Disparities in Diabetes Care: Differences Between Rural and Urban Patients Within a Large Health System

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VISUAL ABSTRACT

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ABSTRACT

PURPOSE We sought to ascertain factors associated with the quality of diabetes care, comparing rural vs urban diabetic patients in a large health care system.

METHODS We conducted a retrospective cohort study assessing patients' attainment of the D5 metric, a diabetes care metric having 5 components (no tobacco use, glycated hemoglobin [A_{1c}] level less than 8%, blood pressure less than 140/90 mm Hg, low-density lipoprotein cholesterol level at goal or statin prescribed, and aspirin use consistent with clinical recommendations). Covariates included age, sex, race, adjusted clinical group (ACG) score as a marker of complexity, insurance type, primary care clinician type, and health care use data.

RESULTS The study cohort consisted of 45,279 patients with diabetes, 54.4% of whom resided in rural locations. The D5 composite metric was met in 39.9% of rural patients and 43.2% of urban patients (P <.001). Rural patients were significantly less likely to have attained all metric goals than urban counterparts (adjusted odds ratio [AOR] = 0.93; 95% CI, 0.88-0.97). The rural group had fewer outpatient visits (mean number of visits = 3.2 vs 3.9, P <.001) and less often had an endocrinology visit (5.5% vs 9.3%, P <.001) during the 1-year study period. Patients with an endocrinology visit were less likely to have met the D5 metric (AOR = 0.80; 95% CI, 0.73-0.86), whereas the more outpatient visits patients had, the greater their likelihood of attainment (AOR per visit = 1.03; 95% CI, 1.03-1.04).

CONCLUSIONS Rural patients had worse diabetes quality outcomes than their urban counterparts, even after adjustment for other contributing factors and despite being part of the same integrated health system. Lower visit frequency and less specialty involvement in the rural setting are possible contributing factors.

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INTRODUCTION

Diabetes continues to grow as a national health priority. Recent estimates suggest it now affects more than 11% of the US population, with approximately 90% to 95% of cases representing type 2 diabetes.[1] As incidence of this chronic disease continues to climb, so does the need for better understanding of the complex issues that contribute to successful treatment of diabetes and its comorbid disorders. Robust national[2-4] and local[5] guidelines exist to guide the medical care of these patients, with the aim of preventing complications. Despite these clear goals, achieving optimal management is difficult. Prior studies have delineated a myriad of nonclinical influences that can negatively impact diabetes management, including social determinants of health, insurance status, age, sex, race, and rurality.[6-11] Of these factors, rurality represents a complex interplay of the others and offers a unique challenge in diabetes care.

In the United States, the rural population is disproportionately affected by diabetes, having a higher prevalence than that of urban or suburban counterparts.[12] In addition, studies suggest that rural patients' disease management may be more affected by social factors compared with their urban peers.[13] Health disparities and general difficulties in care delivery in rural areas have been well described.[14] Patient rurality affects health care delivery and outcomes in diverse ways. Rural areas have health care access and lifestyle challenges as patients often travel greater distances for medical care, have less access to this care, lack specialty care, exercise less, and lack both exercise facilities and high-speed telecommunications.[15-18] Patients with diabetes who reside in rural areas are less likely to receive diabetes education and eye and foot examinations, and to meet management goals.[11,19,20] Patient rurality

thus affects not only the availability and delivery of medical care, but also patient behaviors. Although these rural-urban disparities have been well documented in the literature, there is little information on identifiable interventions to improve outcomes and more research is needed. Improving our understanding of the influence of rurality is vitally important as we face a growing population of rural diabetic patients and the potential costs and comorbidities that will result.[21]

It is against this backdrop that we undertook a study to compare patient-level measures of the quality of diabetes care between rural and urban patients across Mayo Clinic Midwest Family Practice and investigate differences in health care use, including outpatient, endocrinology, nutrition, and diabetes education visits. To our knowledge, there are no large studies comparing comprehensive quality goal attainment between rural and urban patients with diabetes. Given the integrated nature of our health system and the patient-level data available, we were able to control for many potential cofounders to better identify targetable factors that could lessen the disparity.

METHODS

Study Overview

Our study was a retrospective cohort study that was approved by the Mayo Clinic Institutional Review Board (IRB 21-003105). The primary aim of the study was to evaluate the association of rural or urban residence among patients with type 2 diabetes with their attainment of diabetes goals reflecting quality of care.

Study Population

Patients selected for this study were empaneled to a family medicine primary care clinician (physician or advanced practice provider [APP]) within the integrated health system of Mayo Clinic Rochester and Mayo Clinic Health System. The latter includes more than 40 community-based hospitals and clinics that span southern Minnesota, western Wisconsin, and northern Iowa. Adult patients were included if they met Minnesota research authorization criteria, had a documented type 2 diabetes diagnosis, and received care during the study period (January 1 to December 31, 2019).

Measures and Outcomes

We extracted data from electronic health records (EHRs) and Mayo administrative data. Within the Mayo Practice, optimal diabetes care is defined by the D5 metric. This metric is a set of 5 treatment goals for diabetes developed by Minnesota Community Measurement (MNCM) to represent the gold standard for managing the disease. Minnesota Community Measurement is a nonprofit that works with the health care industry on quality outcomes and supports the Statewide Quality Reporting and Measurement System, which is also used for pay-for-performance quality initiatives.[22] The D5 goals consist of no tobacco use, glycated hemoglobin (A_{1c}) level less than 8%, blood pressure less than 140/90 mm Hg, low-density lipoprotein cholesterol level at goal or statin use unless contraindicated, and aspirin use consistent with clinical recommendations.[5] Patients are defined as attaining quality goals if they meet all of these 5 criteria. For this study, we collected year-end quality data for 2019 from the EHR, which included the most recent A_{1c} level, blood pressure reading, cholesterol levels, medication list, and last documented smoking status.

We also collected outpatient, endocrinology, diabetes education, and nutrition visits for all of 2019. Clinician type, insurance type, and adjusted clinical group (ACG) risk score as a marker of complexity were extracted from administrative data, while all other patient characteristics were extracted from the EHR. Rural and urban status were determined based on Rural-Urban Commuting Area (RUCA) codes for each patient's primary zip code. Codes from 1 to 3 were considered urban (living in or near a city of population 50,000 or more), whereas codes from 4 to 10 were considered rural (living in or near a city of population 49,999 or less).[23]

Statistical Methods

We report patient characteristics using frequencies and percentages for categorical variables and means and standard deviation for continuous variables. To compare these characteristics between rural and urban groups, we used χ^2 tests for categorical variables and Kruskal-Wallis tests for continuous variables. We report individual measures that make up the D5 metric by urban or rural status. To analyze the primary outcome of whether the D5 composite metric was met, we used a generalized linear mixed model. In addition to the patient's urban or rural status, the fixed covariates in the model were age, sex, ACG risk score, diabetes education visits, nutrition visits, endocrinology visits, number of outpatient visits, insurance type, race, and clinician type. Site and individual primary care clinician were used as random effects. We report adjusted odds ratios (AORs) and their 95% CIs for the mixed model. *P* values less than .05 were considered statistically significant. All analyses were done with SAS software (SAS Institute Inc).

RESULTS

Analyses were based on 45,279 patients with diabetes, 24,637 (54.4%) of whom resided in rural locations and 20,642 (46.4%) of whom resided in urban settings (Table 1). Seventeen patients were excluded because we were unable to link their primary zip code to a RUCA code.

Age and complexity were similar between rural and urban patients; however, compared with urban peers, rural patients were more likely to be female (46.4% vs 45.1%) and White (94.2% vs 90.6%). The rural group were more likely to have an APP as their primary care clinician (25.5% vs 9.1%) and less likely to have commercial insurance (24.9% vs 28.7%). Rural patients had a lower mean number of outpatient visits

than urban counterparts (3.2 vs 3.9) and were less likely to have an endocrinology visit during the study year (5.5% vs 9.3%). The proportions with visits for diabetes education or nutrition consultation were similar, however.

Attainment of all of the individual goals of the D5 metric differed significantly between rural and urban patients, except for the use of antiplatelet medication (Table 2). The D5 composite metric, requiring that patients attain all 5 goals, was less often met in rural patients than in urban patients (39.9% vs 43.2%; P <.001).

Because of the potential clustering of D5 goal attainment with site and primary care clinician, we derived a generalized linear mixed model with these 2 variables as random effects (Table 3). In this model, rural patients were significantly less likely to have met all D5 goals than urban patients (AOR = 0.93; 95% CI, 0.88-0.97). Odds of attaining all 5 components were higher for women vs men and for older vs younger individuals. Patients with less complexity (lower ACG risk scores) were more likely to meet all D5 goals. Non-White patients were less likely to have attained these goals (AOR = 0.83; 95% CI, 0.77-0.90).

Relative to commercially insured peers, Medicaid patients were less likely to have met the D5 composite metric (AOR = 0.58; 95% CI, 0.53-0.63), whereas Medicare patients were more likely to have done so (AOR = 1.17; 95% CI, 1.10-1.24). Patients whose primary care clinician was an APP did not differ significantly from those whose primary care clinician was a physician. Patients were less likely to have attained all D5 goals if they had at least 1 diabetes education visit (AOR = 0.92; 95% CI, 0.87-0.97) or endocrinology visit (AOR = 0.80; 95% CI, 0.73-0.86) during the year. The number of outpatient visits was positively correlated with D5 attainment (AOR per visit = 1.03; 95% CI, 1.03-1.04).

DISCUSSION

This study shows that rural-dwelling patients have poorer attainment of diabetes quality goals when compared with urban counterparts within the same integrated health system. This association persisted even when controlling for many confounding factors such as age, sex, medical complexity, insurance type, site of care, and primary clinician type. Our analysis highlights important differences between the care rural and urban patients receive. In bivariate analysis, our rural cohort had fewer outpatient visits than their urban counterparts and nearly one-half the frequency of endocrinology visits. Rural patients were also much more likely to have an APP listed as their primary care clinician. In our multivariate model, however, the disparity in attaining quality goals persisted even when controlling for these observed differences in care delivery.

The rural-urban disparity in diabetes care noted in this study aligns with that found in many prior studies including a recent large cross-sectional study that showed higher diabetes mortality rates in rural counties.[24] The lower rate of health care use we found in our rural cohort is important to note as our multivariate analysis showed a correlation between increasing number of clinic visits and attaining D5 goals. Our finding of improved outcomes with greater visit frequency aligns with prior studies that have shown increased emergency department visits, hospitalizations, and costs

Table 1. Characteristics of the Study Population of Patients With Type 2 Diabetes

Characteristic	Total (N = 45,279)	Location		*P* Value
		Rural (n = 24,637)	Urban (n = 20,642)	
Age, mean (SD), y	65.7 (14.0)	65.8 (13.9)	65.6 (13.9)	.20[a]
Female, No. (%)	20,735 (45.8)	11,433 (46.4)	9,302 (45.1)	.004[b]
Race, No. (%)				<.001[b]
White	41,887 (92.5)	23,195 (94.2)	18,692 (90.6)	
Non-White	3,369 (7.5)	1,427 (5.8)	1,942 (9.4)	
ACG risk score, mean (SD)[c]	1.1 (0.96)	1.1 (0.96)	1.1 (0.97)	.91[a]
Insurance, No. (%)				<.001[b]
Commercial	12,034 (26.6)	6,119 (24.9)	5,915 (28.7)	
Medicaid	3,470 (7.7)	1,961 (8.0)	1,509 (7.3)	
Medicare	28,069 (62.1)	15,533 (63.2)	12,536 (60.8)	
Other	1,616 (3.6)	965 (3.9)	651 (3.2)	
Missing	90 (0.2)	59 (0.2)	31 (0.2)	
Number of outpatient visits, mean (SD)	3.5 (4.39)	3.2 (4.04)	3.9 (4.75)	<.001[a]
Visits, No. (%)				
Diabetes education	7,844 (17.3)	4,325 (17.6)	3,519 (17.0)	.16[b]
Nutrition	2,449 (5.4)	1,350 (5.5)	1,099 (5.3)	.47[b]
Endocrinology	3,257 (7.2)	1,347 (5.5)	1,928 (9.3)	<.001[b]
Primary care clinician type, No. (%)				<.001[b]
Advanced practice provider	8,170 (18.0)	6,289 (25.5)	1,881 (9.1)	
Physician	36,356 (80.3)	18,192 (73.8)	18,164 (88.0)	
Resident or fellow	743 (1.6)	152 (0.6)	591 (2.9)	
Other	10 (<0.1)	4 (<0.1)	6 (<0.1)	

ACG = adjusted clinical group.

[a] From Kruskal-Wallis analysis.

[b] From $\chi 2$ analysis.

[c] Higher score indicates greater complexity.

Table 2. Patients' Attainment of the D5 Metric and Its Component Goals

D5 Metric	Total, No. (%) (N = 45,279)	Location		*P* Value[a]
		Rural, No. (%) (n = 24,637)	Urban, No. (%) (n = 20,642)	
Component goals met				
Antiplatelet medication use as indicated	44,740 (98.8)	24,337 (98.8)	20,403 (98.8)	.56
Blood pressure <140/90 mm Hg	34,299 (75.8)	18,553 (75.3)	15,746 (76.3)	.02
A_{1c} level <8.0%	31,364 (69.3)	16,924 (68.7)	14,440 (70.0)	.004
LDL cholesterol level at goal or statin prescribed	38,576 (85.2)	20,722 (84.1)	17,854 (86.5)	<.001
No tobacco use	37,754 (83.4)	20,316 (82.5)	17,438 (84.5)	<.001
All 5 goals met	18,752 (41.4)	9,842 (39.9)	8,910 (43.2)	<.001

A_{1c} = glycated hemoglobin; D5 = diabetes 5-item composite metric; LDL = low-density lipoprotein.

[a] From Kruskal-Wallis analysis.

among patients with fewer regular visits,[25] although it contrasts with others that have not shown significant differences in outcomes based on total visits, but rather point to more organized care[26] and interdisciplinary teams[27] as helping to achieve similar outcomes. The significant difference in endocrinology visits between our cohorts also aligns with findings of prior studies and suggests an area for improvement for our rural patients. It has been shown that lack of access to specialty care can lead to rural-urban disparities in preventable morbidity and mortality[28] and that endocrinology clinics are more likely to adhere to American Diabetes Association guidelines and meet A_{1c} goals.[29] In our multivariate analysis, having an endocrinology visit during the study year was associated with lower odds of meeting all D5 goals. In clinical practice, this association is not surprising as many patients with diabetes are referred for specialty care only when they are not meeting glycemic goals. It is reasonable to assume that having an endocrinology visit during a given year is a marker for poor diabetes control that year, but a longer time horizon may eventually show improved outcomes. The overall lower frequency of care we observed could be explained by prior studies that suggest distance to care is a barrier, especially when related to what is seen as routine care.[30] Physical distance from a clinic can also play a role in the rural population, and it has been shown that increasing distance from the primary care office can compromise health outcomes.[31] In addition, it is worth noting that although our rural cohort was significantly more likely to have an APP as the primary care clinician, multiple prior studies have found similar diabetes outcomes between physicians and APPs,[32,33] although there have been some to the contrary.[11] Our multivariate data align with the former, showing no correlation of primary clinician type with attainment of all D5 goals.

Table 3. Multivariate Model of Characteristics Associated With Meeting the D5 Metric

Characteristic	Adjusted Odds Ratio (95% CI)[a]	*P* Value
Rural vs urban	0.93 (0.88-0.97)	.003
Female vs male	1.08 (1.03-1.12)	.001
Increasing age, per 10 years	1.22 (1.10-1.02)	<.001
ACG risk score <1 vs ≥1	1.19 (1.13-1.25)	<.001
Diabetes education visit vs none	0.92 (0.87-0.97)	.004
Nutrition visit vs none	1.06 (0.97-1.16)	.17
Endocrinology visit vs none	0.80 (0.73-0.86)	<.001
Increasing outpatient visits, per 1 visit	1.03 (1.03-1.04)	<.001
Insurance		
Commercial (reference group)	1.00	…
Medicaid	0.58 (0.53-0.63)	<.001
Medicare	1.17 (1.10-1.24)	<.001
Other	0.97 (0.87-1.09)	.63
Non-White vs White	0.83 (0.77-0.90)	<.001
APP vs physician[b]	0.94 (0.87-1.02)	.12

ACG = adjusted clinical group; APP = advanced practice provider; D5 = diabetes 5-item composite metric.

Notes: Results of the generalized linear mixed model. D5 is a set of 5 treatment goals for diabetes developed by the Minnesota Community Measurement to represent the gold standard for managing diabetes.

[a] An odds ratio greater than 1 indicates that the first characteristic listed is associated with higher odds of meeting the D5 metric. All characteristics shown have been adjusted for in the same model as fixed effects; site and primary care clinician type were random effects in the model.

[b] Physician includes residents and fellows.

Our study has a few important limitations to consider. The data are from 2019, chosen as the last full calendar year before disruption from the COVID-19 pandemic. The pandemic has affected many aspects of chronic disease management, which may change how we interpret these data going forward. As a retrospective cross-sectional evaluation, our study is able to identify only associations rather than causation. We were unable to account for some confounders because of a lack of data; important possible unaccounted confounders to consider include education level, individual health beliefs, physician workload, and clinic access. It should also be noted that studies of this magnitude may find small statistically significant differences that are not clinically relevant.

The main strength of our study stems from our ability to collect outcome and use data from a large number of patients across an integrated health system. This ability gives a unique view into patient rurality and its impact on clinical outcomes. Given the operational similarities of care across the integrated sites, and the granular level of detail we have for each patient, we were able to highlight the differences in the care they received while controlling not only for patient

characteristics, but also for clinician- and site-level influences that could confound results in broader cross-sectional studies. This controlled analysis allows us to show that for rural patients, it is not their clinician or primary clinic that contributes to the disparity, but rather other aspects of rurality that contribute to differences in overall care delivery. To our knowledge, this is the first study looking at a comprehensive quality metric such as the D5 across a large health system that controls for clinician- and site-level influences. Rurality's persistent negative association with quality goal attainment in our multivariate model when controlling for commonly perceived rural-urban patient and care discrepancies supports the notion that rurality is multidimensional and its influence is nuanced.[34] It further suggests that interventions to close the rural-urban gap will need to address more than where, from whom, and how often rural patients receive care.

In summary, our study shows that rural patients have comparatively worse diabetic quality metrics than their urban counterparts even when controlling for other common contributing factors. This negative association persists despite patients being part of an integrated health system and analyses controlling for clinician- and site-level variation. Patient-level health care use points to visit frequency and specialty involvement as possible contributing factors, although our multivariate analysis showed persistent disparities when controlling for these differences. This finding suggests the need for further research on broader interventions to improve the care we deliver to our rural diabetic patients. Novel, team-based methods of care delivery for subsets of this population have been shown to improve clinical outcomes.[35-37] This study highlights the need for further large, pragmatic trials of innovative health care delivery approaches tailored to overcome the obstacles faced by our rural diabetic population.

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Key words: primary care; diabetes control; rural health; rural health disparities; population health; health care delivery; health services; health care disparities; quality of care; health metrics; health services accessibility; vulnerable populations

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