

A Geographic and State Analysis of Medicaid Reimbursement for Over 200 Orthopedic Current Procedure Codes

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Abstract

Background

Little research exists regarding geographic comparisons within the United States for Medicaid reimbursement. We compared Medicaid reimbursement for a broad range of orthopedic surgery codes from each state on a geographic and state level.

Methods

We obtained Medicaid reimbursement rates in each state for 211 orthopedic procedure codes along with corresponding work Relative Value Units (wRVUs). Rates were divided by wRVUs to control for differences between procedures and subspecialties. States were designated as either West, Midwest, South, or Northeast. Kruskal-Wallis tests with Dunn's post-hoc analyses ascertained differences between regions and each orthopedic subspecialty by state. Coefficient of variation (CoV) values were calculated to measure the amount of variability in rates. A Kruskal-Wallis with Dunn's post-hoc test assessed differences in quartiles for reimbursement compared to a square miles per orthopedic surgeon ratio.

Results

The West region reimbursed the highest at \$72.92/wRVU and the Northeast reimbursed the lowest at \$51.78. Hand surgery was the highest reimbursing subspecialty (\$94.58/wRVU) and Oncology the lowest (\$62.89/wRVU). The CoV ranged from 0.15–0.77 by state and 0.27–0.50 by subspecialty. A linear regression model between wRVU-adjusted Medicaid reimbursement and square miles per surgeon yielded an R² value of 0.453. States with the most land area relative to orthopedic surgeons reimbursed significantly higher.

Conclusion

The West geographic region is associated with the highest Medicaid reimbursement for orthopedic procedures, and the Northeast the lowest. Wide variability was seen in rates, both between states and within states. Large, sparsely-populated states may increase Medicaid reimbursement as a tactic to attract physicians.

Level of Evidence:

IV; Economic Analysis

INTRODUCTION

Orthopedic Surgery is a discipline treating a wide range of musculoskeletal conditions that frequently serves patients of all ages and demographics. A past analysis of healthcare expenditure indicated that treatment of musculoskeletal conditions represented the highest healthcare spending in the United States (US), ahead of conditions such as diabetes, cardiovascular diseases, and cancer.¹ Over 37% of this musculoskeletal care is funded by public insurers, including Medicare, Medicaid, and other government-funded programs, highlighting the pivotal role of these programs in paying for orthopedic services in the US.

Prior studies have characterized both Medicare and Medicaid reimbursement to physicians for a variety of orthopedic surgery procedures. These studies have generally reported decreasing inflation-adjusted Medicare reimbursement over the past several decades along with lower Medicaid reimbursement compared to Medicare with wide variability between states.^{2–12} Few studies, however, have analyzed geographical differences in reimbursement. Gill et al. found that Medicare reimbursement was highest for total hip arthroplasty in the Northeast and West, and another study by Gill et al. found that Medicare meniscectomy reimbursement was highest in the Northeast and Midwest.^{13,14} These findings partially reflect wage differences between regions, as Medicare uniformly sets its rates according to the Geographic Practice Cost Indices (GPCIs), which adjust reimbursement according to local factors such as cost-of-living, practice expense, and liability insurance.¹⁵ GPCI adjustments can also be made to incentivize physician work in the state as evidenced by some Western states (Montana, Nevada, North Dakota, South Dakota, and Wyoming) having been

established as “frontier states” with practice expense GPCI minimums of 1.00 to increase reimbursement.¹⁶ Alaska also has a minimum work GPCI of 1.50 (all other states are between 1.002 to 1.100) to incentivize physician work in the state.

Less is known regarding the effect of geographic location on Medicaid reimbursement. Since Medicaid rates are set by individual states, metrics such as state wage differences or Medicare GPICs may not accurately predict variability in reimbursement. Additionally, centralized databases that compare Medicaid rates do not exist. A recent analysis by Wu et al. revealed that hospitals in the West and Northeast charged significantly higher prices for arthroscopic rotator cuff repairs, and that prices were higher in states with Medicaid expansion under the Patient Protection and Affordable Care Act.¹⁷ It is not clear if these findings on hospital charges are translatable to physician reimbursement. The effect of geographic variation on Medicaid reimbursement is important not only to orthopedic surgeons who desire equitable compensation, but also to Medicaid beneficiaries. Labrum et al. found that patients with commercial insurance enjoy greater access to orthopedic care than Medicaid patients, but that increased Medicaid reimbursement is associated with better access to care for Medicaid beneficiaries, highlighting how surgeons may respond to economic incentives to care for this vulnerable population.¹⁸

We are not aware of prior studies that have analyzed geographic variability in orthopedic surgery for a comprehensive list of procedural codes. Our aim was to compare general orthopedic surgery and orthopedic subspecialty reimbursement by geographic area. We also hoped to identify factors that help explain differences in state reimbursement. Based on a cursory overview of previous Medicaid reimbursement analyses,²⁻⁴ we hypothesize that the West will demonstrate the highest Medicaid reimbursement and the Northeast the lowest, with notable variability between subspecialties and states.

METHODS

Included Codes

Institutional review board approval was not required for this study, which used publicly available data from online databases. Current Procedural Terminology (CPT) codes were chosen from various recent analyses of Medicare and Medicaid reimbursement, each with an objective methodology to select the most commonly utilized CPT codes within each subspecialty.²⁻¹² Altogether, 211 codes were included in prior published analysis of each subspecialty, and all were included within this present analysis: nine for Arthroplasty, four for Shoulder Arthroplasty, 20 for Foot/Ankle, 26 for Hand, 38 for Oncology, fifteen for Spine, 80 for Sports, and 20 for Trauma (Arthroplasty and Oncology shared CPT code 27130). These codes widely represent some of the most commonly utilized codes within their given subspecialties, and therefore, all orthopedics. Work Relative Value Units (wRVUs) are a component of reimbursement to physicians, reflecting the perceived amount of effort required to complete a procedure. These were obtained for each CPT code from the Centers for Medicare & Medicaid Services online Physician Fee Schedule Look-Up Tool.¹⁹

Fee Schedules

Medicaid reimbursement rates were collected for each CPT code from online state Medicaid fee schedules. No modifier codes were included. CPT codes were occasionally missing from a state fee schedule. In these instances, that code was excluded from analysis for that state. Tennessee was excluded from this analysis as its state Medicaid program does not utilize a fee-for-service model.

Analyses

All CPT codes were divided by their corresponding number of wRVUs to achieve wRVU-adjusted rates to more easily compare across specialties. To compare wRVU-adjusted reimbursement between states, all of the CPT codes belonging to each of the eight designated orthopedic subspecialties were combined into a mean value. Additionally, all 211 CPT codes were combined to a single mean wRVU-adjusted reimbursement value for easy comparison between states. The coefficient of variation (CoV), a relative measure of the variability of a dataset calculated by dividing the standard deviation by the mean, was recorded for each state and subspecialty using wRVU-adjusted data. Values closer to zero represent less variability, while values further from zero represent greater variability.

Linear regression models were created using overall state wRVU-adjusted data. Orthopedic surgeons per square mile (surgeons/mile²) and square miles per orthopedic surgeon (mile²/surgeon) in each state were calculated using publicly-available information on state land area and surgeon data from the International Society for the Advancement of Spine Surgery.^{20,21} Overall federal funding per person by state in 2020 came from an analysis of US Census data by USAFacts.²² Population density by state was obtained using United States Census Bureau data.²³ Other tested variables included the Medicare Wage Index as a measure for state wage differences, physician acceptance of Medicaid patients by state, poverty rate, percentage of state enrolled in Medicaid, and Medicaid spending per capita.^{24–27}

To further compare the effects of mile²/surgeon on reimbursement, the states were divided into four quartiles, with Quartile 1 representing the lowest mile²/surgeon ratio and Quartile 4 representing the highest. Normality was tested using the Shapiro-Wilk test in R with a resulting p-value less than 0.05, indicating the dataset was not normally distributed. Kruskal-Wallis test with Dunn's post-hoc was performed with Bonferroni-corrected alpha value was set at 0.0083 for significance. This allowed us to characterize very sparsely populated states in relation to the rest of the country. Analysis was conducted in R.

The wRVU-adjusted data were sorted into groups by geographic region (Northeast, South, Midwest, and West) based on US Census guidelines and by subspecialty.²⁸ Combined US and combined Orthopedic Surgery groups were also reported for reference. Normality was tested for each group using the Shapiro-Wilk test in R and all groups were found to be not normally distributed with p-values < 0.05. Kruskal-Wallis tests were performed to assess differences between groups with Dunn's post-hoc analysis. The four geographic regions were compared in each subspecialty and overall in Orthopedic Surgery with a Bonferroni-corrected alpha value set at 0.0083. The eight subspecialties were compared in each geographic region and in the combined US with a Bonferroni-corrected alpha value set at 0.0018. States were divided into four quartiles based on miles²/surgeon. Kruskal-Wallis tests with Dunn's post-hoc analysis were performed to compare population density quartiles among states. All analyses were performed in R.

RESULTS

State Comparisons

Overall, the states with the highest mean wRVU-adjusted reimbursement across all procedures were Alaska (\$125.08), Montana (\$96.41), and New Mexico (\$89.67). The lowest reimbursing states were Rhode Island (\$31.25), New Hampshire (\$37.56), and Colorado (\$45.09). The overall CoV for wRVU-adjusted data across all codes by state ranged from 0.15 (Nevada) to 0.77 (Idaho). Within each subspecialty, CoV of wRVU-adjusted data across each subspecialty's included codes ranged from 0.27 (Shoulder Arthroplasty) to 0.50 (Foot/Ankle). The mean CoV across all CPT codes in every state was 0.42. Table 1 provides a complete breakdown of mean wRVU-adjusted rates by state with associated CoV while Fig. 1 conveys the averages as a heatmap.

Table 1
Average Medicaid Reimbursement per wRVU Overall and by Subspecialty in all 49 Included States with Associated Coefficient of Variation in Parentheses

State	Arthroplasty	Foot/Ankle	Hand	Oncology	Shoulder	Spine	Sports	Trauma	Overall
Alaska	\$106 (0.02)	\$147 (0.15)	\$178 (0.37)	\$110 (0.07)	\$106 (0.02)	\$111 (0.07)	\$118 (0.11)	\$116 (0.05)	\$125 (0.27)
Montana	\$86 (0.02)	\$86 (0.17)	\$123 (0.21)	\$89 (0.08)	\$86 (0.02)	\$93 (0.08)	\$96 (0.11)	\$95 (0.06)	\$96 (0.17)
New Mexico	\$76 (0.06)	\$111 (0.17)	\$126 (0.39)	\$75 (0.11)	\$77 (0.02)	\$83 (0.06)	\$84 (0.13)	\$84 (0.07)	\$90 (0.29)
Nebraska	\$91 (0.18)	\$51 (0.38)	\$77 (0.22)	\$65 (0.39)	\$76 (0.25)	\$97 (0.30)	\$98 (0.45)	\$70 (0.18)	\$82 (0.44)
Arizona	\$68 (0.02)	\$97 (0.16)	\$115 (0.40)	\$71 (0.08)	\$68 (0.02)	\$73 (0.08)	\$76 (0.11)	\$75 (0.06)	\$81 (0.28)
North Dakota	\$66 (0.02)	\$96 (0.17)	\$114 (0.42)	\$68 (0.08)	\$66 (0.02)	\$69 (0.08)	\$74 (0.11)	\$73 (0.06)	\$79 (0.30)
Idaho	\$53 (0.02)	\$193 (0.56)	\$90 (0.40)	\$55 (0.07)	\$54 (0.02)	\$82 (1.23)	\$60 (0.11)	\$59 (0.06)	\$77 (0.77)
Hawaii	\$67 (0.02)	\$70 (0.19)	\$102 (0.25)	\$70 (0.08)	\$67 (0.02)	\$71 (0.09)	\$76 (0.11)	\$75 (0.06)	\$77 (0.20)
Delaware	\$65 (0.02)	\$89 (0.17)	\$110 (0.41)	\$67 (0.08)	\$65 (0.02)	\$67 (0.08)	\$70 (0.11)	\$71 (0.06)	\$76 (0.29)
Oklahoma	\$63 (0.03)	\$96 (0.25)	\$96 (0.34)	\$65 (0.07)	\$62 (0.02)	\$66 (0.07)	\$69 (0.11)	\$68 (0.05)	\$73 (0.26)
Nevada	\$67 (0.03)	\$75 (0.21)	\$88 (0.18)	\$68 (0.07)	\$65 (0.03)	\$70 (0.07)	\$72 (0.10)	\$72 (0.05)	\$73 (0.15)
South Dakota	\$64 (0.03)	\$81 (0.19)	\$93 (0.28)	\$63 (0.09)	\$65 (0.02)	\$63 (0.24)	\$70 (0.13)	\$70 (0.10)	\$72 (0.22)
Indiana	\$60 (0.02)	\$87 (0.16)	\$102 (0.41)	\$62 (0.08)	\$60 (0.02)	\$63 (0.08)	\$68 (0.11)	\$66 (0.06)	\$72 (0.29)
New York	\$60 (0.02)	\$85 (0.17)	\$100 (0.42)	\$62 (0.09)	\$60 (0.02)	\$66 (0.09)	\$68 (0.15)	\$66 (0.05)	\$72 (0.29)
Maryland	\$64 (0.09)	\$66 (0.11)	\$90 (0.32)	\$61 (0.13)	\$68 (0.04)	\$66 (0.06)	\$70 (0.10)	\$68 (0.06)	\$70 (0.21)
Wyoming	\$64 (0.07)	\$92 (0.27)	\$85 (0.30)	\$56 (0.24)	\$52 (0.23)	\$65 (0.08)	\$69 (0.24)	\$65 (0.04)	\$70 (0.29)
Virginia	\$56 (0.02)	\$79 (0.17)	\$94 (0.41)	\$58 (0.09)	\$54 (0.02)	\$60 (0.08)	\$62 (0.11)	\$61 (0.06)	\$67 (0.28)
Iowa	\$66 (0.07)	\$75 (0.19)	\$72 (0.20)	\$54 (0.27)	\$58 (0.08)	\$63 (0.07)	\$69 (0.27)	\$65 (0.17)	\$66 (0.25)
Texas	\$55 (0.02)	\$82 (0.23)	\$92 (0.41)	\$57 (0.09)	\$55 (0.02)	\$59 (0.09)	\$61 (0.11)	\$60 (0.06)	\$66 (0.29)
Pennsylvania	\$34 (0.16)	\$73 (1.00)	\$72 (0.70)	\$37 (0.35)	\$35 (0.19)	\$47 (0.28)	\$86 (0.35)	\$67 (0.25)	\$66 (0.62)
Vermont	\$54 (0.02)	\$79 (0.17)	\$93 (0.41)	\$56 (0.08)	\$54 (0.02)	\$55 (0.14)	\$61 (0.12)	\$60 (0.06)	\$65 (0.30)
Wisconsin	\$57 (0.22)	\$55 (0.48)	\$64 (0.30)	\$57 (0.29)	\$54 (0.11)	\$61 (0.27)	\$71 (0.33)	\$62 (0.11)	\$64 (0.32)
Mississippi	\$54 (0.02)	\$76 (0.16)	\$81 (0.30)	\$56 (0.08)	\$54 (0.02)	\$59 (0.15)	\$60 (0.11)	\$59 (0.07)	\$63 (0.21)

State	Arthroplasty	Foot/Ankle	Hand	Oncology	Shoulder	Spine	Sports	Trauma	Overall
Georgia	\$63 (0.07)	\$71 (0.19)	\$69 (0.19)	\$51 (0.27)	\$56 (0.08)	\$60 (0.08)	\$65 (0.28)	\$62 (0.18)	\$63 (0.25)
Massachusetts	\$52 (0.03)	\$71 (0.17)	\$83 (0.37)	\$54 (0.08)	\$52 (0.02)	\$55 (0.08)	\$57 (0.11)	\$56 (0.05)	\$61 (0.26)
Missouri	\$49 (0.02)	\$74 (0.18)	\$83 (0.42)	\$51 (0.08)	\$49 (0.02)	\$54 (0.07)	\$56 (0.19)	\$54 (0.06)	\$59 (0.30)
Kansas	\$51 (0.04)	\$70 (0.23)	\$79 (0.44)	\$46 (0.26)	\$47 (0.17)	\$51 (0.08)	\$59 (0.27)	\$55 (0.12)	\$59 (0.34)
Oregon	\$48 (0.02)	\$70 (0.17)	\$82 (0.40)	\$51 (0.15)	\$48 (0.02)	\$53 (0.21)	\$54 (0.12)	\$53 (0.06)	\$58 (0.29)
Florida	\$49 (0.04)	\$71 (0.16)	\$82 (0.38)	\$48 (0.16)	\$49 (0.02)	\$53 (0.07)	\$55 (0.11)	\$54 (0.06)	\$58 (0.28)
Utah	\$49 (0.02)	\$68 (0.16)	\$81 (0.40)	\$50 (0.08)	\$49 (0.02)	\$52 (0.08)	\$55 (0.11)	\$53 (0.06)	\$58 (0.28)
Alabama	\$54 (0.10)	\$65 (0.23)	\$72 (0.43)	\$45 (0.27)	\$49 (0.04)	\$52 (0.09)	\$56 (0.32)	\$53 (0.13)	\$56 (0.34)
North Carolina	\$51 (0.07)	\$72 (0.27)	\$70 (0.33)	\$45 (0.24)	\$51 (0.01)	\$51 (0.05)	\$55 (0.25)	\$52 (0.04)	\$56 (0.29)
West Virginia	\$47 (0.02)	\$64 (0.15)	\$76 (0.37)	\$50 (0.13)	\$47 (0.02)	\$52 (0.08)	\$52 (0.11)	\$52 (0.05)	\$55 (0.25)
Illinois	\$59 (0.34)	\$46 (0.25)	\$56 (0.53)	\$39 (0.42)	\$48 (0.28)	\$76 (0.45)	\$57 (0.45)	\$53 (0.22)	\$54 (0.46)
Ohio	\$55 (0.07)	\$56 (0.16)	\$62 (0.35)	\$45 (0.22)	\$49 (0.06)	\$51 (0.13)	\$54 (0.12)	\$52 (0.12)	\$53 (0.21)
South Carolina	\$45 (0.03)	\$71 (0.26)	\$68 (0.34)	\$46 (0.07)	\$45 (0.02)	\$46 (0.09)	\$49 (0.11)	\$48 (0.05)	\$53 (0.26)
Kentucky	\$60 (0.09)	\$49 (0.18)	\$48 (0.14)	\$44 (0.32)	\$53 (0.03)	\$53 (0.22)	\$57 (0.33)	\$52 (0.14)	\$52 (0.28)
Maine	\$44 (0.02)	\$61 (0.18)	\$71 (0.41)	\$46 (0.08)	\$43 (0.02)	\$47 (0.08)	\$50 (0.11)	\$48 (0.06)	\$52 (0.27)
California	\$62 (0.20)	\$51 (0.25)	\$56 (0.22)	\$46 (0.27)	\$52 (0.08)	\$52 (0.24)	\$54 (0.28)	\$46 (0.23)	\$52 (0.27)
Minnesota	\$45 (0.02)	\$48 (0.18)	\$67 (0.21)	\$47 (0.08)	\$46 (0.02)	\$47 (0.09)	\$52 (0.11)	\$51 (0.06)	\$52 (0.18)
Arkansas	\$94 (0.17)	\$64 (0.17)	\$78 (0.22)	\$60 (0.32)	\$71 (0.13)	\$63 (0.37)	\$17 (0.33)	\$69 (0.27)	\$49 (0.60)
Louisiana	\$44 (0.07)	\$61 (0.26)	\$60 (0.30)	\$39 (0.24)	\$44 (0.00)	\$44 (0.05)	\$47 (0.24)	\$45 (0.04)	\$48 (0.28)
Michigan	\$42 (0.02)	\$43 (0.18)	\$59 (0.20)	\$43 (0.09)	\$42 (0.02)	\$45 (0.08)	\$47 (0.11)	\$46 (0.06)	\$47 (0.17)
New Jersey	\$33 (0.02)	\$37 (0.50)	\$46 (0.49)	\$81 (0.39)	\$33 (0.11)	\$35 (0.09)	\$37 (0.12)	\$36 (0.06)	\$45 (0.52)
Connecticut	\$40 (0.07)	\$56 (0.26)	\$62 (0.44)	\$36 (0.24)	\$35 (0.17)	\$40 (0.05)	\$45 (0.25)	\$41 (0.12)	\$45 (0.34)
Colorado	\$58 (0.14)	\$33 (0.59)	\$42 (0.34)	\$37 (0.36)	\$53 (0.15)	\$55 (0.21)	\$50 (0.39)	\$41 (0.25)	\$45 (0.39)
Washington	\$37 (0.02)	\$53 (0.18)	\$63 (0.40)	\$39 (0.08)	\$38 (0.02)	\$40 (0.08)	\$42 (0.12)	\$42 (0.06)	\$45 (0.28)

State	Arthroplasty	Foot/Ankle	Hand	Oncology	Shoulder	Spine	Sports	Trauma	Overall
New Hampshire	\$43 (0.25)	\$29 (0.62)	\$34 (0.44)	\$33 (0.39)	\$30 (0.11)	\$45 (0.24)	\$43 (0.42)	\$30 (0.34)	\$38 (0.43)
Rhode Island	\$39 (0.25)	\$25 (0.34)	\$28 (0.39)	\$26 (0.46)	\$34 (0.20)	\$35 (0.37)	\$35 (0.35)	\$31 (0.22)	\$31 (0.38)
Average	\$57 (0.28)	\$72 (0.50)	\$80 (0.49)	\$55 (0.33)	\$55 (0.27)	\$59 (0.38)	\$61 (0.35)	\$59 (0.28)	\$63 (0.42)

The overall state rates were plotted with numerous variables to assess for potential relationships. The variable with the highest R^2 values was miles²/surgeon with an R^2 value of 0.453. This was followed by overall federal funding received per person and state population density, which had R^2 values of 0.203 and 0.123, respectively. Figure 2 shows these scatter plots with trendlines. When broken into quartiles, Kruskal-Wallis with Dunn's post-hoc for miles²/surgeons ratios demonstrated that Quartile 4, which represents the states most sparsely populated by orthopedic surgeons, had significantly higher wRVU-adjusted reimbursement rates compared to Quartiles 1 and 2. No significant relationships were found amongst the other groups (Table 2).

Table 2

Kruskal-Wallis Test with Dunn's Post-Hoc to Compare Square Miles per Orthopedic Surgeon Quartiles to Medicaid Reimbursement per wRVU

Comparison	Z-Score	Corrected p-value
Quartile 1 vs Quartile 2	0.2429	1.0000
Quartile 1 vs Quartile 3	-0.8857	1.0000
Quartile 2 vs Quartile 3	-0.6429	1.0000
Quartile 1 vs Quartile 4	-2.8913	0.0230
Quartile 2 vs Quartile 4	-2.6436	0.0492
Quartile 3 vs Quartile 4	-1.9881	0.2808
Kruskal-Wallis chi-squared: 10.463, p-value: <0.015. Square miles per orthopedic surgeon in each state set at Quartile 1: <65, Quartile 2: 65–150, Quartile 3: 151–275, Quartile 4: >275. Bonferroni-corrected p-value significant at alpha = 0.00833. Significant p-values bolded		

Geographic Comparisons

The West region had significantly higher reimbursement in the combined Orthopedic Surgery group and all subspecialties compared to all other regions, with the exception of Shoulder Arthroplasty, where no difference was found between West versus Midwest and West versus South. The Northeast was the lowest reimbursing region in all geographic analyses. By subspecialty, Hand and Foot/Ankle were consistently the highest reimbursing subspecialties, with Hand being significantly higher than Foot/Ankle in the combined USA and Midwest. Table 3 provides average work RVU-adjusted reimbursement for all geographic regions and subspecialties as well as significant differences between groups as determined by Kruskal-Wallis tests with Dunn's post-hoc analyses. Figure 3 and Fig. 4 visualize comparative reimbursement by subspecialty and geographic area, respectively. **Supplementary Fig. 1** provides a heatmap of the US by geographic area.

Table 3

Geographic Breakdown of Average Medicaid Reimbursement for all Combined Orthopedic Codes and by Orthopedic Subspecialty, per Work RVU

		Geographic Region						
		US	Northeast	South	Midwest	West	p-value	Significant Differences
Subspecialty	Orthopedic Surgery, combined	\$62.74	\$51.78	\$60.32	\$63.22	\$72.92	< 0.0001	W > MW, W > S, W > NE, MW > NE, S > NE
	Arthroplasty, Hip and Knee	\$57.22	\$44.23	\$57.38	\$58.74	\$64.88	< 0.0001	W > MW, W > S, W > NE, MW > NE, S > NE
	Foot/Ankle	\$71.95	\$57.31	\$71.72	\$65.21	\$88.76	< 0.0001	W > MW, W > S, W > NE, S > MW, S > NE, MW > NE
	Hand	\$80.19	\$65.38	\$79.00	\$77.20	\$94.58	< 0.0001	W > MW, W > S, W > NE, MW > NE, S > NE
	Oncology	\$54.79	\$47.99	\$52.72	\$53.70	\$62.89	< 0.0001	W > MW, W > S, W > NE, MW > NE, S > NE
	Shoulder Arthroplasty	\$54.55	\$41.58	\$54.83	\$55.00	\$62.96	< 0.0001	W > MW, W > S, W > NE
	Spine	\$59.57	\$47.07	\$56.75	\$61.77	\$69.22	< 0.0001	W > MW, W > S, W > NE, MW > NE, S > NE
	Sports	\$61.42	\$52.81	\$56.62	\$64.58	\$69.95	< 0.0001	W > MW, W > S, W > NE, MW > S, S > NE, MW > NE
	Trauma	\$59.22	\$47.85	\$58.28	\$59.72	\$67.49	< 0.0001	W > MW, W > S, W > NE, MW > NE, S > NE
	p-value	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001		
	Significant Differences	H > FA, H > Spo, H > Spi, H > T, H > A, H > O, H > Sh, FA > Spo, FA > Spi, FA > T, FA > A, FA > O, FA > Sh, Spo > A, Spo > O, Spo > Sh, Spi > O, Spi > Sh, T > O, T > Sh	H > Spo, H > O, H > T, H > Spi, H > A, H > Sh, FA > O, FA > A, FA > Sh, Spo > O, Spo > A, Spo > Sh	H > T, H > A, H > Spi, H > Spo, H > Sh, H > O, FA > T, FA > A, FA > Spi, FA > Spo, FA > Sh, FA > O, T > O, Spo > O	H > FA, H > Spo, H > Spi, H > T, H > A, H > Sh, H > O, FA > Sh, FA > O, Spo > A, Spo > O, Spo > Sh, Spi > O, T > O	H > Spo, H > Spi, H > T, H > A, H > Sh, H > O, FA > Spo, FA > Spi, FA > T, FA > A, FA > Sh, FA > O, Spo > O		

Table 3 provides a breakdown of mean Medicaid reimbursement per wRVU in the US and by geographic region for all of orthopedic surgery as well as eight subspecialties. Significant differences between the four geographic regions were assessed for all

subspecialties using Kruskal-Wallis tests with Dunn's post hoc. A Bonferroni correction set the alpha value at 0.0083 for significance. Kruskal-Wallis tests were also used to compare the eight orthopedic subspecialties with Dunn's post hoc within each geographic region. The Bonferroni correction set the alpha value at 0.0018. Abbreviations: A=Arthroplasty, Sh=Shoulder Arthroplasty, FA=Foot/Ankle, H=Hand, O=Oncology, Spi=Spine, Spo=Sports, T=Trauma, NE=Northeast, S=South, W=West, MW=Midwest. NOTE: Combined Orthopedic Surgery is not used in any of the subspecialty comparisons and USA is not used in any of the geographic comparisons.

DISCUSSION

This study found that, for 211 common Orthopedic Surgery procedure codes, the West was the highest reimbursing region in the US for Medicaid, and the Northeast the lowest. Hand and Foot/Ankle were the two highest reimbursing subspecialties across the combined US, with Hand being significantly higher in reimbursement than Foot/Ankle in the combined US and Midwest. States ranged overall from \$31.25 per wRVU (Rhode Island) to \$125.08 per wRVU (Alaska). Subspecialty reimbursement averaged among all states ranged from \$52.34/wRVU (Shoulder Arthroplasty) to \$92.23/wRVU (Hand). The CoV for wRVU-adjusted data across all codes ranged from 0.15 (Nevada) to 0.77 (Idaho), indicating considerable variability both between states, and between CPT codes within states. Linear regression models revealed a moderate correlation between Medicaid reimbursement and miles²/surgeon, suggesting that states with more isolated geographic areas may reimburse at higher rates.

Because miles²/surgeon correlated with Medicaid reimbursement better than any other variable, geographically larger, more rural states, such as those that predominate in the West, may tend to reimburse at a higher rate. This inverse density measure likely fits the data better than the direct density measure (surgeons/mile²) because it favors sparsity, magnifying the most rural states that also tend to reimburse at higher rates. This could reflect intentional decisions by state legislatures in sparsely populated states to attract more physicians to enhance access for Medicaid beneficiaries. This correlates with the Kruskal-Wallis test with Dunn's post-hoc analysis, which found that the states more sparsely inhabited by orthopedic surgeons reimbursed significantly higher than the more concentrated two quartiles, but no other quartiles were significantly different than each other. Noticeably, California does not reimburse relatively well for Medicaid, despite being a large western state, likely because of its high population and physician density,^{20,23} whereas sparsely populated states like Alaska and New Mexico reimburse at much higher rates. Northeastern states, with heavily-populated metropolitan areas like Boston, Philadelphia, and New York City, likely have no trouble maintaining a high physician workforce and have no need to spend additional tax dollars to attract more, thus explaining their comparatively low reimbursement.²⁹ Altogether, our results likely show that state Medicaid rate-setting is either random or too complex to be captured by easily-identified variables, with the general exception of large, sparsely populated states, which tend to reimburse at higher rates, perhaps to entice physicians to practice there.

Variability, both between states and within states, was high as demonstrated by the broad range and elevated CoVs for wRVU-adjusted data. Past analyses using CoVs on Medicare rates have shown consistent and low variability with values around 0.06,^{2,3} highlighting Medicaid's high variability in comparison. The Medicaid and CHIP Payment and Access Commission (MACPAC) released a comprehensive overview of state rate policies using state websites and staff communication in 2017.³⁰ While now dated, it provided important context for how states determine physician reimbursement. Many states reimburse either as a range of percentages of Medicare reimbursement or the underlying Resource Based Relative Value Scale (RBRVS) used to calculate Medicare reimbursement, but others set rates based on "internal processes" or "market assessment".

We chose three states that illustrate particularly outdated reimbursement systems. Virginia's fee schedule is modeled similarly to the 1995 RBRVS; while there is a short list of updates provided in their Per Procedure Fee Audit Trail, a search of five random codes did not yield any updates in this time, and most codes are likely identical in reimbursement since that time.³¹ Arkansas' fee schedule was based on up to 80% of the 2003 Arkansas Blue Cross/Blue Shield state fee schedule and, when comparing five random codes to their earliest archived fee schedule (2007), none had changed.³² Georgia appears to still set rates at 84.645% of the 2000 RBRVS and random sampling of five codes shows no differences when compared to their earliest archived schedule from 2013.³³ With such disparities in methodology between states and often outdated fee schedules, it is easy to recognize how such variability can exist.

Meanwhile, highly-reimbursing western states such as Alaska and Arizona have recently raised their fee schedules, with Arizona's notice stating the changes are "sufficient enough to enlist enough providers so that care and services are available."^{34,35} Indeed, numerous studies have suggested that higher Medicaid reimbursement to physicians is associated with greater access to care for

Medicaid beneficiaries.^{18,36–38} We believe Medicaid rates should be transparent, regularly updated, and reflect values comparable to Medicare, both to ensure access to care for this vulnerable population and to fairly compensate orthopedic surgeons for their work. States that seek to attract surgeons to their sparsely-populated regions should continue to offer elevated rates, as demonstrated by several large western states.

Limitations

There are several limitations of our study. A substantial portion of Medicaid beneficiaries receive some or all of their care through privately-contracted Medicaid managed care plans, which cannot be accounted for in our analysis.³⁹ These managed plans may reimburse physicians differently than corresponding state fee-for-service rates, and there is some limited evidence that physician rates may be higher under managed care plans.⁴⁰ Other data limitations include our exclusion of modifier codes, which can alter reimbursement but are difficult to control for between states, and our inability to include fee schedules for ambulatory surgical centers, which often reimburse using bundled payments. Our analysis of linear regression models to explain reimbursement differences was limited by a paucity of literature on the subject to identify known associations and the decentralized nature by which information from each state is provided. State political, cultural, and social differences may exist that help explain some differences in reimbursement, but we were unable to assess such variables.

Conclusions

In our analysis of 211 orthopedic procedure codes, the West geographic region reimbursed the highest and the Northeast the lowest. Hand and Foot/Ankle were consistently the highest reimbursing of orthopedic subspecialties. States that are most sparsely populated with orthopedic surgeons compared to their land area appear to reimburse at higher rates than the rest of the US, suggesting they may increase reimbursement to encourage more physicians to practice there. Orthopedic surgeons should be aware of state Medicaid rates and advocate for rates that both fairly compensate them for their work and ensure broad access to care for Medicaid beneficiaries.

Declarations

- Ethics approval and consent to participate: No ethical or IRB approval was necessary for this project, which did not use human/animal subjects. All authors agreed to participate.
- All authors have consented to publish this work
- Data for this manuscript is available online at state Medicaid fee schedule websites
- The authors report no competing interests except the following disclosures: BDS reports royalties from Stryker and Osteoremedies; board member/committees on the Hip Society and the International Orthopedic Education Network; consulting for ConvaTec.
- No external funding was obtained for the creation of this work
- Authors' contributions: APH made substantial contributions to the conception, design, analysis, manuscript text, and figures. DWB made substantial contributions to the design, analysis, and figures. MLM made substantial contributions to the design, analysis, and figures. CLB made substantial contributions to the analysis and manuscript text. JMH made substantial contributions to the analysis and manuscript text. JSB made substantial contributions to the conception, design, and analysis. BDS made substantial contributions to the conception, design, and analysis.
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Figures

Average wRVU-adjusted Medicaid Reimbursement for all Orthopedic Surgery Procedure Codes, by State

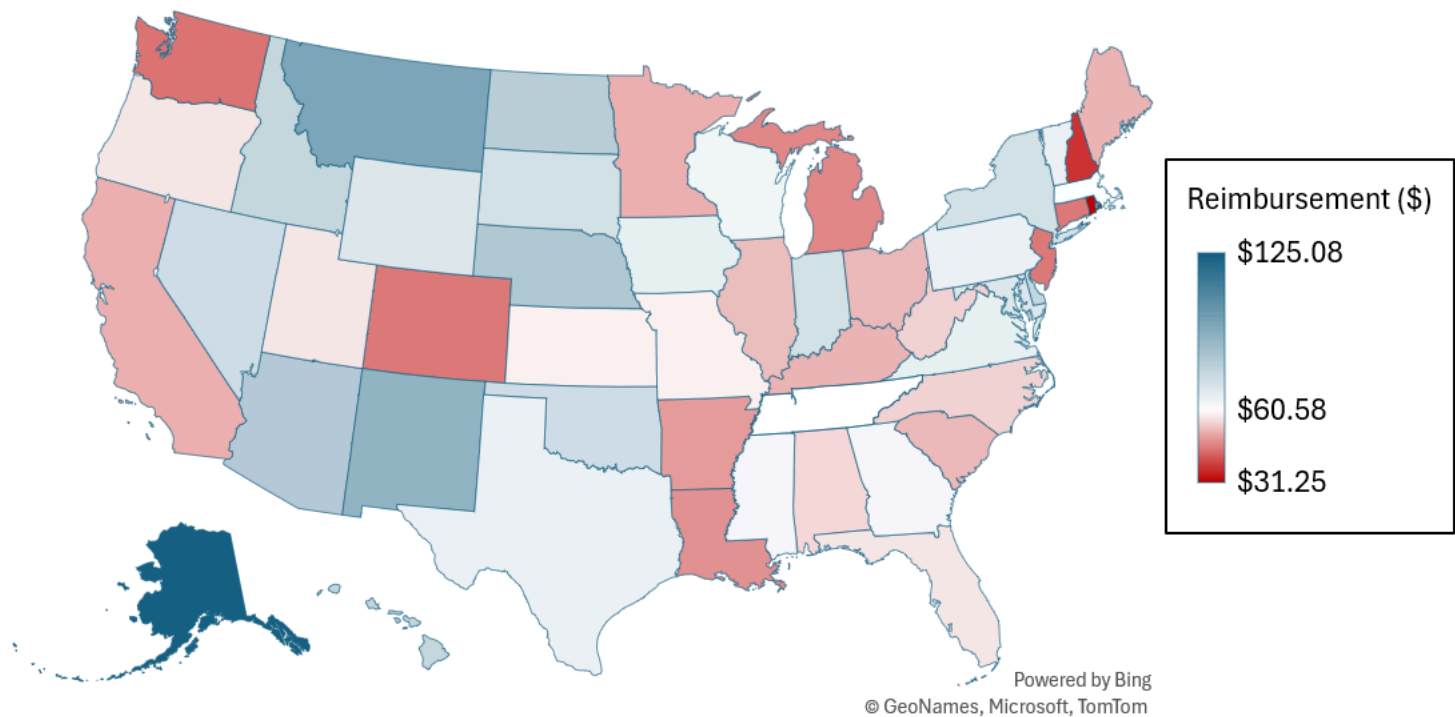


Figure 1

A heatmap of work Relative Value Unit (wRVU) adjusted Medicaid reimbursement for all procedural codes combined. Red indicates states with the lowest values in dollars, whereas blue represents states with the highest values.

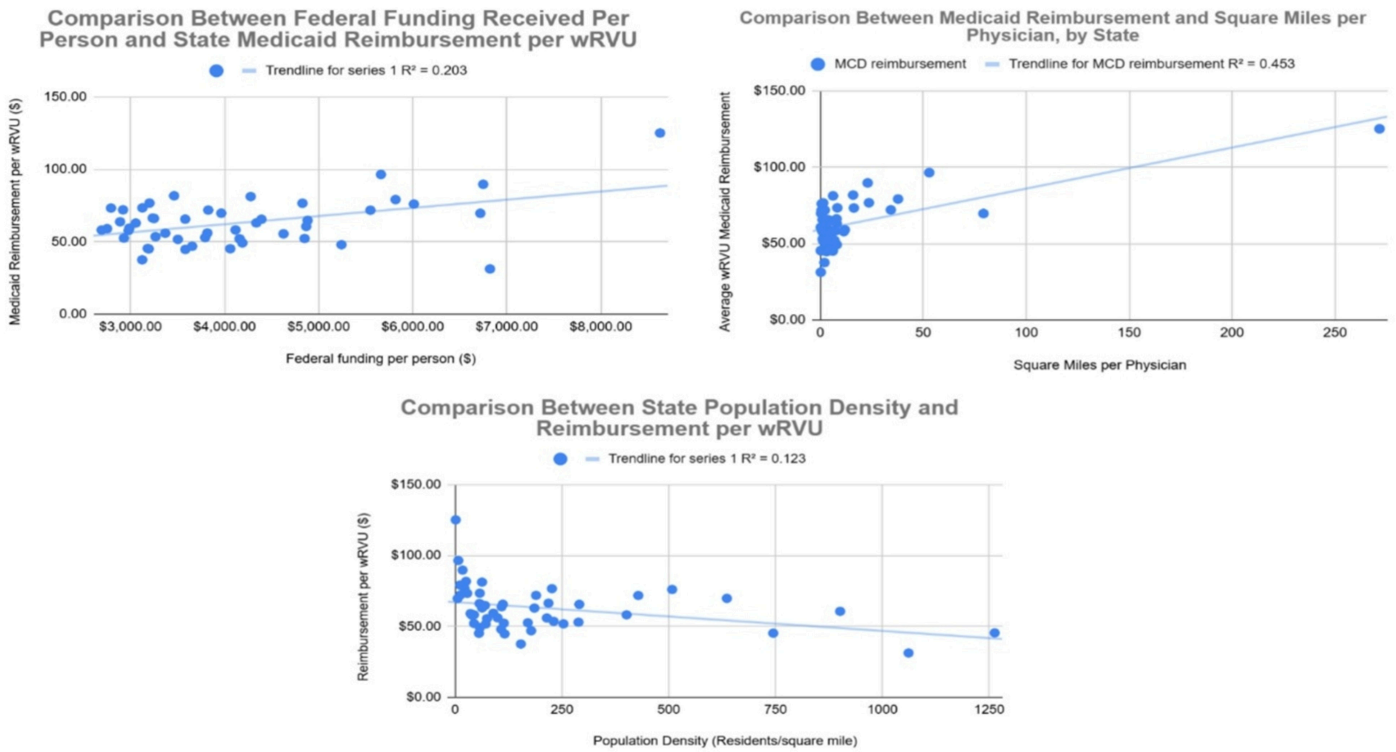


Figure 2

Line plots comparing three variables with the highest R^2 values correlating with Medicaid reimbursement per work Relative Value Unit (wRVU): orthopedic surgeons per square mile, federal funding (\$), and population density. Only orthopedic surgeons per square mile demonstrates a moderate correlation with Medicaid reimbursement.

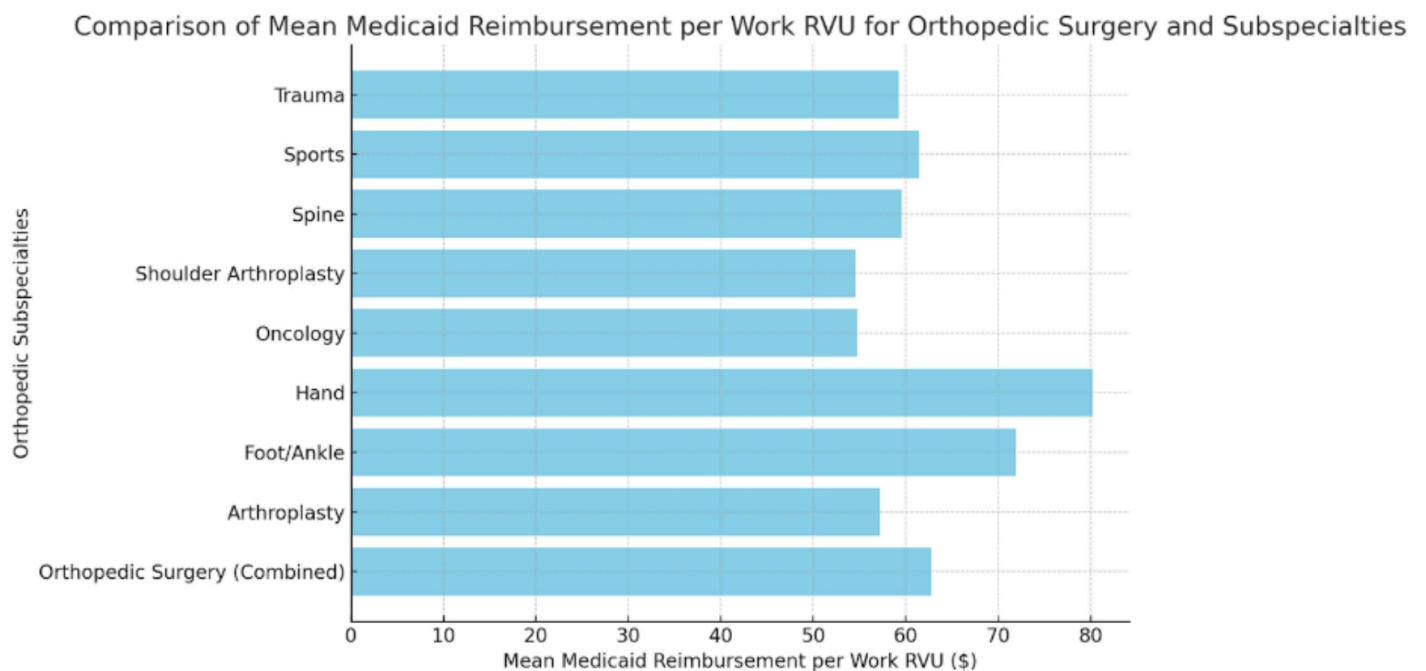


Figure 3

Bar graph comparing mean Medicaid reimbursement per work Relative Value Unit (wRVU) for all orthopedic procedure codes combined and by eight subspecialties.

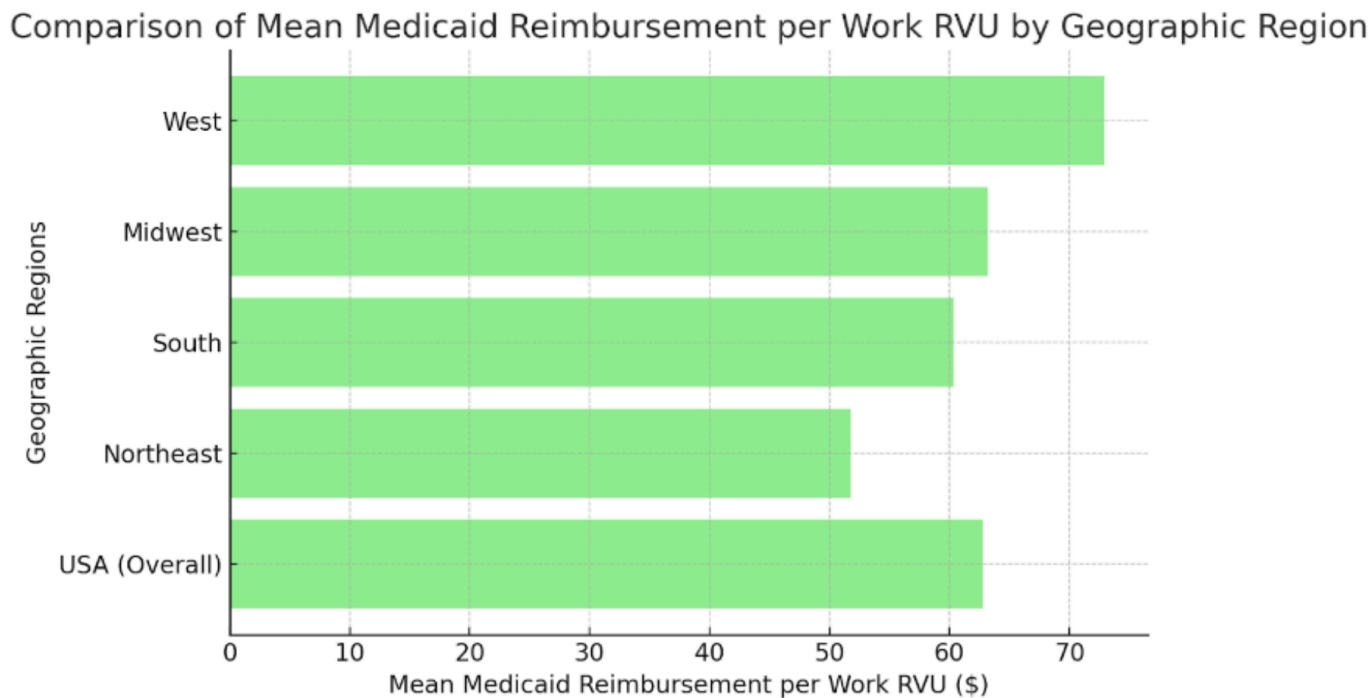


Figure 4

Bar graph comparing mean Medicaid reimbursement per work Relative Value Unit (wRVU) across the United States and within each of the four geographic regions.

Supplementary Files

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