

Prescription Patterns, Responsiveness To Oral Hypoglycemic Agents and Compliance Factors Among Patients With Type 2 Diabetes Mellitus Across Urban, Semi-Urban and Rural Settings

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Abstract

Background

Type 2 diabetes mellitus (T2DM) is a major chronic metabolic disorder associated with progressive hyperglycemia and substantial microvascular and macrovascular morbidity. Despite the availability of multiple pharmacological options, achieving sustained glycemic control remains challenging. Differences in healthcare access, prescribing practices, socioeconomic circumstances and medication adherence may contribute to variation in treatment outcomes across urban, semi-urban and rural populations.

Aim

To evaluate prescription patterns, glycemic control, short-term treatment responsiveness and medication compliance among patients with OHAs in T2DM across urban, semi-urban and rural settings.

Methods

This study included 380 patients with T2DM recruited over a one-year period from the General Medicine Department of Sree Balaji Medical College and Hospital, associated rural and urban health centres, village medical camps and gated communities. An observational approach was used to evaluate prescribing patterns, while an experimental component assessed acute responsiveness to patients' regular oral hypoglycemic therapy following an oral glucose tolerance test (OGTT). Data included demographic characteristics, prescribed antidiabetic medications, fasting and postprandial blood glucose, HbA1c, measurements and medication compliance.

Results

The mean age of participants was 54.2 ± 10.8 years, with males comprising 53.3% of the study population. Urban participants constituted 55.0%, semi-urban participants 25.0% and rural participants 20.0%. Metformin was the most frequently prescribed individual antidiabetic agent (12.6%), followed by glimepiride plus metformin (9.5%) and vildagliptin (7.9%). A significant association was observed between area of residence and prescribing pattern ($p = 0.039$). Overall, 28.4% of participants were categorized as having good glycemic control, 38.4% as moderate and 33.2% as poor. Glycemic control differed significantly by area ($p = 0.029$). Antidiabetic regimen was significantly associated with glycemic control ($p = 0.042$). Mean HbA1c was $7.82 \pm 1.36\%$. Acute OGTT responsiveness was observed in 61.8% of participants and was significantly associated with the prescribed regimen ($p = 0.045$). Good medication compliance was observed in only 35.0% of participants. Compliance was strongly associated with glycemic control ($p = 0.0005$). Hypertension was the most frequently reported comorbidity (46.6%), followed by dyslipidemia (30.0%) and obesity (20.0%).

Conclusion

The study demonstrates substantial variation in oral antidiabetic prescribing patterns across urban, semi-urban and rural settings, together with a high burden of suboptimal glycemic control and inadequate medication compliance. Combination regimens were associated with better glycemic control and greater short-term treatment responsiveness. The findings highlight the importance of treatment optimization, medication adherence, regular monitoring and improved access to diabetes care, particularly in rural populations.

Keywords: Type 2 diabetes mellitus; prescription pattern; oral hypoglycemic agents; glycemic control; HbA1c; oral glucose tolerance test; treatment responsiveness; medication compliance; rural; urban.

Introduction

Type 2 diabetes mellitus (T2DM) is a chronic metabolic disorder characterized by persistent hyperglycemia resulting from impaired insulin secretion, insulin resistance, or a combination of both. Progressive hyperglycemia is associated with damage to multiple organ systems, particularly the cardiovascular, renal, neural and ophthalmic systems. Diabetes therefore represents an important public health challenge because of both its increasing prevalence and its long-term complications.

The therapeutic landscape of T2DM has expanded considerably, with several classes of oral and injectable glucose-lowering agents available. These include biguanides, sulfonylureas, thiazolidinediones, dipeptidyl peptidase-4 (DPP-4) inhibitors, sodium-glucose cotransporter-2 (SGLT2) inhibitors, alpha-glucosidase inhibitors, glucagon-like peptide-1

receptor agonists and insulin preparations. Selection of therapy is influenced by patient age, duration of diabetes, body mass index, comorbidities, risk of hypoglycemia, treatment affordability and patient preferences.

Prescription patterns may vary substantially between populations because healthcare infrastructure, availability of medicines, affordability, physician practices and patient characteristics differ across geographical and socioeconomic settings. In India, these differences are particularly relevant when comparing rural, semi-urban and urban populations. Treatment response is another important component of diabetes management. Short-term responsiveness can be assessed through the immediate glycemic response following administration of a patient's regular glucose-lowering therapy, while intermediate-term response can be assessed through changes in fasting blood glucose, postprandial glucose and HbA1c over subsequent weeks. Treatment response may be influenced by insulin resistance, beta-cell function, adherence, lifestyle factors and comorbidities.

Medication adherence is equally important. Failure to take medications as prescribed may compromise glycemic control and increase the risk of diabetes-related complications. Factors affecting adherence include treatment complexity, adverse effects, patient education, socioeconomic circumstances and access to healthcare.

Although several studies have examined diabetes prescribing and glycemic control, comparatively less attention has been directed toward examining prescription patterns, treatment responsiveness and medication compliance together across rural, semi-urban and urban settings. The present study was therefore undertaken to evaluate these factors among patients with T2DM.

Aim

To evaluate prescription patterns and treatment responsiveness, including short-term response and follow-up glycemic parameters, among patients with T2DM in rural, semi-urban and urban settings.

Objectives

- To determine the distribution of prescribed hypoglycemic agents among rural, semi-urban and urban patients.
- To assess glycemic control across the three geographical groups.
- To assess glycemic control according to different oral antidiabetic regimens.
- To determine acute treatment responsiveness following an OGTT while patients received their regular hypoglycemic medication.
- To assess medication compliance and its relationship with glycemic control.

Materials and Methods

Study Design and Setting

The study employed two components: an observational component for enumeration and assessment of antidiabetic prescriptions and an experimental component involving an OGTT with administration of the patient's regular hypoglycemic dose.

Participants were recruited from the General Medicine outpatient department of Sree Balaji Medical College and Hospital, Chennai, associated rural and urban health centres, village medical camps and gated-community health camps.

Study Population

The study population consisted of patients diagnosed with T2DM receiving ongoing treatment.

Inclusion Criteria

- Diagnosed T2DM or HbA1c >6.5%, fasting blood glucose >126 mg/dL, or postprandial/random blood glucose >200 mg/dL.
- Age >20 years.
- Stable diabetes treatment for at least three months or expected stable treatment for the subsequent three months.

Exclusion Criteria

- Type 1 diabetes mellitus.
- Recent diabetic ketoacidosis.
- Recent myocardial infarction, TIA or stroke.
- Pregnancy or breastfeeding.
- Treatment with steroids, verapamil, hormone replacement therapy or insulin.
- Ryles-tube feeding, terminal illness or conditions expected to substantially affect treatment responsiveness.

- Recent medication changes and inability or unwillingness to undergo OGTT.

Sample Size and Sampling

Purposive sampling was used. A total of 380 participants were included in the study.

Data Collection

After obtaining written informed consent, demographic, clinical and treatment information was collected using a standardized questionnaire and data collection form. Information included place of residence, diabetes history, prescribed medications, laboratory findings, clinical history, symptoms and medication compliance.

Laboratory Assessment

- Fasting blood glucose
- Postprandial blood glucose
- HbA1c
- Oral glucose tolerance testing

The OGTT protocol recorded glucose measurements at baseline and subsequent time points following administration of the glucose load and the patient's regular hypoglycemic medication. The study also incorporated HbA1c assessment during follow-up.

Assessment of Medication Compliance

Compliance was assessed using patient recall and a structured medication-taking record. Participants were asked about regularity of medication use, missed doses and reasons for missed medication. Compliance was categorized as good, moderate or poor according to the study assessment framework.

Statistical Analysis

Descriptive statistics were used to summarize demographic and clinical characteristics. Associations between categorical variables, including area of residence, antidiabetic regimen, glycemic control and treatment responsiveness, were assessed using the statistical procedures specified in the study. Statistical significance was considered at $p < 0.05$.

Ethical Considerations

Written informed consent was obtained from participants before enrolment. The dissertation reports Institutional Review Board approval from Sree Balaji Medical College and Hospital. The specific approval/reference number should be included in the journal submission if required.

Results

Participant Characteristics

A total of 380 patients with T2DM were included. The mean age was 54.2 ± 10.8 years. Urban participants constituted the largest group (209; 55.0%), followed by semi-urban (95; 25.0%) and rural participants (76; 20.0%). There was a slight male predominance, with 203 males (53.3%) and 177 females (46.7%).

Characteristic	Finding
Total participants	380
Mean age, years	54.2 ± 10.8
Male	203 (53.3%)
Female	177 (46.7%)
Urban	209 (55.0%)
Semi-urban	95 (25.0%)
Rural	76 (20.0%)

Antidiabetic Prescription Pattern

Metformin was the most frequently prescribed individual antidiabetic agent, accounting for 12.6% of prescriptions. Glimepiride plus metformin was the most frequently reported combination regimen (9.5%), followed by vildagliptin (7.9%), sitagliptin (7.4%) and gliclazide (6.8%). Other commonly documented regimens included glimepiride plus metformin plus voglibose (7.1%) and dapagliflozin (6.6%).

Prescription pattern differed significantly according to area of residence ($p = 0.039$). Urban participants showed greater utilization of several newer agents and combination regimens, whereas traditional agents were relatively more represented among rural participants.

Antidiabetic agent/regimen	N	%
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Metformin	48	12.6
Glimepiride	32	8.4
Glibenclamide	24	6.3
Gliclazide	26	6.8
Sitagliptin	28	7.4
Vildagliptin	30	7.9
Linagliptin	22	5.8
Voglibose	20	5.3
Saroglitasar	18	4.7
Dapagliflozin	25	6.6
Glimepiride + Metformin + Voglibose	27	7.1
Glimepiride + Metformin	36	9.5
Sitagliptin + Metformin + Voglibose	16	4.2
Glipizide	14	3.7
Acarbose	14	3.7

Glycemic Control

Overall, 108 participants (28.4%) were categorized as having good glycemic control, 146 (38.4%) as moderate and 126 (33.2%) as poor. Thus, approximately 71.6% of participants fell into the moderate or poor-control categories.

Glycemic control differed significantly across geographical groups ($p = 0.029$). Good control was observed in 16.7% of rural, 26.7% of semi-urban and 33.3% of urban participants. Poor control was reported in 50.0% of rural participants compared with 33.3% of semi-urban and 27.3% of urban participants.

Area	Good (%)	Moderate (%)	Poor (%)
Rural	16.7	33.3	50.0
Semi-urban	26.7	40.0	33.3
Urban	33.3	39.4	27.3
p-value	0.029		

Glycemic Parameters

The mean fasting blood glucose was 148.6 ± 34.2 mg/dL, mean postprandial glucose was 226.4 ± 48.7 mg/dL and mean HbA1c was $7.82 \pm 1.36\%$. HbA1c distribution showed that 150 participants (39.5%) had HbA1c $>8.5\%$, 140 (36.8%) had HbA1c between 7.6% and 8.5%, and 90 (23.7%) had HbA1c between 6.5% and 7.5%.

Glycemic Control According to Antidiabetic Regimen

A significant association was observed between antidiabetic regimen and glycemic control ($p = 0.042$). The proportion categorized as having good control was 38.0% among participants receiving glimepiride plus metformin, while the corresponding proportion was 34.0% for metformin and 35.0% for dapagliflozin. The glimepiride plus metformin regimen had a poor-control proportion of 17.0%.

Acute Treatment Responsiveness

Following OGTT assessment with the patient's regular hypoglycemic medication, 235 participants (61.8%) were classified as responsive and 145 (38.2%) as non-responsive.

Treatment responsiveness differed significantly according to antidiabetic regimen ($p = 0.045$). Responsiveness was 74.0% among participants receiving glimepiride plus metformin and 70.0% among those receiving glimepiride plus metformin plus voglibose. Dapagliflozin was associated with 68.0% responsiveness, while metformin alone was associated with 62.0%.

Regimen	Responsive (%)	Non-responsive (%)
Metformin	62.0	38.0
Glimepiride	55.0	45.0
Sitagliptin	65.0	35.0
Vildagliptin	66.0	34.0
Dapagliflozin	68.0	32.0
Glimepiride + Metformin + Voglibose	70.0	30.0

Glimepiride + Metformin	74.0	26.0
Glipizide	52.0	48.0
Acarbose	50.0	50.0
Overall	61.8	38.2
p-value	0.045	

Medication Compliance

Good compliance was observed in 133 participants (35.0%), moderate compliance in 146 (38.4%) and poor compliance in 101 (26.6%). A highly significant association was observed between compliance and glycemic control ($p = 0.0005$). Good compliance was associated with a higher proportion of good glycemic control, whereas poor compliance was associated with a substantially higher proportion of poor glycemic control.

Compliance level	Good control (%)	Poor control (%)
Good	61.9	14.3
Moderate	30.4	34.8
Poor	12.5	56.3
p-value	0.0005	

Comorbidities and Other Clinical Findings

Hypertension was the most common comorbidity, affecting 46.6% of participants, followed by dyslipidemia (30.0%) and obesity (20.0%). The dissertation additionally reports coronary artery disease in 16.7% and chronic kidney disease in 13.3% of participants.

Non-diabetic medications were frequently prescribed. Antihypertensive drugs were used by 53.4%, lipid-lowering agents by 41.6%, antiplatelet drugs by 33.4%, gastroprotective agents by 36.6%, and vitamins or supplements by 30.0%. The most frequently reported symptoms were abdominal bloating (16.6%), burning sensation of the feet (15.0%), constipation (13.4%) and myalgia (11.6%). Ten percent of participants reported no symptoms.

A history of myocardial infarction was reported in 10.0%, stroke in 8.4%, transient ischemic attack in 6.6%, blood transfusion in 15.0% and ketoacidosis in 5.0%.

Discussion

The present study evaluated prescription patterns, glycemic control, acute treatment responsiveness and medication compliance among 380 patients with T2DM across urban, semi-urban and rural settings.

The study population had a mean age of 54.2 years and demonstrated a slight male predominance. The greater representation of urban participants is consistent with the substantial burden of diabetes reported in urban Indian populations.

Metformin was the most frequently prescribed individual agent in the present study, accounting for 12.6% of prescriptions. Glimepiride plus metformin was the most frequently observed combination regimen. This pattern is broadly consistent with previous prescription-pattern studies in which metformin and metformin-containing combinations were prominent components of T2DM treatment.

A significant association was observed between geographical setting and prescribing pattern ($p = 0.039$). Urban participants had relatively greater use of newer agents such as dapagliflozin, sitagliptin and vildagliptin. Differences in healthcare accessibility, affordability, availability of newer medicines and prescribing preferences may contribute to this pattern. However, the present study was not designed to establish the individual contribution of these factors.

Glycemic control was suboptimal in a substantial proportion of participants. Only 28.4% were classified as having good control, while 38.4% had moderate and 33.2% had poor control. The mean HbA1c was $7.82 \pm 1.36\%$, and 39.5% of participants had HbA1c above 8.5%.

An important finding was the significant difference in glycemic control according to area of residence ($p = 0.029$). Half of the rural participants were categorized as having poor control, compared with 27.3% of urban participants. Differences in access to healthcare and awareness may contribute to this disparity, although the study did not independently quantify these factors.

The study also demonstrated a significant association between antidiabetic regimen and glycemic control ($p = 0.042$). Combination regimens, particularly glimepiride plus metformin, demonstrated a greater proportion of participants with good control. Because medication allocation was not randomized, these findings should not be interpreted as evidence that one regimen is superior to another.

Acute responsiveness to therapy was observed in 61.8% of participants. A significant association was observed between prescribed regimen and responsiveness ($p = 0.045$), with the glimepiride plus metformin group demonstrating the highest reported responsiveness at 74%. Differences in baseline disease severity, treatment duration, comorbidities and other patient characteristics may influence response.

Medication compliance was another major finding. Only 35% of participants demonstrated good compliance, while 38.4% had moderate and 26.6% had poor compliance. The strong association between compliance and glycemic control ($p = 0.0005$) emphasizes the importance of medication-taking behaviour in diabetes management.

The burden of comorbid disease was considerable. Hypertension was the most frequent comorbidity, followed by dyslipidemia and obesity. The frequent use of antihypertensive, lipid-lowering and antiplatelet medications reflects the cardiovascular risk profile of the study population.

Taken together, the findings indicate that prescription availability alone does not ensure adequate diabetes control. Treatment effectiveness in real-world settings is influenced by the interaction of pharmacological therapy, adherence, monitoring and healthcare access.

Strengths of the Study

- The study provides an integrated assessment of antidiabetic prescribing, glycemic control, treatment responsiveness and medication compliance.
- It compares patients across rural, semi-urban and urban settings.
- It includes both biochemical measures and patient-reported compliance information.
- It examines the relationship between compliance and glycemic control.

Limitations

- Purposive rather than probability-based sampling may limit generalizability.
- The study was conducted within the defined healthcare network associated with the institution and its community-based settings.
- The observational nature of prescription allocation prevents causal conclusions regarding comparative drug efficacy.
- Medication compliance relied partly on patient-reported information and may therefore be affected by recall or reporting bias.
- Factors such as socioeconomic status, diabetes duration, dietary adherence, physical activity and health literacy were not quantitatively incorporated into the reported analysis.
- OGTT responsiveness provides information regarding acute response and should not be equated with long-term treatment effectiveness.

Conclusion

This study of 380 patients with T2DM demonstrated substantial variation in prescribing patterns across urban, semi-urban and rural settings. Metformin was the most frequently prescribed individual antidiabetic agent, while metformin-containing combination regimens were commonly used.

Despite ongoing pharmacological treatment, glycemic control was suboptimal in a substantial proportion of participants. Urban participants demonstrated a higher proportion of good glycemic control, while rural participants had a greater proportion of poor control. Antidiabetic regimen was significantly associated with both glycemic control and acute treatment responsiveness, although the observational study design does not permit causal conclusions regarding comparative drug efficacy.

Medication compliance emerged as an important factor associated with glycemic control. Only 35% of participants demonstrated good compliance, and poor compliance was strongly associated with poor glycemic control.

The findings support a comprehensive approach to T2DM management that combines appropriate pharmacological treatment with adherence support, regular glycemic monitoring, lifestyle management and improved access to healthcare.

Declarations

Ethics Approval

The dissertation reports Institutional Review Board approval from Sree Balaji Medical College and Hospital. The specific approval/reference number should be included in the journal submission if required.

Informed Consent

Written informed consent was obtained from participants before enrolment.

Funding

To be completed by the authors.

Conflict of Interest

To be completed by the authors.

Author Contributions

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Data Availability

To be completed according to journal and institutional requirements.

References

1. American Diabetes Association. Standards of medical care in diabetes—2023. *Diabetes Care*. 2023;46(Suppl 1):S1-S291.
2. World Health Organization. Diabetes Fact Sheet. Geneva: World Health Organization; 2023.
3. International Diabetes Federation. IDF Diabetes Atlas. 10th ed. Brussels: International Diabetes Federation; 2021.
4. Fowler MJ. Microvascular and macrovascular complications of diabetes. *Clinical Diabetes*. 2008;26(2):77-82.
5. 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. *Lancet*. 1998;352(9131):837-853.
6. Inzucchi SE, Bergenstal RM, Buse JB, Diamant M, Ferrannini E, Nauck M, et al. Management of hyperglycemia in type 2 diabetes: a patient-centered approach. *Diabetes Care*. 2015;38(1):140-149.
7. Joshi SR, Parikh RM, India Diabetes Research Foundation. India—diabetes capital of the world: now the world capital of diabetes. *Journal of the Association of Physicians of India*. 2014;62:1-3.
8. Sharma T, Kalra J, Dhasmana DC, Basera H. Poor adherence to treatment: a major challenge in diabetes. *Journal of Clinical and Diagnostic Research*. 2018;12(1).
9. World Health Organization. Definition and Diagnosis of Diabetes Mellitus and Intermediate Hyperglycaemia. Geneva: WHO; 2006.
10. Anjana RM, Deepa M, Pradeepa R, Mahanta J, Narain K, Das HK, et al. Prevalence of diabetes and prediabetes in India: results from the ICMR–INDIAB study. *Diabetologia*. 2017;60(5):916-930.
11. Shrivastava SR, Shrivastava PS, Ramasamy J. Role of self-care in management of diabetes mellitus. *Journal of Diabetes & Metabolic Disorders*. 2013;12(1):14.
12. Tripathi KD. *Essentials of Medical Pharmacology*. 5th ed. New Delhi: Jaypee Brothers Medical Publishers; 2003.
13. World Health Organization. *Global Report on Diabetes*. Geneva: WHO; 2015.
14. King H, Aubert RE, Herman WH. Global burden of diabetes, 1995–2025: prevalence, numerical estimates and projections. *Diabetes Care*. 1998;21(9):1414-1431.
15. Ramachandran A, Snehalatha C, Kapur A, Vijay V, Mohan V, Das AK, et al. High prevalence of diabetes and impaired glucose tolerance in India. *Diabetologia*. 2001;44(9):1094-1101.
16. Ramachandran A, Snehalatha C, Ma RC. Diabetes in South-East Asia: an update. *Diabetes Research and Clinical Practice*. 2012;103(2):231-237.
17. American Diabetes Association. Standards of medical care in diabetes—2022. *Diabetes Care*. 2022;45(Suppl 1):S1-S264.
18. 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. *Scientific Reports*. 2023;13:23037.
19. Brar MS, et al. Evaluation of oral antidiabetic prescribing patterns. *International Journal of Diabetes in Developing Countries*. 2025;45(4):1010-1016.
20. Ashok P, Subrahmanian VT, Raj R, Babu RR, Ramshad TP, Kevin L. Prescription pattern analysis of type II diabetes mellitus inpatients and associated co-morbidities. *Journal of Drug Delivery & Therapeutics*. 2020;10(3).
21. Shrestha SS, et al. Glycemic control and prescribing patterns in diabetes. *BMC Endocrine Disorders*. 2019;19(1):1-9.
22. Sharma T, Sahai R, Bala S, Dhasmana DC, Kaeley N. Prescribing pattern of oral anti-diabetic agents in type 2 diabetes mellitus patients in a tertiary care hospital. *International Journal of Basic & Clinical Pharmacology*. 2018;7(5):956-960.

23. Mohanty IR, et al. Drug utilization study in patients with type 2 diabetes mellitus attending diabetes clinic of a tertiary care hospital in rural Bengal. *International Journal of Basic & Clinical Pharmacology*. 2017;5(4):1647-1654.
24. Sridevi SA, Ganesh M. Study on the prescription pattern of oral hypoglycemic agents in type 2 diabetes mellitus in the outpatient department of a tertiary care hospital in Chennai. *Indian Journal of Applied Research*. 2016;6(3).
25. DeFronzo RA. From the triumvirate to the ominous octet: a new paradigm for the treatment of type 2 diabetes mellitus. *Diabetes*. 2009;58(4):773-795.
26. DeFronzo RA, Ferrannini E, Groop L, Henry RR, Herman WH, Holst JJ, et al. Type 2 diabetes mellitus. *Nature Reviews Disease Primers*. 2015;1:15019.
27. Jimmy B, Jose J. Patient medication adherence: measures in daily practice. *Oman Medical Journal*. 2011;26(3):155-159.
28. Morisky DE, Green LW, Levine DM. Concurrent and predictive validity of a self-reported measure of medication adherence. *Medical Care*. 1986;24(1):67-74.
29. Osterberg L, Blaschke T. Adherence to medication. *New England Journal of Medicine*. 2005;353(5):487-497.
30. Boulton AJM, et al. Diabetic neuropathies: a statement by the American Diabetes Association. *Diabetes Care*. 2017;40(1):136-154.
31. Kitabchi AE, et al. Hyperglycemic crises in diabetes. *Diabetes Care*. 2009;32(7):1335-1343.
32. Indian Council of Medical Research. Guidelines for Management of Type 2 Diabetes Mellitus in India. New Delhi: ICMR; 2018.