



# Association of CMS-HCC Risk Scores with Health Care Utilization among Rural and Urban Medicare Beneficiaries

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## OVERVIEW

Risk adjustment is the “process of modifying payments and benchmarks to reflect the degree of illness” and is used by the Centers for Medicare & Medicaid Services (CMS) to estimate future expenditures for Medicare beneficiaries.<sup>1</sup> Specifically, CMS uses a risk adjustment methodology based on Hierarchical Condition Categories (HCCs), which are derived from International Classification of Diseases (ICD) codes found in claims data. The CMS-HCC model focuses on chronic health conditions that are the biggest determinants of long-term health care expenditures.<sup>1-3</sup>

The CMS-HCC model was introduced in 2004 to adjust capitation payments for beneficiaries enrolled in Medicare Advantage plans.<sup>1</sup> Since its introduction, the model has also been used to calculate expenditure benchmarks for new value-based payment plans.<sup>1,4-6</sup> In addition to HCCs, the CMS-HCC model also accounts for other demographic characteristics. Example characteristics can include age, sex, disease-disabled status, and Medicaid eligibility (although not all value-based purchasing programs use the same method of risk adjustment). These characteristics can then be used to calculate a risk score for each individual beneficiary, with scores normalized to a value of 1.0. Risk scores generally range between 0.9 and 1.7, such that scores below 1.0 indicate beneficiaries in relatively good health.<sup>1</sup>

Research suggests that rural Medicare beneficiaries have lower average CMS-HCC risk scores than urban beneficiaries,<sup>7</sup> and that rural providers treat beneficiaries with lower average CMS-HCC risk scores than urban providers.<sup>8</sup> However, these findings contradict existing evidence showing that rural populations are generally less healthy than their urban counterparts across multiple metrics, including mortality,<sup>9-10</sup> activity limitations due to chronic conditions, and having a diagnosable severe mental illness.<sup>11</sup> Thus, CMS-HCC risk scores may be underestimating expected health care utilization among rural beneficiaries compared to urban beneficiaries. Incorrect estimation of expected health care utilization can lead to important financial losses for providers.<sup>1</sup>

The goal of this study is to examine the relationship between CMS-HCC risk scores and future health care utilization among rural and urban Medicare beneficiaries. Findings will contribute to understanding whether the HCC risk adjustment model is achieving its objective of giving greater payments to providers with patients that are expected to be more costly. Additionally, this study will explore whether there are systematic differences in the risk adjustment model’s effectiveness in rural versus urban populations, enabling federal and state policymakers to better understand the implications of risk adjustment in alternative payment models for rural providers. Our study hypotheses are as follows:

*Hypothesis #1:* CMS-HCC risk scores will be positively associated with future health care utilization.

*Hypothesis #2:* After controlling for CMS-HCC risk score, future health care utilization will be greater among rural Medicare beneficiaries compared to urban beneficiaries.

## KEY FINDINGS

- ♦ The Centers for Medicare & Medicaid Services (CMS) use Hierarchical Condition Categories (HCC) and demographic information to calculate beneficiary risk scores, which predict expected Medicare spending by beneficiaries. Scores are normalized so that the average beneficiary has a score of 1.0. Beneficiaries with a risk score below (above) 1.0 are relatively healthy (unhealthy), and therefore are predicted to be less (more) costly.
- ♦ CMS-HCC risk scores are significantly and positively associated with increased acute inpatient stays, hospital readmissions, inpatient emergency room visits, and hospital outpatient emergency room visits among Medicare beneficiaries.
- ♦ After controlling for CMS-HCC risk scores, rural beneficiaries generally had greater health care utilization than urban beneficiaries (e.g., more acute inpatient stays, more hospital readmissions, and more hospital outpatient emergency room visits).

## METHODS

Our study sample was national in scope and consisted of Medicare beneficiaries (1) designated as “community-dwelling” for all 12 months of 2014 under the CMS-HCC risk adjustment methodology, (2) not covered by a Medicare Advantage insurance plan (i.e., health maintenance organization insurance plan) for any portion of 2014, and (3) present in all three of the data sets used to construct the analytic data file (with no recorded death dates in any of the three data sets). The study period was selected based on data availability. Specifically, at the time of the analysis, CMS-HCC Risk Score Files were only available for 2014. For each beneficiary in our study sample, we first collected beneficiary demographic information from the 2013 Master Beneficiary Summary File Base segment.<sup>12</sup> Next, using the 2014 CMS-HCC Risk Score Files, we calculated a single risk score for each beneficiary meeting our inclusion criteria by averaging the 12 monthly risk scores.<sup>13</sup> Finally, health care utilization data from 2015 was collected from the 2015 Master Beneficiary Summary File Cost and Utilization segment.<sup>14</sup>

In order to assess the association between 2014 CMS-HCC risk scores and 2015 health care utilization, we fit several negative binomial regression models. Each model focused on a different health care utilization outcome: acute inpatient stays, hospital readmissions, inpatient emergency room visits (i.e., emergency room visits that led to inpatient admission), and hospital outpatient emergency room visits (i.e., emergency room visits that led to outpatient treatment).

Models included an independent variable representing 2014 CMS-HCC risk scores as well as an indicator variable for whether the beneficiary lived in a rural ZIP Code. We defined rural beneficiaries as those residing in ZIP Codes outside metropolitan Core Based Statistical Areas or within metropolitan areas and having a 2010 RUCA code of 4 or greater.<sup>15</sup> Remaining beneficiaries were defined as urban. Each model also included variables for beneficiary race and census region, as well as an interaction variable between CMS-HCC risk score and beneficiary rural status. Additional independent variables such as beneficiary age, sex, disabled status, and Medicaid status were not directly included in our regression models because these variables are used to calculate CMS-HCC risk scores (in contrast, census region and race are *not* used to calculate risk scores).<sup>1-3</sup> In addition, we excluded beneficiaries with risk scores greater than the 99th percentile from our models because (1) we determined these individuals were not representative of the general population, and (2) excluding these beneficiaries resolved issues with model convergence.

## RESULTS

Characteristics of the study’s analysis sample are provided in Table 1. Our sample included 26,542,153 beneficiaries with an average age of 70.68 years. Approximately 55.67% of the sample was female, 83.61% white, and 26.16% rural. The average CMS-HCC risk score of our sample was 0.86 (standard deviation of 0.66), suggesting that, on average, our sample was healthier than the reference Medicare population used by CMS. Given that our sample (1) is comprised solely of community-dwelling beneficiaries and (2) excludes beneficiaries with risk scores greater than the 99th percentile, this latter finding was expected.

**Table 1. Study Sample Characteristics**

<b>Number of beneficiaries</b>	26,542,153		
<b>Percent of sample</b>		<b>Mean (standard deviation)</b>	
<b>Sex</b>		<b>Acute inpatient stays</b>	0.22 (0.64)
Female	55.67%	<b>Hospital readmissions</b>	0.03 (0.25)
Male	44.33%	<b>Inpatient emergency room visits</b>	0.15 (0.54)
<b>Race</b>		<b>Hospital outpatient emergency room visits</b>	0.45 (1.38)
White	83.61%	<b>CMS-HCC risk score<sup>a</sup></b>	0.86 (0.66)
Black	9.47%	<b>Age, years</b>	70.68 (12.26)
Asian	1.97%		
Hispanic	2.14%		
North American Native	0.54%		
Other / Unknown	2.17%		
<b>Rural</b>	26.16%		

<sup>a</sup> Calculated in 2014 as average of monthly risk scores

Results for each of the four regression models are provided in Table 2. CMS-HCC risk score, rural status, race, and census region were statistically significant predictors of utilization in each model ( $p < .001$ ). Specifically, a one-unit increase in CMS-HCC risk score was associated with 0.2 additional acute inpatient stays, 0.03 additional hospital readmissions, 0.1 additional inpatient emergency room visits, and 0.3 additional outpatient emergency room visits, holding all other model covariates constant. In addition, compared to urban beneficiaries, rural beneficiaries were associated with 0.01 additional acute inpatient stays, 0.001 additional hospital readmissions, 0.03 fewer inpatient emergency room visits, and 0.2 additional outpatient emergency room visits, holding all other model covariates (including CMS-HCC risk score) constant.

**Table 2. Marginal Effects<sup>a</sup> from Negative Binomial Multiple Regression Analyses Predicting Health Care Utilization from CMS-HCC Risk Scores and Rural Status of Beneficiary**

	OUTCOME			
	Acute Inpatient Stays	Readmissions	Inpatient ER Visits <sup>b</sup>	Outpatient ER Visits <sup>c</sup>
<b>CMS-HCC risk score</b>	0.2	0.03	0.1	0.3
<b>Rural beneficiary</b>	0.01	0.001	-0.03	0.2
<b>Race<sup>d</sup></b>				
Black	-0.01	0.002	0.01	0.2
Non-White, Non-Black	-0.06	-0.01	-0.03	-0.04
<b>Census Region<sup>e</sup></b>				
Northeast	-0.001	0.0004	0.01	0.001
Midwest	0.01	0.001	-0.005	0.02
West	-0.03	-0.01	-0.03	-0.01
Puerto Rico	-0.1	-0.01	-0.07	-0.1

Notes: All effects had  $p \leq .001$ . ER = Emergency Room

<sup>a</sup> Marginal effects represent the average change in the outcome variable associated with a 1-unit increase in a given predictor variable (for continuous variables) or change from a given predictor variable's reference category to some other category (for categorical variables), holding all other model covariates constant.

<sup>b</sup> Emergency room visits that led to inpatient admission.

<sup>c</sup> Emergency room visits that led to outpatient treatment.

<sup>d</sup> Reference category is White. "Non-White, Non-Black" represents a collapsed category for all non-White, non-Black races and for beneficiaries whose race is unknown.

<sup>e</sup> Reference category is South.

Another way to interpret our model results is to compare the CMS-HCC risk scores of rural and urban residents expected to have the same utilization (we can do this using the raw regression results, which are not shown in this brief for the sake of brevity). Holding race and census region constant, an urban resident with a CMS-HCC risk score of 1.00 would have the same expected number of acute inpatient stays as a rural resident with a CMS-HCC risk score of 0.95. Similarly, an urban resident with a risk score of 1.00 would have the same expected number of hospital readmissions as a rural resident with a risk score of 0.98, the same expected number of inpatient emergency room visits as a rural resident with a risk score of 1.26, and the same expected number of outpatient emergency room visits as a rural resident with a risk score of 0.54.<sup>16</sup>

## DISCUSSION

The goal of this study was to examine the relationship between CMS-HCC risk scores and future health care utilization among rural and urban beneficiaries. We hypothesized that (1) CMS-HCC risk scores would be positively associated with future health care utilization and (2) after controlling for CMS-HCC risk scores, future health care utilization would be greater among rural Medicare beneficiaries compared to urban beneficiaries. Our results support the first hypothesis, as increased risk scores were significantly associated with increased utilization across all four of our regression models. In addition, our results mostly support the second hypothesis, as rural beneficiaries were estimated to have greater utilization in three of the four regression models (after controlling for risk score, race, and census region); the one exception was inpatient emergency department visits, for which rural beneficiaries had lower utilization.

Overall, the results indicate that CMS-HCC risk scores provide utility in predicting patients that are expected to be more costly. However, the results also suggest that there are systematic differences in the risk adjustment model's predictive capabilities in rural versus urban populations, as rural beneficiaries in our study generally had greater health care utilization even after controlling for risk scores. Going forward, policymakers might consider the possibility that Medicare provider payment models using CMS-HCC risks scores may underestimate the costs associated with treatment of rural beneficiaries.

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16. For these calculations, we used the raw negative binomial regression results for each model, not the rounded estimates that appear in Table 2.

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