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Geographic Variation in Antidiabetic Agent Adherence and Glycemic Control Among Patients with Type 2 Diabetes

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ABSTRACT

BACKGROUND: Medication nonadherence is an imperative public health concern. Among patients with type 2 diabetes mellitus (T2DM), poor adherence to antidiabetic agents is strongly associated with suboptimal glycemic control. Poor adherence and hyperglycemia greatly increase diabetes-related morbidity and mortality. At a national level, diabetes drug adherence using average proportion of days covered (PDC) is estimated to range between 36% and 81%, with an estimated range for diabetes control between 38% and 47%. At a state level no such studies exist.

OBJECTIVE: To estimate the level of medication adherence to antidiabetic agents and of diabetes control, and their association among patients with T2DM receiving medication treatment at the state and the Metropolitan Statistical Area (MSA) levels among the populations covered by commercial insurance, Medicare, or Medicaid.

METHODS: The study population included adults with T2DM aged ≥18 years who were identified using ICD-9-CM code 250.xx, who received diabetes medication, and who were covered by private insurance, Medicare, or Medicaid in each state, the District of Columbia, and the top 50 MSAs. Medication adherence was measured by average PDC and the percentage of population that had a PDC ≥ 80%. Diabetes control was identified using ICD-9-CM diagnosis codes. Patients who were not diagnosed with uncontrolled diabetes (250.x2 and 250.x3) were identified as being under control. The administrative claims databases used for this study included the 2012 medical and pharmacy claims from a large U.S. health plan, the complete 2011 Medicare Standard Analytical File linked with Part D claims, and the 2008 Mini-Medicaid Analytic eXtract (Mini-Max). Medication adherence and diabetes control were adjusted for age and sex to allow comparison across insurance coverage, states, and MSAs.

RESULTS: For an insured patient population with T2DM that received diabetic drug treatment, average PDC was 79%. However, 35% of patients did not achieve an adherence of at least 80% of PDC. In addition, at least 40% of patients did not have their diabetes under control. Across insurance types, we found that patients insured with Medicare had relatively high average PDC and adherence levels (83% and 71%) in comparison with the commercially insured population (77% and 60%) and Medicaid patients (75% and 57%). In contrast, commercially insured patients had relatively better diabetes control (69%) than those insured with Medicare and Medicaid (54% and 53%, respectively). At a state level, we found that commercially insured and Medicare populations have relatively smaller geographic variation in drug adherence than the Medicaid population.

CONCLUSIONS: This study identified gaps in T2DM drug adherence and pinpointed geographic areas that lag in terms of diabetes drug adherence or diabetes control and would benefit from implementing strategies to increase drug adherence.

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What is already known about this subject

- Diabetes drug adherence is strongly related to diabetes control and health outcomes.
- There is a need to improve drug adherence and glycemic control.

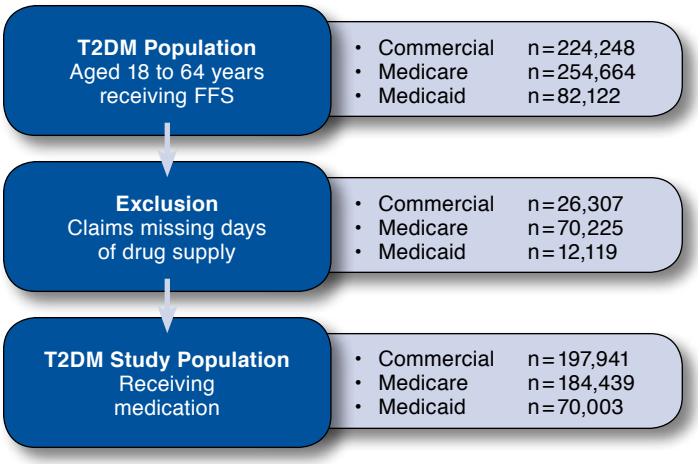
What this study adds

- This study identifies gaps in drug adherence and diabetes control across insurance types, states, and Metropolitan Statistical Areas (MSAs).
- Adherence to oral and injectable antidiabetic medications varied significantly across states and MSAs, as well as insurance types. The Medicare population had the highest adherence, while the commercial population had the highest level of diabetes control, partially because of younger age and shorter disease duration.
- States in the Northeast and Midwest regions were identified as doing better than the national averages in drug adherence and diabetes control, while southern states were found to have larger gaps in these care measures.

Medication nonadherence, particularly among patients with type 2 diabetes mellitus (T2DM), is a vital public health concern. Nonadherence is associated with morbidity and mortality and results in higher health care use and expenditures.[1] In 2012, 29.1 million adults in the United States had diabetes, 90% of whom suffered from T2DM.[2] Among patients with T2DM, poor adherence to antidiabetic agents is strongly associated with suboptimal glycemic control and greatly increases the incidence of diabetes-related morbidity and mortality and costs.[3-5] Therefore, while the American Diabetes Association recommends individualized treatment targets, it does advise that for many nonpregnant adults, lowering hemoglobin A1c (A1c) to below 7% is a reasonable goal.[6]

Existing research has highlighted gaps in medication adherence and diabetes control at the national level. A systematic review found that drug adherence among patients with T2DM in 4 nationally representative studies ranged between 36% and 81%.[7,8] Drug adherence, measured as the proportion of days covered (PDC), was 79% and 81% in 2 studies representative of pharmacy benefit organizations (PBO).[7] The third study, using a large pharmacy claims database, used medication possession ratio as a proxy for drug adherence. This study

FIGURE 1 Flowchart of T2DM Patient Selection



Source: deidentified Normative Health Information database 2012, Medicare 2011, and Medicaid 2008.
FFS = fee for service; T2DM = type 2 diabetes mellitus.

excluded patients with T2DM who used insulin and found 69% of patients to be adherent.[8] The fourth study, using a Medicaid population, concluded that drug adherence measured using PDC ranged between 36% and 49%.[7] Diabetes control, defined by A1c below 7%, has been estimated to be 53% for commercially insured patients and 62% for Medicare patients.[5] To our knowledge, diabetes control for Medicaid patients is not currently available.

Other studies have documented the wide geographic variations in general access to care, health care use, and expenditures across the United States.[9] For example, per capita diabetes-related medical expenditures in Massachusetts are 1.4 times the expenditures in Utah.[10] Regional differences in health care use, expenditures, and drug adherence are partially explained by population demographics, which include age, sex, and socioeconomic characteristics. Other important determinants of population health care use are local, such as supply of care, financial incentives, practice patterns, and behavioral determinants of health. Furthermore, the degree of illness, out-of-pocket drug costs, polypharmacy, complexity in drug regimen, and patients' perceptions toward their illness and drug effectiveness are also known to affect adherence.[11,12]

Little is known about the level of adherence to antidiabetic agents and its potential geographic variation at the state or Metropolitan Statistical Area (MSA) level. One previous study has found that adherence to oral antidiabetic medications varied significantly across 9 regions in the United States, after controlling for age, gender, socioeconomic status, and yearly out-of-pocket pharmacy expenses.[13] This study concluded that diabetic drug adherence, captured by average PDC, among commercially insured patients was highest in the New England, Mid-Atlantic, East North Central, and West North Central states, which had 40% to 60% higher probability of being adherent to their medications than East South Central states. In this study, East North Central states included Wisconsin, Illinois, Indiana, Ohio, and Michigan. West North Central states included North and South Dakota, Nebraska, Kansas, Minnesota, Iowa, and Minnesota. East South Central states included Kentucky, Tennessee, Alabama, and Mississippi. In contrast, among the Medicare population with Part D benefits, New England and East North Central states were 8% to 19% more adherent than East South Central states.

Our purpose in this claims-based retrospective cross-sectional study was to examine the average PDC to antidiabetic agents, the percentage of optimal adherence, and the percentage of patients with controlled diabetes among patients diagnosed with T2DM who received antidiabetic medication. The results are presented at the state and MSA level for commercially insured, Medicare, and Medicaid patients separately.

Methods

Data Sources

Data sources included the 2012 medical and pharmacy claims from UnitedHealth Group and non-UnitedHealth Group health plans (the deidentified Normative Health Information [dNHI] database), the 2011 Medicare Standard Analytical File medical claims linked with Part D claims from the 5% Chronic Conditions Data Warehouse files, and the 2008 Mini-Medicaid Analytic eXtract (Mini-Max), which is a one-time extraction of a 5% stratified random sample of the Medicaid population. These 3 databases were statistically deidentified. This study was reviewed and approved by an institutional review board and the Centers for Medicare & Medicaid Services (CMS) Privacy Review Board.

Study Population

The study population included adults with T2DM who received diabetes medication and were covered by private insurance (aged 18 to 64 years), Medicare (aged 18 years and above), or Medicaid (aged 18 to 64 years) in each state, the District of Columbia, and the top 50 MSAs. For Medicare and Medicaid, only fee-for-service insured were included. The Medicare sample was limited to fee-for-service Part D enrollees and did not include Medicare Advantage Plans with Part D coverage. Adults with T2DM who filled an antidiabetic prescription any time during the year of data availability were included in the study. Patients were also required to be continuously covered during the entire calendar year. Patients with diagnosed diabetes were identified by 1 or more hospital stays or emergency department visits or at least 2 separate physician office or hospital outpatient visits during which diabetes (*International Classification of Diseases, Ninth Revision, Clinical Modification* [ICD-9-CM]

TABLE 1 Sample Statistics of Patients with T2DM Receiving Antidiabetic Medication by Age and Gender

	Commercial		Medicare		Medicaid	
	Sample Size	% Medication	Sample Size	% Medication	Sample Size	% Medication
T2DM patients receiving medication	197,941	88	184,439	73	70,003	82
Age group						
18-34	7,177	89			4,953	74
35-44	26,505	90			9,794	82
45-54	65,419	89			23,500	84
55-59	48,269	87			16,373	86
60-64	50,571	85			15,383	79
<65			39,238	76		
65-69			32,100	76		
≥70			113,101	70		
Gender						
Female	88,770	88	112,335	72	46,727	83
Male	109,171	89	72,104	73	23,276	79

T2DM = type 2 diabetes mellitus

code 250.xx) was recorded. T2DM patients were then identified using an algorithm described in Appendix A (available in online article). Using these criteria, we identified 561,034 individuals with T2DM across the 3 insurance categories (Figure 1). Excluded from this study were claims where number of days supplied were missing or zero or prescription fill dates were missing. The number of T2DM patients identified who received diabetes medication was 197,941 for commercially insured, 184,439 for Medicare, and 70,003 for Medicaid (Figure 1).

Study Measures

Drug adherence was measured using PDC, calculated as the proportion of days with 1 or more drugs available during the study period. This period was defined as the time interval between the index date (the first script fill date during the study year) and the last day of the calendar year. We used an interval-based method to calculate a PDC for each patient using pharmacy claims.[14] Upon calculating a PDC for each person, patients with a PDC≥80% were classified as being adherent to their medications.[15] We reported average PDC and adherence rates.

Antidiabetic agents covered by the PDC calculations included oral antidiabetic drugs (OAD), including alpha-glucosidase inhibitors, meglitinides, biguanides, sulfonylureas, thiazolidinediones, and dipeptidyl peptidase-4 inhibitors, and antidiabetic combinations, insulin mixes, long-acting insulins, and noninsulin injectable drugs (GLP-1 receptor agonists). Rapid-acting insulin was excluded because of the uncertainty of the real days of supply. Days of supply for insulin and noninsulin injectable drugs were adjusted because of titration using existing method.[16,17] Drug lists were constructed using Healthcare Effectiveness Data and Information Set-approved diabetes drugs by 2011 (the National Drug Code list available upon request).

Since our purpose was to examine general medication adherence to antidiabetic therapy, all drugs within antidiabetic agent drug classes were considered interchangeable. Days during which concurrent drugs were supplied were only counted once. We adjusted fill dates and excluded inpatient days for PDC calculations following CMS Technical Notes.[18]

The optimal way to measure diabetes control is through A1c values. While laboratory results are available for a subset of the commercially insured T2DM patients, Medicare and Medicaid files do not contain laboratory results. In order to create a consistent definition of diabetes control across insurance types, we identified patients with controlled diabetes as those who were not diagnosed with uncontrolled diabetes (ICD-9-CM code 250.x2 or 250.x3) during the study year. For the subset of commercially insured T2DM patients for which we had both ICD-9-CM and A1c information, we performed additional correlation analyses to assert the strength of the association between the 2 measures of diabetes control. We found a strongly significant and positive correlation between ICD-9-CM- and A1c-based case identification measures (Spearman rank correlation coefficients of 0.22 [$P<0.001$] for A1c>9% as uncontrolled). Chi-square statistics were also significant.

Statistical Analysis

Age group and sex specific average PDC and rates of adherence and control were calculated for each state/MSA and insurance type. State and MSA representative outcomes were generated by applying the T2DM rate and adherence and control measures to a representative T2DM population residing in each state/MSA. This population file was constructed combining demographics, medical insurance, and type of living arrangement information from the 2012 American Community Survey, diabetes prevalence for a community-based population from the 2011 and 2012

TABLE 2 Average PDC, Drug Adherence Status, and Diabetes Control Status for Patients with T2DM Receiving Antidiabetic Medication by Insurance Type

	Commercial		Medicare		Medicaid	
	Mean (%)	Standard Error	Mean (%)	Standard Error	Mean (%)	Standard Error
Average PDC						
Age group						
18-34	63	0.003			64	0.004
35-44	70	0.002			70	0.003
45-54	76	0.001			75	0.002
55-59	79	0.001			79	0.002
60-64	82	0.001			81	0.002
<65			79	0.001		
65-69			84	0.001		
≥70			84	0.001		
Gender						
Female	75	0.001	83	0.001	73	0.001
Male	78	0.001	83	0.001	76	0.002
Total	77	0.001	83	0.001	75	0.001
Percentage with PDC ≥ 80%						
Age group						
18-34	38	0.006			41	0.005
35-44	44	0.003			48	0.005
45-54	47	0.002			49	0.003
55-59	53	0.003			56	0.004
60-64	57	0.003			57	0.004
<65			63	0.002		
65-69			71	0.003		
≥70			73	0.001		
Gender						
Female	57	0.002	70	0.001	55	0.002
Male	61	0.001	71	0.002	58	0.003
Total	60	0.001	71	0.001	57	0.002
Diabetes Control						
Age group						
18-34	67	0.006			54	0.007
35-44	68	0.003			52	0.005
45-54	67	0.002			52	0.003
55-59	68	0.002			52	0.004
60-64	68	0.002			52	0.004
<65			47	0.003		
65-69			54	0.003		
≥70			56	0.001		
Gender						
Female	69	0.002	53	0.001	53	0.002
Male	68	0.001	54	0.002	53	0.003
Total	69	0.001	54	0.001	53	0.002

PDC = proportion of days covered; T2DM = type 2 diabetes mellitus.

Behavioral Risk Factor Surveillance System, and diabetes prevalence for a nursing home population from the 2004 National Nursing Home Survey. (Appendix B describes the construction of the MSA population files, available in online article.)

A Z-score was calculated to evaluate the standard deviation of each state's/MSA's adherence from the average PDC across states/MSAs. Spearman's correlation coefficients were calculated between percentage adherent and percentage controlled. Statistical significance was determined using a *P* value below 0.050. All analyses were performed using SAS version 9.3 (SAS Institute, Cary, NC).

Results

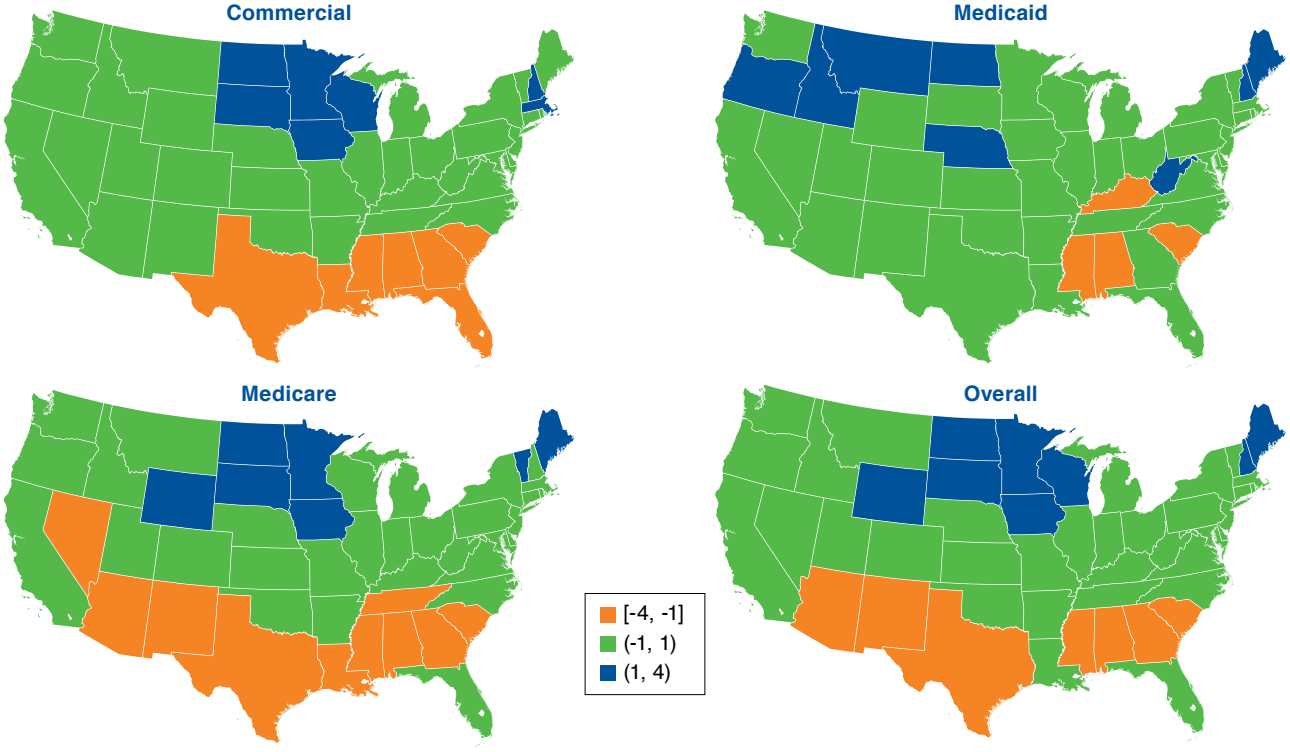
Across the 3 insurance types, 80% of patients received antidiabetic medication and constituted our study population. Respectively, 88%, 73%, and 82% of commercially insured patients, Medicare patients receiving Part D benefits, and Medicaid insured patients with T2DM received antidiabetic medication (Table 1). Among the commercially insured, 45% were female, while 61% and 67% were female among the Medicare and Medicaid insured, respectively. The majority used OAD drugs only: 73% for commercially insured, 64% for Medicare, and 68% for Medicaid.

At the national level, average PDC was 79% for our study population, and 65% of the population had an average PDC of 80% or above. Average PDC and drug adherence increased by age: among commercially insured adults aged 18-34 years, the average PDC was 63%, while the average PDC for people aged 70 years and above insured by Medicare was 84% (Table 2). On average, men had higher adherence than women using average PDC and level of adherence. While the difference was smallest among Medicare patients, the difference was statistically significant: men had an average PDC of 83.2% (95% confidence interval [CI] = 83.0-83.3), while women had an average PDC of 82.7% (95% CI = 82.6-82.9). Average PDC and drug adherence were higher for those patients insured by Medicare (83%, 95% CI = 82.9-83.1) than for those patients who were commercially insured (76.6%, 95% CI = 76.5-76.8) and Medicaid insured (74.4%, 95% CI = 74.2-74.6).

Across the 3 insurance types, 60% of patients with T2DM receiving medication had their diabetes under control (Table 2). Between ages 18 and 64 years, the proportion of patients with their diabetes under control remained stable. However, for Medicare patients, diabetes control increased with age. Below aged 65 years, 46.6% (95% CI = 46.1-47.1) of the patients had their diabetes under control compared with 56.4% (95% CI = 56.1-56.6) of patients aged 70 years and above. Diabetes control was highest for commercially insured patients (68.9%, 95% CI = 69.1-68.7) than for Medicare (53.7%, 95% CI = 53.5-54.0) and Medicaid patients (52.7%, 95% CI = 52.3-53.0).

Figure 2 displays the average PDC across states and insurance types. Across the states, Medicaid patients experienced more variation in average PDC than Medicare or commercially insured patients. Among commercially insured patients, Minnesota had the highest average PDC (85%), while Florida, Georgia, and Mississippi had the lowest average PDC (73%). For

FIGURE 2 State Average PDC in Comparison to Average PDC Across States by Insurance Type and Overall



Note: The numbers in the legend represent the z-score. Blue states have an average PDC at least 1 standard deviation above the average PDC across states for that insurance type. Green states have an average within 1 standard deviation from the average across states. Orange states have an average at least 1 standard deviation below the average across states. State-level sample sizes and average PDC statistics are available in Appendix C (available in online article). The figures do not include Alaska and Hawaii; only Hawaii's Medicaid population has a standard deviation below the average across states.
PDC = proportion of days covered.

Medicare patients, Maine, North Dakota, and Wyoming had the highest average PDC (87%), while the District of Columbia had the lowest average PDC (79%). For the Medicaid patients, Idaho, Montana, and Nebraska had the highest average PDC (82%), while Michigan had the lowest average PDC (61%).

Among Medicare patients, the variation in percent adherent across states is smaller than the variation in percent adherent across states for Medicaid patients (Table 3). Percent adherent varied between 51% (Mississippi) and 74% (Minnesota) among the commercially insured; between 61% (District of Columbia) and 79% (Maine and North Dakota) among the Medicare patients; and between 33% (Kentucky) and 71% (Montana) among the Medicaid patients. Furthermore, the variation in percent adherent across states was larger than the variation in average PDC, suggesting that while average PDC may be similar, there is a larger variation in adherence if an adherence cutoff of 80% were used.

At the state level, variation in diabetes control across states and insurance types are more apparent. Diabetes control among the commercially insured patients was higher than among the Medicare and Medicaid populations (Table 3). Average diabetes control ranged between 60% in Texas and Wyoming and 83% in Idaho among the commercially insured; between 44% in District of Columbia and New Mexico and 71% in Iowa and North Dakota among the Medicare patients; and between 50% in Texas and 60% in Arizona and Ohio among the Medicaid patients.

The correlation between the state adherence rate and diabetes control was positive and significant for all insurance types. The correlation coefficient was smallest for the commercially insured patients (0.28, $P = 0.043$) and somewhat higher for the Medicare and Medicaid patients (0.49 and 0.56, $P < 0.001$, respectively).

MSA variation in diabetes drug adherence and diabetes control followed a pattern similar to the state variation previously presented. Results for average PDC and diabetes control are available in Appendix F (available in online article). Average PDC is higher for the Medicare patients than for the Medicaid and commercially insured patients and experiences less variation in average PDC across MSAs. In contrast, diabetes control

TABLE 3 Proportion of the Population Adherent to Medication and with Diabetes Control

	Drug Adherence				Diabetes Control			
State	Commercial %	Medicare %	Medicaid %	All Three %	Commercial %	Medicare %	Medicaid %	All Three %
Alabama	56	65	52	60	71	55	52	61
Alaska	59	74	59	66	68	67	55	66
Arizona	57	66	50	60	62	50	60	56
Arkansas	57	70	48	62	79	62	51	67
California	61	70	57	65	74	48	51	58
Colorado	61	70	59	65	66	56	52	59
Connecticut	61	72	61	66	70	54	53	61
Delaware	62	75	56	68	70	52	53	59
District of Columbia	56	61	33	56	68	44	53	55
Florida	54	70	55	62	65	50	51	56
Georgia	54	67	58	61	68	51	51	58
Hawaii	59	73	51	65	72	60	52	64
Idaho	61	71	67	66	83	66	55	71
Illinois	61	72	55	66	68	54	52	60
Indiana	60	69	57	65	73	56	51	62
Iowa	70	77	61	73	79	71	53	72
Kansas	65	76	50	69	73	62	52	65
Kentucky	60	70	33	62	76	58	54	65
Louisiana	55	67	59	61	72	53	52	60
Maine	62	79	67	71	77	62	55	67
Maryland	62	72	57	66	62	49	52	55
Massachusetts	68	72	60	69	66	54	52	59
Michigan	58	71	42	63	70	55	53	61
Minnesota	74	78	56	74	81	69	52	72
Mississippi	51	64	37	56	71	54	53	60
Missouri	60	72	64	66	63	54	54	58
Montana	66	75	71	71	81	62	57	69
Nebraska	65	72	67	69	70	70	54	68
Nevada	58	67	63	63	66	52	53	57
New Hampshire	67	73	59	69	72	63	55	66
New Jersey	62	74	59	67	67	49	53	57
New Mexico	59	64	49	60	62	44	51	52
New York	59	75	62	67	70	53	53	59
North Carolina	58	69	53	63	70	54	51	60
North Dakota	71	79	66	75	77	71	56	72
Ohio	61	71	56	66	68	54	60	60
Oklahoma	57	68	56	62	71	55	51	61
Oregon	63	72	69	69	67	55	58	60
Pennsylvania	64	74	67	69	68	58	54	61
Rhode Island	69	68	60	68	71	54	55	61
South Carolina	57	67	49	61	74	60	51	65
South Dakota	68	78	61	72	81	66	55	71
Tennessee	57	67	53	62	68	52	52	58
Texas	55	66	51	60	60	45	50	51
Utah	61	69	66	65	79	67	56	71
Vermont	59	73	57	66	68	67	58	66
Virginia	63	70	66	67	68	54	53	59
Washington	64	73	55	67	70	54	53	60
West Virginia	62	72	66	67	72	55	54	61
Wisconsin	68	74	57	70	72	62	53	65
Wyoming	66	77	60	71	61	63	57	62
Average across states	61	71	57	66	71	57	53	62

Note: The full table including standard errors for drug adherence and diabetes control and a map for diabetes control are presented in Appendices D and E (available in online article).

was highest among the commercially insured patients and lowest among the Medicare patients. Variation in average PDC across MSAs was similar to the variation in average PDC across states. However, variation in diabetes control was larger at the MSA level than the state level.

Discussion

This study identifies gaps in drug adherence and diabetes control at the national, state, and MSA levels. Average PDC for an insured patient population with T2DM that received diabetic medication was 79%. However, for the same population, 1 in 3 patients (35%) did not achieve at least 80% PDC. Furthermore, at least 40% of the insured patient population with T2DM that received diabetic medication did not have their diabetes under control. Average PDC for our 3 insurance populations ranged between 75% and 83%, suggesting little difference in adherence across insurance categories. Our drug adherence results are comparable with 2 other nationally representative PBO populations.[7] However, our Medicaid adherence results are higher than the 39% and 46% adherence for a Medi-Cal dataset using 1996-1998 data.

Compared with the Medicaid (75%) and commercially insured population (77%), the Medicare insured patients had a significantly higher average PDC (83%). However, commercially insured patients had better diabetes control (71%) than Medicare and Medicaid insured patients (57% and 53%, respectively). The relationship between drug adherence and diabetes control is confounded by disease duration, which could explain why Medicare patients on average have high levels of drug adherence but low levels of diabetes control.[19] At the same time, disease complications are more likely to arise as the disease progresses.[20] As a result, elderly patients are more likely to have lower diabetes control despite higher levels of drug adherence, although for elderly patients, less stringent A1c levels may be more appropriate depending on their disease history.

State- and MSA-level variation in drug adherence and diabetes control is relatively small for Medicare and commercially insured populations. For example, among the commercially insured population, average PDC ranged between 73% and 85%, while diabetes control ranged between 60% and 83%. However, the Medicaid population experienced substantial variation in drug adherence across states (ranging between 61% and 82%) but little variation in diabetes control (50%-60%). Regional variations in drug adherence that we describe correspond to findings in earlier literature. Similar to the study by Couto et al. (2014),[13] the states that correspond to the New England, Middle Atlantic, East North Central, and West North Central regions have higher antidiabetic medication adherence than East South Central states in the Medicare population. Our results for the commercially insured population also largely correspond to the results for the commercial population used in that study.

Limitations

This study has several limitations. First, the definition of diabetes control is based on ICD-9-CM codes and captures lack of control only when physicians identify a patient as such. We therefore compared the prevalence rate when using ICD-9-CM with the prevalence rate when using various A1c cutoffs. The ICD-9-CM-based prevalence rate overestimated controlled status relative to the ADA's recommended A1c level of below 7% for tight control (51%) but underestimated controlled status when using the Health Resources and Services Administration's diabetes measure of poor control, which defines poor control with an A1c above 9%. While we do not have laboratory values available for the Medicare and Medicaid patients, we have no reason to suspect that coding would be different across insurance population or across states. Future research should focus on validating the use of ICD-9-CM codes to identify diabetes control across these dimensions.

Second, we used claims from 1 large commercial plan only, which may not be representative of the insured population at subnational levels. These concerns are mitigated partially by reweighting the outcomes by age group and gender. Third, because of data limitations, only Medicare and Medicaid fee-for-service beneficiaries were included in this study. States that have largely transitioned their Medicaid beneficiaries to managed care settings are often more complex. Fourth, some states suffered from small sample size problems including the commercial population in Alaska, Hawaii, and Vermont and the Medicaid population in Arizona. Ohio Medicaid claims did not include number of days supplied and therefore did not meet our selection criteria. Furthermore, our results were not adjusted for individual determinants of drug adherence other than age and gender. Income, race/ethnicity, health status, access to care, and provider treatment patterns could explain some of the geographic variation in outcomes that we highlight in this study. Understanding the significant drivers of geographic variation beyond those that can be explained by population demographics could shed light on creating more effective public health initiatives.

Finally, it is important to note that the Affordable Care Act may have changed the landscape in diabetes care. Expanded coverage such as the further closing of the coverage gap in the Medicare "donut hole" and Medicaid expansion improves access to care and potentially increases the incentives for preventive care and medication adherence. Other factors, such as the emergence of high-deductible employer plans and the large deductibles and cost sharing featured by many individual plans purchased through health exchanges, should also be considered. The interplay of these new trends in the age of health care reform merits additional research.

Conclusions

This study provides a detailed view of the adequacy of diabetes management among the insured population across states

and MSAs. The significant and positive correlations between percentage of patients with optimal adherence and percentage with diabetes under control show that those states and MSAs with higher levels of adherence tend to have higher percentages of T2DM patients with control. The findings of this study highlight the need to develop localized efforts in increasing diabetes drug adherence awareness and improving care. Physicians and other prescribers, insurers, and employers should identify and acknowledge potential barriers to adherence. They should strive to educate patients on why they need to fill their prescriptions, even when patients are asymptomatic, and communicate the consequences of lack of adherence on their health on an ongoing basis. A systematic review concluded that continued multiple elements such as self-management plans, reinforcement, and occasionally rewards over time is a key element of success.[21] In particular, these efforts should concentrate on the states of Arizona, Georgia, New Mexico, and Texas, where diabetes drug adherence and diabetes control remain the lowest in the country.

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DISCLOSURES

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Tan, Yang, and Hogan are employed by The Lewin Group, a research firm that is part of Optum, which is part of UnitedHealth Group. Pang was employed by The Lewin Group at the time of this study.

Study design and concept were contributed by Yang, Hogan, and Tan. Pang took the lead in data collection, along with Dai and Loh, with data interpretation performed primarily by Tan, along with Yang and Pang. The manuscript was primarily written and revised by Tan and Yang, with assistance from Pang and Hogan.

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APPENDIX A Type 2 Diabetes Sample Inclusion Criteria and Identification Algorithm

This appendix describes the inclusion and exclusion criteria that make up the sample of this study and describes the type 2 diabetes (T2DM) identification algorithm that was applied to the sample.

Inclusion criteria

- Evidence of T2DM (see Type 2 Diabetes Identification Algorithm below).
- Continuously enrolled in the fee-for-service coverage type of health plan (UnitedHealth Care, Medicare, Medicaid) during the measurement year.
- For diabetes patients with pharmacy claims or physician orders of prescriptions, ≥ 1 pharmacy claim for an antidiabetic medication.

Exclusion criteria

- Patients aged < 18 years.
- Evidence of type 1 diabetes (T1DM; identified with ICD-9-CM diagnosis codes 250.x1 or 250.x3).
- Evidence of gestational diabetes and/or pregnancy (if longitudinal approach is used during the 6-month baseline and follow-up periods).

Type 2 Diabetes Identification Algorithm

T2DM is defined as a patient who meets the following criteria using data during the measurement period:

- ≥ 1 medical claim for T2DM (ICD-9-CM diagnosis codes 250.x0 or 250.x2) and no claims for T1DM, identified with ICD-9-CM diagnosis codes 250.x1 or 250.x3. Diagnosis codes in the primary or secondary positions will be used.

OR

- If medical claims for both T1DM and T2DM, the patient must meet 1 of the following:
  1. ≥ 1 claim for an oral antidiabetic drug (OAD) including sulfonylureas, metformin, thiazolidinediones, α-glucosidase inhibitors, meglitinide derivatives, DPP-4 inhibitors, or combination of OADs with insulin or noninsulin injectable.

OR

  2. If no claims for OADs, the patient must have 4 or more claims for 250.xx with a valid fifth digit AND the number of claims for T2DM (250.x0, 250.x2) must exceed the number of claims for T1DM (250.x1, 250.x3).

OR

- If no medical claims for 250.xx with a valid fifth digit, then the patient must have ≥1 claim for an OAD AND a claim for an injectable antidiabetic medication (GLP-1, pramlintide, or insulin) and no evidence of medical claims identifying T1DM patient in the previous year.

OR

- If no medical claims for 250.xx with a valid fifth digit and no claims for injectable antidiabetic medications, then the patient must have ≥1 claim for an OAD AND no medical claims with any of the following ICD-9-CM codes: 256.4, 272.6, 277.7, 648.8x, and 790.2x. These diagnosis codes are associated with diseases that require treatment similar to T2DM. As a result, we would be unable to ascertain that a patient was taking the drug for T2DM or another condition. Codes in any position will be used.

APPENDIX B Methods for Metropolitan Statistical Area Analysis

This appendix details the multiple steps that were undertaken to create representative results at the Metropolitan Statistical Area (MSA) level.

The first step involved creating a population file with a representative sample of the population residing in each county. The county files combined demographics, household income, medical insurance, and type of living arrangement information from the 2012 American Community Survey (ACS; n = 2,375,715); disease prevalence and health risk factors for a community-based population from the 2011 and 2012 Behavioral Risk Factor Surveillance System (BRFSS; n = 982,154); and disease prevalence and health risk factors for a nursing home population from the 2004 National Nursing Home Survey (NNHS; n = 14,017).

Using information on residence type, we divided the ACS population into those in nursing facilities to be matched to people in the NNHS and those not in nursing facilities to be matched to the BRFSS. For the noninstitutionalized population, each ACS individual was randomly matched with someone in the BRFSS from the same state, sex, age group (15 groups); race/ethnicity (non-Hispanic white, non-Hispanic black, non-Hispanic other, Hispanic); insured/uninsured status; and household income level (8 levels). Individuals categorized as residing in a nursing home were randomly matched to a person in the NNHS in the same age group, sex, and race/ethnicity strata. The final matched ACS-BRFSS-NNHS database included a sample weight for each person. This weight reflected the number of people he or she represents among the general population.

Using U.S. Census Bureau 2012 data, we identified the current size of the population in each county by age, sex, and race/ethnicity. This county population database was merged with the Current Statistical Area Delineation file to aggregate counties to census-defined metropolitan areas. The county population files with the MSA definitions were then merged with the ACS-BRFSS-NNHS matched national population file to create a health and socioeconomic profile for a representative sample of adults in each of the selected 50 metropolitan areas. Finally, for each metropolitan area, the sample weights for the individuals in the merged file were re-weighted so that the weighted statistics matched the U.S. Census-published MSA demographic composition. Note that not all metropolitan areas correspond with federal designations. The New York-Newark-Jersey City, NY-NJ-PA, was split such that the NY numbers corresponded solely to the population in NY, with the NJ population placed in a constructed Northern NJ metropolitan designation. Likewise, Orange County, California, was carved out of the Los Angeles-Long Beach-Anaheim metropolitan area and reported separately. Similarly, West Palm Beach was reported separately from Miami-Fort Lauderdale, Florida (whereas the official designation of this metropolitan statistical area is Miami-Fort Lauderdale-West Palm Beach).

APPENDIX C Sample Size T2DM Receiving Antidiabetic Medication and Average PDC by State and Insurance Type

	Sample Size			Commercial		Medicare		Medicaid		All Three	
State	Commercial	Medicare	Medicaid	Mean	StdErr	Mean	StdErr	Mean	StdErr	Mean	StdErr
Alaska	42	209	156	76	0.04	84	0.01	75	0.02	80	0.00
Alabama	1,220	3,514	2,169	75	0.01	80	0.00	70	0.01	77	0.00
Arkansas	1,222	2,516	835	75	0.01	82	0.00	70	0.01	78	0.00
Arizona	5,528	1,971	43	75	0.00	81	0.01	70	0.04	77	0.00
California	14,169	16,093	7,440	78	0.00	83	0.00	76	0.00	80	0.00
Colorado	4,120	1,317	742	77	0.00	83	0.01	75	0.01	80	0.00
Connecticut	2,659	2,177	1,023	77	0.00	84	0.00	79	0.01	80	0.00
District of Columbia	565	317	570	76	0.01	79	0.01	64	0.01	76	0.00
Delaware	238	728	522	77	0.02	85	0.01	73	0.01	81	0.00
Florida	13,351	10,621	1,789	73	0.00	83	0.00	74	0.01	78	0.00
Georgia	27,574	5,474	2,924	73	0.00	81	0.00	76	0.00	77	0.00
Hawaii	47	569	370	77	0.03	84	0.01	71	0.01	80	0.00
Iowa	2,329	2,778	854	82	0.00	86	0.00	78	0.01	84	0.00
Idaho	244	795	534	78	0.02	83	0.01	82	0.01	81	0.00
Illinois	5,255	9,507	2,596	77	0.00	84	0.00	74	0.01	80	0.00
Indiana	2,563	4,880	2,292	76	0.00	83	0.00	74	0.01	79	0.00
Kansas	1,465	2,266	692	79	0.01	85	0.00	72	0.01	81	0.00
Kentucky	1,570	4,438	2,499	76	0.01	82	0.00	66	0.01	78	0.00
Louisiana	3,936	3,183	2,650	74	0.00	81	0.00	76	0.00	78	0.00
Massachusetts	1,467	4,112	1,428	81	0.01	84	0.00	76	0.01	82	0.00
Maryland	6,499	3,276	1,356	79	0.00	84	0.00	75	0.01	81	0.00
Maine	186	1,351	526	78	0.02	87	0.01	80	0.01	83	0.00
Michigan	1,379	6,338	340	75	0.01	83	0.00	61	0.02	77	0.00
Minnesota	5,779	1,877	860	85	0.00	86	0.00	75	0.01	85	0.00
Missouri	4,327	4,449	1,706	76	0.00	83	0.00	79	0.01	80	0.00
Mississippi	1,421	3,467	1,673	73	0.01	80	0.00	63	0.01	75	0.00
Montana	126	616	316	79	0.02	85	0.01	82	0.01	82	0.00
North Carolina	3,675	7,722	2,717	76	0.00	82	0.00	74	0.01	78	0.00
North Dakota	257	571	318	83	0.01	87	0.01	81	0.01	85	0.00
Nebraska	836	1,424	311	79	0.01	84	0.01	82	0.01	82	0.00
New Hampshire	293	832	335	80	0.01	84	0.01	75	0.01	81	0.00
New Jersey	8,176	5,893	1,131	78	0.00	85	0.00	78	0.01	81	0.00
New Mexico	980	1,193	473	76	0.01	81	0.01	72	0.01	78	0.00
Nevada	804	891	411	76	0.01	81	0.01	79	0.01	79	0.00
New York	21,020	9,748	7,506	76	0.00	85	0.00	78	0.00	81	0.00
Ohio	8,345	7,068	—	78	0.00	83	0.00	75	0.00	80	0.00
Oklahoma	3,086	2,979	1,179	75	0.00	82	0.00	75	0.01	78	0.00
Oregon	860	1,549	546	79	0.01	84	0.01	81	0.01	82	0.00
Pennsylvania	2,454	7,635	809	79	0.00	84	0.00	80	0.01	82	0.00
Rhode Island	1,524	568	215	81	0.01	82	0.01	78	0.02	81	0.00
South Carolina	1,330	3,377	1,277	74	0.01	81	0.00	69	0.01	77	0.00
South Dakota	128	731	296	81	0.02	86	0.01	76	0.01	83	0.00
Tennessee	2,819	4,799	2,915	75	0.00	81	0.00	73	0.00	78	0.00
Texas	20,952	13,793	4,923	74	0.00	81	0.00	72	0.00	77	0.00
Utah	861	732	320	77	0.01	82	0.01	80	0.01	80	0.00
Virginia	4,330	5,062	1,050	78	0.00	83	0.00	78	0.01	80	0.00
Vermont	41	537	301	76	0.04	86	0.01	76	0.01	81	0.00
Washington	1,385	3,205	1,246	79	0.01	83	0.00	75	0.01	81	0.00
Wisconsin	3,899	2,897	1,276	81	0.00	85	0.00	76	0.01	82	0.00
West Virginia	477	2,085	1,356	78	0.01	84	0.00	81	0.01	81	0.00
Wyoming	128	309	187	79	0.02	87	0.01	77	0.02	82	0.00
Average PDC across states	197,941	184,439	70,003	77	0.00	83	0.00	75	0.00	80	0.00

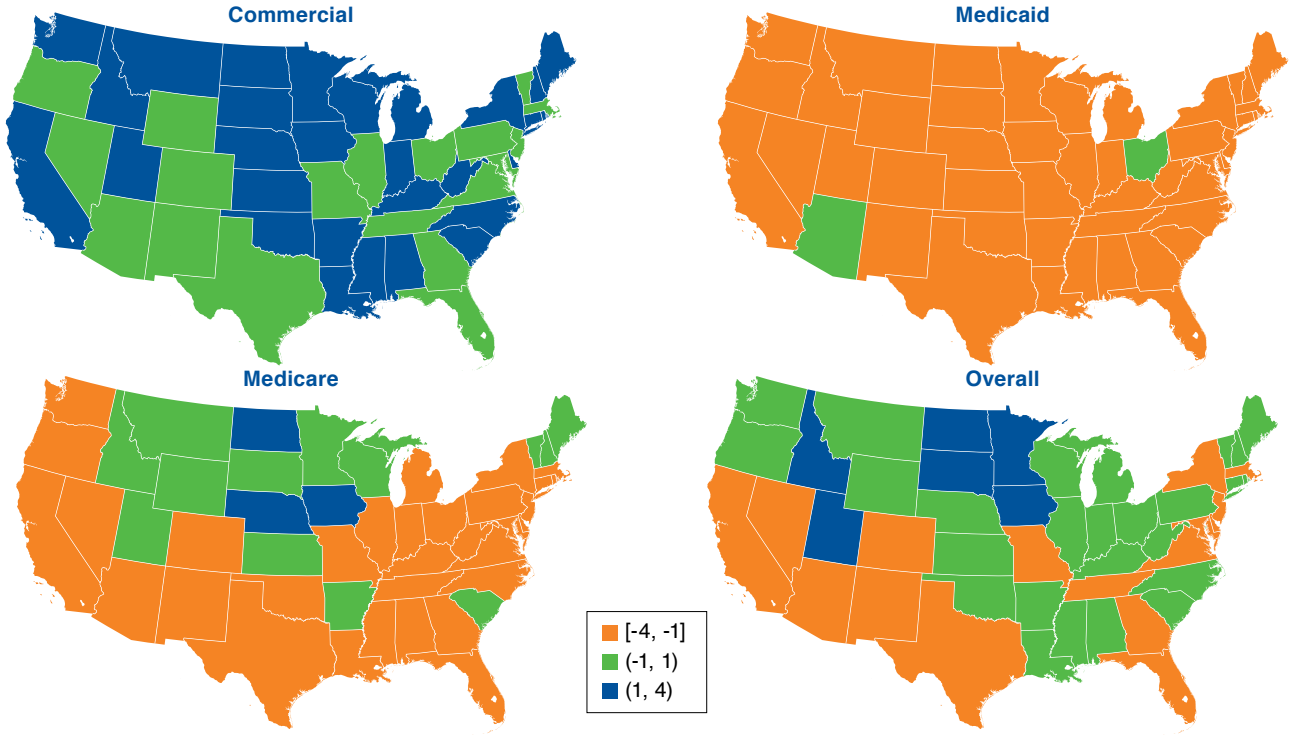
PDC = proportion of days covered; StdErr = standard error; T2DM = type 2 diabetes mellitus.

APPENDIX D Proportion of the Population Adherent to Medication and with Diabetes Control

	Drug Adherence								Diabetes Control							
	Commercial		Medicare		Medicaid		All Three		Commercial		Medicare		Medicaid		All Three	
State	Mean	StdErr	Mean	StdErr	Mean	StdErr	Mean	StdErr	Mean	StdErr	Mean	StdErr	Mean	StdErr	Mean	StdErr
Alabama	56	0.01	65	0.01	52	0.01	60	0.01	71	0.01	55	0.01	52	0.01	61	0.01
Alaska	59	0.07	74	0.03	59	0.04	66	0.02	68	0.07	67	0.03	55	0.04	66	0.01
Arizona	57	0.01	66	0.01	50	0.07	60	0.01	62	0.01	50	0.01	60	0.07	56	0.01
Arkansas	57	0.01	70	0.01	48	0.01	62	0.01	79	0.01	62	0.01	51	0.02	67	0.01
California	61	0.00	70	0.00	57	0.00	65	0.00	74	0.00	48	0.00	51	0.01	58	0.01
Colorado	61	0.01	70	0.01	59	0.02	65	0.01	66	0.01	56	0.01	52	0.02	59	0.01
Connecticut	61	0.01	72	0.01	61	0.01	66	0.01	70	0.01	54	0.01	53	0.01	61	0.01
Delaware	62	0.03	75	0.02	56	0.02	68	0.01	70	0.03	52	0.02	53	0.02	59	0.01
District of Columbia	56	0.02	61	0.03	33	0.02	56	0.01	68	0.02	44	0.03	53	0.02	55	0.01
Florida	54	0.00	70	0.00	55	0.01	62	0.00	65	0.00	50	0.00	51	0.01	56	0.02
Georgia	54	0.00	67	0.01	58	0.01	61	0.00	68	0.00	51	0.01	51	0.01	58	0.00
Hawaii	59	0.07	73	0.02	51	0.03	65	0.02	72	0.07	60	0.02	52	0.03	64	0.01
Idaho	61	0.03	71	0.02	67	0.02	66	0.01	83	0.02	66	0.02	55	0.02	71	0.00
Illinois	61	0.01	72	0.00	55	0.01	66	0.00	68	0.01	54	0.01	52	0.01	60	0.00
Indiana	60	0.01	69	0.01	57	0.01	65	0.00	73	0.01	56	0.01	51	0.01	62	0.01
Iowa	70	0.01	77	0.01	61	0.01	73	0.01	79	0.01	71	0.01	53	0.02	72	0.00
Kansas	65	0.01	76	0.01	50	0.01	69	0.01	73	0.01	62	0.01	52	0.02	65	0.00
Kentucky	60	0.01	70	0.01	33	0.01	62	0.01	76	0.01	58	0.01	54	0.01	65	0.00
Louisiana	55	0.01	67	0.01	59	0.01	61	0.00	72	0.01	53	0.01	52	0.01	60	0.00
Maine	62	0.04	79	0.01	67	0.00	71	0.01	77	0.03	62	0.01	55	0.00	67	0.01
Maryland	62	0.01	72	0.01	57	0.01	66	0.00	62	0.01	49	0.01	52	0.01	55	0.01
Massachusetts	68	0.01	72	0.01	60	0.01	69	0.01	66	0.01	54	0.01	52	0.01	59	0.00
Michigan	58	0.01	71	0.01	42	0.02	63	0.01	70	0.01	55	0.01	53	0.02	61	0.02
Minnesota	74	0.01	78	0.01	56	0.01	74	0.00	81	0.01	69	0.01	52	0.02	72	0.00
Mississippi	51	0.01	64	0.01	37	0.01	56	0.01	71	0.01	54	0.01	53	0.01	60	0.01
Missouri	60	0.01	72	0.01	64	0.01	66	0.00	63	0.01	54	0.01	54	0.01	58	0.00
Montana	66	0.04	75	0.02	71	0.02	71	0.01	81	0.03	62	0.02	57	0.03	69	0.00
Nebraska	65	0.02	72	0.01	67	0.02	69	0.01	70	0.02	70	0.01	54	0.03	68	0.01
Nevada	58	0.02	67	0.02	63	0.02	63	0.01	66	0.02	52	0.02	53	0.02	57	0.00
New Hampshire	67	0.03	73	0.02	59	0.02	69	0.01	72	0.03	63	0.02	55	0.03	66	0.02
New Jersey	62	0.01	74	0.01	59	0.01	67	0.00	67	0.01	49	0.01	53	0.01	57	0.01
New Mexico	59	0.02	64	0.01	49	0.02	60	0.01	62	0.02	44	0.01	51	0.02	52	0.00
New York	59	0.00	75	0.00	62	0.00	67	0.00	70	0.00	53	0.01	53	0.01	59	0.01
North Carolina	58	0.01	69	0.01	53	0.01	63	0.00	70	0.01	54	0.01	51	0.01	60	0.01
North Dakota	71	0.03	79	0.02	66	0.02	75	0.01	77	0.03	71	0.02	56	0.03	72	0.02
Ohio	61	0.01	71	0.01	56	0.00	66	0.00	68	0.01	54	0.01	60	0.00	60	0.01
Oklahoma	57	0.01	68	0.01	56	0.01	62	0.01	71	0.01	55	0.01	51	0.01	61	0.01
Oregon	63	0.02	72	0.01	69	0.01	69	0.01	67	0.02	55	0.01	58	0.02	60	0.01
Pennsylvania	64	0.01	74	0.01	67	0.01	69	0.00	68	0.01	58	0.01	54	0.02	61	0.00
Rhode Island	69	0.01	68	0.02	60	0.03	68	0.01	71	0.01	54	0.02	55	0.03	61	0.01
South Carolina	57	0.01	67	0.01	49	0.01	61	0.01	74	0.01	60	0.01	51	0.01	65	0.00
South Dakota	68	0.04	78	0.02	61	0.02	72	0.01	81	0.03	66	0.02	55	0.03	71	0.00
Tennessee	57	0.01	67	0.01	53	0.01	62	0.00	68	0.01	52	0.01	52	0.01	58	0.01
Texas	55	0.00	66	0.00	51	0.01	60	0.00	60	0.00	45	0.00	50	0.01	51	0.01
Utah	61	0.02	69	0.02	66	0.02	65	0.01	79	0.01	67	0.02	56	0.02	71	0.01
Vermont	59	0.08	73	0.02	57	0.03	66	0.02	68	0.07	67	0.02	58	0.03	66	0.00
Virginia	63	0.01	70	0.01	66	0.01	67	0.00	68	0.01	54	0.01	53	0.01	59	0.01
Washington	64	0.01	73	0.01	55	0.01	67	0.01	70	0.01	54	0.01	53	0.01	60	0.01
West Virginia	62	0.02	72	0.01	66	0.01	67	0.01	72	0.02	55	0.01	54	0.01	61	0.01
Wisconsin	68	0.01	74	0.01	57	0.01	70	0.00	72	0.01	62	0.01	53	0.01	65	0.01
Wyoming	66	0.04	77	0.02	60	0.03	71	0.02	61	0.04	63	0.03	57	0.03	62	0.01
Average across states	61	0.00	71	0.00	57	0.00	66	0.00	71	0.00	57	0.00	53	0.00	62	0.00

StdErr = standard error.

APPENDIX E Variation in Percentage of Diabetes Control Across Insurance Types and States



Note: The numbers in the legend represent diabetes control. Blue states have an average diabetes control of 70% or higher. Green states have an average diabetes control of 60% to below 70%. Orange states have an average diabetes control below 60%. Diabetes control is highest among the commercially insured population and is lowest among the Medicaid population. All states, except Nebraska and Wyoming, have higher diabetes control among the commercially insured population than among the Medicare and Medicaid population. State-level sample sizes and diabetes control are available in Table 3 of this article. This figure does not include Alaska and Hawaii; those statistics are available in Table 3.

APPENDIX F Sample Size of T2DM Receiving Antidiabetic Medication, Average PDC, and Diabetes Control by MSA and Insurance Type

This table presents average proportion of days covered (PDC) and percentage of diabetes control for each of the 50 Metropolitan Stastistical Areas (MSAs) included in this study. Similar to results at the state level, variation in diabetes control at the MSA level is larger than variation in average PDC. Average PDC ranges between 72% (Orlando, FL) and 84% (Minneapolis, MN) for commercially insured patients; 78% (Houston, TX) and 86% (Southern New Jersey, NJ) for Medicare insured patients; and 60% (Detroit, MI) and 82% (Orange County, CA) among Medicaid patients. In contrast, diabetes control varies between 52% (San Antonio, TX) and 82% (Minneapolis, MN) for commercially insured patients; 37% (San Antonio, TX) and 68% (Minneapolis, MN) for Medicare patients; and 42% (Salt Lake City, UT) and 60% (Phoenix, AZ; Pittsburgh, PA; Las Vegas, NV; and Cleveland and Columbus, OH).

For some metropolitan areas, the medical claims sample was small for some demographic groups (in particular the aged 20-34 years population). When the sample size fell below 30 adults for a particular demographic group, we used information for that same demographic group at the state or national level. For example, we did not identify any patients in the metropolitan areas and state level in Ohio. As a result, these statistics are based on the national age group and gender-adjusted estimates.

	Sample Size of T2DM with Treatment			Proportion of Days Covered								Diabetes Control							
				Commercial		Medicare		Medicaid		All Three		Commercial		Medicare		Medicaid		All Three	
MSA, State	Commercial	Medicare	Medicaid	%	Z-score	%	Z-score	%	Z-score	%	Z-score	%	StdErr	%	StdErr	%	StdErr	%	StdErr
Atlanta, GA	8,817	2,079	561	74	-1.24	80	-1.39	75	0.02	77	-1.33	66	0.01	48	0.01	49	0.02	55	0.01
Austin, TX	1,243	556	125	76	-0.28	82	-0.57	73	-0.41	79	-0.52	55	0.01	41	0.02	47	0.04	47	0.01
Baltimore, MD	1,423	1,683	659	81	1.49	83	0.49	75	0.05	81	1.05	61	0.01	48	0.01	48	0.02	53	0.01
Boston, MA	1,538	2,617	860	81	1.54	84	1.07	77	0.68	82	1.50	64	0.01	55	0.01	48	0.02	58	0.01
Charlotte, NC	1,203	1,524	295	75	-0.76	82	-0.13	72	-0.78	78	-0.65	70	0.01	58	0.01	48	0.03	61	0.01
Chicago, IL	2,303	6,203	1,674	76	-0.40	83	0.31	74	-0.10	79	-0.09	70	0.01	52	0.01	48	0.01	58	0.01
Cincinnati, OH	2,271	1,069	78	78	0.34	82	-0.36	71	-0.98	79	-0.22	77	0.01	58	0.01	54	0.06	65	0.01
Cleveland, OH	831	1,128	—	76	-0.33	82	-0.11	75	0.04	79	-0.22	71	0.02	55	0.01	60	0.00	62	0.01
Columbus, OH	1,208	867	—	79	0.62	84	1.08	75	0.04	81	0.86	63	0.01	44	0.02	60	0.00	53	0.01
Dallas, TX	6,296	2,823	665	74	-1.10	81	-0.97	77	0.44	78	-0.96	62	0.01	47	0.01	48	0.02	53	0.02
Denver, CO	2,041	412	201	78	0.24	81	-0.84	76	0.23	79	-0.22	64	0.01	49	0.02	49	0.03	55	0.00
Detroit, MI	349	2,608	98	75	-0.96	82	-0.10	60	-4.05	77	-1.52	69	0.02	48	0.01	51	0.05	56	0.01
Hartford, CT	1,070	714	365	77	-0.05	84	0.63	75	0.03	80	0.28	71	0.01	54	0.02	50	0.02	60	0.00
Houston, TX	2,637	2,219	901	74	-1.25	78	-2.66	70	-1.36	76	-2.27	60	0.01	41	0.01	50	0.02	49	0.00
Indianapolis, IN	793	1,127	321	77	-0.05	83	0.55	70	-1.18	79	-0.04	72	0.02	53	0.01	49	0.03	60	0.01
Jacksonville, FL	887	749	95	73	-1.62	81	-0.82	74	-0.30	77	-1.34	71	0.02	52	0.02	55	0.05	60	0.00
Kansas City, MO	1,125	1,010	281	79	0.66	82	-0.11	75	0.17	80	0.34	69	0.01	56	0.01	48	0.03	60	0.00
Las Vegas, NV	345	580	—	76	-0.39	81	-1.20	75	0.04	78	-0.78	62	0.03	46	0.02	60	0.00	54	0.00
Los Angeles, CA	2,575	4,539	2,172	77	0.06	83	0.17	75	0.14	80	0.14	77	0.01	45	0.01	49	0.01	58	0.00
Memphis, TN	538	877	378	73	-1.51	79	-2.24	69	-1.53	76	-2.25	62	0.02	46	0.02	49	0.03	52	0.01
Miami, FL	2,342	3,040	78	73	-1.42	83	0.48	74	-0.25	79	-0.59	67	0.01	44	0.01	56	0.05	54	0.01
Milwaukee, WI	1,873	784	428	81	1.47	82	-0.23	69	-1.60	80	0.30	71	0.01	57	0.02	48	0.02	62	0.00
Minneapolis, MN	2,998	830	432	84	2.98	85	1.50	73	-0.53	83	2.20	82	0.01	68	0.02	48	0.02	71	0.02
Nashville, TN	493	762	255	77	-0.03	81	-0.99	72	-0.72	78	-0.66	62	0.02	45	0.02	47	0.03	52	0.00
New York, NY	21,432	10,938	5,121	76	-0.25	85	1.52	79	1.12	81	0.85	70	0.00	50	0.00	47	0.01	57	0.01
Norfolk, VA	275	763	95	75	-0.65	82	-0.55	75	-0.05	78	-0.63	57	0.03	49	0.02	56	0.05	53	0.00
Northern New Jersey, NJ	8,495	4,494	729	78	0.37	84	1.17	78	0.75	81	0.94	66	0.01	49	0.01	47	0.02	55	0.00
Oklahoma City, OK	1,268	713	232	76	-0.48	83	0.05	77	0.69	79	-0.07	70	0.01	55	0.02	48	0.03	60	0.01
Orange County, CA	911	1,092	206	79	0.84	85	1.49	82	1.93	82	1.62	73	0.01	47	0.01	43	0.03	56	0.00
Orlando, FL	1,850	1,046	121	72	-2.01	81	-0.69	77	0.51	77	-1.29	64	0.01	50	0.01	53	0.04	56	0.02
Philadelphia, PA	673	3,282	346	79	0.81	84	0.69	73	-0.44	81	0.66	68	0.02	55	0.01	49	0.02	59	0.01
Phoenix, AZ	3,053	986	15	75	-0.69	82	-0.33	75	0.04	79	-0.52	60	0.01	47	0.01	60	0.13	53	0.00
Pittsburgh, PA	159	714	17	80	1.05	83	0.48	75	0.04	81	0.81	67	0.04	56	0.02	60	0.12	61	0.01
Portland, OR	1,020	523	239	78	0.45	84	0.91	78	0.86	81	0.88	66	0.01	53	0.02	48	0.03	57	0.01
Providence, RI	2,699	1,120	298	81	1.60	84	0.75	78	0.82	82	1.41	70	0.01	57	0.01	46	0.03	61	0.02
Raleigh, NC	565	555	120	76	-0.46	83	0.20	77	0.51	79	-0.03	73	0.02	52	0.02	51	0.04	60	0.01
Richmond, VA	755	832	69	78	0.26	82	-0.47	77	0.60	80	0.06	68	0.02	53	0.02	58	0.06	59	0.01
Riverside, CA	1,255	1,251	659	76	-0.41	82	-0.42	74	-0.12	79	-0.45	74	0.01	43	0.01	49	0.02	56	0.01
Sacramento, CA	596	633	500	80	1.03	83	0.14	77	0.69	81	0.78	68	0.02	45	0.02	47	0.02	54	0.00
Salt Lake City, UT	861	292	130	77	-0.05	81	-0.89	81	1.76	79	-0.04	75	0.01	63	0.03	42	0.03	65	0.01
San Antonio, TX	2,275	796	519	76	-0.56	78	-2.65	75	0.05	77	-1.56	52	0.01	37	0.02	48	0.02	44	0.00
San Diego, CA	1,012	934	436	79	0.63	82	-0.10	78	0.83	80	0.49	74	0.01	55	0.02	48	0.02	61	0.00
San Francisco, CA	1,183	1,548	617	79	0.86	85	1.47	81	1.59	82	1.55	74	0.01	50	0.01	47	0.02	59	0.01
Seattle, WA	1,395	1,314	526	79	1.00	84	0.83	75	0.00	81	0.94	68	0.01	53	0.01	47	0.02	58	0.01
Southern Connecticut, CT	2,373	1,054	464	79	0.88	83	0.50	80	1.36	81	1.04	71	0.01	54	0.01	44	0.02	60	0.01
Southern New Jersey, NJ	354	971	180	77	-0.13	86	1.79	79	1.09	81	1.05	71	0.02	51	0.01	48	0.04	58	0.00
St. Louis, MO	2,867	1,694	442	77	-0.05	83	0.26	73	-0.61	79	-0.05	61	0.01	48	0.01	47	0.02	53	0.01
Tampa, FL	4,089	1,202	203	74	-1.22	83	0.45	73	-0.48	79	-0.56	61	0.01	48	0.01	50	0.03	53	0.01
Washington, DC	3,979	1,972	862	78	0.57	83	0.02	70	-1.42	80	-0.02	66	0.01	48	0.01	49	0.02	55	0.01
West Palm Beach, FL	1,706	721	50	74	-1.39	82	-0.20	74	-0.22	78	-0.90	65	0.01	51	0.02	59	0.07	57	0.01
Average across MSAs	114,299	82,240	24,118	77	N/A	83	N/A	75	N/A	80	N/A	67	0.00	51	0.00	50	0.00	57	0.00

MSA = Metropolitan Statistical Area; N/A = not applicable; PDC = proportion of days covered; StdErr = standard error; T2DM = type 2 diabetes mellitus.