Variations in Use of Diabetes Drugs With Cardiovascular Benefits Among Medicaid Patients

Mike Z. Zhai, MD, MBA; Jerry Avorn, MD; Jun Liu, MPH; Aaron S. Kesselheim, MD, JD, MPH

Abstract

**IMPORTANCE** Cardiovascular death remains the leading cause of mortality in patients with type 2 diabetes (T2D). A better understanding of the current use and adoption of glucose-lowering drugs with cardiovascular benefit can inform state policies to ensure their appropriate use in patients with T2D.

**OBJECTIVE** To characterize the use of glucose-lowering agents with known cardiovascular benefit over time and across states.

**DESIGN, SETTING, AND PARTICIPANTS** This cross-sectional pharmacoepidemiological study of Medicaid prescription rates of glucose-lowering agents with known cardiovascular benefit vs those with less well-established cardiovascular benefit was conducted between 2014 and 2019. In 50 states and the District of Columbia, the study focused on nonmetformin, noninsulin glucose-lowering drugs divided into 3 cohorts: (1) sodium-glucose cotransporter 2 (SGLT2) inhibitors, (2) glucagon-like peptide 1 (GLP1) receptor agonists, and (3) all other classes of glucose-lowering drugs. Data were analyzed from January 2014 to December 2019.

**MAIN OUTCOMES AND MEASURES** Number of days supplied of each cohort, use ratios between the aggregated days supplied of glucose-lowering agents with known cardiovascular benefit vs those with less well-established cardiovascular benefit, and the mean change in use ratios per quarter.

**RESULTS** Across the 50 states and the District of Columbia, the use ratio of glucose-lowering agents with known cardiovascular benefit ranged from 1.58 to 0.14 (mean [SD], 0.48 [0.27]) in 2019. A lower use ratio was seen in states with a higher prevalence of diabetes (β = −0.049; 95% CI, −0.086 to −0.012; P = .01), a larger total population (β = −0.013; 95% CI, −0.023 to −0.003; P = .01), a greater number of Medicaid enrollees (β = −0.054; 95% CI, −0.096 to −0.014; P = .01), a greater proportion of people enrolled in Medicaid (β = −0.018; 95% CI, −0.030 to −0.007; P = .002), and a greater proportion of Medicaid patients enrolled in managed care organizations (β = −0.0032; 95% CI, −0.0051 to −0.0013; P = .002). Higher Medicaid expenditures per enrollee (β = 0.047; 95% CI, 0.007 to 0.089; P = .03) were associated with a higher use ratio of these agents. The relative use of glucose-lowering agents with known cardiovascular benefit by Medicaid enrollees increased 7.4% per year from 2014 to 2019, with wide variations across state Medicaid programs.

**CONCLUSIONS AND RELEVANCE** In this cross-sectional study, glucose-lowering agents with cardiovascular benefit increased in use during the study period, but also demonstrated considerable variation among states in their relative use. Medicaid programs should try to clarify which factors may be contributing to relative underuse of these potentially life-saving drugs.


Key Points

**Question** How do state Medicaid programs differ in beneficiaries’ use of glucose-lowering agents that have been shown to reduce cardiovascular mortality in patients with type 2 diabetes?

**Findings** This cross-sectional pharmacoepidemiological study found that the relative use of glucose-lowering agents with known cardiovascular benefit by Medicaid enrollees increased 7.4% per year from 2014 to 2019, with wide variations across state Medicaid programs.

**Meaning** Variable use of glucose-lowering agents with known cardiovascular benefit across state Medicaid programs suggests the need to determine whether certain factors, such as state Medicaid policies or budgets, can be modified to better promote evidence-based treatments.

++ Supplemental content

Author affiliations and article information are listed at the end of this article.

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Introduction

As cardiovascular death is the leading cause of mortality in patients with type 2 diabetes (T2D), a reduction in cardiovascular risk is of critical importance when treating such patients. Traditionally, the first pharmacologic treatment of choice for T2D has been metformin, while insulin is typically reserved for uncontrolled hyperglycemia after patients have tried metformin and other glucose-lowering drugs. Options for scaling up therapy between metformin and insulin include numerous classes of drugs that can be used with metformin, or as a replacement for patients intolerant to metformin. Currently available classes of nonmetformin, noninsulin glucose-lowering drugs include dipeptidyl peptidase IV inhibitors, sulfonylureas, thiazolidinediones, meglitinides, sodium-glucose cotransporter 2 inhibitors (SGLT2i), glucagon-like peptide 1 receptor agonists (GLP1RA), amylin agonists, and α-glucosidase inhibitors.

Since 2008, the US Food and Drug Administration (FDA) has recommended that new glucose-lowering drugs be tested in cardiovascular outcome trials before their regulatory approval to ensure that they do not increase the risk of cardiovascular events. In 2015, one of the first such trials showed a reduction in cardiovascular events. Since then, glucose-lowering drugs in the SGLT2i and GLP1RA classes have demonstrated reductions in cardiovascular mortality. Since 2017, guidance from professional medical societies have recommended prescribing SGLT2i or GLP1RA to patients with uncontrolled T2D and established atherosclerotic cardiovascular disease, with 2019 guidance further expanding recommended use to patients who are at high risk of cardiovascular disease, have chronic kidney disease or heart failure, and have not met their hemoglobin A1c target despite metformin therapy. Furthermore, current diabetes guidelines recommend use of SGLT2i or GLP1RA therapy in patients with indications for these agents regardless of glycemic control levels.

Although positive cardiovascular outcome data exist for SGLT2i and GLP1RA, widespread use of other classes of diabetes drugs is still common. We hypothesized that the prescription rates of glucose-lowering agents with known cardiovascular benefit compared with those with less well-established cardiovascular benefit have increased over time since 2015 and sought to understand what state characteristics may be associated with higher or lower prescription rates of such agents.

We focused our investigation among Medicaid patients, as low-income populations have disproportionately high rates of diabetes and worse cardiovascular outcomes.

Methods

Sample Identification

This study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guideline. The Mass General Brigham institutional review board approved this study and waived patient consent for use of deidentified commercial claims data. Among all FDA-approved glucose-lowering drugs listed on Drugs@FDA, we excluded insulin products and metformin, unless as part of a combination drug with another glucose-lowering agent. We also excluded drugs that did not have improvement of glycemic control in T2D as a primary indication, such as bromocriptine (a dopamine receptor agonist) and colesvelam (a bile acid sequestrant).

We divided qualifying drugs into 3 cohorts: (1) SGLT2i, (2) GLP1RA, and (3) other classes of glucose-lowering drugs for which cardiovascular benefit has not been clearly demonstrated (e.g., sulfonylureas, dipeptidyl peptidase IV inhibitors, meglitinide, thiazolidinediones, α-glucosidase inhibitors, and amylin analogues). If a particular drug had more than 1 dosage form (e.g., tablet and extended-release tablet) or strength, each was treated as a separate drug (eTable 1, eTable 2, and eTable 3 in the Supplement).

Data Collection

We used Medicaid state drug utilization data, which contain data for covered outpatient drugs paid for by state (and District of Columbia) Medicaid agencies. State Medicaid programs submit data,
including numbers of units dispensed, number of prescriptions filled, and reimbursement amount quarterly to Centers for Medicare & Medicaid Services (CMS). These variables are provided for each drug formulation, but do not contain data on beneficiary characteristics. First, we obtained quarterly data on the number of units dispensed for each of these drugs through Medicaid in the 50 states and the District of Columbia from the first quarter of 2014 to the last quarter of 2019. Second, using data from Optum’s deidentified Clininformatics Data Mart Database from 2014 to 2019, we determined the median dosing pattern for each drug formulation and converted the number of units dispensed for each drug to the equivalent number of days supplied of the drug (details about the Optum database are provided in the eMethods in the Supplement). For example, a drug that had 60 units dispensed would be converted to 30 days supplied if the median dosing pattern were twice-daily dosing. These data were then aggregated per quarter and by state to form total days supplied for each of the 3 cohorts (eTable 4 in the Supplement). Using publicly available data from the US Centers for Disease Control and Prevention,21,22 CMS,23 US Bureau of Economic Analysis,24,25 US National Archives and Records Administration,26 Kaiser Family Foundation,27-30 and Pharmaceutical Research and Manufacturers of America,31 we collected metrics on characteristics of each state and its Medicaid program, including metrics on the prevalence and mortality rate of diabetes, population size, and its gross domestic product per capita, as well as metrics on Medicaid expansion status, the number of Medicaid Managed Care Organizations, Medicaid enrollees, and Medicaid expenditures.21-31

Statistical Analysis

To compare the use of the 2 classes of glucose-lowering drugs in our cohort with demonstrated cardiovascular benefit to those with less well-documented cardiovascular benefit, we calculated the following drug use ratios: (1) the ratio of the aggregated days supplied of drugs in the SGLT2i cohort to the other glucose-lowering drugs cohort, (2) the ratio of the aggregated days supplied of drugs in the GLP1RA cohort to the other glucose-lowering drugs cohort, and (3) the ratio of the sum of the aggregated days supplied of drugs in the SGLT2i and GLP1RA cohorts to the other glucose-lowering drugs cohort. For example, a use ratio of 0.5 for SGLT2i would indicate that for every 100 days supplied by all other glucose-lowering drugs excluding SGLT2i and GLP1RA, 50 days were supplied by an SGLT2i.

For each quarter, use ratios of SGLT2i and GLP1RA, first separately and then combined, were calculated for each state, in addition to the mean (SD) use ratio across states. For 2019, we calculated use ratios across the full year for each state and the mean (SD) use ratio across states. The states were then ranked from highest to lowest using the combined use ratios of SGLT2i and GLP1RA. A boxplot of the 2019 combined data was created to visualize the distribution of the use ratios, to determine the median and IQR, and to detect outliers.

To compare the mean rate of change in the drug use ratios over our study period, we performed linear regression analyses for each state. We defined the resulting slope of the linear regression line as the change in use ratio per quarter. We calculated the coefficient of determination, or \( R^2 \), to determine the suitability of linear regression analyses in measuring the change in use ratio per quarter.

Univariable and multivariable ordinary least-squares linear regression models were used to evaluate the association of 15 characteristics of the state and its Medicaid program with the use ratios. Estimates of the coefficients with 95% CIs and \( P \) values were calculated. A final multivariable linear regression model was selected using stepwise regression with all variables with \( P < .10 \) on univariable analysis and were not highly correlated with one another to avoid multicollinearity in the final model. The choice of variables for the model was based on the significance of 2-sided \( P < .05 \) for each variable. Statistical analyses were performed with R statistical software version 4.0.4 (R Project for Statistical Computing). Data were analyzed from January 2014 to December 2019.
Results

Use Ratios

Use ratios for SGLT2i varied widely across states. In 2019, the mean (SD) use ratio was 0.20 (0.12), indicating that for every 100 days supplied by other glucose-lowering drugs, 20 days were supplied by an SGLT2i. Wyoming had the highest use ratio of SGLT2i at 0.67. By comparison, Oregon had the lowest use ratio of 0.06 (Figure 1 and Figure 2A).

Use ratios for GLP1RA similarly varied considerably. The mean (SD) use ratio was 0.28 (0.16). In 2019, Wyoming also had the highest use ratio for GLP1RA at 0.91. By contrast, California had the lowest use ratio at 0.07 (Figure 1 and Figure 2B).

Combining SGLT2i and GLP1RA, we then evaluated the total use of glucose-lowering drugs with established cardiovascular benefits. The Spearman correlation coefficient between the use ratio of SGLT2i and GLP1RA was 0.68 (95% CI, 0.50-0.80; P < .001), which suggests that states with higher use ratios of SGLT2i also tended to have higher use ratios of GLP1RA. The mean (SD) use ratio for combined SGLT2i and GLP1RA across states was 0.48 (0.27). In 2019, Wyoming had the highest combined use ratio of SGLT2i and GLP1RA at 1.58, while Illinois had the lowest combined use ratio at 0.14 (Figure 1 and Figure 2C). The median (IQR) of the combined use ratio was 0.43 (0.32-0.56). Wyoming, North Dakota, and South Dakota were substantial outliers (Figure 3).

Change in Use Ratios Over Time

The change in use ratios over time for SGLT2i across states varied widely. From 2014 to 2019, the mean (SD) increase in use of glucose-lowering agents with known cardiovascular benefit relative to all other classes of nonmetformin, noninsulin glucose-lowering drugs was 1.9% (0.9%) per quarter or 7.4% (3.7%) per year. From 2014 to 2019, the mean (SD) increase in use ratios per quarter was 0.009 (0.005), denoting a 0.9% overall increase in SGLT2i use per quarter over the study period relative to use of other glucose-lowering agents with less well-established cardiovascular benefit. Wyoming had the greatest increase at 2.6% per quarter. West Virginia had the smallest increase at 0.2% per quarter (Figure 4).

The change in use ratios over time for GLP1RA was comparable to that of SGLT2i. The mean (SD) increase was 0.010 (0.005). Wyoming had the greatest increase at 3.2% per quarter, while West Virginia had the smallest increase at 0.2% per quarter (Figure 4).

The mean (SD) increase for combined SGLT2i and GLP1RA was 0.019 (0.009). Wyoming had the greatest increase at 5.8% per quarter, while West Virginia had the smallest increase at 0.4% per quarter (Figure 4).

Associations With State and State Medicaid Characteristics

Univariable linear regression analysis revealed several variables associated with the use ratio (Table). Among the state population characteristics, the prevalence of diabetes (β = −0.049; 95% CI, −0.086 to −0.012; P = .01), population size (β = −0.013; 95% CI, −0.023 to −0.003; P = .01) had negative associations with the state's use ratio for SGLT2i and GLP1RA. The state's age-adjusted diabetes mortality (β = −0.004; 95% CI, −0.022 to 0.013; P = .62), prevalence of obesity (β = −0.0047; 95% CI, −0.025 to 0.015; P = .63), and wealth, as measured by gross domestic product per capita (β = 0.00028; 95% CI, −0.0031 to 0.0036; P = .87), were not associated with the use ratios.

Among Medicaid program characteristics, the number of Medicaid enrollees (β = −0.054; 95% CI, −0.096 to −0.014; P = .01), the Medicaid expenditures (β = −0.0056; 95% CI, −0.0103 to −0.0009; P = .02), Medicaid expenditures on prescription drugs (β = −0.13; 95% CI, −0.24 to −0.02; P = .02), the percentage of the state's population enrolled in Medicaid (β = −0.018; 95% CI, −0.030 to −0.007; P = .002), the number of Medicaid managed care organizations (β = −0.017; 95% CI, −0.028 to −0.006; P = .003), and the proportion of Medicaid enrollees in a managed care organization (β = −0.0132; 95% CI, −0.0051 to −0.0013; P = .002) were all negatively associated with the use ratios. The first 3 of the variables previously listed were all highly correlated (Spearman
Use ratios for SGLT2i, GLP1RA, and combined SGLT2i and GLP1RA in 2019 for each of the 50 states and the District of Columbia, ranked from highest to lowest according to combined SGLT2i and GLP1RA use ratio. The vertical blue dotted line represents the mean use ratio.
Figure 2. Heat Maps of Use Ratios of Sodium-Glucose Cotransporter 2 Inhibitors (SGLT2i), Glucagon-Like Peptide 1 Receptor Agonists (GLP1RA), and Combined SGLT2i and GLP1RA in 2019

A  SGLT2i

Use ratio of SGLT2i

B  GLP1RA

Use ratio of GLP1RA

C  SGLT2i and GLP1RA

Use ratio of combined SGLT2i and GLP1RA

Heat map of use ratios for combined SGLT2i and GLP1RA shows wide variation across states. States with darker shades correspond to a higher use ratio for glucose-lowering agents with established cardiovascular benefit.
Discussion

This cross-sectional study found wide variation by state in the relative use of SGLT2i and GLP1RA, the 2 classes of glucose-lowering drugs that have demonstrated reductions in cardiovascular mortality, among Medicaid patients in the US. States with Medicaid programs that had higher numbers of enrollees, a greater proportion of the total population on Medicaid, higher expenditures on prescription drugs, and greater penetration of Medicaid managed care organizations were all associated with lower use ratios of SGLT2i and GLP1RA.

Trends in glucose-lowering drug use in general have been described, but to our knowledge, no study has examined the relative use of classes of glucose-lowering drugs with established cardiovascular benefit, nor the geographic variation and change in use over time among Medicaid patients.15,16 By leveraging data made publicly available by CMS, we were able to identify whether states have been using newer glucose-lowering drugs that have established cardiovascular benefit at a higher rate than older glucose-lowering drugs and whether this use varies across states, given wide variations in state populations and the support provided to different state Medicaid programs.

To better understand factors potentially associated with the differential use ratios across states, we evaluated the association between the states’ use ratios and the characteristics of the state and its Medicaid program. States that more often contracted with managed care organizations had lower use ratios. Managed care organizations tend to encourage the use of lower-cost drugs, such as generics and drugs which have a negotiated supplemental rebate. Another recent study32 showed greater use of generics and biosimilar products for insulin in Medicaid managed care organizations than in fee-for-service Medicaid. To what extent some managed care organizations have been encouraging the use of cheaper generics of non-SGLT2i and non-GLP1RA glucose-lowering drugs at the expense of expensive, newer glucose-lowering drugs such as SGLT2i and GLP1RA, and how that affects patient outcomes, should be further studied.

Figure 3. Boxplot of 2019 State Use Ratios of Combined Sodium-Glucose Cotransporter 2 Inhibitors (SGLT2i) and Glucagon-Like Peptide 1 Receptor Agonists (GLP1RA)

Box edges indicate the 25th and 75th percentiles. The horizontal line in between the edges indicates the median. Whiskers extend to the furthest point with 1.5 × IQR of the box ends. The dark gray shading indicates the 25th to 50th percentile, and the light gray shading indicates the 50th to 75th percentile.
Change in use ratio for combined SGLT2 and GLP1RA (left), SGLT2 (middle), and GLP1RA (right) per quarter for each of the 50 states and the District of Columbia, ranked from highest to lowest according to combined SGLT2 and GLP1RA use ratio. Mean change in use ratio per quarter across all states and the District of Columbia are shown.
The only variable we found to be positively associated with the use ratio was Medicaid expenditure per enrollee, such that a state that spent more per enrollee on average also had a higher use ratio. This is likely attributable to the high cost of these drugs, which can take up substantial state Medicaid resources. States that cover new prescription drugs such as SGLT2i and GLP1RA may also be less stringent with drug cost controls in general and, therefore, more likely to limit barriers to other costly prescription drugs that cumulatively are associated with a higher expenditure per enrollee.

We did not find Medicaid expansion status to be associated with the use ratios. Previous studies have found that Medicaid expansion has been associated with improvements in self-reported management of diabetes and health status and increased prescription fills for diabetes medications, although this was largely associated with increased use of metformin and insulin, rather than SGLT2i and GLP1RA.

A growing number of state Medicaid programs use preferred drug lists to regulate drug use and minimize Medicaid expenditures used for prescription drugs, so drug coverage, formulary placement, and prescribing restrictions may be associated with the use ratios. For example, among the bottom 5 states, West Virginia has several clinical requirements for SGLT2i and GLP1RA, including continued maintenance on a regimen of at least 1 other agent at a maximum tolerable dose and an hemoglobin A1c of less than 8.0 for reauthorization. By contrast, Wyoming, the state with the highest use ratio, only requires trial and failure of at least 90 days of metformin. South Dakota, the state with the second highest use ratio, does not have prior authorization criteria for SGLT2i, and only requires a diagnosis of T2D before prescribing GLP1RA. Further research should investigate the effects of restrictions such as formulary placement and quantity limits.

Although preferred drug lists can be associated with use ratios, unmeasured factors related to patient preference, physician familiarity, and other Medicaid policies may also contribute to the variation observed in our results. For example, patients may have varying preferences for oral pills over injectables (ie, most GLP1RAs) and varying degrees of cost-consciousness. Physicians may

### Table. Univariable and Multivariable Linear Regression Model Evaluating Associations With Relative Prescribing of SGLT2i and GLP1RA

<table>
<thead>
<tr>
<th>Variable*</th>
<th>β (95% CI)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prevalence of diabetes in 2018</td>
<td>−0.049 (−0.086 to −0.012)</td>
<td>.01</td>
</tr>
<tr>
<td>Age-adjusted diabetes mortality rate in 2018</td>
<td>−0.004 (−0.022 to 0.013)</td>
<td>.62</td>
</tr>
<tr>
<td>Population</td>
<td>−0.013 (−0.023 to −0.003)</td>
<td>.01</td>
</tr>
<tr>
<td>Gross domestic product per capita</td>
<td>0.00028 (−0.0031 to 0.0036)</td>
<td>.87</td>
</tr>
<tr>
<td>Obesity prevalence in 2018</td>
<td>−0.0047 (−0.025 to 0.015)</td>
<td>.63</td>
</tr>
<tr>
<td>Medicaid expansion status</td>
<td>−0.14 (−0.29 to 0.02)</td>
<td>.08</td>
</tr>
<tr>
<td>No. of Medicaid enrollees</td>
<td>−0.054 (−0.096 to −0.014)</td>
<td>.01</td>
</tr>
<tr>
<td>Percentage of population enrolled in Medicaid</td>
<td>−0.018 (−0.030 to −0.007)</td>
<td>.002</td>
</tr>
<tr>
<td>Total expenditure</td>
<td>−0.0056 (−0.0103 to −0.0009)</td>
<td>.02</td>
</tr>
<tr>
<td>Total expenditure per enrollee</td>
<td>0.047 (0.007 to 0.089)</td>
<td>.03</td>
</tr>
<tr>
<td>Expenditure on prescription drugs</td>
<td>−0.13 (−0.24 to −0.02)</td>
<td>.02</td>
</tr>
<tr>
<td>Expenditure on prescription drugs per enrollee</td>
<td>−0.075 (−0.784 to 0.634)</td>
<td>.83</td>
</tr>
<tr>
<td>Percentage of total expenditure on prescription drugs</td>
<td>−0.036 (−0.096 to 0.023)</td>
<td>.23</td>
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<tr>
<td>No. of MCOs in 2018</td>
<td>−0.017 (−0.028 to −0.006)</td>
<td>.003</td>
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<tr>
<td>Percentage of enrollees in MCO in 2018</td>
<td>−0.0032 (−0.0051 to −0.0013)</td>
<td>.002</td>
</tr>
<tr>
<td>Prevalence of diabetes in 2018</td>
<td>−0.044 (−0.076 to −0.013)</td>
<td>.009</td>
</tr>
<tr>
<td>No. of Medicaid MCOs</td>
<td>−0.016 (−0.0255 to −0.0063)</td>
<td>.002</td>
</tr>
</tbody>
</table>

Abbreviations: GLP1RA, glucagon-like peptide 1 receptor agonist; MCO, managed care organizations; SGLT2i, sodium-glucose cotransporter 2 inhibitor.

* Data are from 2019 unless otherwise noted.
have different knowledge about the benefits of these drugs and experience levels in prescribing newer agents.\textsuperscript{39} In a national cohort of clinicians prescribing glucose-lowering agents for patients with T2D, only 1 in 5 prescribed SGLT2i in 2018, and sulfonylurea prescriptions were 3 times more frequent than those of SGLT2i.\textsuperscript{40} Finally, state Medicaid programs use different levers to control prescription drug use and costs.\textsuperscript{41-43} Variability in insurance design controls such as prior authorizations and cost-sharing were not systematically evaluated in this study, but may be associated with variability in drug utilization.

**Limitations**

First, although patient-level dosing data would be a more direct approach to determining utilization rates, as the Medicaid data set does not contain such data, we used a separate data set to convert the number of units dispensed for each drug to the equivalent number of days supplied of the drug. This conversion required assuming that Medicaid patients were, on average, dosed the same way. Second, in our regression analysis, we were only able to determine correlations and could not establish a causal relationship between any of the explanatory variables and use ratios. Third, several of our state population characteristics, such as the prevalence of diabetes and diabetes mortality rate, were not specific to Medicaid patients. Fourth, as Medicaid does not provide patient-level dosing information or patient outcomes data, we were unable to determine whether a higher relative use of SGLT2i and GLP1RA translated to improved mortality outcomes and whether the drugs were prescribed to individuals with atherosclerotic cardiovascular disease, chronic kidney disease, or heart failure. Fifth, prescription drug use and patient outcomes likely vary greatly within a state, but our analysis lacked granularity beyond the state level, reducing all metrics to 1 value representing the entire state. Additionally, our study could only show variability of relative use and change in relative use over time but could not determine what should be the most appropriate level of use for a state.

**Conclusions**

Although there has been an upward trend in the use of cardiovascular-protective diabetes drug classes SGLT2i and GLP1RA, we found considerable variation among states in the relative use of SGLT2i and GLP1RA and their rates of increase. States with substantially lower relative use should determine whether some of their Medicaid enrollees are, in fact, receiving suboptimal diabetes care and examine their Medicaid policies to determine which factors may be contributing to this result. Conversely, high-performing states may want to examine their outcomes in these drug classes to determine whether the use ratios we observed indicate high levels of evidence-based prescribing of diabetes medications with established improvements in cardiovascular drugs, and then determine whether there may be lessons that can be used to support better prescribing for other conditions as well.

**ARTICLE INFORMATION**

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Acquisition, analysis, or interpretation of data: All authors.

Drafting of the manuscript: Zhai.

Critical revision of the manuscript for important intellectual content: All authors.

Statistical analysis: Zhai, Liu.

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REFERENCES


**SUPPLEMENT.**

**eMethods.**

**eTable 1.** FDA-Approved Diabetes Medications With Proven Cardiovascular Benefit—SGLT2i Class of Drugs

**eTable 2.** FDA-Approved Diabetes Medications With Proven Cardiovascular Benefit—GLP1R Class of Drugs

**eTable 3.** FDA-Approved Diabetes Medications With Less Well-Established Cardiovascular Benefit

**eTable 4.** Units Dispensed and Days Supplied of Each FDA-Approved Diabetes Medication of Interest by State in 2019