Prescription pattern study of oral glucose lowering agents in patients with type 2 diabetes in outpatient department of a tertiary care teaching hospital.

Abstract

Background: Type II diabetes mellitus (T2DM) is a chronic metabolic disorder characterised by persistent hyperglycaemia. Globally, an estimated 537 million adults (20–79 years) were living with diabetes in 2021 – about 10.5 % of the world's population in this age group, and the number is projected to reach 643 million by 2030 and 783 million by 2045.[1] In India alone, approximately 77 million people had diabetes in 2019 and this is expected to increase to 134 million by 2045.[2]Appropriate selection of glucose-lowering agents and rational prescribing are therefore essential to control blood glucose and prevent complications.

Objectives: To evaluate the demographic profile, antidiabetic prescription patterns, common drug combinations, and adherence to WHO prescribing indicators among T2DM outpatients at a tertiary care teaching hospital.

Methods: A descriptive, observational, cross-sectional study was conducted on 600 prescriptions of patients with T2DM attending the general medicine OPD of MGM Hospital, Chhatrapati Sambhaji Nagar. Data was extracted from prescriptions into a spreadsheet. For each encounter we recorded the patient's age and gender, the number of oral glucose-lowering agents, the total number of drugs, the number of medicines prescribed by generic name, the number of drugs from the Indian essential medicines list, and whether an injectable drug or antibiotic was prescribed. WHO core prescribing indicators were computed according to standard definitions.[3]

Statistical analysis: - Data were entered in Microsoft Excel and analysed using descriptive statistics. Continuous variables are presented as mean ± standard deviation (SD) and range, and categorical variables as numbers and percentages.

Results: The mean age of the patients was 53.0 ± 11.6 years (range 22–80), and 51.1% were male and 48.9% female. Most patients belonged to the 41–60 year age group (55.5%), followed by 61–80 years (29.2%) and less than 40 years (15.3%). Polytherapy (≥4 classes of glucose-lowering agents) was observed in 39.3% of prescriptions and triple therapy in 27.5%, whereas dual therapy and monotherapy accounted for 17.8% and 15.3%, respectively. DPP-4 inhibitors were the most frequently prescribed class (61.1%), followed by sulfonylureas (58.1%) and biguanides (56.8%); insulin was used in 38.7% of encounters. The average number of drugs per prescription was 3.59. Drugs were prescribed by generic name in 86.4% of cases, injections were used in 23.3% and

antibiotics in 6.0% of encounters, and 55.5% of the drugs were from the essential medicines list. The most frequent oral combination was biguanide + DPP-4 inhibitor + sulfonylurea (8.64%), followed by biguanide + DPP-4 inhibitor + SGLT2 inhibitor + sulfonylurea (6.15%)

Conclusions: The present study highlights extensive use of combination therapy in T2DM, with a preference for newer agents such as DPP-4 and SGLT2 inhibitors. The mean number of medicines per encounter exceeded the WHO reference value of less than 2, and the injection use rate was slightly above the recommended 20 %.[3] Although the percentage of drugs prescribed by generic name was high, adherence to the essential medicines list needs improvement. Regular prescription audits and adherence to national and international guidelines are necessary to promote rational use of antidiabetic agents.

Keywords: Type II diabetes mellitus, prescription pattern, oral antidiabetic drugs, WHO prescribing indicators, rational drug use

Introduction

Type II diabetes mellitus (T2DM) is a chronic metabolic disorder characterised by persistent hyperglycaemia. Globally, an estimated 537 million adults (20–79 years) were living with diabetes in 2021 – about 10.5 % of the world's population in this age group, and the number is projected to reach 643 million by 2030 and 783 million by 2045. [1] It is among the leading global health emergencies, accounting for significant morbidity, mortality and health-care expenditure. [2] India bears a substantial share of this burden: an estimated 77 million people were living with diabetes in 2019, with projections of 134 million by 2045. Alarmingly, over half of these cases remain undiagnosed. Type II diabetes mellitus (T2DM) accounts for about 90 % of all cases and is strongly associated with lifestyle factors such as sedentary behaviour, unhealthy diet and obesity. [2] Recent systematic reviews indicate that polypharmacy—defined as the use of five or more medications—is present in nearly 59% of older adults with diabetes and is associated with increased healthcare utilisation and adverse drug events [3].

T2DM is a progressive disorder; maintenance of glycaemic goals often requires combination therapy. The American Diabetes Association (ADA) recommends stepwise addition of medications to metformin and acknowledges that early combination therapy may be needed to achieve glycaemic targets. Newer agents like dipeptidyl-peptidase 4 (DPP-4) inhibitors, sodium–glucose cotransporter 2 (SGLT2) inhibitors and glucagon-like peptide-1 receptor agonists offer cardiovascular and renal benefits and are being increasingly used. [4] At the same time, inappropriate prescribing practices such as polypharmacy, overuse of injections and antibiotics, and deviation from essential medicines lists can jeopardize patient safety and increase costs. To address these issues the WHO, in collaboration with the International Network for Rational Use of Drugs, developed a set of core drug use indicators to evaluate prescribing patterns. The five prescribing

indicators assess the average number of medicines per encounter, the percentage of drugs prescribed by generic name, the percentage of encounters with an antibiotic prescribed, the percentage of encounters with an injection prescribed and the percentage of medicines prescribed from the essential medicines list. The WHO proposes reference values for these indicators (<2 medicines per encounter, 100 % generic prescribing, <30 % antibiotic encounters, <20 % injections and 100 % essential medicines). [5] Guidelines from international bodies now emphasise early use of SGLT2 inhibitors and GLP-1 receptor agonists in patients with cardiovascular or renal comorbidities due to their cardiorenal benefits [6]. Prescription patterns in developed countries show that metformin monotherapy has stabilised while SGLT2 inhibitors and GLP-1 receptor agonists are being prescribed more frequently, reflecting these guideline changes [7]. However, observational studies from Ethiopia and geriatric clinics have documented widespread polypharmacy, low rates of generic prescribing and limited adherence to essential medicines lists, highlighting the need for local audits [8][9].

The present study was undertaken to describe the current trends in prescribing oral glucose-lowering agents and insulin for T2DM in a tertiary care teaching hospital, to analyse adherence to WHO prescribing indicators and to identify common drug combinations. Such information is vital for promoting rational drug use and aligning practice with guidelines. Hospital-based audits in central Maharashtra and southern India have reported an average of 1.7–3.0 antidiabetic drugs per prescription, with combination therapy employed in approximately 70% of encounters and nearly universal generic prescribing [10][11]. These findings provided a benchmark for the present evaluation.

Methods

Study design and setting

This was a descriptive, observational, non-interventional, cross-sectional study carried out in the general medicine OPD of MGM Medical College & Hospital, Chhatrapati Sambhaji Nagar (Aurangabad), a tertiary care teaching hospital. The study commenced after obtaining approval from the Institutional Ethics Committee. Prescriptions were collected until the target sample size of 600 encounters was reached; a total of 600 prescriptions were analysed. Only prescriptions of adult patients (>18 years) diagnosed with T2DM and receiving at least one glucose-lowering agent were included. Prescriptions for pregnant women, type I diabetes or gestational diabetes were excluded.

Data collection

Data from each eligible prescription was extracted into a structured Excel sheet. Variables included the patient's age and gender, the number of drugs belonging to each class of glucose-lowering agents (insulin, biguanides, SGLT2 inhibitors, thiazolidinediones, sulfonylureas and DPP-4 inhibitors), the total number of drugs in the prescription (including drugs for comorbidities), the number of medicines prescribed by generic name, the number of drugs from the essential medicines list, and whether any injection or antibiotic was prescribed. The presence of a class was defined as at least one drug from that class in the prescription. Monotherapy was defined as the use of a single class of

glucose-lowering agent, dual therapy as two classes, triple therapy as three classes and polytherapy as four or more classes.Age groups were categorized as <40, 41–60, 61–80 and >80 years. Therapy categories (monotherapy, dual therapy, triple therapy and polytherapy) were derived from the number of classes prescribed. WHO core prescribing indicators were computed as follows: [5]

(i) average number of drugs per encounter = total number of drugs prescribed ÷ total number of encounters

(ii) percentage of drugs prescribed by generic name = (total number of drugs prescribed by generic name ÷ total number of drugs prescribed) × 100

(iii) percentage of encounters with an injection or antibiotic = (number of encounters with ≥1 injection/antibiotic ÷ total encounters) × 100

(iv) percentage of drugs prescribed from the essential medicines list = (total number of drugs from the essential medicines list ÷ total number of drugs prescribed) × 100.

(v) Drug combinations were summarized by counting prescriptions containing ≥2 classes and listing the most common combinations.

Statistical analysis

Data were entered in Microsoft Excel and analysed using descriptive statistics. Continuous variables are presented as mean ± standard deviation (SD) and range, and categorical variables as numbers and percentages.

Results

Demographic characteristics

The study included 600 prescriptions. The mean age of patients was 53.0 ± 11.6 years (median 53 years; range 22–80 years). Age distribution is shown in **Figure 1**; most patients (55.5 %) were between 41–60 years. Gender distribution is summarized in **Table 1** – 51.1 % were male and 48.9 % were female.

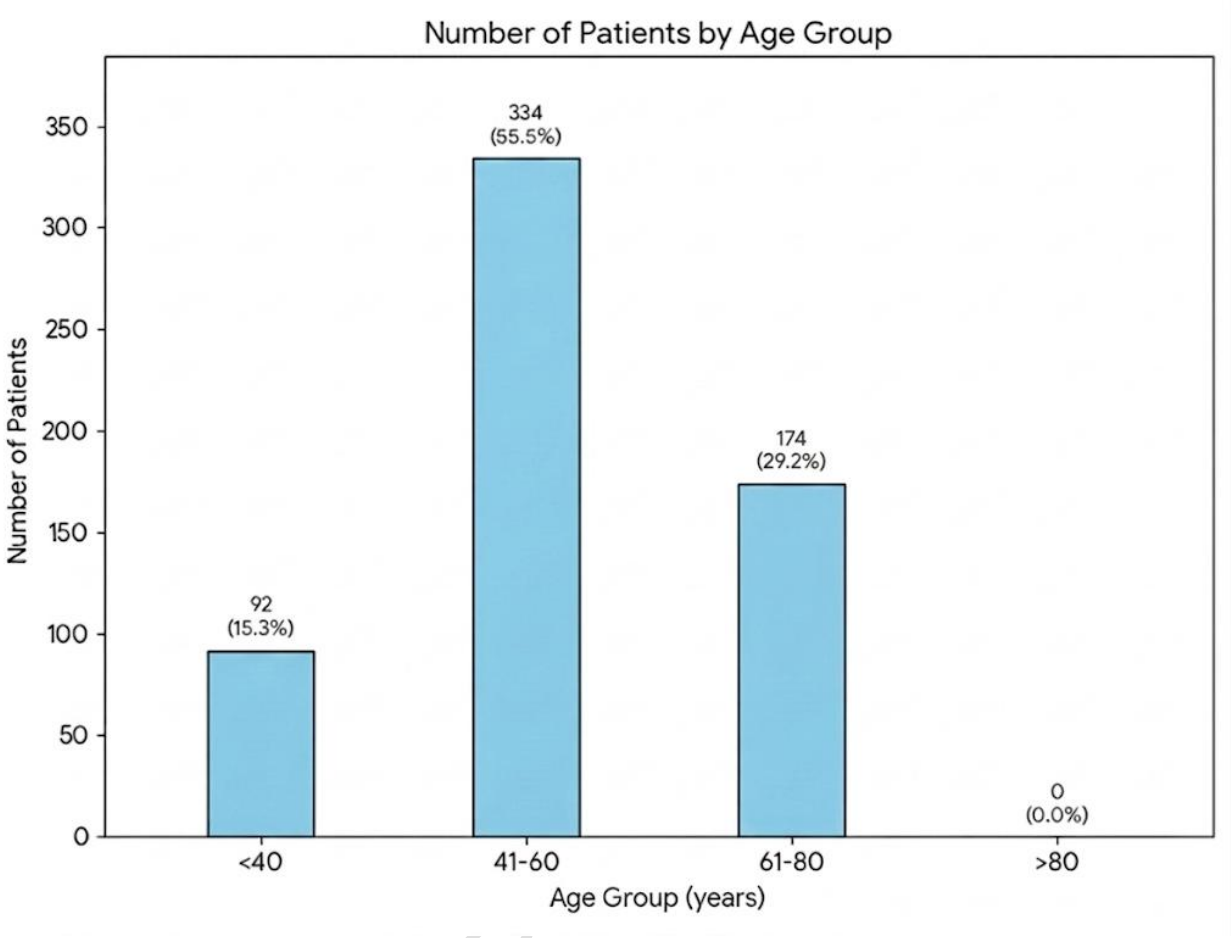

Figure 1: Age distribution

Table 1 – Gender distribution of patients (n = 600)

Gender	Number of patients	Percentage
Male	307	51.1 %
Female	293	48.9 %

Drug therapy distribution

For each prescription the number of different classes of glucose-lowering agents was counted. Monotherapy was observed in 92 prescriptions (15.3 %), dual therapy in 107 prescriptions (17.8 %), triple therapy in 165 prescriptions (27.5 %) and polytherapy (≥4 classes) in 236 prescriptions (39.3 %). The distribution of therapy categories is shown in **Figure 2**.

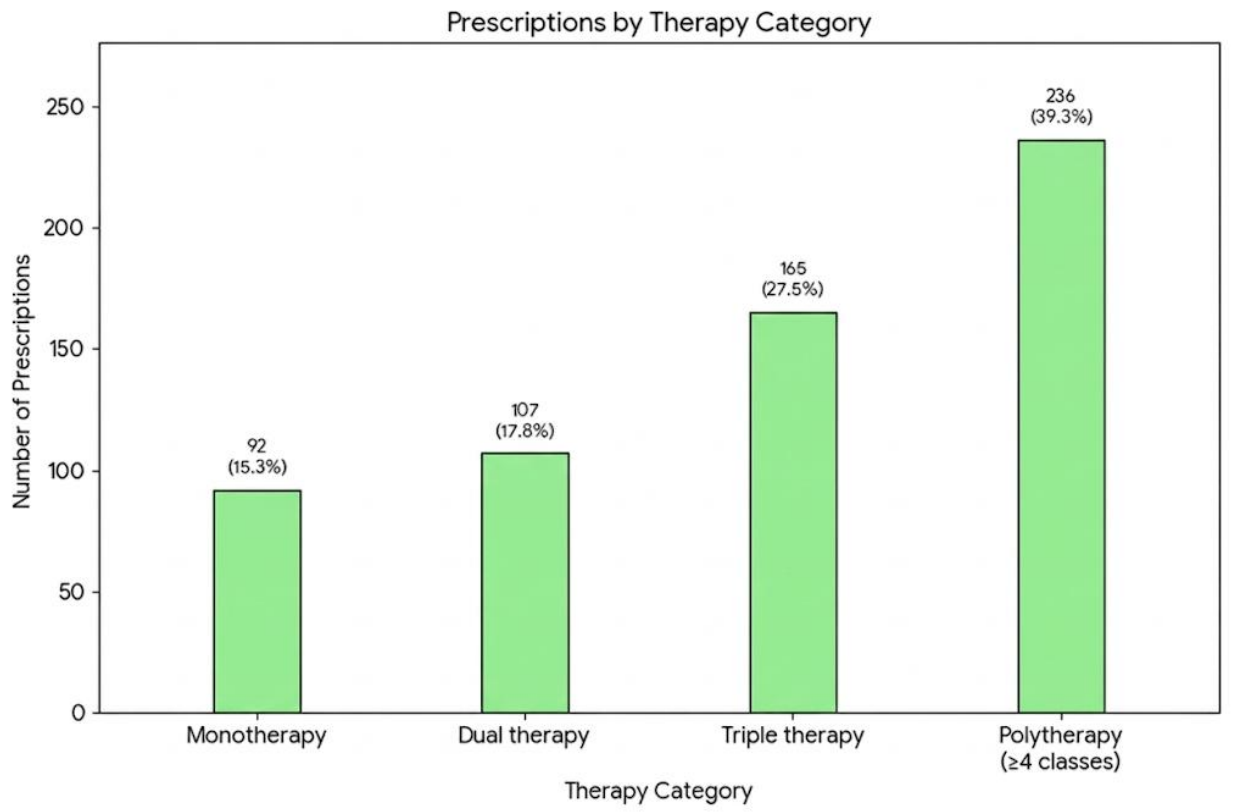

Figure 2:Distribution of drug therapy

Utilization pattern of glucose-lowering agents

The utilization of individual classes of glucose-lowering agents is summarized in**Figure 3**. DPP-4 inhibitors were the most frequently prescribed class (61.1 % of encounters), followed by sulfonylureas (58.1 %) and biguanides (metformin) (56.8 %). SGLT2 inhibitors were prescribed in 46.7 % of encounters, while insulin and thiazolidinediones were used in 38.7 % and 31.9 % of encounters, respectively.

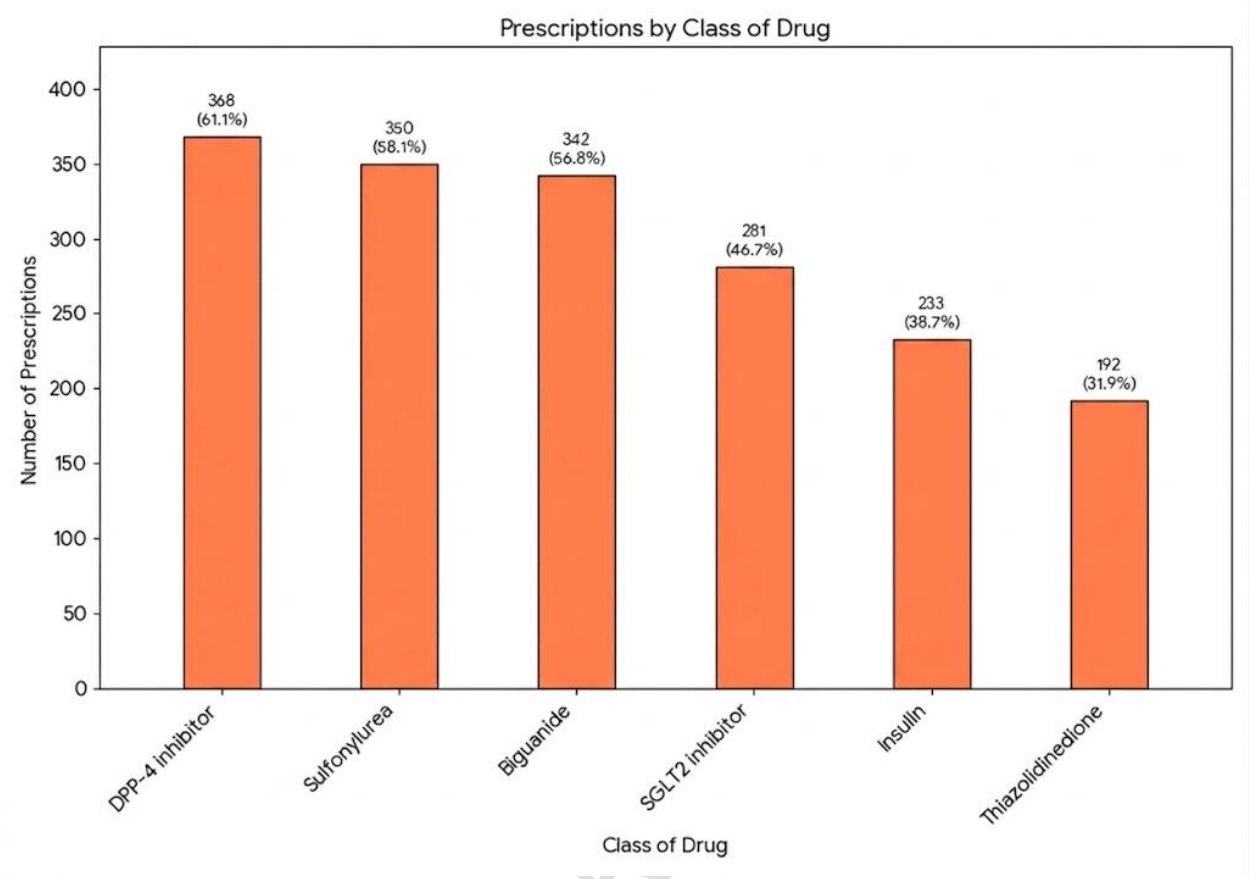

Figure 3: Utilization by drug class

WHO prescribing indicators

The average number of drugs per prescription was 3.59 (SD 1.61; median 3). Drugs were prescribed by generic name in 86.4 % of cases. Injections were prescribed in 23.3 % of encounters and antibiotics in 6.0 %. Overall, 55.5 % of all drugs belonged to the Indian essential medicines list. These findings are compared with the WHO reference values in **Table 2**.

Table 2 – WHO core prescribing indicators

Indicator	Study value	WHO reference value
Average number of medicines per encounter	3.59	< 2 per encounter
Percentage of drugs prescribed by generic name	86.4 %	100 %
Percentage of encounters with an antibiotic prescribed	6.0 %	< 30 %
Percentage of encounters with an injection prescribed	23.3 %	< 20 %
Percentage of drugs prescribed from essential medicines list	55.5 %	100 %

Common drug combinations

Among the 600 prescriptions, 508 (84.7 %) contained ≥2 classes of glucose-lowering agents. The five most common combinations are presented in **Table 3**. The most frequent combination was biguanide + DPP-4 inhibitor + sulfonylurea (8.64 % of all prescriptions), followed by biguanide + DPP-4 inhibitor + SGLT2 inhibitor + sulfonylurea (6.15 %). Dual-class combinations such as biguanide + DPP-4 inhibitor and DPP-4 inhibitor + sulfonylurea each accounted for 3.65 % of prescriptions.

Table 3 – Top combinations of glucose-lowering agents (n = 600)

Combination of classes	Number of prescriptions	Percentage of prescriptions
Biguanide + DPP-4 inhibitor + sulfonylurea	52	8.64 %
Biguanide + DPP-4 inhibitor + SGLT2 inhibitor + sulfonylurea	37	6.15 %
DPP-4 inhibitor + SGLT2 inhibitor + insulin + sulfonylurea	26	4.32 %
Biguanide + DPP-4 inhibitor	22	3.65 %
DPP-4 inhibitor + sulfonylurea	22	3.65 %

Discussion

This cross-sectional study analyzed 600 prescriptions of patients with T2DM attending the general medicine OPD of a tertiary care teaching hospital in India. The mean age of patients (53 years) and predominance of the 41–60 year age group reflect the middle-aged nature of T2DM, consistent with global and Indian reports. IDF estimates suggest that diabetes prevalence increases markedly after 40 years and peaks in older adults. [1] We observed a nearly equal gender distribution (male 51.1 %, female 48.9 %), whereas other studies have reported a slight male preponderance. The high prevalence of polytherapy (multiple glucose-lowering classes) observed in our cohort aligns with the broader global challenge of polypharmacy (total medication burden): a meta-analysis of 21 studies involving more than 520,000 participants found that approximately 59% of older adults with diabetes experience polypharmacy, noting significant associations with longer disease duration and multiple comorbidities [3][8]. Comparable reports from geriatric clinics document an average of 5.22 medications per patient and limited use of generic prescribing [9].

Polytherapy and triple therapy together accounted for 66.8 % of prescriptions, underscoring the progressive nature of T2DM and the need for multiple agents. The ADA emphasizes that maintenance of glycaemic targets often requires combination therapy. [4] In our study, DPP-4 inhibitors were the most commonly prescribed agents, followed by

sulfonylureas and metformin (biguanide). Newer agents such as SGLT2 inhibitors were used in nearly half of the encounters. The high utilization of DPP-4 inhibitors and SGLT2 inhibitors suggests a shift towards medications with favourable cardiovascular and renal profiles, as advocated by recent guidelines. **(Figure 4)** [4]

Figure 4: - Prescription shift toward cardiorenal protection

Hospital-based audits in central Maharashtra and southern India have reported lower mean numbers of antidiabetic drugs per prescription (1.7–3.0), high reliance on metformin and sulfonylureas, and nearly universal generic prescribing [10][11]. Conversely, population-based studies in Spain indicate that prescriptions for SGLT2 inhibitors and GLP-1 receptor agonists have increased significantly over the past decade due to evidence of cardiovascular benefit [7]. Despite this trend, real-world data from the United States reveal that only 7.4% of older adults with T2DM receive SGLT2 inhibitors or GLP-1 receptor agonists, even though 83.4% of high-risk patients might benefit [12]. These discrepancies highlight variability in adoption of newer agents across settings.

The average number of drugs per prescription (3.59) exceeded the WHO reference value of <2. While this average falls just below the strict definition of polypharmacy (five or more medications), it indicates a high overall pill burden and a strong tendency toward polypharmacy in this population. However, patients with T2DM often have comorbidities such as hypertension and dyslipidaemia, necessitating additional medications. **(Figure 5)**

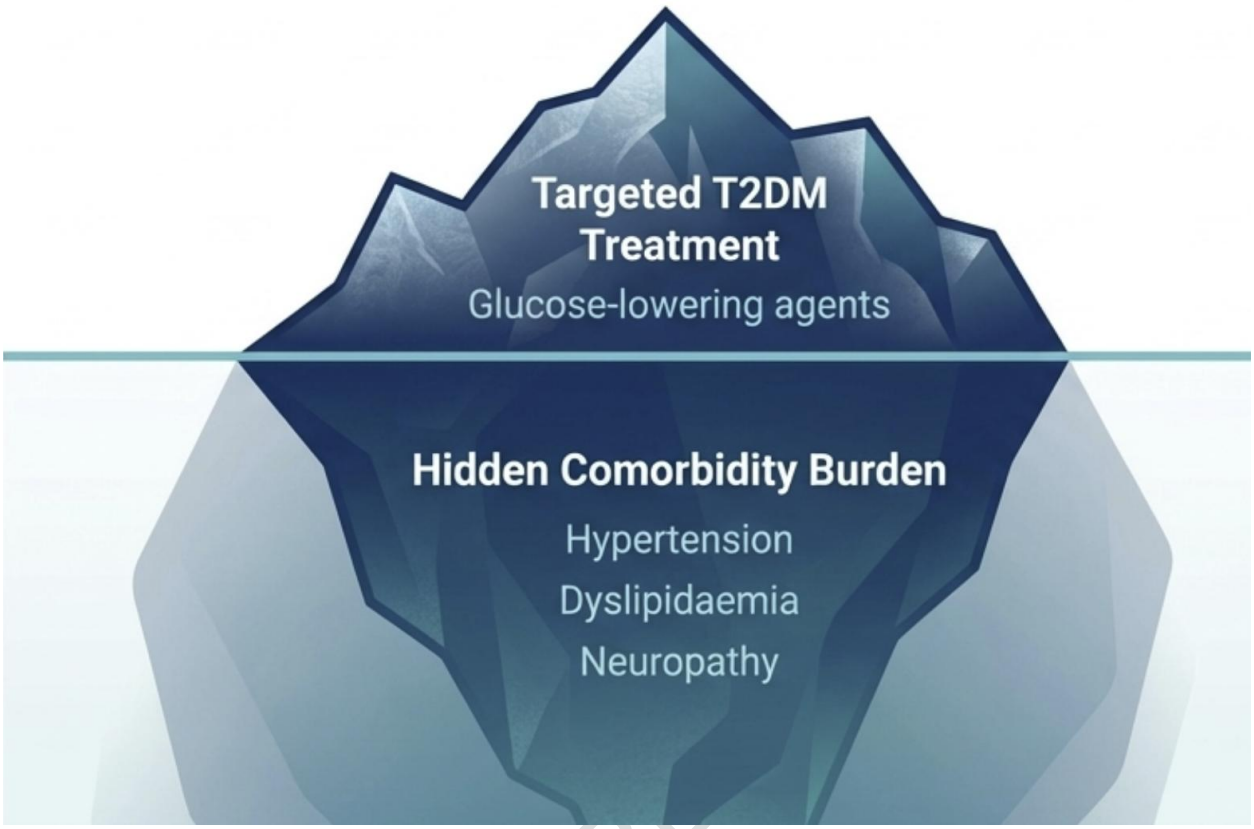

Figure 5: -Progressive disease and co-morbidities drive average prescription beyond normal limits

The rate of generic prescribing (86.4 %) was high but still below the optimal 100 %. Generic prescription promotes affordability and should be encouraged. Injections were used in 23.3 % of encounters, slightly exceeding the WHO's suggested upper limit of 20 %.[5] Many of these injections were insulin or vitamin B12 preparations; nevertheless, prescribers should be cautious about over-use of injectables. Antibiotics were prescribed in only 6.0 % of encounters, well within the recommended limit of 30 %, indicating judicious use. Only 55.5 % of the drugs were from the essential medicines list, suggesting room for improvement in aligning prescriptions with national formularies. Polytherapy with three or more classes accounted for most prescriptions, with biguanide + DPP-4 inhibitor + sulfonylurea being the most common combination. Our average number of drugs per encounter exceeded that reported in a family medicine primary care study (2.89) and cross-sectional audits from central India [13][10], reflecting the burden of comorbidities in our tertiary care cohort. Similarly, our essential medicines list adherence (55.5%) was lower than the 98.3% and 89.80% reported in central Maharashtra and Srikakulam studies respectively [10][11]. Emerging evidence supports combination therapy with SGLT2 inhibitors and GLP-1 receptor agonists: a recent meta-analysis involving over 42,000 participants found that such combinations reduced hospitalisations for heart failure and major adverse cardiovascular events compared with monotherapy and produced greater HbA1c and weight reductions, albeit with an increase in gastrointestinal side-effects [14]. Cost considerations may limit uptake of these agents; a primary care

study reported that financial constraints were a major barrier to prescribing SGLT2 inhibitors [13].

Strengths and limitations

The strengths of this study include a relatively large sample size and a comprehensive evaluation of WHO prescribing indicators. Data were collected from actual prescriptions, minimizing recall bias. The study is limited by its single-centre, cross-sectional design; findings may not be generalizable to other settings. Nevertheless, the study provides valuable insights into current prescribing patterns and highlights areas for quality improvement.

Conclusions

This study highlights the complex reality of managing T2DM in a tertiary care setting, where the progressive nature of the disease frequently necessitates combination therapy. Encouragingly, prescribing patterns reflect a modernizing shift; clinicians are increasingly utilizing newer agents like DPP-4 and SGLT2 inhibitors to align with recent guidelines advocating for cardiovascular and renal protection. Furthermore, the high rate of generic prescribing and judicious use of antibiotics indicate positive prescribing behaviours. However, these clinical benefits are offset by significant challenges regarding rational drug use. The average number of medications per encounter notably exceeded WHO reference values, pointing to a high burden of polypharmacy. Additionally, with only about half of the prescribed drugs belonging to the essential medicines list, there is a clear missed opportunity for cost-effective care. Moving forward, targeted clinician education and regular prescription audits are essential. Healthcare providers must strive to balance aggressive, guideline-directed combination therapy with the principles of rational prescribing to minimize polypharmacy and enhance the affordability of diabetes care

Acknowledgements

We thank the staff of the Department of Medicine for their cooperation in data collection and the Department of Pharmacology for their guidance. No external funding was received for this study. The authors declare no conflict of interest.

References : -

1. International Diabetes Federation. IDF Diabetes Atlas. 10th ed. Brussels: International Diabetes Federation; 2021. Available from: https://diabetesatlas.org/resources/previous-editions/

2. Pradeepa R, Mohan V. Epidemiology of type 2 diabetes in India. Indian J Ophthalmol. 2021;69:2932–8. PMID: 34708726. Full text: PMC8725109

3. Satapathy P, Gaidhane AM, Vadia N, Menon SV, Chennakesavulu K, Panigrahi R, et al. Prevalence of polypharmacy among older adults with diabetes: a systematic review and meta-analysis. Aging Clin Exp Res. 2025;37:335. PMID: 41296133. Full text: PMC12657567

4. American Diabetes Association. Pharmacologic approaches to glycemic treatment: Standards of Care in Diabetes—2024. Diabetes Care. 2024;47(Suppl 1):S158–78. PMID: 38078590. Journal: Link

5. Ofori-Asenso R. A closer look at the World Health Organization's prescribing indicators. J PharmacolPharmacother. 2016;7:51–4. PMID: 27127400. Full text: PMC4831494. DOI: 10.4103/0976-500X.179352

6. Andraos J, Smith SR, Tran A, Pham DQ. Narrative review of data supporting alternate first-line therapies over metformin in type 2 diabetes. J Diabetes MetabDisord. 2024;23(1):385–94. PMID: 38932889. DOI: 10.1007/s40200-024-01406-6

7. Cea-Soriano L, Moreno A, Calonge M, Rivas A, Pulido-Manzanero J, Colchero MC, et al; PRECOZIN Study Group. Changes in prescription patterns of antidiabetic medication in patients newly diagnosed with type 2 diabetes in Spain: an observational study. BMJ Open. 2025;15:e106069. PMID: 40983582. DOI: 10.1136/bmjopen-2025-106069. Journal: Link

8. Tamene FB, Zeleke TK, Desalew AF, Tarekegn GY, Sendekie AK, Tafere SM, et al. Polypharmacy and associated factors among patients with type two diabetes mellitus with comorbidity: a multicentre cross-sectional study in Northwest Ethiopia. BMC EndocrDisord. 2025;25:188. PMID: 40721757. Full text: PMC12302859. PDF: Link

9. Gupta D, Sharma A, Hussain S, Sawlani KK, Katiyar D, Usman K, Nath R. Drug prescribing patterns in geriatric patients with type 2 diabetes mellitus at a tertiary care teaching hospital: a cross-sectional study. Cureus. 2026;18(2):e104264. DOI: 10.7759/cureus.104264. Journal: Link

10. Kothari M, Giri RR, Abraham JP. Assessment of antidiabetic drug utilization and prescribing trends in outpatient care at a district general hospital in central Maharashtra. Int J Basic Clin Pharmacol. 2025;14(6). DOI: 10.18203/2319-2003.ijbcp20253293. Journal: Link

11. Anireddy SR, Narayanappa S, Mansi, Saint Louis R, Aayush. Analysis of prescription pattern of anti-diabetic medications in geriatric population at a tertiary care center: a retrospective observational study. Int J Sci Rep. 2026;12(1). DOI: 10.18203/issn.2454-2156.IntJSciRep20254112. Journal: Link

12. Alhomoud IS, Alamer KA. Real-world prescribing patterns of SGLT2 inhibitors and GLP-1 receptor agonists in older adults with type 2 diabetes and cardiometabolic disease. Pharmaceuticals (Basel). 2025;19(1):9. PMID: 41599611. Full text: PMC12845426. Journal: Link

13. Tiwari K, Bisht M, Kant R, Handu SS. Prescribing pattern of anti-diabetic drugs and adherence to the American Diabetes Association's 2021 treatment guidelines among patients of type 2 diabetes mellitus: a cross-sectional study. J Family Med Prim Care. 2022;11(10):6159–64. PMID: 36618206. Full text: PMC9810884

14. Liakos A, Karagiannis T, Avgerinos I, Bekiari E. SGLT-2 inhibitors and GLP-1 receptor agonists as combination therapy in type 2 diabetes. Curr Diab Rep. 2026;26(1):1. PMID: 41528550. Full text: PMC12799618