg/dL) obtained from recent laboratory reports or measured as part of routine care during the study visit. Glycemic control was defined as HbA1c <7%, consistent with contemporary standards of diabetes care [16]. Participants were also asked about self-reported symptomatic hypoglycemia in the prior 3 months and any diabetes-related emergency room visit or hospitalization in the prior 6 months.

Statistical analysis: Data were entered in a spreadsheet and analyzed using standard statistical software. Continuous variables were summarized as mean ± standard deviation (SD) or median with interquartile range (IQR) as appropriate, and categorical variables as frequencies and percentages. Comparisons across adherence categories used one-way analysis of variance (ANOVA) for continuous outcomes and chi-square/Fisher's exact test for categorical outcomes. To identify independent predictors of low adherence (binary outcome: low vs medium/high), multivariable logistic regression was performed. Candidate predictors included duration of T2DM, pill burden, monthly out-of-pocket medication cost, and missed follow-up visits, which have been linked to adherence in prior studies [14,15]. Adjusted odds ratios (aORs) with 95% confidence intervals (CIs) were reported; $p < 0.05$ was considered statistically significant.

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Ethical considerations: The study protocol was approved by the Institutional Ethics Committee of Sri Siddhartha Medical College and Hospital. All participants provided written informed consent, and confidentiality was maintained throughout the study.

RESULTS

A total of 100 adults with T2DM receiving OHAs were analyzed. The mean age was 54.2 ± 10.6 years (range: 32–78), and 58% (n = 58) were men. Median duration of diabetes was 6 years (IQR: 3–11). Baseline socio-demographic and clinical characteristics are shown in Table 1.

Table 1. Socio-demographic and clinical profile of participants (n = 100)

Variable	n (%) / Mean ± SD
Age (years)	54.2 ± 10.6
Age group (years)	<40: 10 (10.0); 40–59: 58 (58.0); ≥60: 32 (32.0)
Sex	Male: 58 (58.0); Female: 42 (42.0)
Residence	Urban: 46 (46.0); Rural: 54 (54.0)
Education	Up to primary: 34 (34.0); Secondary: 38 (38.0); Graduate+: 28 (28.0)
Duration of T2DM	<5 years: 42 (42.0); 5–10 years: 33 (33.0); >10 years: 25 (25.0)
BMI (kg/m²)	27.1 ± 3.9
Comorbidities	Hypertension: 62 (62.0); Dyslipidemia: 48 (48.0)
Current OHA regimen	Metformin monotherapy: 18 (18.0); Metformin + sulfonylurea: 44 (44.0); Metformin + DPP-4 inhibitor: 22 (22.0); Triple OHA therapy: 16 (16.0)
Pills per day (all meds)	≤3: 41 (41.0); ≥4: 59 (59.0)

Medication adherence was categorized as high, medium, or low. High adherence was observed in 32% (n = 32), medium adherence in 38% (n = 38), and low adherence in 30% (n = 30). Forgetfulness (46%) and cost of medicines (34%) were the leading barriers, followed by busy schedule/travel (28%) and perceived polypharmacy (27%) (Table 2).

Table 2. Adherence level and reported barriers (n = 100)

Parameter	n (%)
Adherence level – High	32 (32.0)
Adherence level – Medium	38 (38.0)
Adherence level – Low	30 (30.0)
Commonly reported barriers* – Forgetfulness / missed doses	46 (46.0)
Commonly reported barriers* – Cost of medicines	34 (34.0)
Commonly reported barriers* – Busy schedule / travel	28 (28.0)
Commonly reported barriers* – Polypharmacy / "too many tablets"	27 (27.0)
Commonly reported barriers* – Fear of adverse effects / hypoglycemia	21 (21.0)
Commonly reported barriers* – Poor understanding of long-term need	19 (19.0)

*Multiple responses permitted.

Overall glycemic outcomes were suboptimal in a substantial proportion. Mean HbA1c in the cohort was $7.8 \pm 1.4\%$, with mean FPG of 152 ± 38 mg/dL and mean PPPG of 228 ± 61 mg/dL. Glycemic control (HbA1c <7%) was achieved by 29% (n = 29). A graded association between adherence and glycemic outcomes was evident: participants with high adherence had lower HbA1c, FPG, and PPPG and were more likely to achieve HbA1c <7% ($p < 0.001$ for HbA1c trends) (Table 3& Figure 1,2).

Table 3. Glycemic outcomes and short-term events by adherence level (n = 100)

Outcome	High (n=32)	Medium (n=38)	Low (n=30)	p-value
HbA1c (%) Mean ± SD	7.0 ± 0.9	7.7 ± 1.0	8.8 ± 1.5	<0.001
HbA1c < 7% n (%)	17 (53.1)	11 (28.9)	2 (6.7)	<0.001
FPG (mg/dL) Mean ± SD	136 ± 28	151 ± 34	171 ± 44	0.002
PPPG (mg/dL) Mean ± SD	204 ± 49	224 ± 55	262 ± 66	<0.001

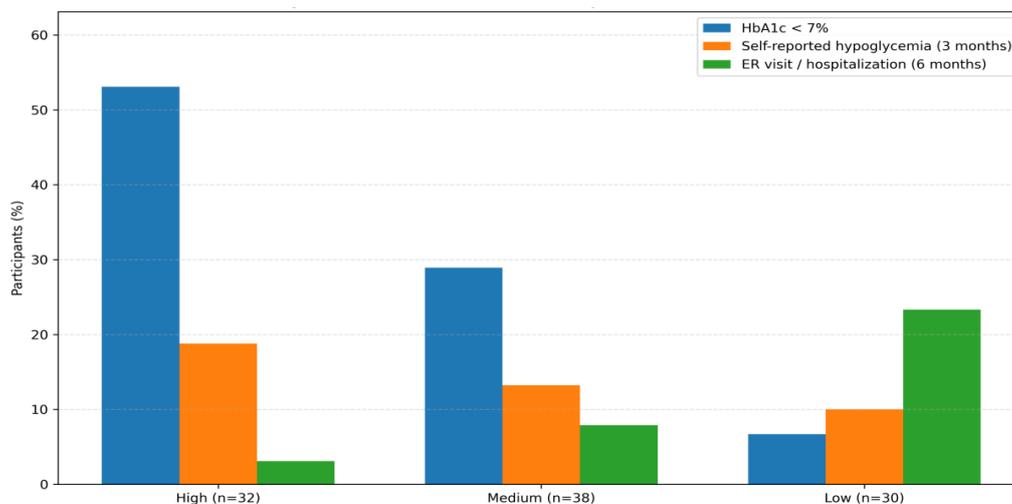| Any self-reported hypoglycemia (past 3 months) n (%)	6 (18.8)	5 (13.2)	3 (10.0)	0.52
Diabetes-related ER visit/hospitalization (past 6 months) n (%)	1 (3.1)	3 (7.9)	7 (23.3)	0.01

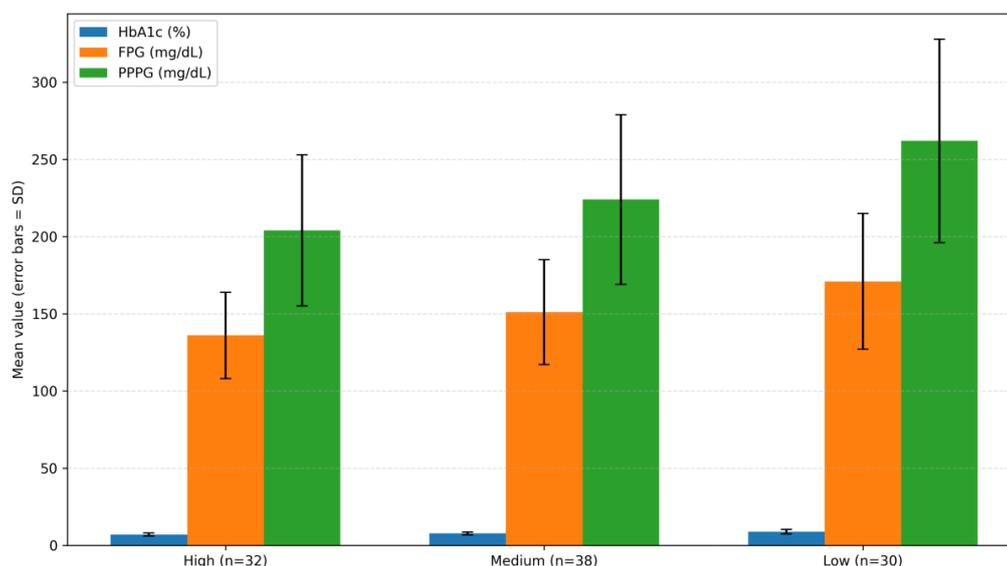**Figure 1: Target Control and Short-term Events by Adherence Level**

Figure :2 Mean Glycemic Parameters by Medication Adherence Level

Self-reported symptomatic hypoglycemia in the previous 3 months did not differ significantly across adherence groups (p = 0.52). However, diabetes-related emergency room visit/hospitalization in the past 6 months was significantly higher in the low-adherence group (23.3%) than in the high-adherence group (3.1%) (p = 0.01) (Table 3).

On multivariable logistic regression with low adherence as the outcome, pill burden ≥4 tablets/day, duration of T2DM >10 years, monthly out-of-pocket medication cost >₹1000, and missed follow-up visits were independently associated with low adherence, while good family support showed a protective association (Table 4).

Table 4. Multivariable analysis for predictors of low adherence (n = 100)

Predictor	Adjusted OR	95% CI	p-value
Duration of T2DM >10 years	2.6	1.0–6.9	0.048
Pills/day ≥4 (all medications)	3.1	1.2–8.1	0.018
Monthly medication cost > ₹1000	2.8	1.1–7.2	0.031
Missed ≥1 scheduled follow-up in past 6 months	4.2	1.6–11.0	0.003
Good family support (present)	0.4	0.2–0.9	0.028

DISCUSSION

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The present observational study evaluated medication adherence to OHAs and its relationship with short-term glycemic outcomes among 100 adults with T2DM. Low adherence was identified in 30% of participants, and glycemic control was achieved in fewer than one-third. These findings reinforce that medication-taking behavior is a critical determinant of routine diabetes outcomes, consistent with broader evidence that adherence is a central driver of treatment effectiveness in chronic disease [1,2].

The proportion of low adherence in our cohort is within the broad ranges reported in the literature, where nonadherence to oral antidiabetic therapy is common and heterogeneous across settings [3]. In a population-based cohort from the United Kingdom, Donnan et al. described incomplete adherence to prescribed oral hypoglycemic medication, underscoring that nonadherence is not restricted to resource-limited contexts [4]. Managed-care analyses similarly demonstrate that lower adherence correlates with poorer glycemic control [5]. Cross-sectional work from other regions has also reported suboptimal adherence to OHAs and a clear association with glycemic indices, supporting the consistency of the adherence–outcome link [13].

A clinically meaningful gradient in HbA1c was observed across adherence categories in our study. Participants with high adherence had substantially lower HbA1c and were markedly more likely to achieve HbA1c targets recommended in clinical standards [16]. Comparable relationships have been shown previously: Krapek et al. demonstrated that poorer adherence was associated with higher HbA1c in adults with T2DM [6], and self-report measures correlate with glycemic outcomes in patients with poor control [7]. Beyond glycemic indices, we found a higher frequency of diabetes-related emergency visits/hospitalizations among patients with low adherence. This aligns with evidence that nonadherence is associated with greater health-care resource utilization and costs [8,12].

Forgetfulness and medication cost were the most commonly reported barriers in our cohort. Reviews summarizing key contributors to poor adherence in T2DM consistently highlight regimen burden, beliefs, and practical constraints such as affordability [9]. Qualitative studies similarly identify motivation, perceived benefit, and contextual barriers as important drivers of implementation behavior [15]. Pill burden and longer duration of diabetes independently predicted low adherence in our analysis, consistent with large-scale work showing that regimen complexity and disease duration are linked to reduced adherence and persistence [14]. Missed follow-up visits also showed a strong association with low adherence, emphasizing that continuity of care provides opportunities for reinforcement, simplification of regimens, and addressing adverse effects [14].

From a practice perspective, adherence interventions in routine clinics should be pragmatic: identify patients with high pill burden and high monthly costs, enable reminders, and strengthen follow-up processes. Systematic reviews indicate that multifaceted adherence-enhancing strategies can improve medication-taking behavior and glycemic outcomes, although effect sizes vary by setting [3,9]. Validated self-report tools remain feasible for screening adherence in outpatient settings, particularly where refill data are unavailable [10,11].

Limitations

This study was single-center with a modest sample and a short study window, limiting external validity. Adherence was assessed by self-report, which is vulnerable to recall and social desirability bias. The design captured associations at one point in time, so temporal relationships between adherence and outcomes cannot be established. Pharmacy refill data and objective pill counts were not collected. Complications and long-term endpoints were not evaluated.

CONCLUSION

In this observational study of 100 adults with T2DM receiving OHAs, low medication adherence affected 30% of participants and was strongly associated with inferior glycemic outcomes. HbA1c, fasting glucose, and post-prandial glucose worsened in a stepwise manner from high to low adherence, and diabetes-related emergency visits/hospitalization were substantially more frequent among low-adherence patients. Forgetfulness and medication cost were the most common barriers, while higher pill burden, longer diabetes duration, higher out-of-pocket expenditure, and missed follow-up visits independently predicted low adherence. Routine screening for adherence and targeted counseling, regimen simplification, cost-sensitive prescribing, and structured follow-up with family engagement are actionable steps to improve outcomes. in tertiary care diabetes clinics today.

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