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Original Research

Rural-Urban Differences in Hospital and Patient-Reported Outcomes Following Total Hip Arthroplasty

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ABSTRACT

Background: Rural patients have unique health-care factors influencing outcomes of arthroplasty, hypothetically putting these patients at increased risk for complications following total joint arthroplasty. The aim of this study is to better understand differences in patient outcomes and satisfaction between rural and urban patients receiving care in an urban setting and to provide more equitable care.
Methods: A retrospective chart review was performed on patients undergoing primary total hip arthroplasty at a single large academic center between January 2013 and August 2020. Demographic, operative, and hospital outcomes were obtained from the institutional electronic medical record. Rurality was determined by rural-urban code (RUC) classifications by zip code with RUC codes 1-3 defined as urban and RUC 4-10 defined as rural.
Results: Patients from urban areas were more likely to visit the emergency department within 30 days postoperatively ($P = .006$) and be readmitted within 90 days ($P < .001$). However, unplanned ($P < .001$) admissions were higher in the rural group. There was no statistical difference in postoperative complications ($P = .4$). At 6 months, rural patients had higher patient-reported outcome measures (PROMs) including Hip Disability and Osteoarthritis Outcome Score total ($P = .05$), Hip Disability and Osteoarthritis Outcome Score interval ($P = .05$), self-reported functional improvement ($P < .05$), improvements in pain ($P < .05$), and that the surgery met expectations ($P < .05$). However, these values did not reach minimal clinically important difference.
Conclusions: There may be differences in emergency department visits, readmissions, and PROMs in rural vs urban populations undergoing total hip arthroplasty in an urban setting. Patient access to care and attitudes of rural patients toward health care may underlie these findings. Understanding differences in PROMs, satisfaction, and hospital-based outcomes based on rurality is essential to provide equitable arthroplasty care.

Introduction

Identifying health-care disparities is essential to effectively allocate resources to combat disease. Disparities in total joint arthroplasty (TJA) utilization and outcomes linked to gender, race, and socioeconomic status have been identified, hindering equitable care for these patients [1–6]. Previous studies have shown differences in the demographics of urban vs rural patients undergoing TJA, indicating rural patients have higher rates of arthroplasty [7,8]. At present, there is a poor understanding of the effect of rurality on hospital-based and patient-reported outcomes following total hip arthroplasty (THA).

Rural patients have unique health-care risk factors influencing outcomes of TJA including poorer health-care indicators and metrics of population health [9,10] and higher behavioral risk factors

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[11]. Rates of inactivity and obesity, 2 significant risk factors for osteoarthritis (OA), are higher in rural populations [12,13]. Rural patients are more likely to have diabetes [14] and use tobacco [15], which independently lead to worse outcomes following TJA [16,17]. Additionally, patients in rural areas have been shown to be less likely to complete physical therapy [18] or comply with other postoperative treatment modalities like pneumatic compression sleeves [19] than patients in urban areas, which may impact recovery. Furthermore, patients in rural areas may experience different complications than patients in an urban setting. Patients at rural hospitals have higher rates of perioperative prosthetic fractures [20]. Undergoing TJA at a rural hospital has been found to be a significant risk factor for 30- and 90-day readmission [21] and increased length of stay following total knee arthroplasty [22]. In the orthopaedic literature, rurality has been associated with increased complications including postoperative hand infections [23]. Therefore, rural patients appear to be at greater risk for complications following TJA. However, there has yet to be literature examining the effect of rurality comparing these patient populations undergoing TJA.

This work seeks to further investigate the effect of patients living in rural vs urban locations as a social determinant of health on patient-reported and hospital outcomes following THA at an urban hospital. We hypothesize that patients in urban areas would have better hospital and patient-reported outcomes due to superior health-care resources and lower risk factors for postoperative complications.

Material and methods

A retrospective chart review was performed on patients undergoing primary THA at a single large academic center between January 1, 2013, and August 31, 2020. Investigational review board approval was obtained. Inclusion criteria were set for patients over the age of 18 who received an anterior-based muscle-sparing THA [24], the approach commonly used at our hospital. All cases performed by the only 3 arthroplasty surgeons performing THA were included for analysis. The primary outcome of interest was urban vs rural home location for patients undergoing THA. Rurality was determined by the 2013 rural-urban code (RUC) classifications of each zip code as determined by the US Department of Agriculture Electronic Research Service. Each county is given a score based on its population and adjacency to a metropolitan area. Areas with RUC codes 1-3 were defined as urban areas, and RUC 4-10 were defined as rural areas, per the US Department of Agriculture [25]. Demographic, operative, and hospital outcome data were obtained from the institutional electronic medical record. Demographic information collected included zip code, sex, age, American Society of Anesthesiologists (ASA) score, preoperative diagnosis, and insurance type. Operative variables collected included arthroplasty fixation (press fit vs cementless), procedure type (primary vs conversion), anesthesia time in minutes, procedure duration in minutes, and estimated blood loss in milliliters. Hospital-reported outcomes included discharge disposition, transfusion within 90 days, intraoperative fracture, myocardial infarction (within 7 days), pneumonia (within 7 days), sepsis/shock (within 7 days), surgical site complication (within 30 days), pulmonary embolism (within 30 days), death (within 30 days), fracture (within 90 days), dislocation (within 90 days), mechanical complication (within 90 days), and infection (within 90 days). Patient-reported outcomes collected included preoperative, 6 weeks, 3 months, 6 months, and 1-year Single Assessment Numeric Evaluation score, pain score, Hip Disability and Osteoarthritis Outcome Score Joint Replacement (HOOS JR), University of California, Los Angeles, and Patient-Reported Outcomes Measurement Information System (PROMIS) mental/physical and satisfaction scores, all collected from an in-house database.

Initially, 6421 patients were included. After excluding patients who were undergoing revision THA, patients who had a preoperative diagnosis of septic arthritis, and patients with a discharge disposition of expired or psychiatric hospital, the data included 6418 patients. After excluding those with missing RUC codes, the final analytic dataset included 6066 patients.

Data analysis

In order to assess the relationship between rurality and our outcomes of interest, all demographic, patient-reported, and hospital-reported variables were analyzed with respect to rurality. Pearson's chi-square test was used for all normally distributed categorical variables, and the Wilcoxon rank sum test or Fisher's exact test were used for nonnormally distributed categorical variables and all continuous variables.

Univariate regression models were created to analyze the relationship between patient- and hospital-reported outcomes and all covariates (RUC category, age, body mass index (BMI) category, insurer type, ASA rating, preoperative diagnosis, length of stay, and discharge disposition). Linear and logistic regression approaches were used according to the respective outcome (linear for continuous outcomes, logistic for binary outcomes). Final linear and logistic multivariate regression models were created using a combination of clinical expertise and purposeful selection ($P < .2$) with respect to each individual outcome. All analysis was done on R version 4.2.1.

Results

From January 1, 2013, to August 31, 2020, 6066 patients underwent primary THA and met inclusion criteria. Of this patient population, 2886 lived in zip codes classified as rural and 3180 lived in zip codes classified as urban at the time of surgery (Table 1). The average age of patients was 65 ($\pm$10) years, with an average BMI of 29.3 ($\pm$6). Women comprised 55% of the patient population with 96% of patients undergoing uncemented THA. Most surgeries performed were primary procedures (99%), with slightly more unilateral right THA (53%). Between the urban and rural groups, these characteristics were not significantly different, yet age varied slightly between urban and rural groups (65 $\pm$ 10, 66 $\pm$ 10; $P <$ .001). While height ($P < .005$) and weight ($P = .021$) varied between groups, the average BMI and BMI category were not significantly different ($P = .4$, $P = .9$). Patients living in rural areas were more likely to have government insurance, while urban patients were more likely to have private insurance ($P < .001$).

Surgical variables, including ASA rating ($P = .3$), anesthesia type ($P = .7$), procedure duration ($P = .075$), blood transfusion ($P = .15$), estimated blood loss ($P = .2$), and intraoperative complication rates between urban and rural groups did not differ significantly ($P = .2$) (Table 2). Anesthesia duration ($P = .015$), room duration ($P = .024$), length of stay ($P = .002$), and room duration were found to be slightly higher within the urban population. The distribution of preoperative diagnoses and postoperative dispositions between groups were statistically significant, however. The diagnosis distribution of degenerative joint disease/OA, fracture, avascular necrosis, rheumatoid arthritis, and dysplasia varied between urban and rural patients ($P < .001$) with slightly higher percentages of fracture in the urban population (2.1% vs 0.8%) and degenerative joint disease/OA in the rural population (98% vs 96%). Among discharge dispositions, including home, home health-care service, skilled nursing facility, and rehabilitation facility, slightly higher percentages of rural patients utilized home health-care services

Table 1
Demographic information.

Characteristic	Overall, N = 6066[a]	Rural, N = 2886[a]	Urban, N = 3180[a]	*P*-value[b]	q-value[c]
Cemented (yes)	228 (3.8%)	107 (3.7%)	121 (3.8%)	.8	0.9
Procedure type (primary)	6000 (99%)	2854 (99%)	3146 (99%)	.9	0.9
Laterality (right)	3239 (53%)	1556 (54%)	1683 (53%)	.4	0.6
Both hips replaced (yes)	1591 (26%)	737 (26%)	854 (27%)	.2	0.4
Sex (female)	3316 (55%)	1601 (55%)	1715 (54%)	.2	0.4
Age at discharge	65 (10)	66 (10)	65 (11)	<.001	<0.001
Weight (kg)	85 (20)	84 (20)	86 (20)	.021	0.057
Height (m)	1.70 (0.10)	1.69 (0.10)	1.70 (0.10)	.009	0.032
BMI	29.3 (6.0)	29.3 (6.0)	29.4 (6.0)	.4	0.6
BMI category				.9	0.9
Underweight	60 (1.0%)	26 (0.9%)	34 (1.1%)		
Healthy weight	1421 (23%)	681 (24%)	740 (23%)		
Overweight	2143 (35%)	1024 (35%)	1119 (35%)		
Obese	2442 (40%)	1155 (40%)	1287 (40%)		
Insurer category				<.001	<0.001
Government	3354 (56%)	1683 (59%)	1671 (53%)		
Private	2652 (44%)	1171 (41%)	1481 (47%)		
Unknown	60	32	28		

[a] n (%); Mean (SD).
[b] Pearson's chi-squared test; Wilcoxon rank sum test.
[c] False discovery rate correction for multiple testing.

(34% vs 31%), while their urban counterparts had comparatively higher rates of home (60% vs 59%) and skilled nursing facility (6.8% vs 5.6%) care ($P = .035$).

Patients from urban areas were significantly more likely to require an emergency department (ED) visit within 30 days of discharge ($P = .006$) and hospital readmission within 90 days of discharge ($P = <0.001$) relative to their rural counterparts (Table 3). While there was no statistically significant difference in number of complications ($P = .4$) or surgical admissions ($P = .2$) within 90 days postoperatively, the rural group was significantly more likely to require an unplanned admission ($P = <0.001$).

Patient-reported outcomes remained statistically similar between groups across time, from the preoperative period to 1-year postoperation, except at 6 months (Table 4). In both urban and rural patient populations, Single Assessment Numeric Evaluation, University of California, Los Angeles scores, HOOS JR interval, PROMIS-physical, 'pain' satisfaction, 'functional improvement' satisfaction, and 'met expectations' satisfaction scores trended upwards over time postoperatively. HOOS JR and pain scores trended downward over time, and PROMIS-mental and 'surgeon' satisfaction remained constant among all groups over time. Significantly improved patient-reported outcomes were noted in the rural group observed in the 'pain' satisfaction survey at 3 ($P = .03$) and 6 ($P = .04$) months, the 'functional improvement' satisfaction survey at 3 ($P = .02$) and 6 ($P = .02$) months, the 'met expectations' satisfaction survey at 6 months ($P = .03$), HOOS JR at 6 months ($P = .05$) and HOOS JR interval ($P = .05$) scores.

On multivariate analysis, any complication was significantly associated with longer length of stay ($P < .001$), higher ASA rating ($P = .009$), and home health care services ($P = .036$). ED visits within

Table 2
Surgical variables and disposition.

Characteristic	Overall, N = 6066[a]	Rural, N = 2886[a]	Urban, N = 3180[a]	*P*-value[b]	q-value[c]
ASA rating	2 (1)	2 (1)	2 (1)	.3	0.3
Unknown	812	390	422		
Preoperative diagnosis				<.001	0.005
DJD/OA	5851 (97%)	2802 (98%)	3049 (96%)		
AVN	89 (1.5%)	41 (1.4%)	48 (1.5%)		
Fracture	89 (1.5%)	24 (0.8%)	65 (2.1%)		
Unknown	37	19	18		
Anesthesia type (general)	5879 (97%)	2800 (97%)	3079 (97%)	.7	0.7
Unknown	1	0	1		
Anesthesia time (min)	109 (21)	108 (22)	109 (21)	.015	0.055
Unknown	3	0	3		
Procedure duration (min)	66 (19)	66 (19)	66 (18)	.075	0.14
Room duration (min)	102 (21)	102 (21)	102 (20)	.024	0.067
Length of stay (h)	34 (20)	34 (19)	35 (22)	.002	0.012
Discharge disposition				.035	0.078
Home or self-care	3623 (60%)	1701 (59%)	1922 (60%)		
Home health care Svc	1988 (33%)	990 (34%)	998 (31%)		
Skilled nursing facility	379 (6.2%)	163 (5.6%)	216 (6.8%)		
Rehab facility	76 (1.3%)	32 (1.1%)	44 (1.4%)		
EBL (mL)	221 (78)	220 (76)	222 (79)	.7	0.7
Unknown	1481	707	774		
Blood transfusion (yes)	53 (0.9%)	20 (0.7%)	33 (1.0%)	.15	0.2
Intraoperative complication (yes)	18 (0.3%)	11 (0.4%)	7 (0.2%)	.2	0.3

EBL, estimated blood loss; DJD, degenerative joint disease; AVN, avascular necrosis.
[a] Mean (SD); n (%).
[b] Wilcoxon rank sum test; Pearson's chi-squared test.
[c] False discovery rate correction for multiple testing.

Table 3
Hospital outcomes.

Characteristic	Overall, N = 6066[a]	Rural, N = 2886[a]	Urban, N = 3180[a]	P-value[b]
ED visit within 30 d	117 (1.9%)	41 (1.4%)	76 (2.4%)	.006
Days after surgery until ED visit	8 (4, 15)	7 (3, 19)	8 (4, 15)	.9
Readmission within 90 d	186 (3.1%)	57 (2.0%)	129 (4.1%)	<.001
Days after surgery until readmission	33 (13, 59)	28 (16, 57)	34 (13, 59)	.8
Surgical admission	53 (66%)	25 (74%)	28 (61%)	.2
Unplanned admission	186 (3.1%)	57 (2.0%)	129 (4.1%)	<.001
Complication	80 (1.3%)	34 (1.2%)	46 (1.4%)	.4
Myocardial infarction within 7 d	8 (0.1%)	4 (0.1%)	4 (0.1%)	>.9
Pneumonia within 7 d	3 (<0.1%)	2 (<0.1%)	1 (<0.1%)	.6
Sepsis within 7 d	0 (0%)	0 (0%)	0 (0%)	
Surgical site infection within 30 d	4 (<0.1%)	0 (0%)	4 (0.1%)	.13
Pulmonary embolism within 30 d	4 (<0.1%)	2 (<0.1%)	2 (<0.1%)	>.9
Death within 30 d	2 (<0.1%)	0 (0%)	2 (<0.1%)	.5
Fracture within 90 d	23 (0.4%)	11 (0.4%)	12 (0.4%)	>.9
Dislocation within 90 d	9 (0.1%)	3 (0.1%)	6 (0.2%)	.5
Mechanical complication within 90 d	4 (<0.1%)	2 (<0.1%)	2 (<0.1%)	>.9
Joint infection within 90 d	12 (0.2%)	5 (0.2%)	7 (0.2%)	.7
Wound infection within 90 d	11 (0.2%)	5 (0.2%)	6 (0.2%)	.9

[a] n (%); Median (interquartile range).
[b] Pearson's chi-squared test; Wilcoxon rank sum test; Fisher's exact test.

30 days were more likely to be associated with urban patients ($P = .011$), higher ASA rating ($P < .001$), and home health care services ($P = .021$). Furthermore, ED visits within 90 days were more likely to be associated with urban patients ($P < .001$), higher ASA rating ($P < .001$), government insurance ($P = .008$), and an increased length of stay ($P = .008$). Unplanned readmissions were also associated with patients from urban areas ($P < .001$), higher ASA rating ($P < .001$), government insurance ($P = .008$), and length of stay ($P = .008$).

Discussion

We examined the differences in demographic, hospital, and patient-reported outcomes in a rural and urban population undergoing THA at a single large academic medical center. Patient demographic, surgical, and complication metrics were similar among the 2 populations. However, patients residing in urban areas were more likely to return to the ED within 30 days, be readmitted within 90 days, and have an unplanned admission. Patient-reported outcomes were generally similar preoperatively at 6 weeks, 3 months, and a year. However, patients from rural areas were statistically more satisfied at 6 months including HOOS JR, functional, pain, and surgeon satisfaction scores. These findings highlight the need to recognize differences in THA outcomes based on patient rurality.

Complication rates after 90 days were similar between the 2 populations, contrary to previous studies and our hypothesis that patients in rural areas would experience higher rates of complications. Patients living in rural areas did not have higher rates of surgical site injections, as previously demonstrated in the hand literature [23]. There was no difference in incidence of periprosthetic fracture following primary THA, contrasting previous studies that found rural hospitals had a higher incidence of periprosthetic fracture [20]. TJA at rural hospitals has been associated with increased risk for 30- and 90-day readmission [21] and increased length of stay following total knee arthroplasty [22], which did not occur in our rural patient population. Taken together, this data suggests complications associated with the rural population may be more related to hospital rather than patient-specific factors. Previous studies have looked at TJA performed at rural hospitals, which likely have lower volumes, unlike our study, which was performed at a high-volume tertiary care center. High-volume hospitals demonstrate superior outcomes following arthroplasty [26–31]. Thus, while it appears rural patients may be more at-risk for orthopaedic complications while undergoing TJA in smaller rural hospitals; complications were equal within the 2 populations when treated in a larger, tertiary center.

Contrary to our hypothesis and previous literature [21], significantly more urban patients visited the ED within 30 days and were readmitted within 90 days. Although it is possible that some of the rural patients may have sought care at facilities closer to where they reside and were not picked up in our health system database, we feel that early readmission would be directed to the surgeon that performed the original surgery. While it could be argued that rural patients willing to travel for THA may be more affluent, a protective factor, rural patients were more likely to have government insurance, a proxy we utilized for income. On multivariate analysis, government insurance was a risk factor for 90-day ED visits and unplanned admission, suggesting it may be a risk factor independently of rurality. Furthermore, transportation and access to care may have been a barrier for these patients to receive care at the tertiary care center within this 90-day period. Rural patients were more likely to require home health-care services, suggesting the population needed more assistance to access care. While lower rates of ED visits and readmission could be due to healthier patients that are able to travel to a tertiary facility, rural patients in this study were older and more likely to have government insurance, a proxy for socioeconomic status.

Alternatively, patient mindset toward health care in rural populations may shape this difference, as rural patients are more likely to avoid going to the doctor, delay care due to cost, or tell anyone they are sick [32]. Within the TJA patient population, Kamath et al. [11] found rural patients had fewer diagnosed comorbidities, which could further support poor access and lower health-care utilization in this patient population. When rural patients were admitted in our study, the admission was more likely to be unplanned, potentially a result of lack of access to care. Furthermore, lower income for this population, as supported by higher rates of government vs private insurance, may underlie several of these differences. Patients of lower income are more likely to avoid medical care due to cost and have more avoidable hospital admissions [33,34]. Therefore, while rural patients were less likely to have an ED visit or readmission, barriers to access to care may alter the postoperative problems for which they seek care. Additionally, this evidence does

Table 4
Patient-reported outcome measures.

Characteristic	Preoperative	6 wk	3 mo	6 mo	1 y
Single Assessment Numeric Evaluation (SANE):					
All (n = 6069)	41.51 ± 21.31	77.07 ± 17.96	85.56 ± 17.52	89.78 ± 15.47	90.04 ± 15.81
Urban (n = 3183)	41.72 ± 21.82	77.13 ± 17.48	84.95 ± 19.37	88.83 ± 16.50	89.96 ± 15.64
Rural (n = 2886)	41.27 ± 20.75	77.01 ± 18.49	86.17 ± 15.50	91.02 ± 13.94	90.13 ± 16.01
P-value:	.53	.85	.58	.09	.84
Pain:					
All (n = 6069)	5.61 ± 2.21	1.56 ± 1.69	1.04 ± 1.36	0.95 ± 1.64	0.89 ± 1.65
Urban (n = 3183)	5.65 ± 2.23	1.56 ± 1.71	1.12 ± 1.41	1.02 ± 1.79	0.88 ± 1.62
Rural (n = 2886)	5.57 ± 2.20	1.55 ± 1.67	0.96 ± 1.31	0.85 ± 1.43	0.91 ± 1.68
P-value:	.24	.95	.33	.17	.65
University of California, Los Angeles:					
All (n = 6069)	7.70 ± 2.00	4.86 ± 1.40	5.72 ± 1.78	6.14 ± 1.91	6.37 ± 1.89
Urban (n = 3183)	7.76 ± 1.83	4.84 ± 1.42	5.55 ± 1.77	6.13 ± 1.91	6.38 ± 1.87
Rural (n = 2886)	7.63 ± 2.17	4.88 ± 1.38	5.90 ± 1.78	6.16 ± 1.92	6.37 ± 1.91
P-value:	.07	.46	.11	.83	.87
Hip Disability and Osteoarthritis Outcome Score Joint Replacement (HOOS JR):					
All (n = 6069)	15.37 ± 4.43	4.78 ± 3.42	3.09 ± 2.98	2.58 ± 3.63	2.32 ± 3.37
Urban (n = 3183)	15.25 ± 4.57	4.73 ± 3.48	3.53 ± 3.23	2.90 ± 4.00	2.38 ± 3.34
Rural (n = 2886)	15.49 ± 4.26	4.83 ± 3.36	2.69 ± 2.71	2.16 ± 3.07	2.26 ± 3.40
P-value:	.14	.40	.13	.05	.47
Hip Disability and Osteoarthritis Outcome Score Joint Replacement (HOOS JR) interval:					
All (n = 6069)	40.93 ± 15.47	76.37 ± 13.08	83.59 ± 13.07	86.72 ± 15.23	87.88 ± 14.33
Urban (n = 3183)	41.27 ± 15.93	76.66 ± 13.39	81.90 ± 13.81	85.41 ± 16.41	87.45 ± 14.12
Rural (n = 2886)	40.57 ± 14.94	76.05 ± 12.71	85.11 ± 12.27	88.39 ± 13.44	88.33 ± 14.55
P-value:	.22	.20	.19	.05	.23
Patient-Reported Outcomes Measurement Information System (PROMIS), mental:					
All (n = 6069)	50.32 ± 7.39	51.50 ± 7.04	51.44 ± 6.35	51.33 ± 6.95	51.89 ± 7.29
Urban (n = 3183)	50.35 ± 7.55	51.41 ± 7.12	51.83 ± 6.58	51.17 ± 7.27	51.88 ± 7.27
Rural (n = 2886)	50.28 ± 7.22	51.60 ± 6.95	51.06 ± 6.12	51.50 ± 6.58	51.90 ± 7.31
P-value:	.77	.44	.33	.53	.96
Patient-Reported Outcomes Measurement Information System (PROMIS), physical:					
All (n = 6069)	39.83 ± 5.26	44.95 ± 5.48	46.48 ± 5.78	46.82 ± 6.24	47.28 ± 6.29
Urban (n = 3183)	39.85 ± 5.32	45.01 ± 5.52	46.72 ± 6.03	46.51 ± 6.53	47.15 ± 6.41
Rural (n = 2886)	39.81 ± 5.19	44.89 ± 5.44	46.25 ± 5.54	47.17 ± 5.89	47.42 ± 6.16
P-value:	.81	.53	.51	.16	.31
Pain satisfaction:					
All (n = 6069)	/	8.89 ± 1.73	9.22 ± 1.57	9.41 ± 1.34	9.44 ± 1.26
Urban (n = 3183)	/	8.90 ± 1.74	8.88 ± 1.90	9.28 ± 1.52	9.45 ± 1.18
Rural (n = 2886)	/	8.87 ± 1.72	9.54 ± 1.13	9.59 ± 1.01	9.44 ± 1.35
P-value:	/	.64	.03	.04	.87
Functional improvement satisfaction:					
All (n = 6069)	/	8.64 ± 1.69	9.01 ± 1.38	9.30 ± 1.40	9.34 ± 1.30
Urban (n = 3183)	/	8.65 ± 1.68	8.70 ± 1.50	9.15 ± 1.54	9.36 ± 1.24
Rural (n = 2886)	/	8.64 ± 1.69	9.30 ± 1.19	9.51 ± 1.17	9.32 ± 1.36
P-value:	/	.83	.02	.02	.56
Met expectations satisfaction:					
All (n = 6069)	/	9.02 ± 1.66	9.17 ± 1.69	9.38 ± 1.44	9.44 ± 1.37
Urban (n = 3183)	/	9.05 ± 1.63	8.90 ± 1.89	9.24 ± 1.64	9.45 ± 1.30
Rural (n = 2886)	/	8.98 ± 1.70	9.41 ± 1.45	9.57 ± 1.10	9.43 ± 1.44
P-value:	/	.30	.12	.03	.75
Surgeon satisfaction:					
All (n = 6069)	/	9.81 ± 0.73	9.60 ± 1.38	9.88 ± 0.61	9.86 ± 0.65
Urban (n = 3183)	/	9.81 ± 0.72	9.42 ± 1.78	9.86 ± 0.72	9.85 ± 0.69
Rural (n = 2886)	/	9.82 ± 0.74	9.77 ± 0.83	9.91 ± 0.42	9.87 ± 0.60
P-value:	/	.95	.18	.50	.51

not support the rural population as a more privileged subgroup that is able to access care at a tertiary center.

Patients from the rural population had significantly higher patient-reported outcome measures (PROMs) including HOOS JR, pain satisfaction, functional improvement, and that the surgery met expectations at 6 months. While statistically significant, it is noteworthy that these values likely do not reach minimal clinically important differences, suggesting no clinically significant difference in PROMs [35]. Previous literature on patient satisfaction and rurality remains unclear. Ho [36] reported rural patients had higher satisfaction in safety-net hospitals compared with nonsafety-net hospitals. A larger study of Medicare patients by Henning-Smith et al. [32] found increased rurality led to decreased satisfaction, mainly due to travel distance and availability of care specialists. However, our study differs from these previous studies in that rural patients receive care at a tertiary center as opposed to a smaller safety-net hospital. Within the rural population, patients are likely more willing to travel for perceived better care and have increased expectations for TJA, which has been associated with better patient-reported outcomes [37]. Additionally, patients undergoing arthroplasty received multidisciplinary, team-based care at our tertiary center, which has shown improved patient satisfaction [38,39] along with the increased resources of a tertiary academic center to provide this level of care. Improved preoperative and rehabilitation protocols at a high-volume arthroplasty center may result in more equitable care, resulting in improved patient-reported and hospital outcome metrics.

Ultimately, patient-reported outcomes were comparable at 1 year, potentially due to the similar preoperative demographic and patient-reported outcome metrics. While rural patients were slightly older in this study, BMI, ASA, and all preoperative patient-reported outcomes were comparable between the 2 populations. While the rural population has poorer health-care indicators and metrics of population health [9,10], this may not be reflective of patients that are suitable TJA candidates. Previously, Dowsey et al. [40] found no difference in pain and function scales between urban and rural patients at 12 and 24 months after TJA at a large, tertiary academic center in Australia. This study found rural patients were significantly younger when they underwent TJA but otherwise had similar demographic and preoperative metrics consistent with our study. This contrasts previous findings in which Banerjee et al. [7] concluded that females and minorities living in rural areas were less likely to undergo TJA than their urban counterparts, likely due to barriers in accessing health care. Furthermore, lower preoperative PROMs have been shown in at-risk populations, non-White race/ethnicity, and lower-income populations, although this may not apply to rural populations [41]. Comparable levels of comorbidities are consistent with Kamath et al. [11], who found rurality was not associated with comorbidities in a large population undergoing TJA. Thus, similar patient-reported outcomes in our study may be due to comparable preoperative comorbidities and PROMs, potentially due to patient selection and ability to travel. Alternatively, the extremely high rates of successful THA may further dilute any difference in clinical or PROM between these 2 patient populations.

Lower rates of readmissions and ED visits with similar patient-reported outcomes in a rural, potentially at-risk population may support regionalization of TJA to high-volume centers to minimize differences in outcomes. Benefits of regionalized TJA include improved outcomes, operative room efficiency, and decreased costs [42]. Alternatively, removing cases from local rural hospitals may limit access to care, infringe upon patient autonomy where they receive care and have a devastating economic effect on local hospitals and communities. Dy et al. [43] found high-volume centers decreases risk of complications, although vulnerable patients are less likely to utilize these high-volume hospitals. Centralization of revision TJA has been shown to affect patients from rural counties travel burden more so than other demographic factors [44], potentially a significant barrier to care. Regionalized TJA care may improve individual outcomes but would likely have unintended consequences for overall access to TJA, especially in vulnerable populations. However, our results may support a model of performing more complex TJA cases in high-volume centers and having low-risk patients undergo TJA in rural centers to optimize outcomes and accessibility. Another model could include establishing more efficient, cost-effective centers in rural and suburban areas to best balance access, cost and efficiency for arthroplasty. This could minimize travel costs and barriers to care for rural patients while supporting and optimizing high-volume, fellowship-trained surgeons in rural areas. These findings are limited as we did not compare costs of undergoing THA in a rural or urban hospital and outcomes of fellowship-trained arthroplasty surgeons in a rural vs urban hospital setting. Future comparative studies would further elucidate if there are any hospital- and patient-specific factors in rural vs urban areas that alter outcomes for patients undergoing THA.

Limitations

There are several notable limitations to this study. With patient-reported outcome surveys, there is potential for incomplete data and bias. Nevertheless, previous studies have found nonresponders have similar responses in TJA PROMs [45]. Furthermore, the population was racially and ethnically homogenous, limiting generalizability to areas where there is more diversity. Previous studies have found only 31.1% of rural patients undergo TJA at an urban, nonteaching hospital; thus, these results may not apply to patients undergoing care at rural hospitals [7]. The rates of complications were low in our population, making it difficult to pick up any potential differences. Data from only 3 surgeons at one center was analyzed in this study, further limiting generalizability. Access to tertiary centers is different in different rural areas; therefore, it is important to consider that care is not homogenous among all rural populations.

Conclusions

The present findings indicate that there may be some differences in ED visits, readmissions, and patient satisfaction metrics in rural vs urban populations undergoing THA. Patient access to care and attitudes of rural patients toward health care may underlie these findings. While previous literature has shown differences in health-care outcomes based on rurality, no differences in preoperative risk factors or postoperative complications in our patient population may underlie similar long-term outcomes. Understanding differences in patient-reported satisfaction and hospital-based outcomes in rural vs urban populations is essential to improve management of those undergoing THA while providing equitable care.

Conflicts of interest

B. McGrory is a paid consultant and speaker for Smith & Nephew and has received royalties from Smith & Nephew and Innomed, Inc. He also received royalties/financial support from Springer Nature. He also serves as an editorial board member of Arthroplasty Today/ American Association of Hip and Knee Surgeons. A. Rana is a paid consultant and has received research support from Smith & Nephew. He is a board member for American Association of Hip and Knee Surgeons. G. Babikian is a speaker for Smith & Nephew and has received royalties from Smith & Nephew and Innomed, Inc.; all other authors declare no potential conflicts of interest.

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References

[1] Dunlop DD, Manheim LM, Song J, Sohn M-W, Feinglass JM, Chang HJ, et al. Age and racial/ethnic disparities in arthritis-related hip and knee surgeries. Med Care 2008;200:200–8.
[2] Holtzman J, Saleh K, Kane R. Gender differences in functional status and pain in a Medicare population undergoing elective total hip arthroplasty. Med Care 2002;461:461–70.
[3] Ibrahim SA. Racial and ethnic disparities in hip and knee joint replacement: a review of research in the Veterans Affairs Health Care System. J Am Acad Orthop Surg 2007;15 Suppl 1:S87–94.
[4] Novicoff WM, Saleh KJ. Examining sex and gender disparities in total joint arthroplasty. Clin Orthop Relat Res 2011;469:1824–8.
[5] Cram P, Hawker G, Matelski J, Ravi B, Pugely A, Gandhi R, et al. Disparities in knee and hip arthroplasty outcomes: an observational analysis of the ACS-NSQIP Clinical Registry. J Racial Ethn Health Disparities 2018;5:151–61.
[6] Patel AP, Gronbeck C, Chambers M, Harrington MA, Halawi MJ. Gender and total joint arthroplasty: variable outcomes by procedure type. Arthroplasty Today 2020;6:517–20.

[7] Banerjee D, Illingworth KD, Novicoff WM, Scaife SL, Jones BK, Saleh KJ. Rural vs. urban utilization of total joint arthroplasty. J Arthroplasty 2013;28:888–91.
[8] Bederman SS, Rosen CD, Bhatia NN, Kiester PD, Gupta R. Drivers of surgery for the degenerative hip, knee, and spine: a systematic review. Clin Orthop Relat Res 2012;470:1090–105.
[9] Gamm L, Hutchison L, Bellamy G, Dabney B. Rural healthy people 2010: identifying rural health priorities and models for practice. J Rural Health 2002;18:9–14.
[10] Bellamy GR, Bolin JN, Gamm LD. Rural healthy people 2010, 2020, and beyond: the need goes on. Fam Community Health 2011;34:182–8.
[11] Kamath CC, O'Byrne TJ, Lewallen DG, Berry DJ, Kremers HM. Association of rurality and neighborhood level socioeconomic deprivation with perioperative health status in total joint arthroplasty patients: analysis from a large, tertiary care hospital. J Arthroplasty 2022;37:1505–13.
[12] Patterson PD, Moore CG, Probst JC, Shinogle JA. Obesity and physical inactivity in rural America. J Rural Health 2004;20:151–9.
[13] Morgan A. A national call to action: CDC's 2001 urban and rural health chartbook. J Rural Health 2002;18:382–3.
[14] Hale NL, Bennett KJ, Probst JC. Diabetes care and outcomes: disparities across rural America. J Community Health 2010;35:365–74.
[15] Roberts ME, Doogan NJ, Kurti AN, Redner R, Gaalema DE, Stanton CA, et al. Rural tobacco use across the United States: how rural and urban areas differ, broken down by census regions and divisions. Health Place 2016;39:153–9.
[16] Singh JA. Smoking and outcomes after knee and hip arthroplasty: a systematic review. J Rheumatol 2011;38:1824–34.
[17] Hogan C, Bucknell AL, King KB. The effect of diabetes mellitus on total joint arthroplasty outcomes. JBJS Rev 2016;4:e3.
[18] Braaten AD, Hanebuth C, McPherson H, Smallwood D, Kaplan S, Basirico D, et al. Social determinants of health are associated with physical therapy use: a systematic review. Br J Sports Med 2021;55:1293–300.
[19] Dietz MJ, Ray JJ, Witten BG, Frye BM, Klein AE, Lindsey BA. Portable compression devices in total joint arthroplasty: poor outpatient compliance. Arthroplasty Today 2020;6:118–22.
[20] Park KJ, Menendez ME, Barnes CL. Perioperative periprosthetic fractures associated with primary total hip arthroplasty. J Arthroplasty 2017;32:992–5.
[21] Kurtz SM, Lau EC, Ong KL, Adler EM, Kolisek FR, Manley MT. Which hospital and clinical factors drive 30-and 90-day readmission after TKA? J Arthroplasty 2016;31:2099–107.
[22] El Bitar YF, Illingworth KD, Scaife SL, Horberg JV, Saleh KJ. Hospital length of stay following primary total knee arthroplasty: data from the Nationwide Inpatient Sample database. J Arthroplasty 2015;30:1710–5.
[23] Menendez ME, Lu N, Unizony S, Choi HK, Ring D. Surgical site infection in hand surgery. Int Orthop 2015;39:2191–8.
[24] Rana AJ, Sturgeon CM, McGrory BJ, Frazier MV, Babikian GM. The ABLE anterior-based muscle-sparing approach: a safe and effective option for total hip arthroplasty. Arthroplasty Today 2022;16:264–269.e1.
[25] Ingram DD, Franco SJ, 2013 NCHS urban–rural classification scheme for counties. National Center for Health Statistics. Vital Health Stat 2014;2(166). https://www.cdc.gov/nchs/data/series/sr_02/sr02_166.pdf. [Accessed 2 August 2023].
[26] Mufarrih SH, Ghani MOA, Martins RS, Qureshi NQ, Mufarrih SA, Malik AT, et al. Effect of hospital volume on outcomes of total hip arthroplasty: a systematic review and meta-analysis. J Orthop Surg Res 2019;14:468.
[27] Jeschke E, Gehrke T, Günster C, Heller K-D, Leicht H, Malzahn J, et al. Low hospital volume increases revision rate and mortality following revision total hip arthroplasty: an analysis of 17,773 cases. J Arthroplasty 2019;34:2045–50.
[28] Halder AM, Gehrke T, Günster C, Heller K-D, Leicht H, Malzahn J, et al. Low hospital volume increases re-revision rate following aseptic revision total knee arthroplasty: an analysis of 23,644 cases. J Arthroplasty 2020;35:1054–9.
[29] Brodeur PG, Boduch A, Kim KW, Cohen EM, Gil JA, Cruz AI. Surgeon and facility volumes are associated with social disparities and post-operative complications after total hip arthroplasty. J Arthroplasty 2022;37(8S):S908–918.e1.
[30] Baker P, Jameson S, Critchley R, Reed M, Gregg P, Deehan D. Center and surgeon volume influence the revision rate following unicondylar knee replacement: an analysis of 23,400 medial cemented unicondylar knee replacements. J Bone Joint Surg Am 2013;95:702–9.
[31] Malik AT, Jain N, Scharschmidt TJ, Li M, Glassman AH, Khan SN. Does surgeon volume affect outcomes following primary total hip arthroplasty? A systematic review. J Arthroplasty 2018;33:3329–42.
[32] Henning-Smith C, Hernandez A, Lahr M, Kozhimannil K. Rural-urban differences in access to, attitudes toward, and satisfaction with care among Medicare beneficiaries. Health Serv Res 2020;55:20–1.
[33] Dickman SL, Woolhandler S, Bor J, McCormick D, Bor DH, Himmelstein DU. Health spending for low-, middle-, and high-income Americans, 1963–2012. Health Aff 2016;35:1189–96.
[34] Swan J, Breen N, Coates RJ, Rimer BK, Lee NC. Progress in cancer screening practices in the United States: results from the 2000 National Health Interview Survey. Cancer 2003;97:1528–40.
[35] Hung M, Bounsanga J, Voss MW, Saltzman CL. Establishing minimum clinically important difference values for the patient-reported outcomes measurement information system physical function, hip disability and osteoarthritis outcome score for joint reconstruction, and knee injury and osteoarthritis outcome score for joint reconstruction in orthopaedics. World J Orthop 2018;9:41–9.
[36] Ho V. Healthcare safety-net in the United States: patient satisfaction across rural and urban hospitals. Columbia, SC: University of South Carolina; 2022.
[37] Mahomed NN, Liang MH, Cook EF, Daltroy LH, Fortin PR, Fossel AH, et al. The importance of patient expectations in predicting functional outcomes after total joint arthroplasty. J Rheumatol 2002;29:1273–9.
[38] Epstein NE. Multidisciplinary in-hospital teams improve patient outcomes: a review. Surg Neurol Int 2014;5(Suppl 7):S295–303.
[39] Will KK, Johnson ML, Lamb G. Team-based care and patient satisfaction in the hospital setting: a systematic review. J Patient Cent Res Rev 2019;6:158–71.
[40] Dowsey MM, Petterwood J, Lisik JP, Gunn J, Choong PF. Prospective analysis of rural-urban differences in demographic patterns and outcomes following total joint replacement. Aust J Rural Health 2014;22:241–8.
[41] Cohen-Levy WB, Lans J, Salimy MS, Melnic CM, Bedair HS. The significance of race/ethnicity and income in predicting preoperative patient-reported outcome measures in primary total joint arthroplasty. J Arthroplasty 2022;37(7S):S428–33.
[42] Bronson WH, Lindsay D, Lajam C, Iorio R, Caplan A, Bosco J. Ethics of provider risk factor modification in total joint arthroplasty. J Bone Joint Surg Am 2015;97:1635–9.
[43] Dy CJ, Marx RG, Ghomrawi HM, Pan TJ, Westrich GH, Lyman S. The potential influence of regionalization strategies on delivery of care for elective total joint arthroplasty. J Arthroplasty 2015;30:1–6.
[44] Ramirez G, Myers TG, Thirukumaran CP, Ricciardi BF. Does hypothetical centralization of revision THA and TKA exacerbate existing geographic or demographic disparities in access to care by increased patient travel distances or times? A large-database study. Clin Orthop Relat Res 2022;480:1033–45.
[45] Ross L, O'Rourke S, Toland G, Harris Y, MacDonald D, Clement N, et al. Non-response to hip and knee arthroplasty patient-reported outcome questionnaires. In: Orthopaedic Proceedings8. United Kingdom: The British Editorial Society of Bone & Joint Surgery; 2022. p. 275–83.