

## SPECIAL ARTICLE

## Sources of Regional Variation in Medicare Part D Drug Spending

Julie M. Donohue, Ph.D., Nancy E. Morden, M.D., M.P.H.,  
Walid F. Gellad, M.D., M.P.H., Julie P. Bynum, M.D., M.P.H.,  
Weiping Zhou, Ph.D., Joseph T. Hanlon, Pharm.D., and Jonathan Skinner, Ph.D.

## ABSTRACT

**BACKGROUND**

From the Department of Health Policy and Management, Graduate School of Public Health (J.M.D.), and the Departments of Medicine (General Internal Medicine) (W.F.G.) and Medicine (Geriatrics), Pharmacy and Therapeutics, and Biomedical Informatics Epidemiology and the Clinical and Translational Science Institute (J.T.H.), University of Pittsburgh; the Center for Health Equity Research and Promotion, Veterans Affairs Pittsburgh Healthcare System (W.F.G.); RAND (W.F.G.); and the Geriatric Research Education and Clinical Center, Veterans Affairs Pittsburgh Healthcare System (J.T.H.) — all in Pittsburgh; and the Dartmouth Institute for Health Policy and Clinical Practice (N.E.M., J.P.B., W.Z., J.S.); the Department of Community and Family Medicine, Dartmouth Medical School (N.E.M., J.S.); and the Department of Economics, Dartmouth College (J.S.) — all in Hanover, NH. Address reprint requests to Dr. Donohue at the Graduate School of Public Health, University of Pittsburgh, 130 DeSoto St., Crabtree Hall A613, Pittsburgh, PA 15261, or at [jdonohue@pitt.edu](mailto:jdonohue@pitt.edu).

Sources of regional variation in spending for prescription drugs under Medicare Part D are poorly understood, and such variation may reflect differences in health status, use of effective treatments, or selection of branded drugs over lower-cost generics.

**METHODS**

We analyzed 2008 Medicare data for 4.7 million beneficiaries for prescription-drug use and expenditures overall and in three drug categories: angiotensin-converting-enzyme (ACE) inhibitors and angiotensin-receptor blockers (ARBs), 3-hydroxy-3-methylglutaryl coenzyme A (HMG-CoA) reductase inhibitors (statins), and selective serotonin-reuptake inhibitors (SSRIs) and serotonin–norepinephrine reuptake inhibitors (SNRIs). Differences in per capita expenditures across hospital-referral regions (HRRs) were decomposed into annual prescription volume and cost per prescription. The ratio of prescriptions filled as branded drugs to all prescriptions filled was calculated. We adjusted all measures for demographic, socioeconomic, and health-status differences.

**RESULTS**

Mean adjusted per capita pharmaceutical spending ranged from \$2,413 in the lowest to \$3,008 in the highest quintile of HRRs. Most (75.9%) of that difference was attributable to the cost per prescription (\$53 vs. \$63). Regional differences in cost per prescription explained 87.5% of expenditure variation for ACE inhibitors and ARBs and 56.3% for statins but only 36.1% for SSRIs and SNRIs. The ratio of branded-drug to total prescriptions, which correlated highly with cost per prescription, ranged across HRRs from 0.24 to 0.45 overall and from 0.24 to 0.55 for ACE inhibitors and ARBs, 0.29 to 0.60 for statins, and 0.15 to 0.51 for SSRIs and SNRIs.

**CONCLUSIONS**

Regional variation in Medicare Part D spending results largely from differences in the cost of drugs selected rather than prescription volume. A reduction in branded-drug use in some regions through modification of Part D plan benefits might lower costs without reducing quality of care. (Funded by the National Institute on Aging and others.)

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**T**HERE IS CONSIDERABLE GEOGRAPHIC variation in health care spending across the United States,<sup>1-5</sup> and a recent study showed regional variation in prescription-drug spending for Medicare Part D enrollees.<sup>6</sup> However, the sources of regional variation in drug spending are not well understood. Prescription-drug use and expenditures could be higher in regions with more seriously ill patient populations requiring more medications. Alternatively, expenditures could be higher in regions with greater use of expensive brand-name drugs rather than lower-cost generic equivalents.<sup>7,8</sup> Knowledge of whether variation in Medicare drug spending arises principally from differences in volume or medication choice could inform interventions to improve the quality of prescribing for older adults and to reduce drug costs.

We used Medicare Part D data to investigate sources of variation in drug spending. After adjusting for demographic, socioeconomic, and health-status differences, we measured regional variation in pharmaceutical expenditures overall and in three drug categories: angiotensin-converting-enzyme (ACE) inhibitors and angiotensin-receptor blockers (ARBs), 3-hydroxy-3-methylglutaryl coenzyme A (HMG-CoA) reductase inhibitors (statins), and newer antidepressants (selective serotonin-reuptake inhibitors [SSRIs] and serotonin-norepinephrine reuptake inhibitors [SNRIs]). We decomposed regional differences in total and category-specific prescription-drug expenditures into two components: annual prescription volume and the cost of filling each prescription per month. In addition, we hypothesized that the proportion of prescriptions filled as branded products in each region would be strongly associated with cost per prescription.

## METHODS

### DATA SOURCES AND SAMPLE

From a 40% random sample of the 2008 Medicare Denominator file, we identified beneficiaries 65 years of age or older who were continuously enrolled in fee-for-service Medicare and a stand-alone Part D prescription-drug plan (PDP). Medicare Prescription Drug Event files do not contain Medicare Advantage PDP enrollee data; thus, we excluded these beneficiaries. Medicare Prescription Drug Event and Pharmacy Characteristics files include the National Drug Code (NDC), the date the pre-

scription was filled, the quantity dispensed, the number of days of supply, the type of pharmacy (e.g., retail or long-term care), and the amount paid to the pharmacy by the PDP and the beneficiary. The Lexi-Data Basic database (Lexicomp) was used to obtain the drug name, dose, brand or generic status, and active ingredient according to the NDC.<sup>9</sup> From the 2008 Medicare Provider Analysis and Review (MEDPAR), Outpatient, Carrier, and Denominator files, we obtained outpatient and inpatient diagnoses, beneficiaries' demographic characteristics and ZIP Code, and Part D low-income subsidy (LIS) status. ZIP Code-level income and proportion of the population living in poverty were obtained from 2000 Census data.<sup>10</sup>

We measured individual-level prescription-drug use and expenditures overall and for three drug categories that are widely used by the elderly and that account for a large share of spending, lack over-the-counter substitutes, and include generic options: ACE inhibitors and ARBs, which are close substitutes<sup>11</sup>; statins; and newer antidepressants (SSRIs and SNRIs). Prescriptions were standardized to a 30-day (considered 1 month) supply (i.e., a 90-day supply equaled three prescriptions).

### MEASURES OF PRESCRIPTION USE AND EXPENDITURE

On the basis of ZIP Code, beneficiaries were assigned to 1 of 306 hospital-referral regions (HRRs) described in the Dartmouth Atlas of Health Care.<sup>12</sup> We created four HRR-level measures: per capita annual prescription-drug expenditure, per capita annual number of prescriptions filled, cost per prescription filled, and ratio of branded-drug prescriptions to total prescriptions filled. We calculated the mean, range, and 5th and 95th percentiles for each measure for both overall and category-specific drug use.

### COVARIATES

We included as covariates demographic factors (age, sex, and race or ethnic group [black, white, Hispanic, or other])<sup>13</sup> and socioeconomic characteristics (individual-level Part D LIS status and ZIP Code-level measures of median household income [by quintile] and proportion of the population living in poverty).<sup>10</sup> An indicator of institutional residence was created for enrollees who filled any prescriptions in a long-term care pharmacy.

To address potential differences in population characteristics across HRRs, we estimated region-

al measures adjusted for sociodemographic variables alone and then added individual-level prescription-drug Hierarchical Condition Category (RxHCC) scores.<sup>14</sup> The RxHCC classification system is used to adjust PDP payments according to health status,<sup>15</sup> and scores were constructed with the use of diagnoses from 2008 inpatient and outpatient claims. Because of potential biases in RxHCC measures (e.g., physicians who are more likely to prescribe antidepressants may be more likely to record a diagnostic code for depression<sup>16,17</sup>), results are presented with and without adjustment for RxHCC scores.

#### STATISTICAL ANALYSIS

We used ordinary least-square regression models to compute all HRR-level measures. Individual-level covariate values were reset to equal differences from the sample mean (i.e., centered) so that the coefficient on the HRR categorical variable could be interpreted as the average spending in that HRR for persons with covariate values at the sample mean. This estimates the “HRR effect” independent of demographic, socioeconomic, or health-status factors.

We categorized HRRs into quintiles of adjusted overall per capita annual spending for prescriptions. Comparing the top and bottom quintiles of spending, we used a form of Oaxaca decomposition<sup>18</sup> to separate variation into differences in annual volume (per capita number of prescriptions filled) and cost per 30-day prescription (see the Supplementary Appendix, available with the full text of this article at NEJM.org). We used the same approach to decompose spending differences for the three drug categories.

The number of LIS recipients, who have poorer health than other beneficiaries and minimal Part D cost sharing, may affect medication use in a region. In a sensitivity analysis that stratified our sample to test whether the sources of spending variation differed according to LIS status, we found similar patterns across LIS and non-LIS recipients. Therefore, we present the results of the pooled analyses.

Our primary analyses that decomposed variation in spending rest on the assumptions that prices paid for the same product (by ingredient and dosage form) did not vary across HRRs<sup>19</sup> and that differences in cost per prescription arose instead from the choice of different drugs. In a sensitivity analysis, we relaxed our assumption of

similar prices paid for the same product. We calculated the prices paid per HRR for the 3 most common generic products and the 3 most common branded products in each of the three categories (i.e., 6 products per category and 18 products overall). We found virtually no difference in branded prices across HRRs and very small differences in generic prices. Adjusting for price did not affect our analysis, so we present measures unadjusted for variation in retail price.

To quantify the magnitude of the effect of medication choice on drug spending, we measured the correlation between the ratio of branded-drug to total prescriptions and cost per prescription and the correlation between that ratio and per capita spending. We estimated drug spending that could be averted by a reduction in branded-drug prescription use in the four quintiles of HRRs with the highest ratio of branded-drug to total prescriptions. We multiplied the number of prescriptions filled in the four quintiles by the ratio in the lowest quintile and by the mean cost per prescription for branded drugs. A similar approach was used to calculate spending on generics. The percent difference between actual spending in these quintiles and the sum of branded-drug and generic-drug spending assuming reduced use of branded products was then multiplied by estimates of total Part D spending in 2008 to calculate dollars saved.<sup>20</sup>

Analyses were conducted with the use of SAS software, version 9.2 (SAS Institute), and Stata software, version 11.0 (StataCorp). Statistical tests were two-sided, with a P value of less than 0.05 considered to indicate statistical significance.

## RESULTS

### CHARACTERISTICS OF THE STUDY SAMPLE

We identified 5,754,908 beneficiaries 65 years of age or older who were enrolled in fee-for-service Medicare and Part D in 2008. Of these beneficiaries, 670,349 were excluded owing to discontinuous enrollment, and 408,693 owing to enrollment in Medicare Advantage plans. In our final cohort (4,666,866 beneficiaries), 94.1% filled at least one prescription, and 70.3% used one or more drugs in our three categories (47.7% used ACE inhibitors or ARBs, 44.7% used statins, and 18.2% used SSRIs or SNRIs) (Table 1). These three categories accounted for 23% of total drug spending.

**Table 1. Characteristics of the Overall Sample and of Persons with Any Use of Drugs in Specific Categories.\***

Characteristic	Overall Sample (N=4,666,866)	ACE Inhibitors and ARBs (N=2,227,226)	Statins (N=2,085,921)	SSRIs and SNRIs (N=847,059)
Any use of drugs in category (% of overall sample)		47.7	44.7	18.2
Age (yr)	76.5±7.8	76.7±7.6	75.8±7.1	77.2±8.2
Female sex (%)	64.6	65.5	63.0	76.5
Race or ethnic group (%)†				
Black	8.0	9.2	7.6	5.2
Hispanic	6.9	7.6	7.1	6.5
White	80.1	78.0	79.9	85.9
Other	5.1	5.2	5.4	2.6
Low-income subsidy (%)	36.0	37.7	34.9	44.7
Household income in ZIP Code (U.S. \$)‡	43,247±19,327	42,692±18,924	43,761±19,474	43,172±18,677
Proportion of population in ZIP Code living in poverty	0.10±0.08	0.11±0.09	0.10±0.08	0.10±0.08
RxHCC score§	0.90±0.37	1.00±0.35	1.00±0.36	1.09±0.40
At least one prescription dispensed by a long-term care pharmacy (%)	0.08	0.07	0.06	0.20

\* Plus–minus values are means ±SD. ACE denotes angiotensin-converting enzyme, ARB angiotensin-receptor blocker, SNRI serotonin–norepinephrine reuptake inhibitor, and SSRI selective serotonin-reuptake inhibitor.

† Race and ethnic group were self-reported to the Social Security Administration (SSA). To improve identification of ethnic group, this information was imputed, by the Research Triangle Institute, using an algorithm based on information obtained from the SSA (e.g., language preference), surname lists from the U.S. Census Bureau (to identify Hispanics, Asians, and Pacific Islanders), and residence in Puerto Rico or Hawaii.

‡ Household income is based on the median income of the patient's geographic area according to ZIP Code and 2000 U.S. Census data.

§ Prescription-drug Hierarchical Condition Category (RxHCC) scores are based on diagnoses from 2008 inpatient and outpatient claims and are normalized to equal 1.00 on average for all Medicare Part D enrollees, with a range in our sample of 0.27 to 4.80. Higher scores indicate an increased likelihood of higher drug spending and poorer health status.

## REGIONAL VARIATION IN DRUG SPENDING

After adjustment for demographic, socioeconomic, and health-status differences, per capita prescription-drug spending in Part D varied by 24.7% (from \$2,413 to \$3,008) between the lowest and highest quintiles of HRRs (Table 2). The difference was modestly larger (32.9%) after adjustment for demographic and socioeconomic characteristics alone (\$2,353 vs. \$3,126). Hereafter, we present measures adjusted for demographic, socioeconomic, and health-status factors.

There was slightly more regional variation in per capita spending for each of the three categories of drugs than for drugs overall. When we ranked HRRs by category-specific spending, spending for ACE inhibitors and ARBs was 50.7% higher in the highest quintile of regions than in the lowest quintile (\$208 vs. \$138), spending for statins was 39.4% higher (\$262 vs. \$188), and

spending for SSRIs and SNRIs was 50.9% higher (\$86 vs. \$57) (Table 2).

## KEY COMPONENTS OF VARIATION IN DRUG SPENDING

Most (75.9%) of the regional variation in per capita spending for all prescription drugs was explained by the cost per prescription filled, with the remainder (24.1%) due to small differences in volume of use (Table 2). A similar pattern held for two of the three categories. Fully 87.5% of the difference in spending for ACE inhibitors and ARBs between the lowest-spending and highest-spending quintiles of HRRs was attributable to differences in the cost per prescription. More than half (56.3%) of the variation in spending for statins between the bottom and top quintiles was accounted for by differences in the cost per prescription filled. In contrast, differences in cost per

**Table 2. Decomposition of Variation in Per Capita Spending for Prescription Drugs (Overall and According to Drug Category) into Differences in Cost per Prescription and Volume of Use, 2008.\***

Variable	All Prescription Drugs		ACE Inhibitors and ARBs	Statins	SSRIs and SNRIs
	Adjusted for Demographic and Socioeconomic Factors	Adjusted for Demographic, Socioeconomic, and Health-Status Factors†	Adjusted for Demographic, Socioeconomic, and Health-Status Factors†		
<i>U.S. dollars</i>					
<b>Mean per capita spending for prescription drugs‡</b>					
5th percentile of HRRs	2309	2360	130	181	54
Lowest-spending quintile	2353	2413	138	188	57
Highest-spending quintile	3126	3008	208	262	86
95th percentile of HRRs	3192	3140	216	270	88
Range across all HRRs	2047–4151	2125–3774	108–252	158–316	43–126
<i>% of difference attributable to each component of spending</i>					
<b>Oaxaca decomposition of spending into key components§</b>					
Cost per prescription (30-day supply)¶	69.2	75.9	87.5	56.3	36.1
Per capita volume of prescriptions per year	30.8	24.1	12.5	43.7	63.9

\* Demographic and socioeconomic factors included age, sex, race or ethnic group, ZIP Code–level income and rate of poverty, low-income subsidy status, and institutional-residence status.

† RxHCC scores were used to adjust for health-status factors.

‡ Hospital-referral regions (HRRs) were ranked by per capita spending (overall or for each drug category) and then divided into quintiles.

§ Data shown are for the difference between the highest-spending and lowest-spending quintiles of HRRs.

¶ Cost per prescription is conditional on any use overall or within each category.

|| Per capita volume of prescriptions is for persons with and those without use. Prescriptions were standardized to a 30-day supply.

prescription were smaller for SSRIs and SNRIs, for which differences in prescription volume explained 63.9% of spending variation.

#### PRESCRIPTION VOLUME

With respect to all prescriptions filled, there was little variation across high- and low-spending regions in the volume of use; total prescriptions filled varied by only 5.3% between the lowest- and highest-spending quintiles of HRRs (45.2 prescriptions per capita annually vs. 47.6) (Table 3). Similarly, there was only a 4.3% difference in the volume of use of ACE inhibitors and ARBs between the top and bottom quintiles of HRRs ranked by per capita spending for ACE inhibitors and ARBs. There was slightly more regional variation in prescription volume for statins (3.8 prescriptions per capita in the highest-spending quintile vs. 4.3 in the lowest-spending quintile, a difference of 13.2%) and even larger regional differences for SSRIs and SNRIs, with the highest-spending quintile filling 28.6% more prescriptions per capita (1.8 vs. 1.4) (Table 3).

#### COST PER PRESCRIPTION

For all drugs, there was an 18.9% difference in the cost per prescription between the bottom and top quintiles (\$53 vs. \$63) (Table 3). There was much more variation in cost per prescription for ACE inhibitors and ARBs, with a 46.7% difference (\$30 vs. \$44) between quintiles. The degree of variation for statins and for SSRIs and SNRIs was similar to that for all drugs, with differences of 22.0% and 16.7%, respectively, between the top and bottom quintiles of HRRs ranked by spending in those categories.

#### SHARE OF PRESCRIPTIONS FOR BRAND-NAME DRUGS

The share of prescriptions filled for brand-name drugs was strongly associated with (and showed variation that was similar to) the cost per prescription overall and in each drug category (Table 3). The correlation coefficients across HRRs between cost per prescription and the ratio of branded-drug to total prescriptions were 0.85 for overall drug use and 0.89 or greater in each category.

**Table 3. Differences in Mean Cost per Prescription, Ratio of Branded-Drug Prescriptions to Total Prescriptions, and Per Capita Volume of Prescriptions between High- and Low-Spending Regions, for All Drugs and Selected Drug Categories, 2008.\***

Variable	All Drugs	ACE Inhibitors and ARBs	Statins	SSRIs and SNRIs
Cost per 30-day prescription (U.S. \$) †				
5th percentile of HRRs for spending	50	28	47	36
Lowest-spending quintile	53	30	50	42
Highest-spending quintile	63	44	61	49
95th percentile of HRRs for spending	67	45	64	55
Range across all HRRs	47–71	25–49	40–68	30–61
Ratio of branded-drug to total prescriptions †				
5th percentile of HRRs for spending	0.28	0.27	0.38	0.23
Lowest-spending quintile	0.32	0.30	0.41	0.29
Highest-spending quintile	0.38	0.46	0.52	0.38
95th percentile of HRRs for spending	0.42	0.51	0.56	0.45
Range across all HRRs	0.24–0.45	0.24–0.55	0.29–0.60	0.15–0.51
Per capita volume of prescriptions (no./yr) ‡				
5th percentile of HRRs for spending	42.9	4.3	3.6	1.2
Lowest-spending quintile	45.2	4.6	3.8	1.4
Highest-spending quintile	47.6	4.8	4.3	1.8
95th percentile of HRRs for spending	51.4	5.0	4.6	1.9
Range across all HRRs	42.1–53.3	4.0–5.5	3.2–4.8	1.0–2.2

\* All measures were adjusted for age, sex, race or ethnic group, ZIP Code-level income and rate of poverty, low-income subsidy status, institutional-residence status, and RxHCC score. Spending quintiles for ACE inhibitors and ARBs, statins, and SSRIs and SNRIs are based on HRRs ranked by category-specific spending.

† Cost per 30-day prescription and ratio of branded-drug to total prescriptions were conditional on any use overall or within each category.

‡ Prescriptions were standardized to a 30-day supply, so prescriptions filled with a 90-day supply would count as three prescriptions. Volume is based on the total sample, including persons with and those without use overall or in the category.

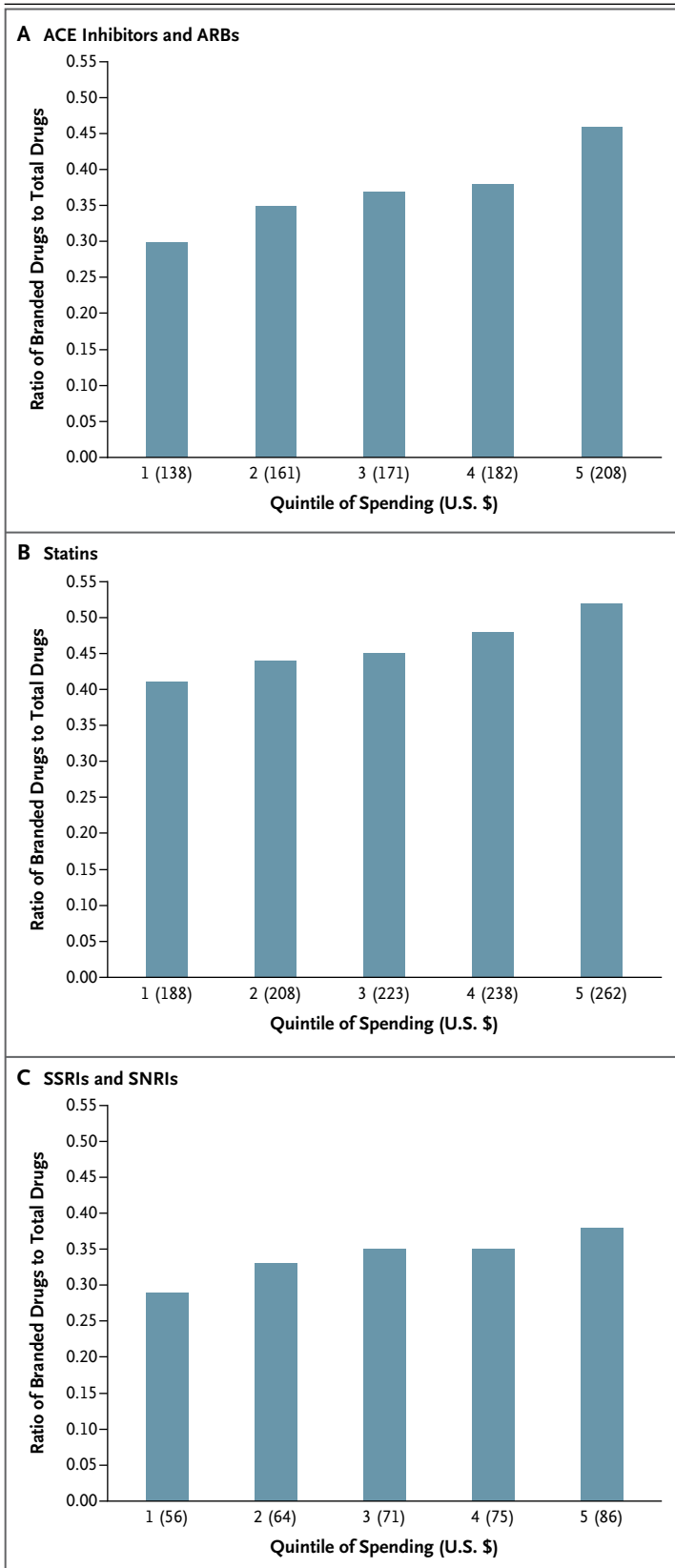
The ratio of branded-drug to total prescriptions also correlated with spending in each of the categories, although correlation coefficients were higher for statins (0.64) and for ACE inhibitors and ARBs (0.85) than for SSRIs and SNRIs (0.52). The ratio for ACE inhibitors and ARBs was 0.36, on average, but ranged from 0.30 to 0.46 across spending quintiles (Fig. 1). Nearly all (92.6%) of the prescriptions for branded ACE inhibitors and ARBs were for ARBs, which had no generic equivalents during our study period. The mean ratio for statins was 0.45 and ranged from 0.41 to 0.52 between the lowest- and highest-spending quintiles. For SSRIs and SNRIs, the ratio was lower (0.33 on average) and varied less across spending quintiles (0.29 to 0.38) (Fig. 1).

Some regions had consistently high (or low) branded-drug use in all three categories. For example, Miami and McAllen, Texas, were in the top quintile for branded ACE inhibitors and ARBs

(with ratios of 0.50 and 0.51, respectively), statins (both 0.56), and SSRIs and SNRIs (0.51 and 0.47). Dearborn, Michigan, and Rochester, Minnesota, had low use of branded drugs in all three categories, with ratios of only 0.26 for ACE inhibitors and ARBs and 0.24 and 0.17, respectively, for SSRIs and SNRIs (see the Supplementary Appendix).

#### POTENTIAL SAVINGS ASSOCIATED WITH REDUCED USE OF BRANDED DRUGS

If HRRs had been ranked by their overall ratio of branded-drug to total prescriptions and the top four quintiles had adopted the ratio in the lowest quintile, we estimate that overall Part D drug spending would have been 10% lower in 2008. If this rate of savings had been applied to total Part D spending in 2008, the Medicare program and beneficiaries would have saved \$4.5 billion.



**Figure 1.** Ratio of Prescriptions for Branded Drugs to Total Prescriptions Filled in Hospital-Referral Regions in 2008, According to Drug Category and Quintile of Per Capita Spending.

The three drug categories shown are angiotensin-converting-enzyme (ACE) inhibitors and angiotensin-receptor blockers (ARBs) (Panel A), 3-hydroxy-3-methylglutaryl coenzyme A (HMG-CoA) reductase inhibitors (statins) (Panel B), and selective serotonin-reuptake inhibitors (SSRIs) and serotonin-norepinephrine reuptake inhibitors (SNRIs) (Panel C). Measures for spending and the ratio of branded-drug prescriptions to total prescriptions were adjusted for age, sex, race or ethnic group, ZIP Code-level income and rate of poverty, low-income subsidy status, institutional-residence status, and prescription-drug Hierarchical Condition Category (RxHCC) score.

## DISCUSSION

Our study has three main findings. First, we found that the cost per prescription was more important than the volume of prescriptions filled in explaining regional variation in overall Medicare Part D spending. Second, one cannot generalize entirely from the aggregate regional associations to specific categories. Although variation in expenditures for ACE inhibitors and ARBs and for statins was driven primarily by differences in the cost per prescription, most of the variation in spending for SSRIs and SNRIs was due to volume differences. This finding may reflect differences in patient preferences for antidepressant treatment, although studies have shown little variation in preferences for treatment generally,<sup>21</sup> or the propensity of physicians to treat depression in elderly patients. Our third main finding is that at the regional level, the cost per prescription closely paralleled the ratio of branded-drug prescriptions to total prescriptions.

Substantial variation in benefit design across Part D plans<sup>22</sup> may partially explain the widespread variation in branded-drug use.<sup>23</sup> Part D plans differ with respect to the drugs covered and beneficiary cost-sharing. Many Part D plans have adopted three-tiered formularies, which create powerful incentives for consumers to use lower-cost drugs and may reduce drug spending.<sup>24,25</sup> The average copayment for a generic in Part D plans with three-tiered formularies is \$7, as compared with \$37 to \$75 for prescriptions for branded drugs.<sup>22</sup> The steep gradient in cost sharing between generic and branded drugs in Medicare

means that a reduction in branded-drug use in high-spending regions would result not only in lower Medicare drug spending but also in lower out-of-pocket costs to beneficiaries. A reduction of the financial burden of prescription-drug use on the elderly through greater use of generics may improve medication adherence<sup>26</sup> and ultimately lead to better health outcomes.

The clinical and policy implications of our findings depend critically on the question of the right rate of use of prescription branded drugs. A rate of zero would minimize costs but would deprive some patients of needed treatment options. Prescriptions written for branded drugs with generic equivalents are filled with the generic 88% of the time in Medicare.<sup>23</sup> This substitution is probably appropriate, given the evidence of equivalent effectiveness for generics in most drug classes.<sup>27,28</sup> However, most variation in branded-drug use stems from the prescription of drugs without generic equivalents. For example, there were considerable differences in the use of ARBs (all of which were branded during our study period) as compared with that of ACE inhibitors (most of which were generic) across regions. ACE inhibitors and ARBs have similar effectiveness<sup>11,29,30</sup> but different side-effect profiles. ARBs are recommended for patients in whom dry cough or angioedema develops with ACE inhibitors; however, the incidence of these side effects is quite low.<sup>31,32</sup> Therefore, even if the rates of these effects were found to vary across regions, such case-mix differences would be unlikely to fully explain the magnitude of variation in the use of ARBs.

Although it is unclear what rate of branded-drug use among Medicare beneficiaries would be preferable, our finding that branded-drug use differed by a factor of almost two across regions provides a signal of potentially wasteful prescribing in some regions. We estimate that the Medicare program and beneficiaries would have saved \$4.5 billion if branded-drug use in all HRRs had been similar to that in the lowest quintile. This finding is consistent with studies showing the potential for greater generic use

and resultant savings on the part of commercial insurance plans, Medicaid, Veterans Affairs medical centers, and the elderly.<sup>7,23,33-36</sup>

Our study has important limitations. We examined variation in three categories regardless of clinical indication, which may influence patterns of use. We adjusted our measures for demographic, socioeconomic, and health status but not for Part D plan characteristics, which may affect medication use. Moreover, our risk-adjustment measure may not have adequately adjusted for health status. However, given that the RxHCC classification system outperforms most risk-adjustment models,<sup>15</sup> we expect bias to be minimal. Our analysis includes only persons with 12 months of continuous enrollment in PDP plans, which provide coverage for approximately 55% of Medicare beneficiaries nationally,<sup>37</sup> and drug use by other Medicare beneficiaries may differ. Finally, we do not have information on rebates negotiated by Part D plans with pharmaceutical manufacturers, which could vary by region and affect branded-drug use.

In conclusion, regional variation in Medicare Part D spending primarily reflects differences in the cost of drugs selected rather than the volume of drugs used. An increase in the use of lower-cost agents could substantially reduce Medicare program spending and out-of-pocket costs for beneficiaries without compromising the quality of care or health. These savings could be realized by modifying the benefit design and utilization management of Part D plans in high-cost regions.

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