

Access to Chiropractic Care and the Cost of Spine Conditions Among Older Adults

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Back pain and neck pain are associated with an estimated direct cost of \$86 billion to the United States economy.¹ Among the top contributors to disability, back pain and neck pain outrank chronic diseases such as chronic pulmonary disease, ischemic heart disease, and diabetes.² Although back pain can be attributed to a serious underlying medical problem, up to 85% of cases are classified as nonspecific (ie, cases without an underlying pathology).³ Approximately one-fourth of all adults will experience nonspecific back pain during a 3-month period, and at any one point in time, approximately 30% of older adults suffer from back pain.⁴ Older adults are particularly vulnerable to back pain and most who experience nonspecific back pain have future recurrences^{4,5}; thus, it is among the most common reasons older Americans visit physicians.⁶

With more than 100 million visits for spine conditions each year,^{7,8} the chiropractic profession is the largest health service that operates outside of the conventional medical system^{9,10} and the only such service reimbursed by Medicare.^{11,12} Medicare beneficiaries can use chiropractic care without a medical referral; however, the only reimbursable modality is manual therapy, which costs approximately \$30 to \$50 per visit. Chiropractors cannot be reimbursed directly for diagnostic imaging nor prescribe medications. In light of the ongoing debate regarding coverage of presumably nonessential services, there is a specific need to more rigorously examine how chiropractic care may affect national healthcare spending.

Previous observational research that has examined spending among chiropractic patients compared with medical care patients suggests that chiropractic care may reduce utilization of and expenditures on medical services for back pain.^{13,14} Traditional observational studies use assignment of patients to a specific treatment type (eg, chiropractic vs usual care) to study the cost of chiropractic care. These designs, however, are unable to account for the potential impacts from those who choose to use chiropractic care in place of medical care. To date, previous studies have neglected to consider such indirect effects of the service on the system at large.

Therefore, we performed a quasi-experimental study to examine how accessibility of chiropractic care among Medicare beneficiaries

ABSTRACT

OBJECTIVES: Chiropractic care is a service that operates outside of the conventional medical system and is reimbursed by Medicare. Our objective was to examine the extent to which accessibility of chiropractic care affects spending on medical spine care among Medicare beneficiaries.

STUDY DESIGN: Retrospective cohort study that used beneficiary relocation as a quasi-experiment.

METHODS: We used a combination of national data on provider location and Medicare claims to perform a quasi-experimental study to examine the effect of chiropractic care accessibility on healthcare spending. We identified 84,679 older adults enrolled in Medicare with a spine condition who relocated once between 2010 and 2014. For each year, we measured accessibility using the variable-distance enhanced 2-step floating catchment area method. Using data for the years before and after relocation, we estimated the effect of moving to an area of lower or higher chiropractic accessibility on spine-related spending adjusted for access to medical physicians.

RESULTS: There are approximately 45,000 active chiropractors in the United States, and local accessibility varies considerably. A negative dose-response relationship was observed for spine-related spending on medical evaluation and management as well as diagnostic imaging and testing (mean differences, \$20 and \$40, respectively, among those exposed to increasingly higher chiropractic accessibility; $P < .05$ for both). Associations with other types of spine-related spending were not significant.

CONCLUSIONS: Among older adults, access to chiropractic care may reduce medical spending on services for spine conditions.

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affects healthcare spending for spine conditions. To do so, we used a cohort of older adults in Medicare with back and/or neck pain who relocated and experienced a change in geographic accessibility of chiropractic care. In this way, the change in accessibility of chiropractic care served as a proxy for access to the service among Medicare beneficiaries, providing us with the unique opportunity to observe how either reducing or increasing access affects spine-related spending among older adults.

TAKEAWAY POINTS

- ▶ Chiropractic care is a Medicare-reimbursed service that operates outside of the conventional medical system and provides a sizable amount of the nation's spine care.
- ▶ Medicare beneficiaries can use chiropractic care without a medical referral.
- ▶ Previous studies have not considered how use of chiropractic care affects spending on costly medical services.
- ▶ We found some evidence of a relationship between lower accessibility of chiropractic care and higher spending on diagnostic imaging and testing for spine conditions.

METHODS

We examined the effect of accessibility of chiropractic care on spine-related spending using a quasi-experimental design. For our study, we geocoded Medicare beneficiaries and identified a cohort with back and/or neck pain who relocated once from 2010 to 2014. Then, using the variable-distance enhanced 2-step floating catchment area method^{15,16} to estimate provider to population ratios, we determined the effect of a change in accessibility of chiropractic care on spine-related spending. This method for estimating provider accessibility is the gold standard because it has a higher resolution that incorporates travel time, takes into account the location of healthcare in adjacent areas, and is less affected by choice of geographic scale.

As our study used administrative claims and publicly available data on healthcare providers, it received an expedited review by the University of Michigan Health Sciences and Behavioral Sciences Institutional Review Board.

Study Population

First, we identified all older adults (65 years and older) enrolled in Medicare Part B throughout 2010 to 2014—this resulted in the identification of 16,842,729 beneficiaries (eAppendix Figure 1 [eAppendix available at ajmc.com]). For each calendar year, we merged beneficiary residential zip codes with hospital referral regions (HRRs) that represent the 306 regional US healthcare markets. We then identified 986,076 beneficiaries who relocated at least once by changing HRR. We restricted our sample to the 887,917 beneficiaries who relocated only once during the 5-year time period—634,935 had at least 1 year of data prior to and after the relocation (eAppendix Figure 2).

Of those 634,935, we identified 84,679 beneficiaries who had a back and/or neck pain visit using an established list of *International Classification of Disease, Ninth Revision, Clinical Modification* codes for spine conditions.¹⁷ Our aim was to identify a cohort of beneficiaries who had back and/or neck pain prior to relocation (ie, those most likely to be affected by accessibility of chiropractic care). Therefore, we restricted our sample to beneficiaries who had 2 separate claims for back or neck pain at least 4 months apart in the year prior to relocation.

Chiropractic Care Accessibility

For each year, we gathered data on provider location from historic versions of the National Plan and Provider Enumeration System (NPPES). We used provider specialty code 35 in NPPES data to identify the practice locations of chiropractors.¹⁸ We removed chiropractors who were clinically inactive in Medicare by linking NPPES provider data to the 20% Carrier file and removing any providers who did not submit a claim in the relevant year. Medicare beneficiaries were aggregated to Zip Code Tabulation Areas (ZCTAs) according to their zip code of residence for each year. ZCTAs are generalized areal representations of US Postal Service zip code service areas. Once assigned a ZCTA, beneficiaries in our study cohort were assigned measures of chiropractic care accessibility. For each ZCTA, we measured chiropractic care accessibility using an enhanced version of the variable-distance enhanced 2-step floating catchment area method first developed by Luo and Wang¹⁵ and modified by others.¹⁶

Our measure was constructed based on the 2010 US Census block-level population aggregated up to ZCTA level in order to assign each patient estimates of chiropractic care accessibility. First, we calculated a drive time-based service area for each practice location. US Census block centroids within each service area provided population estimates. These estimates were summed to generate provider to population ratios for each practice location. Next, we estimated chiropractic care accessibility based on the weighted sum of all practice locations within a given drive time from each Census block centroid. For locations within a threshold distance (eg, 5, 10, or 15 miles), scores were summed and scaled according to drive time from the block centroid. These estimates of chiropractic care accessibility were then aggregated to the ZCTA in order to assign a measure of provider accessibility around each ZCTA population-weighted centroid.

Medicare Spine Spending

Our primary dependent variable was annual spine-related spending. We used the combination of ResDAC Carrier, Medical Provider Analysis and Review (referred to as MedPAR), and Outpatient files to calculate total spending on back and neck pain diagnoses by summing across all types of inpatient and outpatient care for each calendar year. We calculated spine-related spending on inpatient and ambulatory care (office-based and outpatient claims combined) separately. To examine more subtle differences in spending, we

used the Berenson-Eggers Type of Service categories for “evaluation and management” and “procedures”; furthermore, we combined the categories “imaging” and “testing.” Healthcare spending was adjusted for inflation to 2014 dollars using the Consumer Price Index for medical services.¹⁹

Covariates

To adjust for baseline differences, we extracted several socio-demographic characteristics, including age, sex, and race/ethnicity, from the Master Beneficiary Summary File. To account for differences in health status (and changes in health status over time) for each calendar year, we used all administrative data to calculate a comorbidity score using the Charlson-Deyo Comorbidity Index.²⁰ We adjusted for differences in accessibility of primary care physicians.²¹ Accessibility of primary care physicians (internal medicine, family practice, and general practitioners) was calculated using an approach identical to that described for chiropractic care.

Statistical Analyses

We displayed our national estimate of chiropractic care accessibility for each ZCTA and calculated the coefficient of variation. In order to illustrate high versus low area accessibility, we converted data to standard normal deviations for 2014 ZCTAs (the most recent year of data). We also plotted the unadjusted chiropractor to population ratios collapsed by quintile (**eAppendix Figure 3**).

We used data from the year before and the year after relocation (referred to herein as baseline year and postrelocation year). The estimated effect of a change in chiropractic care accessibility was evaluated in 2 ways. First, we simply identified whether the beneficiary relocated to a higher or a lower chiropractic care accessibility quintile relative to their baseline location. Second, we examined the magnitude of the increase or decrease in chiropractic care accessibility by reporting results according to the number of quintiles up or down a beneficiary moved by relocating, regardless of starting point, to identify the equivalent of a dose response. The comparison group in these analyses was all beneficiaries who moved but did not experience a change in accessibility (ie, remained in the same quintile). The 2 approaches highlight different dimensions of relocation change: The first focuses on the initial level of accessibility but aggregates change into broad categories of any increase or decrease, and the second captures how much change in accessibility occurred, with less focus on the starting level.

The end point for all analyses was the change in spine-related spending (eg, spending on inpatient care, ambulatory care), which was normally distributed. Across baseline accessibility of chiropractic care, age and sex differed very little; however, race and health status varied (**eAppendix Table 1**). Therefore, we adjusted for differences in our analyses using linear regression. Specifically, our models adjusted for baseline chiropractic care accessibility, beneficiary characteristics (age, sex, race, baseline comorbidities, and change in comorbidities), and access to primary care physicians (at baseline and a change in access). Analyses were based on

complete case analysis and we assumed any missing values to be missing completely at random. A 2-sided *P* value of less than .05 was considered statistically significant. Geospatial analyses were conducted using ArcGIS version 10.5 (Esri; Redlands, California) and analyses of claims data were conducted using SAS version 9.4 (SAS Institute; Cary, North Carolina).

Our analyses were restricted to beneficiaries who had evidence of a back and/or neck condition in the baseline year. In a subanalysis we repeated all analyses on a subset of 57,807 older adults who also had spine claims in the postrelocation year.

RESULTS

Characteristics of Study Population

Among the 84,679 older adults enrolled in Medicare with a spine condition prior to relocating, 9.5%, 18.0%, 22.9%, 26.7%, and 22.9% resided in quintiles 1 through 5 of chiropractic care accessibility, respectively. The mean (SD) age of older adults with a spine condition who moved once was 77.0 (7.2) years; 68.4% were female, and 3.9% were black.

Accessibility of Chiropractic Care

The total number of active chiropractors varied little from 2010 to 2014—from a high of 45,264 in 2012 to a low of 44,040 in 2014. Across the country, local accessibility varied considerably, with a higher concentration of chiropractors observed in the upper Midwest and a relatively lower concentration in the South (coefficient of variation = 93%) (**Figure 1**; **eAppendix Figure 3**). Across US ZCTAs in 2014, the mean (SD) ratio of chiropractors per 100,000 population was 15.6 (14.4). Ratios for quintile 1 were 0.0 to 4.6; quintile 2, 4.7 to 9.4; quintile 3, 9.5 to 15.0; quintile 4, 15.1 to 23.6; and quintile 5, 23.7 to 44.5. The several ZCTAs with very high chiropractor to population ratios were in the upper Midwest, where the profession originated and a large chiropractic school is located (in Davenport, Iowa).

Chiropractic Care Accessibility and Spine-Related Spending

When examining whether the beneficiaries relocated to an area with higher or lower chiropractic care accessibility relative to where they started, we found few differences in mean spending on total, inpatient, and ambulatory spine care (**Table 1**). The only marginally statistically significant differences in spending were mean increases of \$513 in total spine-related spending (*P* = .05) and \$434 in inpatient spine-related spending (*P* = .06) among older adults who resided in quintile 3 and who moved to an area of lower chiropractic care accessibility. Although attenuated, some small differences were observed by category of ambulatory care spine spending (**Table 2**). Among residents of quintile 5 who moved to an area of lower chiropractic care accessibility, mean spending on medical procedures decreased by \$53 (*P* = .04). Residents of quintile 2 who moved to an area of higher chiropractic care accessibility had a decrease of \$30 (*P* < .001) in mean spending on spine diagnostic imaging and tests.

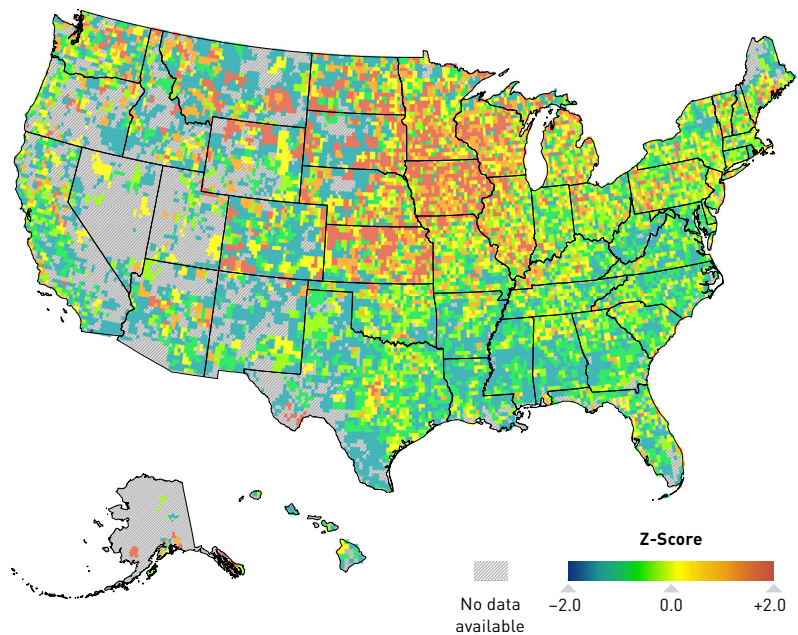
We found more consistent changes when examining the association of spending with the magnitude of the change in chiropractic care accessibility (Figures 2 and 3). In general, increases in spending were observed among older adults who moved to areas with lower accessibility of chiropractic care—however, the only statistically significant increase was for inpatient spending among those who moved to areas with chiropractic accessibility 2 quintiles higher than where they started (mean difference in spending of \$291; $P = .05$). In addition, a small dose–response relationship was observed for ambulatory care spine spending on “evaluation and management” and “imaging and testing” (Figure 3). For both, decreases of 3 and 4 quintiles of chiropractic accessibility were associated with approximate mean increases in spending of \$20 ($P < .05$) and \$40 ($P < .01$), respectively.

The inverse association between accessibility of chiropractic care and spending on spine imaging and testing persisted when restricted to the subset of older adults who had a spine condition in the postrelocation year.

DISCUSSION

Despite a sizable literature devoted to describing health services that function outside of the conventional medical system in the United States, our study is among the first to attempt to quantify the effect of access to such a service on spending using a quasi-experimental approach. We applied state-of-the-art geospatial methods both for developing the geographic accessibility measures and for using relocation as a tool for approximating causal mechanisms in observational studies. Originating from the field of economics, natural experiments are being used by a growing number of health researchers who seek to identify causal mechanisms from nonexperimental data.^{22–25} Taking advantage of unique opportunities to balance confounding factors and designs that allow for temporal observations to be made offers stronger evidence of cause and effect.²⁶ For instance, in an influential report, Song et al used Medicare patients who relocated to examine variation in practice intensity.²⁴ Although effects of chiropractic care accessibility on spending were inconsistent and overall small, we did find some evidence of chiropractic care accessibility affecting spending on certain types of spine-related care. Specifically, we observed small, consistent differences in spending on diagnostic imaging and tests for spine conditions. This is among the first evidence to suggest a potential reduction in medical service use due to a health service that operates primarily outside of traditional pathways of care.

FIGURE 1. Geographic Variation in Accessibility of Chiropractic Care Across the United States



To our knowledge this is also the first application of the variable-distance enhanced 2-step floating catchment area method to national provider data. This approach has several advantages over other measures, including that it (1) provides a more realistic estimation of impact of moving that incorporates travel time in both the urban and rural settings, (2) allows for movement/interaction across areas to account for accessibility in adjacent locales, and (3) is less sensitive to changes in scale because it uses a continuous measure of impedance to calculate provider to population ratios. Use of this method led us to identify relatively high accessibility of chiropractic care in the upper Midwest and lower accessibility in the South, which aligns with previous reports.²¹ Although our analyses cannot fully explain this pattern, the profession did originate in the upper Midwest, suggesting that cultural factors may play a role. A recent report that compared availability of different provider types found that chiropractors were more likely to locate in areas of higher income and health status.²⁷

Healthcare Policy Implications

In spite of the *Choosing Wisely* campaign’s mantra that “less is more” for clinical management of back pain,^{28,29} trends indicate worrisome increases in the use of opioid analgesic medications, overreliance on medical specialists, and unwarranted diagnostic imaging.^{30–32} All of these practices lead to higher healthcare costs.^{3,33–35}

Medicare spends \$400 million to \$500 million on chiropractic care each year,^{36,37} and chiropractic care has been scrutinized

TABLE 1. Adjusted Mean Difference in Total, Inpatient, and Ambulatory Care Spine-Related Spending After Relocation (postrelocation year – baseline year) to Areas of Higher or Lower Chiropractic Care Accessibility^a

Starting Chiropractic Care Accessibility	Total		Inpatient		Ambulatory Care	
	Mean Difference, \$	P	Mean Difference, \$	P	Mean Difference, \$	P
Resident of quintile 1, lowest						
Moved to area of higher chiropractic accessibility	46	.92	202	.60	-156	.17
Resident of quintile 2						
Moved to area of lower chiropractic accessibility	-57	.89	-38	.91	-19	.86
Moved to area of higher chiropractic accessibility	-297	.26	-176	.46	-121	.08
Resident of quintile 3						
Moved to area of lower chiropractic accessibility	513	.05	434	.06	79	.25
Moved to area of higher chiropractic accessibility	242	.30	165	.43	77	.21
Resident of quintile 4						
Moved to area of lower chiropractic accessibility	108	.60	32	.86	76	.16
Moved to area of higher chiropractic accessibility	132	.59	15	.95	118	.07
Resident of quintile 5, highest						
Moved to area of lower chiropractic accessibility	38	.86	64	.73	-26	.64

^aAdjusted for age, sex, race, baseline comorbidity, change in comorbidity, and primary care physician accessibility.

TABLE 2. Adjusted Mean Difference in Categories of Ambulatory Spine-Related Spending After Relocation (postrelocation year – baseline year) to Areas of Higher or Lower Chiropractic Care Accessibility^a

Starting Chiropractic Care Accessibility	Evaluation and Management		Medical Procedures		Imaging and Testing	
	Mean Difference, \$	P	Mean Difference, \$	P	Mean Difference, \$	P
Resident of quintile 1, lowest						
Moved to area of higher chiropractic accessibility	9	.55	-36	.49	6	.67
Resident of quintile 2						
Moved to area of lower chiropractic accessibility	4	.76	28	.57	20	.11
Moved to area of higher chiropractic accessibility	-2	.82	-34	.29	-30	<.001
Resident of quintile 3						
Moved to area of lower chiropractic accessibility	9	.36	12	.70	3	.67
Moved to area of higher chiropractic accessibility	11	.19	3	.91	1	.88
Resident of quintile 4						
Moved to area of lower chiropractic accessibility	11	.14	37	.14	18	<.01
Moved to area of higher chiropractic accessibility	4	.66	40	.18	21	<.01
Resident of quintile 5, highest						
Moved to area of lower chiropractic accessibility	-11	.14	-53	.04	-8	.22

^aAdjusted for age, sex, race, baseline comorbidity, change in comorbidity, and primary care physician accessibility.

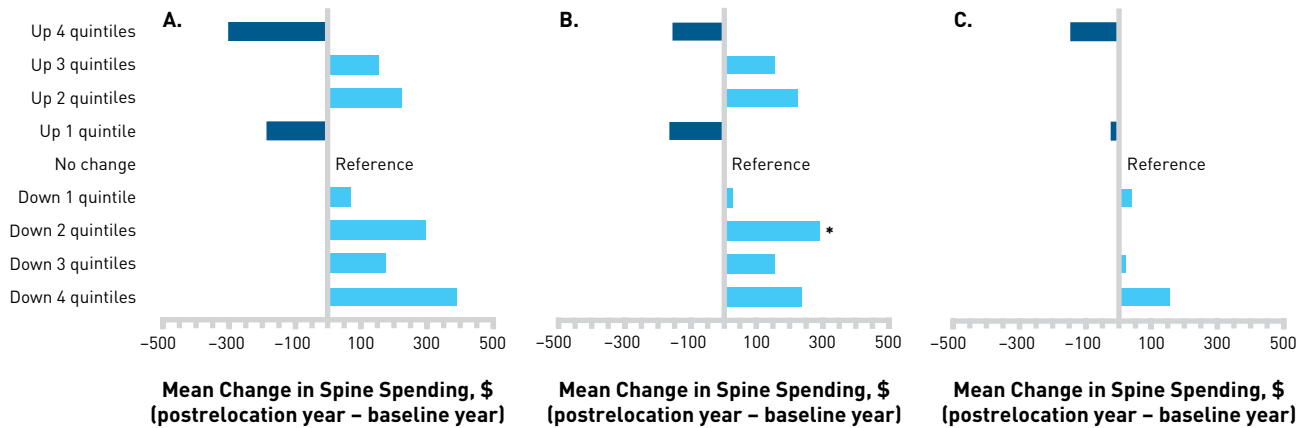
several times by the Office of the Inspector General.^{12,36-38} A prior study uncovered an association between higher accessibility of chiropractic care and lower reliance on primary care services, suggesting that chiropractic care may substitute for medical care.³⁹ We sought to determine whether or not chiropractic care is merely additive to the system (ie, patients use chiropractic care who would have otherwise not used health services or patients use chiropractic care in addition to other health services). We find that chiropractic care may be associated with small savings in aspects of ambulatory care. Although these are small per-person dollar differences (\$40 reduction in annual spending), the cumulative effect could be

quite large given the prevalence of spine conditions among older adults. Thus, it is conceivable that CMS is recapturing a portion of the payout for coverage of chiropractic care.

Limitations

Our study has several potential limitations that must be acknowledged. The cohort consisted of older adult Medicare beneficiaries who relocated once from 2010 to 2014, which could be perceived to limit the generalizability of our findings. However, considering that each beneficiary included in our cohort served as his or her own control, there is no reason to believe that the change in spending

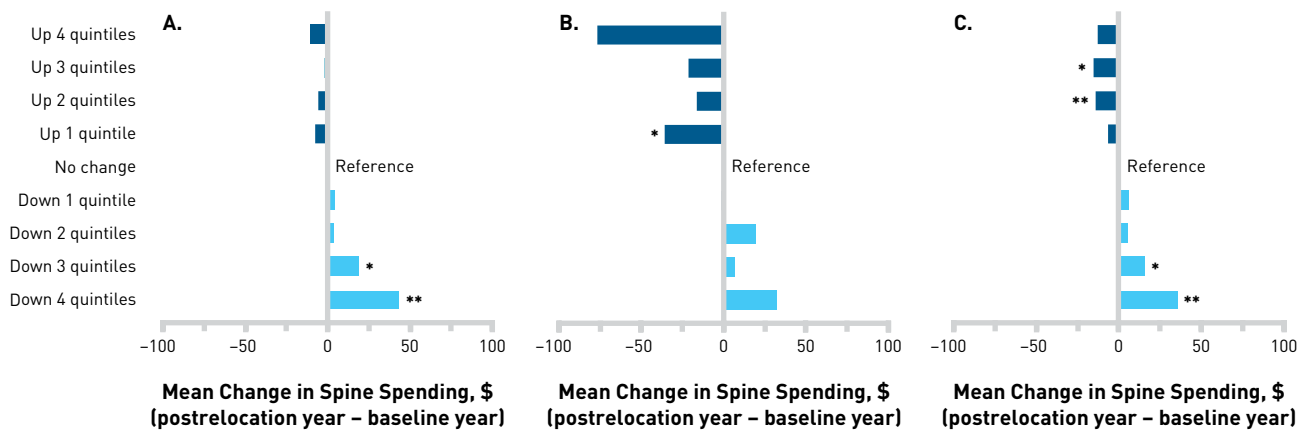
FIGURE 2. Relationship Between the Magnitude of Difference in Chiropractic Care Accessibility After Relocation (postrelocation year – baseline year) and Mean Change in (A) Total, (B) Inpatient, and (C) Ambulatory Care Spine-Related Spending^a



* $P < .05$; ** $P \leq .01$.

^aAdjusted for age, sex, race, baseline comorbidity, change in comorbidity, and primary care physician availability.

FIGURE 3. Relationship Between the Magnitude of Difference in Chiropractic Care Accessibility After Relocation (postrelocation year – baseline year) and Mean Ambulatory Care Categories of Spine-Related Spending, Including (A) Evaluation and Management, (B) Medical Procedures, and (C) Imaging and Testing^a



* $P < .05$; ** $P \leq .01$.

^aAdjusted for age, sex, race, baseline comorbidity, change in comorbidity, and primary care physician availability.

is not more broadly generalizable. A particular strength of using Medicare beneficiary relocation as an exogenous change unlikely to be related to our primary variable of interest is that it can be considered a more rigorous study design compared with traditional observational studies. However, we found differences in race and health status according to the change in chiropractic care accessibility. Despite accounting for these differences in our analyses, we cannot completely rule out residual confounding. Lastly, because our study used administrative data, we focused on spending, which is only one aspect of the important issues related to management of back and neck pain. We cannot say whether reductions in pain,

improvements in quality of life, or use of pharmacological agents were any different from the data in this study. These are particularly important avenues for investigation in the context of the current opioid crisis and will be addressed in future work.

CONCLUSIONS

This study is among the first to examine whether access to chiropractic care, a health service that provides a significant amount of the nation's conservative management of nonspecific back pain, has any effect on Medicare spending. We found some evidence of

a relationship between lower accessibility of chiropractic care and higher spending on diagnostic imaging and testing. Future work is required to determine if indeed access to chiropractic care for Medicare beneficiaries in any way breaks the pathway to care that is discordant with practice guidelines. ■

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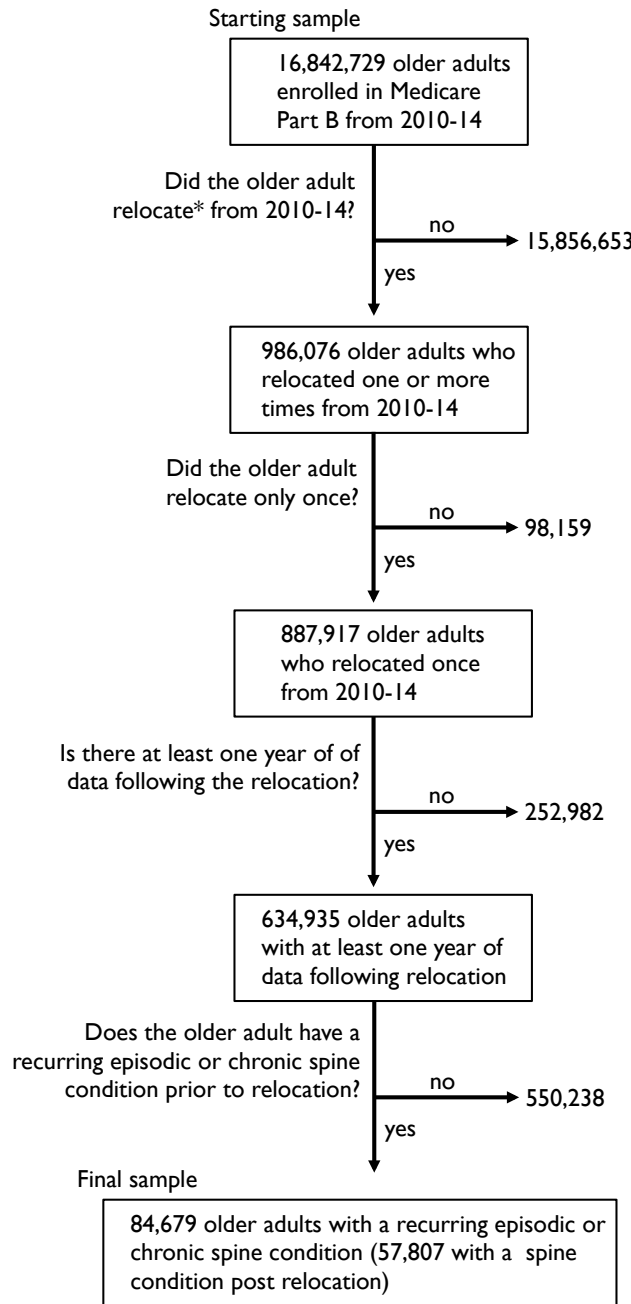
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eAppendix Table. Sociodemographic characteristics of older adults with spine conditions according to chiropractic accessibility at baseline




	No.	Mean age in years	Mean or % (95% CI)		
			% Female sex	% Black race	% with ≥ 1 comorbidity
Resident of quintile 1, lowest					
Moved yet remained within quintile 1	1,123	75.5 (75.1, 75.9)	67.5 (64.8, 70.2)	15.3 (13.2, 17.4)	40.6 (37.7, 43.5)
Moved to area of higher chiropractic care	7,002	76.4 (76.3, 76.6)	68.3 (67.3, 69.4)	8.3 (7.7, 8.9)	37.6 (36.5, 38.7)
Resident of quintile 2					
Moved to area of lower chiropractic care	1,672	75.8 (75.5, 76.1)	65.6 (63.3, 67.8)	11.5 (10.0, 13.1)	37.3 (34.9, 39.6)
Moved yet remained within quintile 2	3,232	76.7 (76.5, 77.0)	68.3 (66.7, 69.9)	6.9 (6.0, 7.8)	36.3 (34.7, 38.0)
Moved to area of higher chiropractic care	10,356	77.0 (76.9, 77.2)	69.5 (68.6, 70.4)	4.3 (3.9, 4.7)	34.7 (33.8, 35.6)
Resident of quintile 3					
Moved to area of lower chiropractic care	5,356	76.4 (76.3, 76.6)	67.6 (66.3, 68.8)	6.6 (5.9, 7.2)	36.7 (35.4, 37.9)
Moved yet remained within quintile 3	4,810	77.1 (76.9, 77.3)	69.9 (68.6, 71.2)	3.8 (3.2, 4.3)	35.1 (33.7, 36.4)
Moved to area of higher chiropractic care	9,208	77.1 (77.0, 77.3)	67.8 (66.8, 68.7)	2.5 (2.2, 2.9)	33.6 (32.6, 34.5)
Resident of quintile 4					
Moved to area of lower chiropractic care	10,708	77.1 (76.9, 77.2)	68.8 (67.9, 69.7)	4.1 (3.7, 4.5)	35.3 (34.4, 36.2)
Moved yet remained within quintile 4	6,616	77.4 (77.3, 77.6)	68.6 (67.4, 69.7)	2.1 (1.8, 2.5)	35.0 (33.8, 36.1)
Moved to area of higher chiropractic care	5,243	77.6 (77.4, 77.8)	69.1 (67.8, 70.3)	1.5 (1.2, 1.9)	34.6 (33.3, 35.9)
Resident of quintile 5, highest chiropractic care					
Moved to area of lower chiropractic care	13,378	77.0 (76.9, 77.2)	67.6 (66.8, 68.4)	1.9 (1.7, 2.1)	35.3 (34.5, 36.2)
Moved yet remained within quintile 4	5,975	77.6 (77.4, 77.8)	68.8 (67.6, 70.0)	0.5 (0.4, 0.7)	35.0 (33.8, 36.2)



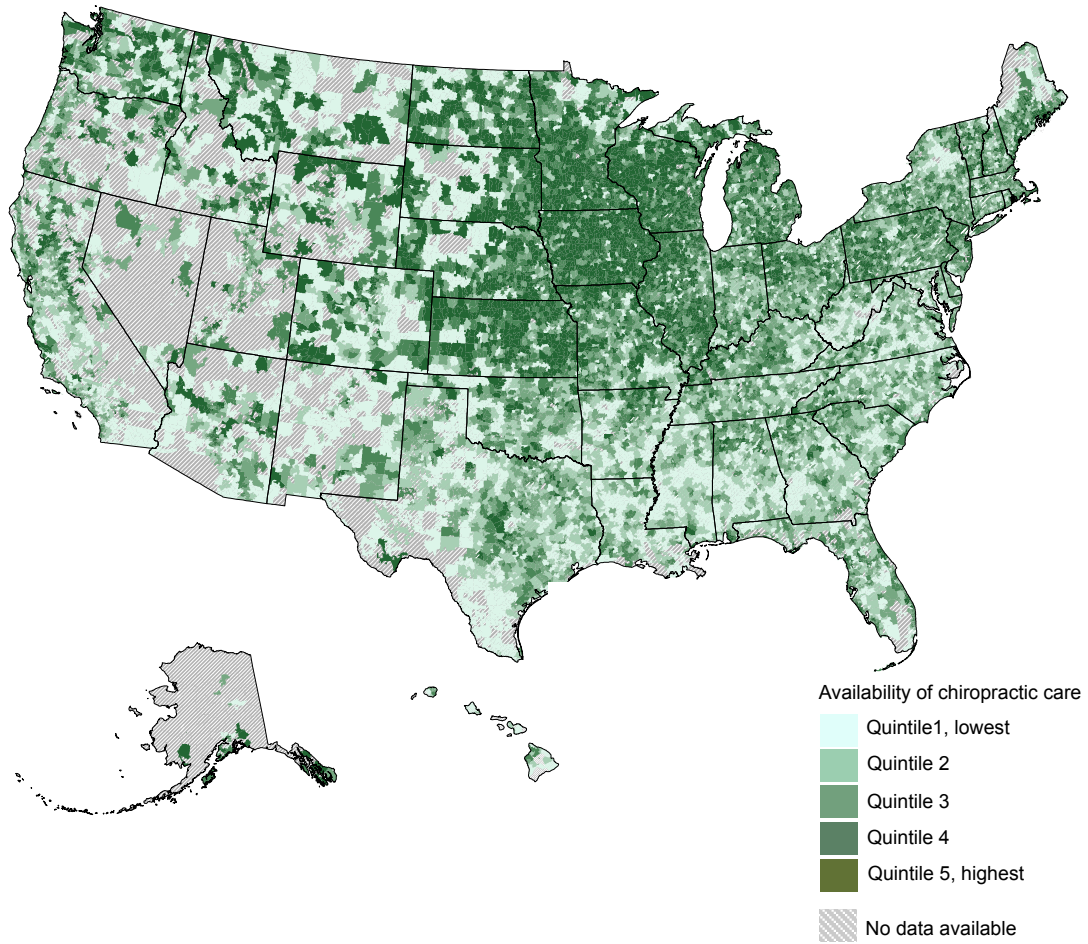
eAppendix Figure 1. Flow diagram of study inclusion for older adults

* Relocation defined as changing a Hospital Referral Region based on residential address in the Master Beneficiary Summary File

		Calendar Year					
		2010	2011	2012	2013	2014	Included in study?
Hospital Referral Region of residence		34	34	89	89	89	Yes
		18	90	90	90	90	Yes
		93	93	93	93	93	No (did not move)
		290	290	290	290	07	No (no follow-up data)
		62	09	09	09	77	No (moved multiple times)
		...					

	Baseline year	Year of relocation	Post-relocation year
			

eAppendix Figure 2. Identification of baseline and post-relocation year based on change in Hospital Referral Region of residence



eAppendix Figure 3. Unadjusted geographic variation in the accessibility of chiropractic care across U.S. ZIP Code Tabulation Areas