International Clinical and Medical Case Reports Journal
Research Article (ISSN: 2832-5788)

Geographic Variation and Patient Financial Burden in Total Hip and Knee Arthroplasty: A Population-Based Analysis Across California

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Citation: *Marra R, Sangimino M. Geographic Variation and Patient Financial Burden in Total Hip and Knee Arthroplasty: A Population-Based Analysis Across California. Int Clinc Med Case Rep Jour. 2026;5(7):1-7.*

Received Date: 07 July, 2026; **Accepted Date:** 10 July, 2026; **Published Date:** 13 July, 2026

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ABSTRACT

Background: Total hip and knee arthroplasty are highly effective procedures for end-stage degenerative joint disease, yet substantial geographic variation in utilization and patient financial burden persists.

Objective: To evaluate geographic variation in utilization rates and patient out-of-pocket (OOP) costs associated with total hip and knee arthroplasty across California.

Methods: A retrospective population-based analysis was conducted using statewide healthcare utilization data from 2018-2023. County-level total hip and knee arthroplasty encounters were analysed. Utilization rates were calculated per 1,000 member-months. Median OOP costs and proportion of patients with zero OOP responsibility were assessed. Geographic variation was evaluated using Kruskal–Wallis testing and multivariable linear regression identified factors associated with utilization.

Results: A total of 1,180 county-year observations were included. Mean arthroplasty utilization was 0.325 procedures per 1,000 member-months, with substantial variation across counties. Utilization differed significantly by geographic region ($p < 0.001$). Medicare coverage was independently associated with higher utilization, while Medi-Cal coverage was associated with lower utilization. Median OOP cost averaged approximately $1,400 and only 25% of patients had no OOP responsibility. Higher OOP burden and lower rates of zero-cost coverage were associated with variation in utilization across regions.

Conclusion: Significant geographic variation exists in total hip and knee arthroplasty utilization across California, accompanied by meaningful differences in patient financial burden. Insurance type and cost-sharing structure appear to be important drivers of utilization patterns. These findings highlight persistent disparities in access to arthroplasty care and support the need for policies addressing both geographic and financial barriers.

Keywords: Significant geographic; Financial barriers; Median OOP costs

INTRODUCTION

Total hip arthroplasty (THA) and total knee arthroplasty (TKA) represent some of the most successful interventions in modern medicine, providing substantial improvements in pain, mobility, quality of life and long-term functional outcomes[1]. As the population ages and the prevalence of degenerative joint disease continues to increase, demand for lower extremity arthroplasty is projected to rise dramatically over the coming decades[2].

California represents a highly diverse healthcare market with substantial variation in insurance coverage, socioeconomic status and healthcare infrastructure, making it an ideal setting in which to evaluate disparities in arthroplasty utilization and financial burden.

Despite the proven clinical efficacy and cost-effectiveness of arthroplasty, previous investigations have demonstrated significant variation in orthopedic procedure utilization across geographic regions[3,4]. Such variation may reflect differences in healthcare infrastructure, surgeon availability, socioeconomic status, insurance coverage, referral patterns and patient access to specialty care. Understanding variation in arthroplasty utilization is essential, as both underutilization and overutilization may reflect inequities in access, differences in healthcare delivery systems or non–value-based care.

Simultaneously, increasing attention has been directed toward the concept of financial toxicity within healthcare. Although arthroplasty procedures are generally covered by public and private insurance programs, patients often remain responsible for substantial out-of-pocket expenses[5,6]. Financial barriers may influence treatment decisions, delay surgical care and contribute to disparities in access.

While previous studies have examined national trends in arthroplasty utilization, fewer investigations have simultaneously evaluated procedure utilization and patient financial burden at a population level. The purpose of this study was to evaluate geographic variation in utilization rates and patient financial responsibility associated with total hip and knee arthroplasty across California. We hypothesized that significant geographic variation would exist in both utilization rates and out-of-pocket costs and that financial burden would be independently associated with arthroplasty utilization.

METHODS

Study design

A retrospective population-based analysis was performed utilizing statewide healthcare utilization data from 2018 through 2023. The database contains county-level information regarding procedure utilization, insurance coverage, patient cost-sharing and healthcare utilization metrics.

Inclusion criteria

All records classified as "Total Hip or Knee Replacement" were identified. Observations suppressed because of low procedural volume were excluded. County-year observations with complete utilization and financial data were included in the final analysis.

Outcome measures

The primary outcome of the study was arthroplasty utilization rate, which was calculated by dividing the total number of total hip and knee replacement procedures by the number of member-months and multiplying the result by 1,000, thereby expressing utilization as procedures per 1,000 member-months. Secondary outcomes included the median out-of-pocket (OOP) cost associated with each arthroplasty procedure, the proportion of patients who incurred no out-of-pocket financial responsibility and the degree of geographic variation in both utilization rates and patient cost burden across counties. These measures were selected to assess not only patterns of access to arthroplasty care but also the financial impact experienced by patients undergoing these procedures.

Statistical analysis

Descriptive statistics were calculated for all study variables. Continuous variables are reported as mean ± standard deviation. County-level geographic variation was evaluated using Kruskal-Wallis testing because utilization rates demonstrated non-normal distributions across geographic regions. Multivariable linear regression was performed to identify independent predictors of arthroplasty utilization. Covariates included payer type, reporting year, median out-of-pocket cost and percentage of patients with zero out-of-pocket responsibility. Statistical significance was defined as $p < 0.05$.

RESULTS

Overall utilization and patient cost burden

A total of 1,180 county-year observations representing total hip and knee arthroplasty procedures across California were included in the final analysis. Overall, the mean arthroplasty utilization rate was 0.325 ± 0.321 procedures per 1,000 member-months. The mean median patient out-of-pocket (OOP) expenditure was $1,393 ± $736, while 25.4% of patients experienced no direct OOP financial responsibility for their procedure. Considerable variation was observed across both utilization and financial metrics, suggesting substantial heterogeneity in access to arthroplasty care and patient cost burden throughout the state. Baseline study characteristics are summarized in (Table 1).

Table 1: Overall Arthroplasty Utilization and Financial Characteristics

Variable	Value
County-year observations	1,180
Mean utilization rate (procedures/1,000 member-months)	0.325 ± 0.321
Mean median OOP cost ($)	1,393 ± 736
Mean percentage with zero OOP (%)	25.4
Study period	2018–2023

Geographic variation in arthroplasty utilization

Marked geographic variation in arthroplasty utilization was identified across California counties. Utilization rates varied by greater than tenfold between the highest- and lowest-volume regions. Mariposa County demonstrated the highest utilization rate at 1.32 procedures per 1,000 member-months, followed closely by Mono County at 1.30 procedures per 1,000 member-months and Inyo County at 0.89 procedures per 1,000 member-months. Conversely, San Bernardino County exhibited the lowest utilization rate at 0.13 procedures per 1,000 member-months, with similarly low rates observed in Santa Clara County (0.15 procedures per 1,000 member-months) and Sacramento County (0.15 procedures per 1,000 member-months). Statistical testing confirmed significant geographic heterogeneity in arthroplasty utilization across counties (Kruskal-Wallis $H = 160.95$, $p < 0.001$), supporting the presence of substantial regional differences in procedure access and delivery. Representative county-level utilization data are presented in (Table 2).

Table 2: Counties Demonstrating Highest and Lowest Arthroplasty Utilization Rates

County	Utilization Rate (per 1,000 member-months)
Mariposa	1.32
Mono	1.30
Inyo	0.89
Sacramento	0.15
Santa Clara	0.15
San Bernardino	0.13

Variation in financial burden across regions

Patient financial responsibility demonstrated substantial variation across geographic regions. Median OOP expenditures ranged widely among counties and payer groups, indicating considerable differences in healthcare affordability despite comparable procedural indications. Although approximately one-quarter of patients incurred no direct procedural costs, a large proportion of individuals remained responsible for substantial OOP expenditures. Regions with higher utilization frequently demonstrated greater patient financial contributions, suggesting that healthcare market characteristics, insurance design and local practice patterns may influence both utilization and cost-sharing. County-level variation in OOP expenditures and zero-cost encounters is summarized in (Table 3).

Table 3: Financial Burden Associated with Arthroplasty Procedures

Variable	Value
Mean median OOP cost ($)	1,393 ± 736
Mean percentage with zero OOP (%)	25.4
Percentage with any OOP responsibility (%)	74.6

Arthroplasty utilization by payer type

Significant differences in arthroplasty utilization were observed among insurance categories. Medicare beneficiaries demonstrated the highest utilization rates, averaging 0.545 procedures per 1,000 member-months. Patients with combined Commercial and Medicare coverage exhibited the second-highest utilization rate at 0.435 procedures per 1,000 member-months. In contrast, utilization among commercially insured patients was substantially lower at 0.098 procedures per 1,000 member-months, while Medi-Cal beneficiaries demonstrated

the lowest utilization at 0.031 procedures per 1,000 member-months. These findings suggest that age-related disease burden, insurance coverage structure and healthcare access may contribute significantly to arthroplasty utilization patterns. Detailed payer-based utilization data are presented in (Table 4).

Table 4: Arthroplasty Utilization by Insurance Type

Insurance Type	Utilization Rate (per 1,000 member-months)
Medicare	0.545
Commercial + Medicare	0.435
Commercial	0.098
Medi-Cal	0.031

Multivariable regression analysis

Multivariable linear regression was performed to identify factors independently associated with arthroplasty utilization after adjustment for payer type, study year, patient financial responsibility and geographic variation. Medicare coverage was independently associated with increased arthroplasty utilization compared with commercial insurance ($\beta = 0.382$, $p < 0.001$). Similarly, higher median OOP expenditures demonstrated a significant positive association with utilization ($\beta = 9.77 \times 10^{-5}$, $p < 0.001$). In contrast, increasing proportions of patients with zero OOP responsibility were associated with lower utilization rates ($\beta = -0.331$, $p < 0.001$). Temporal analysis additionally demonstrated a significant decline in utilization during later study years relative to 2018. Complete regression model results are presented in (Table 5).

Table 5: Multivariable Regression Analysis of Factors Associated with Arthroplasty Utilization

Variable	β Coefficient	p-value
Medicare coverage	0.382	<0.001
Median OOP cost	9.77×10^{-5}	<0.001
Percentage with zero OOP	-0.331	<0.001
Later study year	Negative association	<0.05

Summary of key findings

The principal findings of this study were threefold. First, substantial geographic variation exists in total hip and knee arthroplasty utilization across California, with more than tenfold differences observed between counties. Second, considerable variation in patient financial burden persists despite broad insurance coverage, with median OOP expenditures exceeding $1,300 statewide. Third, payer type and financial responsibility independently influenced utilization patterns, suggesting that both healthcare access and economic factors contribute to observed disparities in arthroplasty delivery.

DISCUSSION

The principal finding of this study was the presence of substantial geographic variation in total hip and knee arthroplasty utilization across California. Counties with the highest utilization rates demonstrated nearly tenfold greater procedural volume than low-utilization regions, highlighting persistent disparities in access to orthopedic care.

Geographic variation in arthroplasty utilization has been recognized for decades and is likely multifactorial[7]. This variation likely reflects differences in healthcare supply factors, including specialist availability, hospital capacity and referral patterns, as well as underlying population health differences. These factors can be broadly categorized into supply-side (surgeon density, healthcare infrastructure, referral networks) and demand-side (socioeconomic status, patient demographics, insurance coverage) determinants of care delivery[7,8].

Importantly, several highly populated metropolitan regions demonstrated lower utilization rates than many rural counties, suggesting that procedure access may not be solely determined by population size.

A second important finding was the considerable financial burden borne by patients undergoing arthroplasty. Mean median out-of-pocket costs exceeded $1,300 across the study population and approached $1,800 among Medicare-associated populations. These findings emphasize the continued relevance of financial toxicity within orthopedic surgery despite broad insurance coverage[5,6].

Interestingly, higher out-of-pocket expenditures were associated with greater utilization in multivariable modeling. This likely reflects underlying differences in insurance design and healthcare market characteristics rather than a causal relationship between higher costs and increased surgery rates.

The observation that Medicare beneficiaries experienced the highest utilization is consistent with the age distribution of degenerative joint disease, which disproportionately affects older adults[9]. Conversely, markedly lower utilization among Medi-Cal beneficiaries may suggest barriers related to specialist access, socioeconomic factors or healthcare infrastructure.

From a policy perspective, these findings highlight potential targets for intervention, including improving equitable access to arthroplasty services and addressing financial barriers that may influence surgical decision-making. Future investigations should evaluate the contribution of surgeon workforce distribution, hospital availability, social determinants of health and patient-level outcomes to observed regional differences.

LIMITATIONS

This study is subject to several limitations. The database does not provide patient-level clinical characteristics, radiographic severity, comorbidity profiles or postoperative outcomes. County-level analyses may be influenced by ecological bias. Additionally, causality cannot be established because of the retrospective observational design.

CONCLUSION

Significant geographic variation exists in total hip and knee arthroplasty utilization across California. Patient financial responsibility varies substantially across regions and payer groups. Medicare coverage, out-of-pocket costs and geographic location were independently associated with arthroplasty utilization. These findings

highlight important disparities in access to orthopaedic care and underscore the need for future policy initiatives focused on improving healthcare equity and reducing financial barriers to treatment.

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