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Pharmacological treatment patterns, factors associated with glycemic control, and renal function parameters in a real-world cohort of Hispanic adults with type 2 diabetes

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Abstract. Type 2 diabetes mellitus (T2DM) disproportionately affects Hispanic populations, yet real-world treatment patterns and factors associated with glycemic control in this group are poorly characterized. Optimal glycemic control is essential to reduce complications. A cross-sectional study of 1,397 Hispanic adults with T2DM was conducted in a community primary care clinic. Demographic characteristics, comorbidities, pharmacological regimens, glycemic control (HbA1c) and renal function parameters [estimated glomerular filtration rate (eGFR) and urine albumin-to-creatinine ratio] were extracted from electronic medical records. Multivariable logistic regression was performed to identify factors independently associated with optimal glycemic control [glycated hemoglobin (HbA1c) ≤7%]. Overall, 59.6% of patients received glucose-lowering medications, with metformin being the most frequently prescribed agent. Monotherapy with sodium-glucose cotransporter-2 (SGLT2) inhibitors, glucagon-like peptide-1 receptor agonists, or metformin was associated with the highest rates of glycemic control (≥85% achieving HbA1c ≤7%). Insulin and sulfonylurea use were associated with poorer glycemic and renal profiles, likely reflecting confounding by indication, as these agents were preferentially prescribed to patients with more advanced disease. The association between SGLT2 inhibitor use and lower eGFR similarly appeared to reflect targeted prescribing in patients with renal impairment. In multivariable analysis, female sex [adjusted odds ratio (aOR), 3.25] and frequent specialist visits (aOR 8.27) were independently associated with optimal glycemic control, whereas insulin and sulfonylurea use were independently associated with lower odds of achieving HbA1c ≤7%. In the current real-world Hispanic cohort, pharmacological patterns were strongly influenced by clinical complexity. These findings provide insight into diabetes management and factors associated with glycemic control in an underserved population receiving care in a community-based setting.

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Introduction

Type 2 diabetes mellitus (T2DM) is one of the leading chronic diseases worldwide and continues to increase in prevalence, particularly in low-income and minority populations. It is estimated that over 37 million individuals in the United States live with diabetes, of whom 90-95% have T2DM (1). Hispanic and Latino adults bear a disproportionate share of this burden, often presenting with earlier onset, higher rates of obesity and metabolic syndrome, and poorer long-term outcomes compared with non-Hispanic White populations (1,2). These disparities are influenced not only by genetic predisposition but also by socioeconomic barriers, healthcare access limitations, and cultural factors that affect disease management and treatment adherence (3,4).

Achieving and maintaining adequate glycemic control is fundamental to reducing the risk of both microvascular complications (for example, nephropathy, retinopathy and neuropathy) and macrovascular complications (for example, cardiovascular disease and stroke) (5). Current guidelines from the American Diabetes Association (ADA) and other international bodies recommend a patient-centered, stepwise intensification of pharmacological therapy, starting with metformin monotherapy and progressing to dual or triple therapy, and eventually to insulin or more complex combinations when needed (6). While these guidelines provide a clear framework, real-world prescribing patterns often diverge from this idealized stepwise approach, being heavily influenced by patient-specific comorbidities, tolerability, cultural factors that shape treatment decisions and adherence (7), and systemic barriers to care. These variations are particularly relevant in underserved Hispanic communities, where evidence describing treatment pathways and their real-world patterns and associated clinical profiles remains scarce (8,9).

While glycated hemoglobin (HbA1c) is the most widely accepted biomarker for assessing glycemic control (10), additional outcomes such as renal function, measured by estimated glomerular filtration rate (eGFR) and urine albumin-to-creatinine ratio (UACR), are essential to understanding the broader impact of diabetes management (10,11). This is particularly critical as diabetic kidney disease represents one of the most severe and costly long-term complications of T2DM, making renal status a key indicator of disease progression and treatment context (12,13). Given that diabetic kidney disease is one of the most severe and costly complications of T2DM, assessing renal function parameters in relation to pharmacological strategies provides descriptive insights into the clinical profiles observed across treatment strategies (12,13).

Previous studies, such as pharmacist-led interventions designed to improve adherence and guideline-concordant care, have reported modest benefits in glycemic control among Hispanic patients (8,9,14). Building upon this, the present study addresses a critical gap by providing a comprehensive, real-world evaluation of existing pharmacological treatment patterns and their association with both glycemic and renal function parameters. By characterizing medication utilization in routine care, it was aimed to identify key clinical factors associated with optimal glycemic control within this high-risk, community-based clinical population (15,16). By characterizing medication utilization and identifying clinical factors associated with optimal glycemic control in routine care, the present study complements existing interventional studies and addresses an important gap in the understanding of diabetes management within this high-risk population.

Accordingly, the present study focuses exclusively on Hispanic adults with T2DM attending a community-based primary care clinic. The current objectives were threefold: i) to describe real-world pharmacological treatment patterns in this population; ii) to compare glycemic and renal profiles across different pharmacological regimens as observed in real-world practice; and iii) to identify demographic, clinical and therapeutic factors independently associated with optimal glycemic control.

Materials and methods

Study design and setting. This observational, cross-sectional study analyzed clinical and demographic data retrospectively extracted from electronic medical records (EMR) of adult patients attending a community-based primary care clinic (Caridad Center, Palm Beach, Florida, USA) between 2022 and 2024. In addition, to contextualize the study period, key descriptive indicators were summarized by calendar year (2022, 2023, and 2024).

Participants and inclusion criteria. Eligible participants were adults (≥18 years) who received at least two medical visits at the clinic during the study period. During the study period, 8,862 adult patients were identified in the EMR. Of these, 1,397 met the criterion of having a confirmed diagnosis of T2DM, resulting in a final analytical sample of not-treated (n=564) and treated (n=833) (Fig. 1). For this analysis, only patients with a confirmed diagnosis of T2DM were included (n=1,397). Diagnosis was confirmed based on laboratory evidence (for example, HbA1c ≥6.5% or fasting plasma glucose ≥126 mg/dl) consistent with ADA criteria (3,17-19). Patients with incomplete records, defined as missing essential clinical or biochemical data, were excluded. Data quality was independently validated by two clinically trained researchers, and records with inconsistent or implausible values were systematically removed to ensure accuracy and reliability. Importantly, clinical staff at the clinic, who were not part of the research team, conducted the initial de-identification of EMR prior to sharing data for analysis, thereby ensuring blinding of the investigators.

Data collection. Clinical, demographic and biochemical data were systematically collected from the EMR. Demographic and socioeconomic variables included age, sex, education level, employment status, household composition and lifestyle behaviors (alcohol and tobacco use). Clinical variables focused on comorbidities, including hypertension, obesity, chronic kidney disease (CKD), hyperlipidemia, cardiovascular disease, depression/anxiety, and liver disease, which were used as adjustment covariates in regression models (20,21). Biochemical markers included glycated hemoglobin (HbA1c) to evaluate glycemic control, and renal function parameters, estimated glomerular filtration rate (eGFR) and UACR (22). Data on duration of diabetes and medication adherence were not consistently available and therefore not analyzed. Healthcare utilization during the study period (2022-2024) was recorded, including primary care visits, specialist consultations, diabetes education sessions, mental health visits, and case management encounters. These measures were primarily used as covariates for adjustment in multivariable analyses.

Medication use and treatment regimens. Medication data included prescribed glucose-lowering agents: Insulin, biguanides (metformin), sulfonylureas, sodium-glucose cotransporter-2 (SGLT2) inhibitors, glucagon-like peptide-1 (GLP-1) receptor agonists (RAs), and dipeptidyl peptidase-4 (DPP-4) inhibitors. Mineralocorticoid receptor antagonists (MRAs) were also captured as a medication class documented in the EMR and reported descriptively. Patients were categorized by treatment regimen complexity into monotherapy,

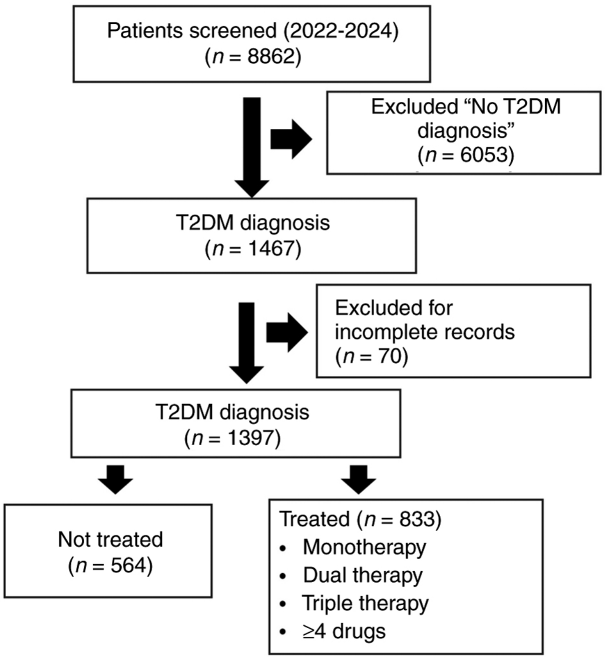

Figure 1. Flow diagram of patient selection from electronic medical records (2022-2024). Patients with incomplete essential data or inconsistent records were excluded prior to final analysis. T2DM, type 2 diabetes mellitus.

dual therapy, triple therapy, or regimens with ≥4 medications, to assess treatment intensity (23-26). Fixed-dose combinations were counted according to the number of active agents contained. Medication doses and adherence data were not available.

Medication exposure was defined cross-sectionally based on active prescriptions recorded during the full 2022-2024 period; therefore, year-stratified medication patterns are not emphasized because prescriptions may span multiple calendar years and do not capture initiation, discontinuation, or sequencing.

Information on treatment duration, sequencing of therapies, prior medication changes, dosage adjustments, and medication adherence was not consistently available in the EMR and therefore could not be analyzed. As a result, medication classes were treated as static exposure variables, and analyses stratified by medication type reflect cross-sectional associations rather than longitudinal treatment effects. Therefore, medication-related findings should not be interpreted as evidence of therapeutic effectiveness.

Study outcomes. The primary outcome was optimal glycemic control, defined as an HbA1c ≤7% (27). For patients with more than one HbA1c measurement during the study period, the lowest recorded HbA1c value was selected to represent their best-achieved glycemic status. HbA1c measurements per patient during the study period were also counted. This approach was chosen to descriptively capture the best glycemic value recorded during the study period under routine clinical care. Secondary outcomes included: i) Renal function parameters: Best-achieved eGFR and UACR; ii) treatment regimen comparisons: Glycemic control rates stratified by regimen complexity (monotherapy, dual, triple, ≥4 agents).

Covariates. Covariates included age, sex, tobacco and alcohol use, employment status, comorbidities (obesity, hyperlipidemia, hypertension and CKD), healthcare utilization variables, and use of major medication classes (insulin, sulfonylureas, biguanides, GLP-1 RAs and SGLT2 inhibitors).

Statistical analysis. Descriptive statistics summarized demographic, clinical, biochemical and treatment characteristics. Comparative analyses were conducted using independent t-tests for continuous variables and chi-square tests for categorical variables. Pairwise comparisons of glycemic control rates across treatment regimens were performed using Fisher's exact test (28). A multivariable logistic regression model was used to identify independent factors associated with optimal glycemic control (HbA1c ≤7%). Covariates included age, sex, tobacco and alcohol use, employment status, comorbidities (obesity, hyperlipidemia, hypertension and CKD), healthcare utilization variables, and use of major medication classes (insulin, sulfonylureas, biguanides, GLP-1 RAs and SGLT2 inhibitors). Results were reported as adjusted odds ratios (aOR) with 95% confidence intervals (CI). Variable selection followed a backward stepwise approach (entry criterion $P \le 0.05$; removal criterion $P \ge 0.10$). Statistically significant difference was set at $P<0.05$ (two-tailed). Multivariable logistic regression models used a complete-case approach (listwise deletion), and no imputation was performed. Analyses were conducted using SPSS software (version 26; IBM Corp.) (29).

Ethical approval. The present study was approved by the Florida International University Institutional Review Board (approval no. IRB-24-0488; Miami, USA). The requirement for individual informed consent was waived due to the retrospective nature of the analysis. All procedures complied with ethical standards for research involving human subjects and ensured strict confidentiality of patient data. The present study was not preregistered; analyses should be interpreted as descriptive and exploratory.

Results

General characteristics of patients with type 2 diabetes and comparison between medicated and non-medicated. The study population included a total of 1,397 participants with type 2 diabetes. Demographic, clinical and healthcare utilization characteristics among patients with type 2 diabetes (T2DM) according to their use of glucose-lowering medications are presented in Table I. Patients receiving pharmacological treatment were significantly older and had a higher prevalence of comorbidities, including CKD, hypertension, hyperlipidemia and obesity, compared with non-medicated patients (all $P<0.05$). Furthermore, medicated patients exhibited worse glycemic control, as reflected by higher mean HbA1c levels, and lower renal function, indicated by reduced eGFR values (both $P<0.001$). Healthcare utilization was significantly greater among treated patients, who had more primary care appointments, specialist visits, case management encounters, mental health visits, and health education sessions. Although the proportion of females was slightly lower in the medicated group (59.5%) than in the non-medicated group (64.2%), this difference was not statistically significant ($P=0.083$). During 2022-2024, the number of

Table I. Characteristics of diabetic patients according to use of glucose-lowering medication.

Clinicopathological characteristics	No medication (n=564)	Medication (n=833)	P-value
Demographic characteristics			
Age, years[a]	50.17±14.41	53.08±11.30	<0.001
Female[b]	64.2%	59.5%	0.083
Hispanic[b]	100%	100%	
High School or Less[b]	86.5%	83.6%	0.644
Employment status[b]			
Unemployed[b]	38.0%	44.6%	0.021
Lifestyle characteristics (%)			
Alcohol use[b]	21.3%	24.9%	0.238
Tobacco[b]	9.1%	16.3%	0.073
Chronic comorbidities[b]			
Chronic kidney disease [b]	6.0%	15.2%	<0.001
Hypertension[b]	38.1%	56.5%	<0.001
Hyperlipidemia[b]	51.4%	66.7%	<0.001
Liver disease[b]	13.3%	16.9%	0.070
Cardiovascular disease[b]	2.7%	4.1%	0.183
Obesity[b]	28.7%	34.5%	0.027
Depression/anxiety[b]	11.7%	14.8%	0.111
Healthcare utilization[a]			
Primary care appointments[a]	0.60±2.15	1.49±3.48	<0.001
Specialist doctor[a]	9.40±9.22	17.17±16.34	<0.001
Case management[a]	1.79±2.72	3.73±4.21	<0.001
Mental health[a]	1.54±6.11	3.10±10.99	0.002
Health education[a]	0.37±0.95	0.82±1.59	<0.001
Biochemical markers			
HbA1c[a]	6.07±1.11	7.06±1.62	<0.001
Estimated glomerular filtration rate (ml/min/1.73 m^2)[a]	102.45±20.77	96.92±24.42	<0.001
Urine albumin-to-creatinine ratio[a]	63.46±155.82	69.19±202.28	0.864
Total cholesterol-to-high-density lipoprotein cholesterol ratio[a]	3.71±1.14	3.35±1.04	<0.001
HbA1c ≤7%[b]	91.4%	65.4%	<0.001

[a]Continuous variables are presented as mean ± standard deviation (SD). [b]Categorical variables as percentages. P-values were obtained using Student's t-test for continuous variables and Chi-square test for categorical variables.

HbA1c measurements per patient had a median of 2.0 (IQR 2), with minimum and maximum values of 1 and 13, respectively.

Pharmacological treatment patterns in treated type 2 diabetes patients. Medication use among the treated subgroup (n=833) of patients with T2DM is shown in Table II. Within these patients, metformin was the most prescribed medication, used by 86.4% of patients, followed by insulin (25.5%), GLP-1 RAs (24.1%) and SGLT2 inhibitors (19.3%). Sulfonylureas were prescribed to 17.4% of patients treated, while MRAs and DPP-4 inhibitors were less frequently used, at 2.2 and 0.1%, respectively. Regarding therapy regimens, just over 50% of the patients were on monotherapy (51.4%), while 28.9 and 14.1% were on dual and triple therapy, respectively. A smaller proportion (4.6%) received four or more medications.

Glycemic control according to therapeutic regimen and medication class. In Table III, the proportion of patients achieving optimal glycemic control (HbA1c ≤7%) according to medication class and regimen complexity is shown. Among patients receiving monotherapy, the highest control rates were observed for SGLT2 inhibitors (90.9%) or GLP-1 Ras (85.7%), followed closely by biguanides (85.5%). Sulfonylureas showed intermediate control rates, (62.5%), while insulin monotherapy revealed notably lower rates of glycemic control (33.3%). Pairwise comparisons of glycemic control among monotherapy regimens using Fisher's exact test are demonstrated in Table IV. Higher proportions of glycemic control were observed among patients receiving SGLT2 inhibitors or GLP-1 RAs compared with those receiving insulin monotherapy; however, these differences likely reflect variation in

Table II. Medication use patterns among patients with diabetes.

Medication class	Percentage (%)
Biguanides (Metformin)	86.43
Insulin	25.45
GLP-1 receptor agonists	24.13
SGLT2 inhibitors	19.33
Sulfonylureas	17.41
Mineralocorticoid receptor antagonists	2.16
DPP-4 inhibitors	0.12
Number of medications	**Percentage (%)**
1 (Monotherapy)	51.38
2 (Dual therapy)	28.93
3 (Triple therapy)	14.05
≥4	4.56

Percentages indicate the proportion of patients receiving each medication class or therapy regimen. Abbreviations: GLP-1, glucagon-like peptide-1; SGLT2, sodium-glucose cotransporter 2; DPP-4, dipeptidyl peptidase-4; MRA, mineralocorticoid receptor antagonist.

underlying disease stage and treatment selection (P<0.001 for both comparisons). Biguanides also showed a higher proportion of glycemic control than insulin (P<0.001). Although sulfonylureas showed intermediate glycemic control rates, differences compared with other medications were not statistically significant, highlighting intermediate control rates in monotherapy.

Differences in monotherapy by comorbidity. Table V shows, for each comorbidity, the proportion of patients with (Yes) or without (No) the condition who receive monotherapy with each medication class. Among patients with CKD, a significantly higher proportion received SGLT2 inhibitors (20.5%) compared with those without CKD (2.8%) (P<0.001). GLP-1 RAs are more frequently prescribed to patients with obesity, with 13.1% of obese patients receiving this therapy compared with 1.0% of non-obese patients (P<0.001). Biguanide use is dominant among patients without CKD (85.7%) and less common in those with CKD (38.5%) (P<0.001); similarly, biguanides are more frequent in patients without hypertension than in those with it. Sulfonylureas show no significant differences in prescription rates between patients with or without the evaluated comorbidities. Insulin monotherapy is characteristically prescribed to patients with more complex clinical states, such as CKD and possibly lower metabolic reserve, as suggested by the lower prevalence of obesity among insulin users (1.4%) compared with non-users (8.0%) (P=0.004). This is evidenced by the markedly higher proportion of patients with CKD receiving insulin (25.6%) vs. those without CKD (3.8%) (P<0.001). Additionally, insulin use is significantly higher among unemployed patients (8.6%) compared with employed ones (4.0%) (P=0.047), which may reflect differences in clinical complexity, health care access, or other unmeasured factors. These data suggest that prescribing patterns reflect selective use of SGLT2 inhibitors and GLP-1 RAs in specific clinical phenotypes (such as CKD and obesity) rather than uniform superiority across disease stages, while insulin monotherapy is commonly observed among patients with more advanced clinical profiles of advanced diabetes, associated with more severe comorbidities and complex patient profiles. Notably, patients with regimens that include the use of insulin, either as monotherapy or in combination with other medications, are those with the lowest proportion of glycemic control (Table III).

Differences in glycemic control and renal function across monotherapy regimens. HbA1c, eGFR and UACR among patients treated with different monotherapy regimens are compared in Table VI. Significant differences in HbA1c were observed, with the lowest mean values found in patients treated with SGLT2 inhibitors (5.95%), GLP-1 RAs (6.28%), and biguanides (6.38%). Patients treated with insulin (7.89%) and sulfonylureas (7.92%) had significantly higher mean HbA1c levels, indicating lower glycemic control (P<0.001 for comparisons). By contrast, renal function parameters (eGFR and UACR) appeared indicative of baseline patient characteristics rather than therapeutic effects. Patients on insulin monotherapy had significantly lower eGFR (67.7 ml/min/1.73 m^2) compared with those on biguanides (101.1 ml/min/1.73 m^2; P<0.001) and GLP-1 RAs (102.5 ml/min/1.73 m^2; P<0.001). Patients receiving SGLT2 inhibitors showed the lowest eGFR (59.9 ml/min/1.73 m^2), indicating targeted prescription among patients with advanced renal impairment. The UACR, reflecting renal damage, was significantly elevated in patients treated with sulfonylureas (349.0 mg/g) and insulin (148.6 mg/g), compared with notably lower values in those receiving biguanides (30.6 mg/g; P<0.001), GLP-1 RAs (47.3 mg/g), and SGLT2 inhibitors (66.6 mg/g; P=0.047). In summary, it can be stated that patients receiving insulin or sulfonylureas had higher HbA1c levels and less favorable renal parameters; however, these differences likely reflect more advanced disease stage and selective prescribing rather than medication-related effects, consistent with more advanced disease.

Glycemic control and renal function parameters in dual and triple diabetes therapy regimens. Glycemic control, eGFR and UACR values among patients on dual and triple diabetes medication regimens are compared in Table VII. In dual therapy, glycemic control was significantly more favorable in regimens containing GLP-1 RAs, with a mean HbA1c of 6.68%, compared with those without GLP-1 RAs (7.92%; P<0.001). Dual therapy involving insulin was associated with significantly poorer glycemic control (HbA1c, 8.51%) compared with those without insulin (7.07%; P<0.001). Dual regimens including sulfonylureas did not show significant glycemic advantages (7.41 vs. 7.58%; P=0.549). Triple therapy regimens including sulfonylureas demonstrated significantly poorer glycemic outcomes (HbA1c, 8.12%) compared with regimens without sulfonylureas (7.50%; P=0.035). Although triple therapies involving GLP-1 RAs had slightly improved glycemic control (7.55%) compared with regimens without GLP-1 RAs (7.97%), this difference was not statistically significant (P=0.138). Regarding renal function parameters, patients receiving dual therapy with biguanides had significantly improved eGFR (102.0 ml/min/1.73 m^2 vs. 79.2 ml/min/1.73 m^2 without biguanides; P<0.001). Similarly,

Table III. Percentage of diabetic patients achieving glycemic control (Hba1c ≤7%) by medication class and regimen complexity.

	Percentage of patients achieving glycemic control			
		In combination with		
Medication class	Monotherapy	Dual therapy Biguanides +	Dual therapy Insulin +	Triple therapy SGLT2 + Biguanides +
SGLT2 inhibitors	90.90	61.90	25.00	
Insulin	33.30	12.80	33.30	50.00
GLP-1 receptor agonists	85.70	76.70	66.70	88.90
Sulfonylureas	62.50	60.00	-	43.80
Biguanides	85.50	85.50	12.80	-

Data are presented as percentages. Glycemic control rates are shown for each medication class used as monotherapy or in combination therapies (dual or triple therapy). A dash (-) indicates that no patients in the sample were receiving that combination. GLP-1, glucagon-like peptide-1 receptor agonist; SGLT2, sodium-glucose cotransporter 2 inhibitor.

Table IV. P-values from Fisher's Exact Test comparing the proportion of patients achieving glycemic control (HbA1c ≤7%) with monotherapy.

Medication class	SGLT2 inhibitors	Insulin	GLP-1 receptor agonists	Sulfonylureas	Biguanides
SGLT2 inhibitors	-	0.0027	1	0.2621	1
Insulin	<0.001	-	0.0007	0.2191	0
GLP-1 receptor agonists	1	0.0007	-	0.3045	1
Sulfonylureas	0.108	0.2191	0.3045	-	0.1042
Biguanides	1	0	1	0.1042	-

P-values from pairwise comparisons of glycemic control (HbA1c ≤7%) among monotherapy regimens in patients with type 2 diabetes mellitus, using Fisher's exact test. The table compares each medication class against the others in terms of the proportion of patients achieving glycemic control. P<0.05 was considered to indicate a statistically significant difference. GLP-1, glucagon-like peptide-1 receptor agonist; SGLT2, sodium-glucose cotransporter 2 inhibitor.

dual therapy involving GLP-1 RAs demonstrated significantly improved eGFR (104.5 ml/min/1.73 m^2 vs. 95.6 ml/min/1.73 m^2 without GLP-1; P=0.018). Patients treated with dual therapies containing SGLT2 inhibitors had significantly lower mean eGFR (81.4 ml/min/1.73 m^2 vs. 102.9 ml/min/1.73 m^2; P<0.001), reflecting their targeted use among patients with impaired renal function. The UACR was significantly lower in dual therapies with GLP-1 RAs (24.1 mg/g vs. 95.2 mg/g; P=0.023) and biguanides (31.4 mg/g vs. 267.8 mg/g; P<0.001), showing favorable renal parameter profiles in this cross-sectional comparison. In triple therapy, higher UACR values among patients on SGLT2 inhibitors (88.7 mg/g vs. 32.0 mg/g without SGLT2 inhibitors; P=0.044) likely reflect selective prescribing for those with advanced renal disease.

Factors associated with optimal glycemic control (HbA1c ≤7%). Factors significantly associated with optimal glycemic control (defined as HbA1c ≤7%) among patients with diabetes are presented in Table VIII. In the multivariable logistic regression model, female sex (aOR=3.246, 95% CI: 1.323-7.964; P=0.010) and frequent specialist visits (more than nine visits, aOR=8.267, 95% CI: 2.344-29.164; P=0.001) were significantly associated with better glycemic control. By contrast, insulin use (aOR=0.018, 95% CI: 0.005-0.060; P<0.001) and sulfonylurea use (aOR=0.072, 95% CI: 0.019-0.268; P<0.001) were strongly associated with poorer glycemic control. These results suggest that insulin and sulfonylureas are predominantly used among patients with more advanced disease, greater therapeutic complexity, or non-optimal therapeutic regimen, reflecting clinical challenges in achieving optimal glucose control. Meanwhile, increased specialist care and certain demographic factors (such as female sex) were important factors associated with more favorable glycemic management. Overall, these findings underscore the importance of targeted healthcare resource utilization and careful medication selection in optimizing glycemic outcomes among diabetic patients.

Calendar-year descriptive patterns (2022-2024). Of the 1,397 patients included in the analysis, a total of 4,099 HbA1c laboratory determinations were recorded during the 2022-2024 study period. The annual distribution was 1,202 measurements in 2022 (29.3%), 1,347 in 2023 (32.9%), and 1,550 in 2024 (37.8%), demonstrating a progressive increase in the absolute number of HbA1c assessments over time.

Table V. Proportion of patients receiving monotherapy by medication class according to presence or absence of comorbidities.

		SGLT2 I	GLP-1 RA	Biguanides	Sulfonylureas	Insulin
Age	With	57.5+12.0	51.6+9.0	52.4+11.8	53.8+12.2	54.6+15.7
	Rest	52.5+12.0	52.8+12.1	54.4+12.6	52.7+12.0	52.6+11.7
	P	0.077	0.705	0.178	0.742	0.424
Chronic kidney disease	Yes	20.5%	7.7%	38.5%	7.7%	25.6%
	No	2.8%	4.8%	85.7%	2.8%	3.8%
	P	<0.001	0.442	<0.001	0.112	<0.001
HT	Yes	7.0%	6.0%	75.3%	4.7%	7.0%
	No	1.9%	4.2%	87.5%	1.9%	4.6%
	P	0.010	0.976	0.001	0.102	0.298
Hyperlipidemia	Yes	5.9%	5.1%	78.8%	3.5%	6.7%
	No	2.3%	5.1%	85.2%	2.8%	4.5%
	P	0.094	0.994	0.102	0.787	0.407
Obesity	Yes	4.1%	13.1%	82.9%	2.8%	1.4%
	No	4.5%	1.0%	78.6%	3.5%	8.0%
	P	0.999	<0.001	0.296	0.781	0.004
Unemployed	Yes	3.1%	1.9%	81.5%	3.1%	8.6%
	No	4.9%	8.0%	81.3%	3.6%	4.0%
	P	0.427	0.011	0.999	0.999	0.047

Proportion of patients receiving monotherapy by medication class (SGLT2 inhibitors, GLP-1 receptor agonists, biguanides, sulfonylureas, and insulin) according to the presence or absence of comorbidities and sociodemographic conditions. Data are expressed as percentages unless otherwise indicated. P-values correspond to comparisons between groups with and without the specified condition. GLP-1, glucagon-like peptide-1 receptor agonist; SGLT2, sodium-glucose cotransporter 2 inhibitor.

Regarding cumulative measurement frequency per patient across the entire study period, 138 patients (9.9%) had one determination, 564 (40.4%) had two, 327 (23.4%) had three, and 368 (26.3%) had four or more measurements.

Overall, these descriptive findings indicate an increase in outpatient laboratory monitoring activity throughout the study period. Although this pattern is consistent with the gradual normalization of healthcare delivery following the acute phase of the COVID-19 pandemic, no formal temporal trend analysis was conducted; therefore, this interpretation should be considered exploratory rather than causal evidence of post-pandemic recovery or the absence of temporal sampling bias. During 2022-2024, the number of HbA1c measurements per patient had a median of 2.0 (IQR 2), with minimum and maximum values of 1 and 13, respectively.

Association between glucose-lowering medication type and healthcare utilization. Healthcare utilization patterns varied notably according to the type of pharmacological treatment received by patients with T2DM. Those treated with insulin, SGLT2 inhibitors, or GLP-1 RAs exhibited significantly higher use of healthcare services, including primary care, specialist consultations, case management encounters and health education sessions (all P<0.001) (Table IX). Insulin users, in particular, showed the highest engagement in specialist visits (28.21±21.51) and case management services (6.61±5.45), reflecting insulin's typical use in patients with greater clinical complexity who require closer follow-up. Similarly, patients treated with SGLT2 inhibitors or GLP-1 RAs demonstrated substantial healthcare resource use, which may reflect differences in clinical complexity and prescribing patterns and the relatively recent introduction of these therapies, which may necessitate more intensive monitoring. Notably, mental health service utilization was also higher among patients treated with insulin (P=0.005) and GLP-1 RAs (P<0.001), possibly reflecting the psychosocial burden associated with complex treatment regimens or disease severity. By contrast, sulfonylureas and biguanides were associated with lower use of specialist services and case management, suggesting their preferential use in patients with less complicated disease profiles or those with stable glycemic control. Particularly, metformin users had significantly fewer specialist visits (P<0.001), consistent with their common use as first-line therapy in routine clinical practice (Table IX).

Factors influencing diabetes medication prescription. Factors independently associated with the prescription of specific diabetes medications revealed distinct clinical and healthcare engagement patterns (Table X). In the adjusted multivariable

Table VI. Comparison of HbA1c, eGFR and UACR values among patients treated with different monotherapy regimens.

				P-value comparing				
Parameter		Mean ± SD		Sulfonylureas	Insulin	Biguanides	GLP-1	SGLT2
eGFR	Sulfonylureas	90.22	39.66	-	0.131	0.999	0.999	0.039
	Insulin	67.66	43.36	0.131	-	<0.001	<0.001	0.999
	Biguanides	101.05	18.98	0.999	<0.001	-	0.999	<0.001
	GLP-1RAs	102.47	24.86	0.999	<0.001	0.999	-	-
	In SGLT2	59.90	34.98	0.039	0.999	<0.001	<0.001	-
	All	97.66	24.84	0.363	<0.001	<0.001	0.361	<0.001
UACR	Sulfonylureas	349.00	412.07	-	0.116	<0.001	0.095	0.095
	Insulin	148.60	324.62	0.116	-	0.107	0.999	0.999
	Biguanides	30.64	70.58	<0.001	0.107	-	0.999	0.999
	GLP-1RAs	47.33	71.61	0.095	0.999	0.999	-	-
	In SGLT2	66.60	84.68	0.047	0.999	0.999	0.999	-
	All	65.86	177.18	<0.001	0.051	<0.001	0.855	0.992
HbGlu	Sulfonylureas	7.92	2.25	-	0.999	0.001	0.004	0.002
	Insulin	7.89	1.67	0.999	-	<0.001	<0.001	<0.001
	Biguanides	6.38	1.09	<0.001	<0.001	-	0.999	<0.001
	GLP-1RAs	6.28	1.34	0.004	<0.001	0.999	-	-
	In SGLT2	5.95	1.14	0.002	<0.001	0.999	0.999	-
	All	6.50	1.27	<0.001	<0.001	<0.001	0.398	0.143

Data are presented as the mean ± standard deviation (SD). P-values represent pairwise comparisons between medication groups using appropriate statistical tests. Significant differences (P<0.05) highlight variations in glycemic control and renal function among treatment groups. eGFR, estimated glomerular filtration rate; UACR, urine albumin-to-creatinine ratio; GLP-1RAs, glucagon-like peptide-1 receptor agonists; SGLT2, sodium-glucose cotransporter 2 inhibitors.

logistic regression analysis, insulin use was significantly linked to the presence of hypertension (aOR=2.94; 95% CI: 1.29-6.69; P=0.010) and attendance at diabetes education sessions (aOR=4.89; 95% CI: 2.30-10.41; P<0.001). Conversely, insulin was less likely to be prescribed in combination with sulfonylureas (aOR=0.30; 95% CI: 0.10-0.87; P=0.027), likely reflecting prescribing practices that aim to reduce therapeutic complexity and the risk of hypoglycemia. The use of SGLT2 inhibitors was strongly associated with hypertension (aOR=4.18; 95% CI: 1.53-11.47; P=0.005), suggesting this is consistent with selective prescribing patterns for patients with increased cardiovascular or renal risk. Prescription of GLP-1 RAs was significantly associated with overweight or obesity (aOR=2.55; 95% CI: 1.30-5.00; P=0.006) and participation in diabetes education programs (aOR=3.72; 95% CI: 1.84-7.52; P<0.001), consistent with their known benefits in weight management and the role of patient engagement in complex therapy adherence. By contrast, biguanides (metformin) were significantly less likely to be prescribed in patients with impaired renal function (aOR=0.34; 95% CI: 0.13-0.84; P=0.019), in line with clinical guidelines recommending caution due to the risk of lactic acidosis in this population.

These findings emphasize that prescription decisions for diabetes medications are associated not only with comorbid conditions such as hypertension, renal function and obesity but also by healthcare engagement factors such as diabetes education attendance. The observed patterns reflect a personalized approach in pharmacological management, in which medication selection varies with efficacy, safety and complexity according to each patient's clinical profile (Table X).

Discussion

The present real-world analysis of 1,397 Hispanic adults with T2DM provides critical insights into how pharmacological therapies are utilized in a community setting, revealing that prescription patterns are driven more by clinical complexity and comorbidities, and other contextual factors affecting treatment decisions and adherence than by a standardized, stepwise approach. The findings of the present study contribute to the growing body of evidence on diabetes management in minority populations, while highlighting the importance of tailoring therapeutic strategies to clinical complexity and healthcare engagement.

Nearly 40% of diagnosed patients were not receiving glucose-lowering medication at the time of data extraction. Whether this reflects early-stage disease managed through lifestyle, loss to follow-up, clinical inertia, or access barriers remains unclear. As expected, metformin was the most commonly prescribed drug, consistent with current international guidelines recommending it as first-line therapy (19). Notably, the relatively high use of insulin (25.5%), GLP-1 RAs (24.1%), and SGLT2 inhibitors (19.3%) indicates increasing adoption of newer agents in this population. However, the low use of DPP-4 inhibitors and mineralocorticoid receptor antagonists

Table VII. Comparison of eGFR, UACR and HbA1c levels among patients on dual and triple diabetes medication regimens.

		Dual Therapy Including			Triple Therapy Including		
Parameter	With	No	Yes	P-value	No	Yes	P-value
eGFR	Sulfonylureas	99.02±23.58	99.25±20.61	0.948	91.01±25.98	95.72±22.98	0.290
	Insulin	100.90±18.25	95.36±29.60	0.096	90.56±26.43	93.39±24.54	0.528
	Biguanides	79.18±37.24	102.01±18.05	<0.001	61.50±24.15	94.28±24.03	0.005
	GLP-1RAs	95.59±25.34	104.47±14.19	0.018	87.61±27.35	95.16±23.50	0.080
	In SGLT2	102.86±17.56	81.37±33.56	<0.001	101.92±16.92	87.56±27.25	0.001
UACR	Sulfonylureas	49.88±110.02	41.96±103.01	0.712	73.80±156.50	55.64±163.10	0.566
	Insulin	35.82±81.95	66.67±137.48	0.089	43.92±79.67	79.82±180.64	0.236
	Biguanides	134.45±211.36	31.41±62.47	<0.001	184.28±192.18	62.49±154.00	0.047
	GLP-1RAs	61.52±126.08	24.09±58.65	0.043	85.13±193.04	60.82±136.92	0.408
	In SGLT2	27.84±58.51	139.00±199.76	<0.001	31.97±117.37	86.36±169.99	0.047
HbGlu	Sulfonylureas	7.58±1.85	7.41±1.69	0.549	7.50±1.52	8.12±1.90	0.035
	Insulin	7.07±1.54	8.51±1.93	<0.001	7.54±1.78	7.77±1.63	0.441
	Biguanides	7.52±1.53	7.53±1.84	0.984	6.50±0.78	7.77±1.69	0.037
	GLP-1RAs	7.92±1.89	6.68±1.22	<0.001	7.97±2.00	7.55±1.46	0.138
	In SGLT2	7.55±1.84	7.44±1.63	0.735	7.98±1.52	7.55±1.74	0.140

Data are presented as mean±standard deviation (SD). The table shows comparisons between patients whose treatment regimens included a specific medication vs. those whose regimens did not. P-values correspond to comparisons between groups using Student's t-test. P-value comparing values between patients who received the medication and those who did not include it in their treatment regimen. Significant differences (P<0.05) indicate associations between medication inclusion and glycemic or renal outcomes. eGFR (ml/min/1.73 m^2), estimated glomerular filtration rate; UACR, urine albumin-to-creatinine ratio; HbA1c, glycated hemoglobin; GLP-1RAs, glucagon-like peptide-1 receptor agonists; SGLT2, sodium-glucose co-transporter 2 inhibitors.

reflects either prescribing preferences, formulary restrictions, or access barriers. The low utilization of DPP-4 inhibitors, for instance, may reflect their modest glycemic efficacy compared with the robust benefits of GLP-1 RAs and SGLT2 inhibitors, particularly regarding weight and cardiorenal protection.

The data of the present study show that patients receiving SGLT2 inhibitors, GLP-1 RAs, or metformin as monotherapy were disproportionately represented among those with optimal glycemic profiles, with >85% of patients achieving the HbA1c goal of ≤7%. By contrast, insulin and sulfonylureas were associated with poor glycemic outcomes, both as monotherapy and in combination regimens. While this may reflect intrinsic limitations of these therapies (30,31), it likely indicates confounding by indication, namely, that these drugs are preferentially prescribed to patients with advanced or more difficult-to-control diabetes (32,33). This phenomenon, known as confounding by indication, is critical for interpreting real-world observational data. It means that the poor outcomes associated with insulin and sulfonylureas do not necessarily reflect drug ineffectiveness but rather serve as a marker for patients with a longer disease duration, greater beta-cell failure, and higher comorbidity burden, for whom these therapies are appropriately reserved (32-34).

Although not directly modeled, descriptive comparisons suggest that individuals requiring dual or triple therapy tended to have poorer glycemic outcomes compared with those on monotherapy, reinforcing that regimen complexity likely reflects underlying disease severity rather than treatment failure. Within dual therapy, combinations involving GLP-1 RAs and metformin were more frequently observed among patients achieving glycemic targets; however, this pattern likely reflects underlying differences in disease stage and treatment selection rather than comparative treatment effectiveness. In comparison, combinations including insulin or sulfonylureas consistently yielded poorer glycemic results (35,36).

Renal function parameters provided additional insights into prescribing patterns. Patients receiving SGLT2 inhibitors had the lowest eGFR, consistent with selective prescribing among individuals with established renal impairment. Importantly, patients on biguanides or GLP-1 RAs exhibited more favorable renal profiles (higher eGFR and lower UACR), in line with evidence of nephroprotective effects of these agents. Conversely, insulin and sulfonylurea users had worse renal parameters, again reflecting their use in more complex or advanced disease. These findings reinforce the clinical importance of considering renal status in treatment selection and are consistent with existing clinical trial evidence supporting the disease-modifying effects of GLP-1 RAs and SGLT2 inhibitors (37,38).

Our multivariable analysis identified female sex and frequent specialist visits as independent factors associated with improved glycemic control. The association with sex may reflect sex differences in health-seeking behavior, medication adherence, or lifestyle practices, although further research is warranted (39). The association between specialist visits and improved glycemic control likely reflects differences in healthcare access, monitoring intensity, disease complexity, or patient engagement rather than a direct causal effect of specialist care itself (40-42). In addition, insulin and sulfonylureas users exhibited poorer glycemic outcomes, likely reflecting more advanced or complex disease status (43).

Table VIII. Factors associated with optimal glycemic control (HbA1c≤7%) among patients with diabetes.

	Univariate model				Multivariable model			
		95% C.I.				95% C.I.		
	OR	Low	Upper.	Sig	aOR	Low	Upper	Sig
Age >52	1.042	0.797	1.364	0.762				
Female	1.351	1.029	1.775	0.030	3.246	1.323	7.964	0.010
Tobacco use	0.423	0.210	0.852	0.016				
Alcohol use	1.155	0.759	1.756	0.502				
Unemployed	0.748	0.562	0.997	0.047				
Obesity/overweight	1.582	1.180	2.120	0.002				
Hyperlipidemia	1.063	0.801	1.412	0.671				
Hypertension	0.833	0.637	1.090	0.184				
Chronic kidney disease	0.652	0.447	0.950	0.026				
Primary care appointments	0.341	0.257	0.452	0.000				
Specialist appointments (>9 visits)	1.262	0.961	1.659	0.095	8.267	2.344	29.164	0.001
Case management visits	0.643	0.485	0.854	0.002				
Mental health appointments	0.922	0.678	1.254	0.607				
Health education sessions	0.799	0.604	1.056	0.115				
Sulfonylurea use	0.274	0.186	0.403	0.000	0.072	0.019	0.268	<0.001
Biguanide use	0.347	0.258	0.465	0.000				
SGLT2 inhibitor use	0.334	0.234	0.476	0.000				
Insulin use	0.102	0.073	0.144	0.000	0.018	0.005	0.060	<0.001
GLP-1 receptor agonist use	0.481	0.345	0.670	0.000				

OR, odds ratio; aOR, adjusted OR; CI, confidence interval; GLP-1RAs, glucagon-like peptide-1 receptor agonists; SGLT2, sodium-glucose co-transporter 2 inhibitors.

Healthcare utilization patterns varied by medication class: Patients treated with insulin, SGLT2 inhibitors, or GLP-1 RAs had substantially higher healthcare engagement, including specialist care and diabetes education (44). This may reflect that complex or advanced cases are associated with greater resource allocation, but also that proactive disease management, including structured education, may be associated with the adoption of newer agents. Importantly, prescription decisions were strongly associated with comorbidities: Insulin and SGLT2 inhibitors were associated with hypertension, GLP-1 RAs with obesity, and lower metformin use with impaired renal function (45,46). These findings are consistent with guideline-concordant, individualized care, balancing efficacy, comorbidity profiles and safety (47).

Taken together, the results of the present study highlight critical opportunities for improving diabetes care among Hispanic adults. First, the absence of pharmacotherapy in nearly 40% of patients may reflect lifestyle management, access barriers, loss to follow-up, or early disease stage, although this cannot be determined from available data (48-50). Second, the observed glycemic and renal profiles among patients receiving GLP-1 RAs and SGLT2 inhibitors, in conjunction with established evidence from randomized trials, underscore the importance of ensuring equitable access to these agents, particularly given their proven cardiometabolic and renal benefits (3,51). Finally, the strong association between specialist engagement and glycemic control reinforces the value of integrated, multidisciplinary care models tailored to underserved populations.

The present study has several strengths, including its large, community-based Hispanic cohort, comprehensive characterization of pharmacological treatment patterns, and simultaneous evaluation of glycemic and renal function parameters within a real-world safety-net clinical setting. However, several limitations warrant consideration. First, the cross-sectional design precludes causal inference regarding the associations observed between medication use and clinical outcomes. Second, confounding by indication is likely, as medications such as insulin and sulfonylureas are typically prescribed to patients with more advanced or complex disease, which may partially explain observed differences in glycemic control and comorbidity burden. Third, medication exposure was defined cross-sectionally based on active prescriptions recorded during the study period. Detailed information on treatment duration, sequencing, dose adjustments, switching patterns, and adherence was not available. Although the clinic operates under a centralized multidisciplinary care model, where patients receive comprehensive services within a single healthcare system, reducing fragmentation, the absence of longitudinal prescription data limits interpretation of medication-stratified analyses and precludes assessment of treatment dynamics over time. Fourth, the primary outcome was defined using the lowest recorded HbA1c during the study period. While this

Table IX. Differences in healthcare utilization by medication type among patients with diabetes receiving pharmacological treatment.

Medication type	Service utilization	Not receiving medication	Receiving medication	P-value
SGLT2 inhibitors	Primary care visits	1.25±3.12	2.48±4.58	<0.001
	Specialist visits	14.69±13.92	27.55±21.02	<0.001
	Case management visits	3.13±3.72	6.30±5.11	<0.001
	Mental health visits	2.83±10.64	4.26±12.31	0.138
	Health education sessions	0.64±1.42	1.58±2.01	<0.001
Insulin	Primary care visits	1.14±2.97	2.51±4.53	<0.001
	Specialist visits	13.41±12.04	28.21±21.51	<0.001
	Case management visits	2.76±3.15	6.61±5.45	<0.001
	Mental health visits	2.48±10.03	4.93±13.29	0.005
	Health education sessions	0.56±1.26	1.61±2.12	<0.001
GLP-1 receptor agonists	Primary care visits	1.19±2.84	2.45±4.88	<0.001
	Specialist visits	15.19±15.27	23.44±17.97	<0.001
	Case management visits	3.15±3.96	5.60±4.45	<0.001
	Mental health visits	2.35±8.73	5.47±15.97	<0.001
	Health education sessions	0.63±1.38	1.44±2.02	<0.001
Sulfonylureas	Primary care visits	1.51±3.55	1.40±3.12	0.729
	Specialist visits	17.72±16.91	14.62±13.07	0.038
	Case management visits	3.94±4.38	2.78±3.14	0.002
	Mental health visits	3.24±11.40	2.48±8.80	0.448
	Health education sessions	0.90±1.69	0.47±0.94	0.003
Biguanides (Metformin)	Primary care visits	1.93±4.55	1.42±3.28	0.150
	Specialist visits	26.59±21.45	15.70±14.87	<0.001
	Case management visits	5.59±5.45	3.45±3.91	<0.001
	Mental health visits	5.70±15.72	2.70±10.01	0.007
	Health education sessions	0.99±1.64	0.80±1.58	0.232

Data are presented as the mean ± standard deviation (SD). Comparisons were made between patients receiving each medication and those not receiving it. P-values correspond to group comparisons using appropriate statistical tests. Significant differences (P<0.05) suggest an association between medication type and healthcare service use. SGLT2, sodium-glucose cotransporter 2 inhibitors; GLP-1, glucagon-like peptide-1 receptor agonists.

Table X. Factors associated with receiving specific diabetes medications.

Medication class	Associated factor	Adjusted OR	95% CI	P-value
Insulin	Hypertension	2.941	1.292-6.693	0.010
	≥1 Diabetes education visit	4.893	2.301-10.407	<0.001
	Concomitant sulfonylurea use	0.297	0.102-0.871	0.027
SGLT2 inhibitors	Hypertension	4.184	1.527-11.465	0.005
GLP-1 receptor agonists	Obesity or overweight	2.554	1.304-5.003	0.006
	≥1 Diabetes education visit	3.722	1.843-7.515	<0.001
Biguanides (Metformin)	Chronic kidney disease or impaired eGFR	0.335	0.134-0.836	0.019

OR, odds ratio; CI, confidence interval; eGFR, estimated glomerular filtration rate.

approach captures best-achieved glycemic control under routine care, it may overestimate overall metabolic status and does not necessarily reflect sustained glycemic control. Additionally, outcome ascertainment may be influenced by measurement frequency, although the distribution of HbA1c measurements per patient has been reported to contextualize this definition.

Fifth, the study period (2022-2024) followed the acute phase of the COVID-19 pandemic. Although calendar-year summaries suggest progressive normalization of laboratory monitoring, residual temporal effects related to healthcare system adaptation cannot be entirely excluded. Finally, although these findings provide important insight into diabetes management within an underserved Hispanic population receiving care in a community-based safety-net clinic, caution is warranted when extrapolating results to other Hispanic subgroups with different sociodemographic profiles or to healthcare systems with distinct organizational structures and access patterns.

In conclusion, the present real-world study of Hispanic adults with T2DM demonstrates that pharmacological treatment patterns are strongly associated with clinical complexity, comorbidities, and healthcare engagement. The superior glycemic and renal profiles associated with newer agents such as GLP-1 RAs and SGLT2 inhibitors are heavily influenced by their selective use in patients with less advanced disease, highlighting significant confounding by indication. Importantly, specialist engagement was independently associated with glycemic control; however, this finding should be interpreted as a marker of healthcare access, monitoring intensity, or disease complexity rather than evidence of a direct therapeutic effect. These findings underscore that addressing diabetes-related disparities in this high-risk population may require a dual strategy: Ensuring equitable access to effective modern therapies and emphasizing the importance of structured healthcare engagement and coordinated care delivery models to support patients with the most complex needs.

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Availability of data and materials

The data generated in the present study may be requested from the corresponding author.

Authors' contributions

IDE conceptualized and supervised the study and conducted project administration. EW, ZB and IDE curated data. JDM, CD, GAHF, FRL, LK, JM and YMR performed formal analysis. JDM and IDE acquired funding. CD, AB, YMR and LPV conducted investigation. JDM, CD, MH, GAHF, FRL, LK and AJP developed methodology. JDM, EW and IDE provided resources. JDM, GAHF, JM, AB, YMR, LPV, EW and ZB performed software analysis. Validation, JDM, CD, MH, GAHF, FRL, LK, AJP and OAML validated data. OAML and IDE visualized data. GAHF wrote the original draft, and wrote, reviewed and edited the manuscript. All authors read and approved the final version of the manuscript. IDE, JDM and GAHF confirm the authenticity of all the raw data.

Ethics approval and consent to participate

The present study was approved by the Florida International University Institutional Review Board (approval no. 24-0488; Miami, USA). All procedures complied with ethical standards for research involving human subjects and ensured strict confidentiality of patient data. The requirement for individual informed consent was waived due to the retrospective nature of the analysis.

Patient consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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