Impact of Environmental Factors on Differences in Quality of Medication Use: An Insight for the Medicare Star Rating System

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ABSTRACT

BACKGROUND: The Medicare star ratings system incentivizes health plan sponsors based on their performance across a measurement system that contains quality measures related to medication use. As health plan sponsors seek to further engage their network providers, specifically network pharmacies, to improve performance on these measures, it is important to consider the effect of environmental factors on the performance of network pharmacies.

OBJECTIVE: To determine the effect of environmental factors on pharmacy quality as measured by (a) medication adherence for noninsulin diabetes medications, (b) medication adherence for renin angiotensin receptor antagonists (RASA), (c) medication adherence for cholesterol medications (statins), and (d) use of high-risk medications (HRM) in the elderly.

METHODS: The EQuIPP database, which contains performance information for pharmacies for a nationwide sample of Medicare beneficiaries, was used for this analysis. Environmental factors included regions or characteristics of a community or county. County-level data was obtained from the Area Health Resource Files, a resource product available from the Health Resources & Service Administration. A logistic regression model was developed with performance as the dependent variable and regions and environmental factors as independent variables. Performance and county characteristics, such as proportion of patients in an age group, race, income, or number of outpatient visits, were classified as high and low based on a median cutoff of nationwide performance scores.

RESULTS: A total of 28,950 pharmacies were included in this analysis. For most measures, the proportion of low-performing pharmacies was significantly higher in the East South Central, Mid-Atlantic, Mountain, Pacific, and West South Central regions. Pharmacies in counties with high median income, high proportion of elderly population (aged >84 years), high proportion of elderly patients who were white or Hispanic, high proportion of elderly males, and high proportion of elderly urban patients were less likely to have low performance, whereas those with high proportion of elderly African Americans and high density of independent pharmacies were more likely to have low performance ($P < 0.05$ – 0.0001).

CONCLUSIONS: This study found that environmental characteristics of a region, including pharmacy and sociodemographic characteristics, explained regional variation in quality measures related to medication use for patient populations served by pharmacies. This evaluation serves to further inform the discussion regarding case-mix adjustment of quality measures and provides information that may be important to further refine intervention strategies for pharmacies and pharmacists who serve certain regional populations. Additionally, pharmacies in greatest need of support for quality improvement may be those who serve populations that are predominantly low income and elderly African American.

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What is already known about this subject

- The star rating system for Medicare Part D includes several quality measures related to medication use.
- Medicare payment models and public reports on Medicare plan quality may incentivize improved quality of medication use and patient safety.

What this study adds

- This study evaluated the impact of environmental factors, using Medicare data, on regional variation in the quality of medication use among pharmacies.
- The influence of environmental factors—sociodemographic, cultural, or otherwise—on health behaviors may be a significant predictor of performance independent of the care-providing capabilities of individuals or organizations.
- The findings of this analysis suggest that pharmacies in greatest need of support for quality improvement may be those who serve populations that are predominantly low income and elderly African American.

The star rating system for Medicare Part D includes several quality measures related to medication use, which were developed by the Pharmacy Quality Alliance (PQA). For example, measures of medication adherence and use of high-risk medications in the elderly are important indicators of the quality of medication use, which especially affects the health outcomes of patients with chronic health conditions. Poor quality of medication use is associated with the progression of disease and an increase in morbidity and mortality.¹⁻⁶ Moreover, while it is difficult to measure the economic impact of poor quality of medication use, it is costly. The estimated cost of nonadherence to medication is approximately \$300 billion per year, and the estimated cost of preventable adverse drug events is \$3.5 billion.^{7,8}

Medicare payment models and public reports on Medicare plan quality may provide incentives for the improvement of medication use and patient safety. Currently, the Medicare Part C and D star rating system does not account for factors such as severity of illness or sociodemographic characteristics of beneficiaries,⁹ which may disincentivize certain plans. Recently, the Centers for Medicare & Medicaid Services (CMS), along with

the RAND Corporation, found that plans with a high percentage of dual eligible enrollees, enrollees who receive low-income subsidies, or enrollees who are disabled were mostly disadvantaged in their ability to achieve high star ratings.¹⁰ Because the star ratings have been affected by patient demographics, CMS is now evaluating how to best risk adjust the ratings. Given that this risk adjustment is necessary, it is important to understand the impact of other variables and whether further risk adjustment is needed. There is limited information on how star ratings are affected by provider, patient, and environmental factors.

Differences among patients could be viewed at either the individual patient level or at the community or environmental level. Social influences specific to a patient's environment may affect that patient's health behaviors.¹¹ Several models and theories describe the influence of environmental factors, which include interpersonal relationships, organizations, and neighborhood communities, on patient health behaviors.¹²⁻¹⁵ Environmental factors also include characteristics of a store or geographic region, which represent the economic and cultural characteristics of the people and organizations residing within the region or who frequent a particular store.

Recent studies have shown the importance of controlling for patient and environmental factors. At the patient level, Dharmarajan et al. (2014) found that age, race, sex, and low-income subsidy significantly predicted pharmacy quality and that the scores adjusted for these factors were more robust compared with the unadjusted scores.¹⁶ When comparing the adjusted scores with the unadjusted scores, the unadjusted score methodology failed to identify 39%-43% of those pharmacies within the top or bottom 20%. At the environmental level, the quality of medication use varied by geographic region.¹⁷⁻²⁰ Variations across regions existed despite adjusting for patient-level factors such as age, race, sex, income, and education level. Store-level environmental factors, such as neighborhood population characteristics, also affected primary medication adherence.¹⁷ Interestingly, research that applied geospatial mapping to health-related questions supports the idea that health may be affected by environmental factors.^{21,22}

While region- and some store-level characteristics have been studied, there is a lack of knowledge regarding how other environmental factors affect quality measures. The purpose of this study was to examine differences in environmental factors that influence a pharmacy's quality performance. Specifically, the objective for this study was to determine the effect of environmental factors on pharmacy quality as measured by (a) medication adherence for noninsulin diabetes medications, (b) medication adherence for renin angiotensin receptor (RAS) antagonists, (c) medication adherence for cholesterol medications (statins), and (d) use of high-risk medications (HRM) in the elderly.

Methods

Study Design and Period

This study was a retrospective claims database study, which used the EQuIPP database for pharmacy performance information. The EQuIPP database contained performance information for pharmacies covering 11.7 million Medicare beneficiaries at the time of this study. The measurement period for analysis was January 1, 2014-June 30, 2014.

Store Selection

The cohort of pharmacies was divided into the following 9 divisions based on their geographic locations and the U.S. Census: New England, Mid-Atlantic, East North Central, West North Central, South Atlantic, East South Central, West South Central, Mountain, and Pacific (see Appendix A for a list of states, available in online article). Pharmacies excluded from the analysis were those classified by the National Council for Prescription Drug Programs as government pharmacies, alternate dispensing pharmacies, long-term care pharmacies, mail order pharmacies, home infusion therapy providers, non-pharmacy dispensing sites, Indian Health Service pharmacies, Veterans Administration pharmacies, institutional pharmacies, managed care organization pharmacies, durable medical equipment outlets, clinic pharmacies, specialty pharmacies, nuclear pharmacies, and military pharmacies. Also excluded from the analysis were pharmacies with ≤ 10 patients meeting the inclusion criteria for a specific measure.

Primary Outcome Measure

Four quality performance measures, as developed and specified by PQA, were used to obtain the primary outcome measure: (1) proportion of days covered for noninsulin diabetes medications (PDC Diabetes), (2) proportion of days covered for RAS antagonists (PDC RAS), (3) proportion of days covered for statins (PDC Statins), and (4) use of high-risk medications in the elderly (HRM). PQA technical specifications are based on the proportion of days covered (PDC) method to measure adherence from prescription claims data.²³ These store-level performance measures are available in the EQuIPP database. Pharmacies with performance scores in the bottom 50% of the performance scores across the pharmacies in the United States were categorized as low-performing pharmacies, while those in the top 50% were categorized as high-performing pharmacies.

Covariates

The primary independent variable was geographic region. Covariates were calculated with county-level or store-level data. County-level data on age, race, sex, ethnicity, education, income, health professional shortage area (HPSA), and urban population were obtained from the Area Health Resource Files, a resource product available from the Health Resources &

TABLE 1 Proportion of Low-Performing Pharmacies by Quality Measure and Region

Region	PDC Diabetes			PDC RASA			PDC Statins			HRM Use in Elderly		
	Counties n (%) ^a	Pharmacies n (%) ^a	Low- Performing Pharmacies n (%) ^a	Counties n (%) ^a	Pharmacies n (%) ^a	Low- Performing Pharmacies n (%) ^a	Counties n (%) ^a	Pharmacies n (%) ^a	Low- Performing Pharmacies n (%) ^b	Counties n (%) ^b	Pharmacies n (%) ^b	Low- Performing Pharmacies n (%) ^b
East North Central	143 (12.0)	580 (6.4)	264 (45.5)	312 (16.3)	2,332 (11.3)	949 (40.7)	296 (16.3)	2,083 (10.9)	896 (43.0)	386 (17.3)	4,326 (15.0)	1,857 (42.9)
East South Central	247 (20.8)	1,493 (16.5)	779 (52.2) ^c	338 (17.6)	3,028 (11.3)	1,700 (56.1) ^d	331 (18.3)	2,794 (14.7)	1,498 (53.6) ^d	352 (15.8)	3,454 (12.0)	1,827 (52.9) ^d
Mid-Atlantic	72 (6.1)	1,870 (20.7)	923 (49.4)	99 (5.2)	2,994 (14.5)	1,530 (51.1) ^d	92 (5.1)	2,930 (15.4)	1,502 (51.3) ^d	113 (5.1)	3,703 (12.8)	1,824 (49.3) ^d
Mountain	48 (4.0)	214 (2.4)	119 (55.6) ^c	94 (4.9)	1,060 (5.1)	451 (42.6)	85 (4.7)	876 (4.6) ^c	340 (38.8) ^c	110 (4.9)	1,866 (6.5)	996 (53.4) ^d
New England	5 (0.4)	33 (0.4)	21 (63.6) ^c	16 (0.8)	109 (0.5)	53 (48.6)	14 (0.8)	99 (0.5)	45 (45.5)	23 (1.0)	227 (0.8)	112 (49.3)
Pacific	20 (1.7)	153 (1.7)	98 (64.1) ^d	32 (1.7)	594 (0.5)	321 (54.0) ^d	33 (1.8)	507 (2.7)	256 (50.5) ^d	43 (1.9)	1,250 (4.3)	558 (44.6)
South Atlantic	356 (30.0)	2,859 (31.6)	1,335 (46.7)	492 (25.7)	6,328 (30.6)	3,005 (47.5)	475 (26.2)	5,930 (31.1)	2,877 (48.5)	534 (24.0)	8,016 (27.8)	4,169 (52.0) ^d
West North Central	110 (9.3)	558 (6.2)	248 (44.4)	224 (11.7)	1,385 (6.7)	547 (39.5)	210 (11.6)	1,316 (6.9)	450 (34.2) ^d	301 (13.5)	2,065 (7.2)	1,212 (8.4)
West South Central	186 (15.7)	1,286 (14.2)	737 (57.3) ^d	311 (16.2)	2,853 (13.8)	1,627 (57.0) ^d	277 (15.3)	2,540 (13.3)	1,413 (55.6) ^d	367 (16.5)	3,962 (13.7)	1,890 (47.7) ^d
Total	1,187	9,046	4,524	1,918	20,683	10,183	1,813	19,075	9,277	2,229	28,869	14,445

^aPercentage of column total.^bPercentage of total pharmacies.^cP < 0.05.^dP < 0.0001.

HRM = high-risk medication; PDC = proportion of days covered; RASA = renin angiotensin receptor antagonist.

Service Administration.²⁴ The county-level data were linked to store-level data using ZIP codes that had county names and ZIP codes in which the pharmacies were located. The following characteristics were calculated for each county:

- Proportion of the elderly population aged >64 or >84 years
- Proportion of the elderly population that was white versus African American, Asian, or Hispanic
- Proportion of the population with a college degree
- Median income
- Proportion of urban population
- Health professional shortage (HPSA)
- Proportion of chain pharmacies versus independent pharmacies
- Proportion of pharmacies that had a high volume of patients

These characteristics, except HPSA, were characterized as high or low based on a median cutoff point. Store characteristics were obtained from the EQuIPP database. Store volume was the number of Medicare Advantage patients in a store for a specific measure. Pharmacy type was classified as either independent or chain.

Analysis

The proportion of low-performing pharmacies was calculated for each of the regions, and chi-square tests were performed to determine significant differences in the distribution of low-performing pharmacies across the regions. The ranges that defined the performance and the variables as high and low are listed in Appendices B and C (available in online article). East North Central, the region with a consistent percentage of low-performing stores, was used as the reference region. Logistic regression was performed with low-performing pharmacies as the dependent variable and the region, county-level, and store characteristics as the independent variables. Pearson correlation coefficient of 0.7 was used to detect multicollinearity between the variables. When multicollinearity was detected, 1 of the variables was removed from the regression model. All analyses were conducted using SAS, version 9.4 (SAS Institute, Cary, NC). This project was designated as exempt from the University of Cincinnati Institutional Review Board.

Results

At least 1 of the 4 performance measures was calculated for 28,969 pharmacies. The number of pharmacies varied by region, and for each measure, the number of pharmacies

TABLE 2 Store-Level and County-Level Characteristics by Region for PDC Diabetes^a

Region	Total Pharmacies n	High Volume Pharmacies n (%)	High Average Outpatient Visits n (%)	High Proportion of White Population Aged >64 Years n (%)	High Proportion of African-American Population Aged >64 Years, n (%)	High Proportion of Hispanic Population Aged >64 Years n (%)	High Proportion of Male Population Aged >64 Years n (%)	High Proportion of Population Aged >64 Years Who Were >84 Years, n (%)	High Median Income n (%)	High Proportion of Population with College Education n (%)	High Proportion of Urban Population n (%)	Part of County Area with HPSA n (%)	Whole County Area with HPSA n (%)	Independent Pharmacies n (%)
PDC Diabetes														
East North Central	580	164 (28.3)	430 (74.1)	333 (57.4)	244 (42.1)	259 (44.7)	298 (51.4)	495 (85.3)	418 (72.1)	302 (52.0)	270 (46.6)	310 (53.5)	221 (38.1)	30 (5.2)
East South Central	1,493	709 (47.5)	629 (42.1)	786 (52.7)	679 (45.5)	12 (0.8)	551 (36.9)	326 (21.8)	519 (34.8)	553 (37.0)	244 (16.3)	261 (17.5)	798 (53.5)	375 (25.1)
Mid-Atlantic	1,870	1,091 (58.3)	1,519 (81.2)	953 (51.0)	1,151 (61.6)	1,074 (57.4)	919 (49.1)	1,861 (99.5)	1,056 (56.5)	1,024 (54.8)	1,201 (64.2)	923 (49.4)	888 (47.5)	825 (44.1)
Mountain	214	57 (26.6)	62 (29.0)	124 (57.9)	2 (0.9)	206 (96.3)	87 (40.7)	19 (8.9)	149 (69.6)	63 (29.4)	123 (57.5)	151 (70.6)	61 (28.5)	11 (5.1)
New England	33	10 (30.3)	7 (21.2)	33 (100.0)	0	31 (93.9)	32 (97.0)	32 (97.0)	32 (97.0)	32 (97.0)	31 (93.9)	6 (18.2)	27 (81.9)	2 (6.1)
Pacific	153	41 (26.8)	49 (32.0)	8 (5.2)	1 (0.7)	149 (97.4)	96 (62.8)	55 (36.0)	127 (83.0)	60 (39.2)	102 (66.7)	108 (70.6)	45 (29.4)	27 (17.7)
South Atlantic	2,859	1,465 (51.2)	779 (27.3)	1,399 (48.9)	1,614 (56.5)	1,670 (58.4)	1,674 (58.6)	1,205 (42.2)	1,207 (42.2)	1,643 (57.5)	1,557 (54.5)	414 (14.5)	2,138 (74.8)	417 (14.6)
West North Central	558	261 (46.8)	318 (57.0)	425 (76.2)	133 (23.8)	162 (29.0)	299 (53.6)	408 (73.1)	300 (53.8)	352 (63.0)	253 (34.0)	48 (8.6)	474 (85.0)	105 (18.8)
West South Central	1,286	677 (52.6)	733 (57.0)	519 (40.4)	697 (54.2)	965 (75.0)	572 (44.5)	125 (9.7)	728 (56.6)	495 (38.5)	740 (57.5)	785 (61.0)	415 (32.3)	226 (17.6)

^an = number of stores; % = row percentage.

HPSA = health professional shortage area.

varied. The number of pharmacies (range=2,859-8,016 pharmacies per measure) was highest in the South Atlantic region, while the number of pharmacies (range=33-127) in the New England region was the lowest, followed by the Pacific region (range=153-1,250).

Table 1 indicates the proportion of low-performing pharmacies across the 9 regions. For most measures, the proportion of low-performing pharmacies was significantly higher in the East South Central, Mid-Atlantic, Mountain, Pacific, and West South Central regions.

Table 2 shows the distribution of pharmacies stratified by county-level and store level factors across the regions for PDC Diabetes (see Appendix D for other quality measures, available in online article). The county- and store-level factors varied greatly across the regions. For example, the proportion of pharmacies in counties with a high median income ranged from 34.8% in the East South Central region to 97.0% in the New England region. The proportion of pharmacies in counties with a high proportion of elderly Hispanics ranged from 0.8% in the East South Central region to 96.3% in the Mountain region.

In Table 3, the results of logistic regression predicting the likelihood of low performance of the pharmacies are presented. For most of the quality measures, pharmacies were less likely to have low performance if they were located in counties with high median income, with a high proportion of elderly males, high proportion of elderly Hispanics, or high proportion of elderly who are aged >84 years. Independent pharmacies (PDC RASA: odds ratio [OR]=1.68, 95% confidence interval [CI]=1.56-1.80; PDC Statin: OR=1.47, 95% CI=1.37-1.58) and pharmacies in counties with a high proportion of elderly African Americans (PDC RASA: OR=1.61, 95% CI=1.46-1.78; PDC Statin: OR=1.53, 95% CI=1.38-1.70) were more likely to have low performance. Interestingly, pharmacies in counties with a large elderly white population were less likely to have poor performance for measures PDC Diabetes (OR=0.77, 95% CI=0.65-0.91), PDC RASA (OR=0.81, 95% CI=0.73-0.91), and PDC Statins (OR=0.68, 95% CI=0.61-0.76), but they were more likely to have poor performance for HRM use in the elderly (OR=1.15, 95% CI=1.06-1.25). Except for the HRM measure, pharmacies in counties with large

TABLE 3 Association of Pharmacies and Quality Measures

	PDC Diabetes		PDC RASA		PDC Statin		HRM Use in Elderly	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Region								
East North Central	reference							
East South Central	0.86	0.68-1.07	1.15	1.01-1.31	0.99	0.87-1.14	1.07	0.96-1.18
Mid-Atlantic	1.01	0.83-1.23	1.23	1.10-1.39	1.13	1.00-1.27	1.39	1.26-1.53
Mountain	1.71	1.21-2.40	1.34	1.13-1.58	0.90	0.75-1.07	2.18	1.92-2.47
New England	4.32	2.06-9.06	1.71	1.15-2.54	1.30	0.86-1.97	1.46	1.11-1.93
Pacific	2.41	1.60-3.62	1.99	1.62-2.45	1.26	1.01-1.58	1.73	1.49-1.99
South Atlantic	0.92	0.75-1.13	1.00	0.89-1.12	0.88	0.78-0.99	1.52	1.39-1.66
West North Central	1.00	0.78-1.27	1.01	0.88-1.16	0.74	0.64-0.86	1.75	1.57-1.96
West South Central	1.34	1.07-1.67	1.47	1.30-1.67	1.15	1.00-1.31	1.35	1.22-1.49
Store characteristics								
Independent pharmacy	1.23	1.10-1.37	1.68	1.56-1.80	1.47	1.37-1.58	1.48	1.40-1.57
Chain pharmacy	reference							
High-volume pharmacies	1.01	0.92-1.10	1.03	0.97-1.09	1.02	0.96-1.08	0.90	0.86-0.94
County-level characteristics								
High average number of outpatient visits	1.01	0.91-1.12	1.02	0.95-1.08	0.98	0.91-1.05	1.17	1.11-1.24
High proportion of white population aged >64 years	0.77	0.65-0.91	0.81	0.73-0.91	0.68	0.61-0.76	1.15	1.06-1.25
High proportion of African-American population aged >64 years	1.38	1.18-1.61	1.61	1.46-1.78	1.53	1.38-1.70	1.08	1.00-1.17
High proportion of Hispanic population aged >64 years	0.78	0.69-0.87	0.87	0.80-0.94	0.97	0.90-1.05	0.73	0.69-0.78
High proportion of male population aged >64 years	0.74	0.66-0.84	0.77	0.71-0.82	0.80	0.74-0.87	0.91	0.86-0.97
High proportion of population aged >64 years who were >84 years	0.91	0.80-1.03	0.91	0.84-0.98	0.89	0.82-0.97	0.86	0.81-0.92
High median income	0.74	0.66-0.82	0.82	0.76-0.88	0.80	0.74-0.86	0.88	0.83-0.94
High proportion of population with college education	0.86	0.76-0.97	0.79	0.73-0.85	0.81	0.75-0.88	1.12	1.05-1.19
Counties with HPSA for part of area	0.88	0.74-1.03	0.83	0.75-0.92	0.89	0.80-0.99	0.83	0.76-0.90
Counties with HPSA for entire area	0.81	0.69-0.94	0.81	0.73-0.89	0.90	0.82-1.00	0.87	0.80-0.94
High proportion of urban population	1.00	0.88-1.14	0.91	0.84-0.99	0.98	0.89-1.06	0.67	0.62-0.71

CI=confidence interval; HPSA=health professional shortage area; HRM=high-risk medication; OR=odds ratio; PDC=proportion of days covered; RASA=renin angiotensin receptor antagonist.

college- educated populations were less likely to have low performance (PDC Diabetes: OR=0.86, 95% CI=0.76-0.97).

Differences in performance across regions can be explained by adjusting for environmental factors. For example, the East South Central region, which was significantly more likely to have low-performing pharmacies for all 4 measures, was no longer a low performer (except for PDC RASA) after adjusting for environmental factors. Conversely, while New England did not have a significantly higher proportion of low-performing pharmacies, except for PDC Diabetes, before adjustment, it was significantly more likely to have low-performing pharmacies for all 4 measures, except for PDC Statins, after adjustment of environmental factors.

Similarly, an important finding of this study was the characteristics that explained low performance in the East South Central region, compared with the East North Central region. Before adjustment, the proportion of low-performing pharmacies was significantly higher in the East South Central region for all 4 measures, compared with the East North Central region.

However, after adjustment for environmental factors, the East South Central region was not likely to have low-performing pharmacies, except for the PDC RASA measure. A parsimonious regression was modeled to further explain the factors affecting the difference in the proportion of low-performing pharmacies between the East North Central region and the East South Central region (Table 4). For the measures PDC Diabetes, PDC Statins, and HRM, several covariates predicted performance, such as income, type of pharmacy, age, race, and HPSA. Conversely, for the PDC RASA measure, none of the environmental factors could explain the significant difference.

Discussion

In this study, the effect of environmental factors on regional variation in the quality of medication use among pharmacies was evaluated, using Medicare data. Of particular interest was the finding that pharmacies in counties with a high proportion of elderly people aged >84 years were less likely to have low performance for the PDC RASA, PDC Statins, and

TABLE 4 Parsimonious Regression Models Explaining Difference in Performance Between East North Central and East South Central Regions

Effect	PDC Diabetes		PDC Statins		HRM Use in Elderly	
	OR	95% CI	OR	95% CI	OR	95% CI
Regions						
East North Central	reference					
East South Central	0.78	0.60-1.01	0.98	0.84-1.16	0.98	0.87-1.10
Store characteristics						
Chain pharmacy	reference					
Independent pharmacy	1.36	1.08-1.72	1.42	1.23-1.64	1.37	1.23-1.53
County-level characteristics						
High median income	0.67	0.56-0.81	0.74	0.65-0.84	0.71	0.64-0.79
High proportion of African-American population aged >64 years	2.48	2.04-3.03	2.08	1.83-2.37	–	–
High proportion of population aged >64 years who were >84 years	0.63	0.49-0.80	0.74	0.64-0.86	0.95	0.85-1.07
High proportion of Hispanic population aged >64 years	–	–	–	–	0.57	0.49-0.65
High proportion of urban population	–	–	–	–	0.96	0.86-1.08
Counties with HPSA for part of area	–	–	–	–	0.78	0.67-0.90
Counties with HPSA for entire area	–	–	–	–	0.72	0.63-0.82
R-square	0.052		0.04		0.04	

CI = confidence interval; HPSA = health professional shortage area; HRM = high-risk medication; OR = odds ratio; PDC = proportion of days covered; RASA = renin angiotensin receptor antagonist.

HRM measures. Perhaps elderly patients who are dependent on others receive better care than the younger group of the elderly population who take care of themselves. Pharmacies in counties with a high proportion of elderly African Americans were more likely to have low performance for all measures, which was consistent with previous studies regarding race and adherence.^{25,26} Pharmacies in counties with a high proportion of elderly whites were more likely to have low performance for the HRM measure. Additionally, for the HRM measure, pharmacies in counties with patients who had higher income or were in an urban setting were less likely to have poor performance. Pharmacies in counties with a high proportion of elderly Hispanics were less likely to have poor performance for the HRM measure; however, Pugh et al. (2011) found that elderly Hispanics were more likely to receive HRMs between 2004 to 2006.²⁷ It is possible that over recent years, along with the implementation of Medicare Part D in 2006, efforts may have been made to reduce the use of HRMs. Recently, a study by Hussein et al. (2014) found that the Hispanic-white disparities in medication adherence decreased after 2006 ($P < 0.02$), while the black-white disparities in medication adherence still persisted after 2006 ($P < 0.09$).²⁸

The results of regional differences in quality of medication use in this study were different from the studies by Couto et al. (2014) and Qato and Trivedi (2013), which evaluated performance measures among Medicare enrollees.^{17,19} These 2 studies found that the New England region had the best rate of medication adherence, followed by the Mid-Atlantic and East North Central regions, compared with the East South Central region (reference), which had the lowest performance. In contrast,

this study found that, for all measures, the pharmacies in the East South Central region performed similarly to pharmacies in the East North Central region. This may be explained by the different use of covariates: Couto et al. did not adjust for race, ethnicity, and age >84 years, and Qato and Trivedi did not adjust for income and ethnicity.

The findings of this study further add to the body of evidence seeking to define the “nature/nurture” debate regarding health care professional performance on quality measures. This debate centers around how responsible health care professionals, or patient care organizations (pharmacies, in this case), can be for the health behaviors of the population they serve. The influence of environmental factors (e.g., sociodemographic and cultural) on health behaviors are often argued to be significant predictors of performance independent of the care-providing capabilities of individuals or organizations. Pharmacy programs such as automatic refills, medication therapy management, and synchronization of refills can improve adherence, but the success of these programs may also be influenced by environmental factors. What has yet to be determined is whether these findings support the case for risk adjusting the performance of certain organizations being measured, which may accept that lower levels of positive health behaviors will exist among certain populations, or if these findings should be used to improve the ability of health care professionals to understand their populations and refine their interventional tactics to fit the dynamics of those they serve. The findings of this study do not offer a definitive resolution to this debate, but they do support the recent CMS findings regarding the need for risk adjustment and are intended to add to the body of evidence

that will refine the debate as quality measurement and performance assessment surrounding medication use evolves. Future studies could explore additional associations between quality measure performance and other potential variables known to influence medication-taking behavior (e.g., beliefs influencing the perceived severity of illness and perceived benefits of medication therapy, pharmacists' counseling efforts, and the presence of social-medical support systems for patients).

Limitations

This study has several limitations. As with all database studies, it is assumed that patients take the prescriptions that they fill. County-level data was used to study the effect of neighborhood population characteristics. Counties are large, and the population characteristics of the counties may not necessarily reflect medication use of patients in the particular ZIP code in which a pharmacy is located. U.S. Census tract-level data could not be used for population characteristics, since a database that merged census tract-level data to the ZIP code-level data of pharmacies in the EQuIPP database was unavailable. Also, health care system variables, such as HPSA and average number of outpatient visits, were only available at the county level from the Area Resource Files. The number of stores varied by region and was particularly small in the New England region, which may limit generalizability within that region.

Conclusions

This study found that environmental characteristics of a region, including pharmacy and sociodemographic characteristics, explained regional variation in quality of medication use. This evaluation serves to further inform the discussion regarding the case-mix adjustment of quality measures and provides information that may be important to further refine intervention strategies among pharmacies and pharmacists who serve certain regional populations. Additionally, pharmacies in greatest need of support for quality improvement may be those who serve populations that are predominantly low income and elderly African American.

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DISCLOSURES

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Study concept and design were contributed by Conklin, Nau, Desai, and Heaton. Desai and Conklin took the lead in data collection, assisted by Nau and Heaton. The manuscript was primarily written by Desai and Heaton, with assistance from Conklin and Nau. All authors contributed to data interpretation and manuscript revision.

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APPENDIX A Regions

New England	Maine, Massachusetts, New Hampshire, Vermont, Rhode Island, Connecticut
Mid-Atlantic	New York, New Jersey, Pennsylvania
East North Central	Illinois, Indiana, Michigan, Ohio, Wisconsin
West North Central	Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota
South Atlantic	Delaware, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, West Virginia, District of Columbia
East South Central	Alabama, Kentucky, Mississippi, Tennessee
West South Central	Arkansas, Louisiana, Oklahoma, Texas
Mountain	Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Wyoming
Pacific	Alaska, California, Hawaii, Nevada, Oregon, Washington

APPENDIX B Performance Definition

Performance	Number	Mean	Minimum	Maximum
PDC Diabetes				
Low	4,524	75.59	30	84.3
High	4,522	91.40	84.4	100
PDC RASA				
Low	10,183	77.25	27.3	85.6
High	10,500	91.69	85.7	100
PDC Statins				
Low	9,277	74.67	27.3	83.2
High	9,798	89.87	83.3	100
HRM Use in Elderly				
Low	14,445	10.45	5.8	95.2
High	14,424	2.39	0	5.7

HRM = high-risk medication; PDC = proportion of days covered; RASA = renin angiotensin receptor antagonist.

APPENDIX C Variable Definition

High/Low	Statistics	Store Volume	Average Number of Outpatient Visits	Proportion of Whites Aged >64 Years	Proportion of African-Americans Aged >64 Years	Proportion of Asians Aged >64 Years	Proportion of Hispanics Aged >64 Years	Proportion of Elderly Aged >84 Years	Proportion of Males Aged >64 Years	Median Income, \$	Proportion with College Education	Proportion of Urban Population
PDC Diabetes												
Low	N	4,571	4,520	4,466	4,525	4,448	4,518	4,520	4,518	4,510.00	4,522	45
Low	MIN	10	0.00	0.14	0.00	0.00	0.00	0.04	0.30	22,148.00	0.04	0.00
Low	MAX	17	2.19	0.61	0.06	0.01	0.01	0.09	0.34	45,806.00	0.17	0.91
High	N	4,475	4,526	4,580	4,521	4,598	4,528	4,526	4,528	4,536.00	4,524	45
High	MIN	18	2.20	0.61	0.06	0.01	0.01	0.09	0.34	45,813.00	0.17	0.91
High	MAX	321	67.25	0.79	0.51	0.47	0.68	0.19	0.39	118,934.00	0.42	1.00
PDC RASA												
Low	N	10,472	10,340	10,344	10,342	10,321	10,356	10,341	10,340	10,351.00	10,316	103
Low	MIN	10	0.00	0.14	0.00	0.00	0.00	0.03	0.29	22,126.00	0.04	0.00
Low	MAX	24	2.14	0.61	0.05	0.01	0.01	0.09	0.34	46,396.00	0.17	0.88
High	N	10,211	10,343	10,339	10,341	10,362	10,327	10,342	10,343	10,332.00	10,367	103
High	MIN	25	2.14	0.61	0.05	0.01	0.01	0.09	0.34	46,412.00	0.17	0.88
High	MAX	875	67.25	0.79	0.51	0.47	0.68	0.19	0.40	118,934.00	0.42	1.00
PDC Statins												
Low	N	9,361	9,549	9,539	9,536	9,546	9,549	9,536	9,550	9,539.00	9,481	95
Low	MIN	10	0.00	0.14	0.00	0.00	0.00	0.03	0.29	22,126.00	0.04	0.00
Low	MAX	22	2.14	0.61	0.05	0.01	0.01	0.09	0.34	46,396.00	0.17	0.88
High	N	9,714	9,526	9,536	9,539	9,529	9,526	9,539	9,525	9,536.00	9,594	96
High	MIN	23	2.14	0.61	0.05	0.01	0.01	0.09	0.34	46,412.00	0.17	0.88
High	MAX	900	67.25	0.79	0.51	0.47	0.68	0.19	0.39	118,934.00	0.42	1.00
HRM Use in Elderly												
Low	N	14,562	14,402	14,436	14,429	14,327	14,427	14,441	14,442	14,434.00	14,642	144
Low	MIN	10	0.00	0.14	0.00	0.00	0.00	0.03	0.29	22,126.00	0.03	0.00
Low	MAX	33	2.14	0.61	0.05	0.01	0.01	0.09	0.34	47,214.00	0.17	0.88
High	N	14,307	14,467	14,433	14,440	14,542	14,442	14,428	14,427	14,435.00	14,227	145
High	MIN	34	2.14	0.61	0.05	0.01	0.01	0.09	0.34	47,227.00	0.17	0.88
High	MAX	1,354	67.25	0.81	0.55	0.47	0.68	0.20	0.41	121,250.00	0.50	1.00

HRM = high-risk medication; MIN = minimum; MAX = maximum; PDC = proportion of days covered; RASA = renin angiotensin receptor antagonist.

APPENDIX D Store-Level and County-Level Characteristics by Region for PDC RASA, PDC Statins, and HRM Use in Elderly

Region	Total Pharmacies n	High-Volume Pharmacies n (%)	High Average Outpatient Visits n (%)	High Proportion of White Population Aged > 64 Years n (%)	High Proportion of African-American Population Aged > 64 Years n (%)	High Proportion of Hispanic Population Aged > 64 Years n (%)	High Proportion of Male Population Aged > 64 Years n (%)	High Proportion of Population Aged > 64 Years Who Were Aged > 84 Years n (%)	High Median Income n (%)	High Proportion of Population with College Education n (%)	High Proportion of Urban Population n (%)	Part of County Area with HPSA n (%)	Whole County Area with HPSA n (%)	Independent Pharmacies n (%)
PDC RASA														
East North Central	2,332	642 (27.5)	1656 (71.01)	1511 (64.79)	845 (36.23)	847 (36.32)	1,288 (55.23)	1,921 (82.38)	1,463 (62.74)	1,124 (48.20)	1,075 (46.10)	1,100 (47.17)	928 (39.79)	245 (10.51)
East South Central	3,028	1,774 (58.6)	1,375 (45.4)	1,579 (52.2)	1,469 (48.5)	24 (0.8)	1,382 (45.6)	852 (28.1)	660 (21.8)	1,018 (33.6)	672 (22.2)	638 (21.1)	1,654 (54.6)	1,069 (35.3)
Mid-Atlantic	2,994	1,891 (63.2)	2,364 (79.0)	1,643 (54.9)	1,734 (57.9)	1,668 (55.7)	1,508 (50.4)	2,961 (98.9)	1,732 (57.9)	1,750 (58.5)	1,879 (62.8)	1,354 (45.2)	1,501 (50.1)	1,282 (42.8)
Mountain	1,060	298 (28.1)	347 (32.7)	736 (69.4)	196 (18.5)	1,019 (96.1)	546 (51.5)	191 (18.0)	800 (75.5)	604 (57.0)	750 (70.8)	718 (67.7)	326 (30.8)	82 (7.8)
New England	109	33 (30.3)	55 (50.5)	109 (100.0)	79 (72.5)	81 (74.3)	97 (89.0)	100 (91.7)	92 (84.4)	93 (85.3)	79 (72.5)	42 (38.5)	65 (59.6)	18 (16.5)
Pacific	594	140 (23.6)	210 (35.4)	56 (9.4)	12 (2.0)	564 (95.0)	304 (51.2)	263 (44.3)	486 (81.8)	222 (37.4)	466 (78.5)	422 (71.0)	172 (29.0)	83 (14.0)
South Atlantic	6,328	3,316 (52.4)	1,885 (29.8)	2,514 (39.7)	4,069 (64.3)	3,535 (55.9)	3,208 (50.7)	2,387 (37.7)	2,688 (42.5)	3,534 (55.9)	3,326 (52.6)	1,105 (17.5)	4,340 (68.6)	1,340 (21.2)
West North Central	1,385	691 (49.9)	908 (65.6)	1,146 (82.7)	277 (20.0)	479 (34.6)	761 (55.0)	1,095 (79.1)	850 (61.4)	853 (61.6)	612 (44.2)	157 (11.3)	1,099 (79.4)	369 (26.6)
West South Central	2,853	1,426 (50.0)	1,543 (54.1)	1,045 (36.6)	1,660 (58.2)	2,110 (74.0)	1,249 (43.8)	572 (20.1)	1,561 (54.7)	1,169 (41.0)	1,490 (52.2)	1,581 (55.4)	986 (34.6)	671 (23.5)
PDC Statins														
East North Central	2,083	565 (27.1)	1,492 (71.6)	1,350 (64.8)	761 (36.5)	758 (36.4)	1,153 (55.4)	1,698 (81.5)	1,318 (63.3)	1,019 (48.9)	950 (45.6)	978 (47.0)	843 (40.5)	208 (10.0)
East South Central	2,794	1,668 (59.7)	1,267 (45.4)	1,437 (51.4)	1,334 (47.8)	52 (1.9)	1,240 (44.4)	722 (25.8)	644 (23.1)	966 (34.6)	636 (22.8)	568 (20.3)	1,519 (54.4)	942 (33.7)
Mid-Atlantic	2,930	1,892 (64.6)	2,302 (78.6)	1,620 (55.3)	1,684 (57.5)	1,615 (55.1)	1,486 (50.7)	2,901 (99.0)	1,674 (57.1)	1,698 (58.0)	1,823 (62.2)	1,332 (45.5)	1,459 (49.8)	1,266 (43.2)
Mountain	876	239 (27.3)	275 (31.4)	604 (69.0)	179 (20.4)	841 (96.0)	442 (50.5)	138 (15.8)	666 (76.0)	476 (54.3)	614 (70.1)	596 (68.0)	267 (30.5)	65 (7.4)
New England	99	29 (29.3)	52 (52.6)	98 (99.0)	69 (69.7)	70 (70.7)	86 (86.9)	92 (92.9)	78 (78.8)	81 (81.8)	70 (70.7)	37 (37.4)	59 (59.6)	19 (19.2)
Pacific	507	118 (23.3)	159 (31.4)	52 (10.3)	7 (1.4)	478 (94.3)	248 (48.9)	226 (44.6)	425 (83.8)	201 (39.6)	396 (78.1)	351 (69.2)	156 (30.8)	73 (14.4)
South Atlantic	5,930	3,195 (53.9)	1,757 (29.6)	2,423 (40.9)	3,750 (63.2)	3,362 (56.7)	3,066 (51.7)	2,255 (38.0)	2,496 (42.1)	3,303 (55.7)	3,123 (52.7)	993 (16.8)	4,109 (69.3)	1,227 (20.7)
West North Central	1,316	724 (55.0)	846 (64.3)	1,084 (82.4)	275 (20.9)	461 (35.0)	704 (53.5)	1,030 (78.3)	829 (63.0)	825 (62.7)	597 (45.4)	147 (11.2)	1,048 (79.6)	332 (25.2)
West South Central	2,540	1,284 (50.6)	1,376 (54.2)	868 (34.2)	1,480 (58.3)	1,889 (74.4)	1,100 (43.3)	477 (18.8)	1,406 (55.4)	1,025 (40.4)	1,341 (52.8)	1,419 (55.9)	886 (34.9)	572 (22.5)

continued

APPENDIX D Store-Level and County-Level Characteristics by Region for PDC RASA, PDC Statins, and HRM Use in Elderly (*continued*)

Region	Total Pharmacies n	High-Volume Pharmacies n (%)	High Average Outpatient Visits n (%)	High Proportion of White Population Aged > 64 Years n (%)	High Proportion of African-American Population Aged > 64 Years n (%)	High Proportion of Hispanic Population Aged > 64 Years n (%)	High Proportion of Male Population Aged > 64 Years n (%)	High Proportion of Population Aged > 64 Years Who Were Aged > 84 Years n (%)	High Median Income n (%)	High Proportion of Population with College Education n (%)	High Proportion of Urban Population n (%)	Part of County Area with HPSA n (%)	Whole County Area with HPSA n (%)	Independent Pharmacies n (%)
HRM Use in Elderly														
East North Central	4,326	1,375 (31.8)	3,097 (71.6)	2,710 (62.6)	1,754 (40.6)	1,479 (34.2)	2,361 (54.6)	3,353 (77.5)	2,367 (54.7)	2,095 (48.4)	2,016 (46.6)	1,937 (44.8)	1,851 (42.8)	629 (14.5)
East South Central	3,454	2,100 (60.8)	1,546 (44.8)	1,717 (49.7)	1,788 (51.8)	29 (0.8)	1,653 (47.9)	893 (25.9)	669 (19.4)	1,088 (31.5)	730 (21.1)	783 (22.7)	1,880 (54.4)	1,287 (37.3)
Mid-Atlantic	3,703	2,215 (59.8)	2,836 (76.6)	2,151 (58.1)	1,989 (53.7)	1,993 (53.8)	1,911 (51.6)	3,617 (97.7)	2,163 (58.4)	2,232 (60.3)	2,244 (60.6)	1,573 (42.5)	1,890 (51.0)	1,485 (40.1)
Mountain	1,866	714 (38.3)	649 (34.8)	1,304 (69.9)	242 (13.0)	1,785 (95.7)	936 (50.2)	409 (21.9)	1,384 (74.2)	1,198 (64.2)	1,390 (74.5)	1,197 (64.2)	633 (33.9)	197 (10.6)
New England	227	43 (18.9)	132 (58.2)	220 (96.9)	129 (56.8)	129 (56.8)	171 (75.3)	200 (88.1)	180 (79.3)	189 (83.3)	129 (56.8)	96 (42.3)	127 (56.0)	27 (11.9)
Pacific	1,250	235 (18.8)	430 (34.4)	150 (12.0)	276 (22.1)	1,131 (90.5)	481 (38.5)	705 (56.4)	1,068 (85.4)	601 (48.1)	994 (79.5)	838 (67.0)	412 (33.0)	155 (12.4)
South Atlantic	8,016	4,619 (57.6)	2,434 (30.4)	3,048 (38.0)	5,580 (69.6)	4,377 (54.6)	3,929 (49.0)	2,830 (35.3)	3,096 (38.6)	4,358 (54.4)	4,101 (51.2)	1,442 (18.0)	5,389 (67.2)	1,897 (23.7)
West North Central	2,065	1,075 (52.1)	1,331 (64.5)	1,796 (87.0)	333 (16.1)	607 (29.4)	1,258 (60.9)	1,631 (79.0)	1,303 (63.1)	1,188 (57.5)	817 (39.6)	255 (12.4)	1,553 (75.2)	643 (31.1)
West South Central	3,962	1,931 (48.7)	2,012 (50.8)	1,337 (33.8)	2,349 (59.3)	2,912 (73.5)	1,727 (43.6)	790 (19.9)	2,205 (55.7)	1,278 (32.3)	2,029 (51.2)	2,120 (53.5)	1,364 (34.4)	1,070 (27.0)

HRM=high-risk medication; PDC=proportion of days covered; RASA=renin angiotensin receptor antagonist.