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Taking the Long Way to Care: Who is Traveling Farthest to Undergo Elective Total Hip Arthroplasty?

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ABSTRACT

Background: Disparities in access to total hip arthroplasty (THA) exist. The purpose of this study is to examine how distance traveled to undergo elective THA correlates with sociodemographic variables and postoperative outcomes.

Material and methods: The Healthcare Cost and Utilization Project New York and Florida state inpatient databases were used to identify patients who underwent elective THA between 2006 and 2014. Data from the American Hospital Association and United States Postal Service were used to calculate the distance patients traveled to receive THA, and only those who traveled more than 25 miles were included. We stratified patients into 4 groups based on their distance traveled (25-50 miles, 50.01-100 miles, 100.01-500 miles, and >500.01 miles) and compared demographic characteristics and postoperative outcomes between groups.

Results: Age, race, insurance provider, zip code income quartile, and Charlson Comorbidity Index scores were each significantly associated with travel distance ($P < .001$) among our cohort of 25,734 patients. Patients who were older, were white, had Medicare insurance coverage, lived in zip codes with a higher median household income, and had increased comorbidities were more likely to travel the farthest to receive care. There were minimal associations between travel distance and postoperative outcomes.

Conclusion: There may be specific demographic groups who either are forced to travel long distances to receive care or have the resources to seek out and travel to distant hospitals in an effort to receive optimal care. Understanding the interconnected relationships between demographic variables is necessary to address disparities in access to specialized orthopedic surgical care.

Introduction

Total hip arthroplasty (THA) is a common, effective procedure performed in order to alleviate pain caused by osteoarthritis of the hip. With an aging population, it is estimated that there will be 635,000 THA procedures performed annually in the United States by 2030 [1]. However, there is evidence that patient demographics may be associated with distance traveled to receive orthopaedic care as well as postoperative outcomes. One study found that patients who traveled farthest to undergo total knee arthroplasty (TKA) were younger and had more severe disease processes [2]. Another study examined outcomes following femoroacetabular impingement syndrome operations based on whether patients traveled more or less than 50 miles to receive care. This study found that postoperative complications were similar between the 2 groups [3].

While existing literature describes the association between postoperative outcomes following total joint replacements and sociodemographic factors, to date, characteristics of patients that are associated with increased travel distance for hip arthroplasty are not well understood [4–6]. In addition, there is limited literature describing the association between preoperative travel distance and postoperative outcomes following THA.

The purpose of this study was to identify associations between socioeconomic factors and travel distance required for elective THA as well as to assess the relationship between travel distance and postoperative complications. In order to focus on issues of access to

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care, we specifically focused our analysis on patients requiring greater than 25 miles of travel to undergo THA. We hypothesized that age, medical comorbidities, insurance status, race, and income would be associated with travel distance. In addition, we hypothesized that patients who traveled farther to receive care may be more likely to have postoperative complications as these patients may travel farther to receive specialized care for complex disease processes or increased medical comorbidities.

Material and methods

We used the Healthcare Cost and Utilization Project (HCUP) New York and Florida State Inpatient Databases (SID) from 2006 to 2014 to identify patients who underwent THA (CPT Code 27130). These states were chosen due to their large populations, geographic diversity, and quality of data available. We excluded patients younger than 18 years at the time of surgery, those admitted through the emergency room, those who underwent bilateral THA, those without complete or zip code data, and those who traveled fewer than 25 miles.

The HCUP database was used to capture demographic information including age, race, gender, and resident zip code; preoperative medical diagnoses which were used to calculate the Charlson Comorbidity Index (CCI); and postoperative diagnoses which were used to determine complications [7] (Appendix A and Appendix B). In order to calculate the distance traveled to receive care, we linked the data from the HCUP and American Hospital Association databases by matching entries with the same hospital ID number. We used the American Hospital Association database to obtain the latitude and longitude coordinate points for each hospital at which a patient underwent THA. We then employed the UnitedStatesZipCodes.org Enterprise data set to gather population-weighted zip code centroids for each patient in the study, which provides an estimate of latitude and longitude within a zip code weighted by population density [8]. We then used Stata's "geodist" command to calculate the distance between each patient's population-weighted zip code centroid and the location of the hospital at which he/she underwent THA. The "geodist" command calculates distance using the Great Circle Equation, which computes the shortest distance between 2 points on a sphere as measured by the distance traveled along the surface of the sphere and is accurate within about 0.5% [9].

We divided patients into 1 of 4 groups based on their calculated travel distance to undergo THA: 25-50 miles, 50.01-100 miles, 100.01-500 miles, and greater than 500 miles. We evaluated the relationship between distanced traveled for surgery and demographic variables including age, CCI, race, gender, insurance provider, and median zip code income, using the Chi-square test for categorical variables and one-way analysis of variance tests for continuous variables. Logistic regression was used to analyze the relationship between travel distance and postoperative outcomes, using travel distance as a continuous variable. Statistical significance was set at $P < .05$. All statistical analyses were performed using Stata MP 16 analytical software (StatCorp, LLC, College Station, TX).

Results

From 2006 to 2014, 262,912 patients underwent THA in Florida and New York. One hundred fifty-two patients were excluded for being under 18 years old, 25,487 were excluded for emergent procedures, 25,467 were excluded for incomplete location data, and 186,072 were excluded for traveling less than 25 miles to receive care, leaving 25,734 patients included in analyses. The average age of patients was 63.8 years (standard deviation: 12.1 years) with an average CCI score of 2.63 (standard deviation: 1.71). Women comprised 52.4% of the patient population, and 89.1% of the patients were White. Medicare (52.0%) and commercial (40.0%) insurance plans were the most common providers. Patients were relatively evenly distributed among zip code, with median-income quartiles with the lowest bracket comprising 28.1% of the patients and the highest-income group comprising 19.5% of the sample. Table 1 summarizes these data.

Patients who traveled increased distance were significantly more likely to be older ($P < .0001$) and have increased CCI ($P = .0008$) than those who traveled shorter distances. Patients who traveled over 500 miles to undergo THA were an average of 70.2 years old compared to the mean age across all travel distance groups of 63.81 years. Additionally, patients who traveled at least 500 miles had an average CCI score of 3.16, compared to the composite average of 2.63. Patients traveling 25-500 miles were both of a similar average age (63.1-63.8 years) and had similar CCI scores (2.60-2.64). Thus, among our cohort of patients, significant differences in age and CCI were more pronounced among patients traveling the considerable distance of greater than 500 miles for undergo THA. These data are summarized in Table 2.

Race was significantly associated with travel distance ($P < .001$) with White patients over-represented and Black patients under-represented in the group of patients traveling the greatest distances (>500 miles) for care (Table 3). Black patients were 0.287 times as likely to travel 500 miles to receive care compared to non-Black patients, whereas White patients were 1.795 times more likely to travel at least 500 miles to undergo THA as compared to non-White patients.

Patients who traveled at least 500 miles to undergo THA were significantly more likely to have Medicare insurance ($P < .001$) (Table 4). Patients with Medicare were 2.91 times more likely to travel at least 500 miles to receive care than patients with any other insurance provider. The proportions of patients in the 25-50 miles, 50-100 miles, and 100-500 miles groups were each similar to the overall proportions of patients as stratified by insurance provider. As such, like with age and CCI, it is possible that differences in patient travel distance are most pronounced at the extreme range of travel distance, the greater than 500 miles traveled group.

Table 1
Demographic data.

Age: mean ± standard deviation	63.8 ± 12.1
CCI: mean ± standard deviation	2.63 ± 1.71
Gender: n (%)	
Male	12,251 (47.6)
Female	13,482 (52.4)
Race: n (%)	
Asian	54 (0.2)
Black	1074 (4.2)
Hispanic	697 (2.7)
Native American	48 (0.2)
White	22,930 (89.1)
Missing or other	931 (3.6)
Insurance provider: n (%)	
Commercial	10,275 (40.0)
Medicaid	851 (3.3)
Medicare	13,374 (52.0)
Other	1234 (4.8)
Hospital state: n (%)	
Florida	16,054 (62.4)
New York	9680 (37.6)
Zip code income quartile: n (%)	
1 (lowest)	7239 (28.1)
2	7881 (30.6)
3	5267 (20.5)
4 (highest)	5023 (19.5)
Null	324 (1.3)

Table 2
Travel distance vs age & CCI.

Distance group	Frequency	Mean age (SD)	Mean CCI (SD)
25-50 miles	17,404	63.8 (11.9)	2.61 (1.69)
50-100 miles	5401	63.1 (12.5)	2.60 (1.77)
100-500 miles	2293	63.7 (12.2)	2.64 (1.76)
>500 miles	636	70.2 (10.1)	3.16 (1.53)
		$P < .0001$	$P = .0008$

Patients who lived in zip codes with higher median incomes were more likely to travel farther for their operations ($P < .001$) (Table 5). Patients who lived in areas in the top median-income quartile were 2.349 times more likely to travel at least 500 miles to undergo elective THA than all other patients. Patients in the 2 highest-income quartile groups were relatively over-represented in both the 100-500 miles and greater than 500 miles groups. Conversely, patients in the 2 lowest-income quartile groups were under-represented in each of these distance groups. This suggests that differences in distance traveled may be stratified in a step-wise manner by both income bracket and by distance traveled.

Of the 13 postoperative complications that were analyzed, three were significantly associated with travel distance. This included death within 30 days of operation ($P = .02$), death within 90 days of operation ($P = .03$), and mechanical malfunction within 365 days of operation ($P = .04$). Death within 30 days of THA and death within 90 days of THA were correlated with increased travel distance, while mechanical malfunction within 365 days of surgery was associated with decreased travel distance. Despite statistical significance, the coefficient of effect for each of these analyses was low, as summarized in Table 6.

Discussion

This study provides evidence that patient demographic characteristics including age, comorbid conditions, race, insurance provider, and zip code income quartile are significantly associated with the distance traveled by patients to undergo THA. Notably, there was no clinically significant relationship between postoperative adverse outcomes and distance traveled to receive this care.

We found that older age and increased medical comorbidities were associated with increased travel distance. This is in contrast to a prior study which reported that younger patients traveled farther to undergo TKA, but similar in that patients with more complex disease etiologies more often traveled long distances to receive care [2]. It is possible that older individuals are able to devote more time and resources to travel long distances for operations although we cannot determine this from these data. In addition, age and CCI are likely related as older individuals may have increased medical comorbidities. Based on these data, we may speculate that patients with significant medical comorbidities may be referred to tertiary care centers for more specialized perioperative care; however, future research should further investigate this possibility. This would indicate a specific type of access to care issue.

Table 3
Travel distance vs race (percent).

Distance group	Asian	Black	Hispanic	Other	Native American	White
25-50 miles	0.2	4.0	2.8	3.4	0.2	89.4
50-100 miles	0.2	5.2	2.0	4.6	0.2	87.8
100-500 miles	0.3	4.1	3.8	3.3	0.04	88.5
>500 miles	0.2	1.3	2.2	2.7	0.2	93.6
Total	0.2	4.2	2.7	3.6	0.2	89.1

$P < .001$.

Table 4
Travel distance vs insurance provider (percent).

Distance group	Commercial	Medicaid	Medicare	Other
25-50 miles	40.6	3.1	51.7	4.6
50-100 miles	38.3	4.4	50.9	6.4
100-500 miles	43.0	3.3	49.8	3.9
>500 miles	23.3	0.2	75.5	1.0
Total	40.0	3.3	52.0	4.8

$P < .001$.

We found statistically significant associations between travel distance and race, insurance provider, and zip code income quartile. We found that White patients, those with Medicare insurance, and those living in zip codes with higher median income levels were more likely to travel farther to undergo THA. This may be due to White Americans being more likely to live in rural areas and thus be more likely to live far from hospitals at which they can undergo THA [10]. Alternatively, this finding may also be due to income inequality based on race. In 2017, White Americans had a median household income of $68,145, whereas Black households had a median income of $40,258 [11]. As such, it may be the case that White Americans are better able to deploy financial resources in order to travel to undergo surgical care far from their homes. As most individuals begin to qualify for Medicare insurance at age 65 years, it is possible that the differences in insurance provider are based in large part on age. As noted previously, older individuals were found to be more likely to travel great distances to receive care. The present data also indicate that patients with greater financial resources are more likely to travel long distances to receive care. This may be due to the cost of transportation and lodging for family members accompanying patients. In addition, individuals with higher income levels may be better positioned to take off time from work and other pursuits such as child care to travel a great distance to receive a joint replacement procedure than their less well-off counterparts. It is also possible that access for patients on Medicare in rural settings has declined with declining reimbursements, forcing these patients to travel farther, although more granular data are needed to define this relationship.

While death within 30 days of operation ($P = .02$), death within 90 days of operation ($P = .03$), and mechanical malfunction within 365 days of operation ($P = .04$) were statistically associated with travel distance, none were clinically significant with odds ratios of 1.001 or less. It is likely that these statistically significant outcome results are due in part to the large sample size of the study and not due to true clinical differences in postoperative outcomes. This is consistent with findings from Beck et al. who noted no difference in postoperative outcomes based on travel distance following femoroacetabular impingement syndrome surgery, although these operations are not truly comparable in terms of complication risk [3]. It is encouraging that there does not appear to be a disparity in ultimate operative outcomes based on distance traveled to receive care. However, future studies may include more data points to better capture associations with these rare outcomes.

It is likely that the demographic characteristics assessed in this analysis interact with one another in various ways. Understanding

Table 5
Travel distance vs zip code income (percent).

Distance group	1 (lowest)	2	3	4 (highest)	Null
25-50 miles	28.6	30.6	20.2	19.5	1.2
50-100 miles	31.7	32.5	19.4	14.7	1.7
100-500 miles	20.9	27.8	23.4	27.0	0.9
>500 miles	11.2	24.7	27.5	35.7	0.9
Total	28.1	30.6	20.5	19.5	1.3

$P < .001$.

Table 6
Travel distance vs postoperative adverse outcomes.

Outcome	Coefficient	*P* value
Stroke	0.0002	.65
Death within 30 d	0.001	.02
Death within 90 d	0.001	.03
Death within 365 d	0.0005	.27
Cardiac complication within 30 d	0.0002	.64
DVT within 60 d	0.00004	.91
Genitourinary complication within 30 d	−0.0004	.18
Hematoma within 30	0.0004	.32
Mechanical malfunction within 365 d	−0.0004	.04
Pulmonary embolism within 60 d	0.0004	.46
Prosthetic joint infection within 365 d	−0.0004	.38
Respiratory complication within 30 d	−0.0006	.23
Readmission within 30 d	0.0003	.06

DVT, deep vein thrombosis.

the complex associations between these variables may allow improved predictions regarding which patients are more likely to travel great distances to receive care and why. Our data suggest that, on average, older, sicker patients with greater financial resources are able to travel far from home in order to receive the care that they require. However, patients who have similar comorbid conditions and advanced age but limited resources may not be able to travel to a tertiary care facility to undergo THA. Because we captured only patients who underwent THA, we were unable to analyze those who were indicated for surgery but either declined or were not offered operative management. Access to care may be limited for patients who require tertiary care facilities for THA but are not financially able to deploy the resources needed to travel to these hospitals.

Limitations

Zip code income quartiles are an adequate but imperfect approximation of patient wealth, and future research should investigate patient-specific measures of income in order to better elucidate the association between travel distance and income. The patients in our study were 89.1% White, greater than the 69.6% White population in New York or 77.3% White population in Florida [12,13]. There are data that non-White patients have lower utilization rates of arthroplasty operations [14]. Thus, while our data may be in line with these prior findings, the generalizability of our findings to patients of all racial groups may be somewhat diminished.

In addition, future work may assess the degree to which patients who are traveling great distances to receive care are choosing to do so while seeking specific levels of care or are being forced to do so due to a lack of access to adequate care nearby. This will help to further illustrate the causal mechanisms leading some patients to travel hundreds of miles to undergo THA. This may include using databases that are able to determine the nearest hospital at which each given patient may be able to undergo THA. This would allow researchers to better assess whether patients are choosing distant hospitals despite access to nearby facilities or whether patients who travel greater distance live in areas without hospitals performing this specialized procedure. In addition, future work may seek to better understand what resources are available in the nearby hospitals to support patients in the perioperative period. For example, if a given patient has cardiovascular disease and is likely to need specialized care from a cardiologist perioperatively, it would be important to know whether the hospitals nearest to the patient's zip code have cardiologists available to provide care. Although these data were unavailable in the databases utilized in this project, these points would be valuable directions for future research.

Finally, future studies should analyze the role that urbanicity plays with regard to the relationships between travel distance, race, and income specifically. Because patients who are White are more likely to live in rural areas, it is possible that White patients are traveling farther to receive care based on a paucity of healthcare facilities near their homes and not because of the differences in income when stratified by race that were discussed previously. The databases utilized in the present study did not contain markers of rural vs suburban vs urban zip codes. However, future studies may benefit from using databases with this information. Researchers may consider either stratifying patients based on this characteristic or including a map showing the relative proportions of patients in the study living in rural vs suburban vs urban areas. Future work is required in order to further elucidate the causal mechanisms involved in these relationships and potentially work toward more equitable access to care.

Conclusions

In summary, we found that patients who were older, had more comorbidities, were White, had Medicare insurance coverage, and lived in more wealthy areas were more likely to travel long distances to undergo THA. However, we did not find clinically significant differences in postoperative outcomes based on travel distance. There is a complex interplay between the various factors associated with increased travel distance, and future studies should seek to assess the ways in which these factors interact and either allow or force patients to travel great distances to receive the care they need. Examining the close interplay of these factors may help inform decisions for medical resource allocation to help address healthcare inequities.

Conflicts of interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Dr. Derek Ward is a consultant for DePuy Synthes; all other authors declare no potential conflicts of interest.

For full disclosure statements refer to https://doi.org/10.1016/j.artd.2022.05.002.

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Table Appendix A
Complications.

Outcome	Definition	ICD-9 codes
Death (≤30 d)		N/A; Coded from discharge disposition
Death (≤90 d)		N/A; Coded from discharge disposition
Death (≤1 y)		N/A; Coded from discharge disposition
Myocardial infarction (≤30 d)		'410.01', '410.11', '410.21', '410.31', '410.41', '410.51', '410.61', '410.71', '410.81', '410.91'
Ischemic stroke (≤30 d)		'997.02', '433.01', '433.11', '433.21', '433.31', '433.81', '433.91', '434.01', '434.11', '434.91'
Cardiac complications (≤30 d)		'997.1', '428.21', '428.23', '428.31', '428.33', '428.41', '428.43', '427.5', '785.51'
Respiratory complications (≤30 d)		'997.3', '466.0', '466.1', '480', '481', '482', '483', '484', '485', '486', '487', '488'
Digestive complications (≤30 d)		'997.4', '560.1'
Genitourinary complications (≤30 d)		'997.3', '584.5', '584.6', '584.7', '584.8', '584.9', '590.10', '590.11', '595.0'
Hematoma (≤30 d)		'998.12', '719.15', '719.16'
Deep vein thrombosis (≤60 d)		'415.11', '415.19', '451.81', '451.83', '451.89', '453.40', '453.41', '453.42', '453.8', '453.9', '444.22', '444.81', '996.77'
Pulmonary embolism (≤60 d)		'415.11', '415.12', '415.13', '415.19'
Knee infection (≤1 y)	A periprosthetic joint infection requiring revision hip arthroplasty, liner removal, arthrotomy, debridement, synovectomy, or other excision	Any of ('996.66', '996.67', '998.59') AND any of ('00.80', '00.82', '00.83', '00.84', '80.06', '80.16', '86.22', '80.76', '80.86', '81.55')
Hip infection (≤1 y)	A periprosthetic joint infection requiring revision hip arthroplasty, liner removal, arthrotomy, debridement, synovectomy, or other excision	Any of ('996.66', '996.67', '998.59') AND any of ('00.70', '00.71', '00.72', '00.73', '80.05', '80.15', '80.75', '80.85', '80.95', '81.53', '86.05', '86.22')
Mechanical malfunction, knee (≤1 y)	A mechanical malfunction of the prosthetic joint such as loosening, dislocation, fracture, surface wear, osteolysis, or ankyloses/arthrofibrosis, that required revision hip arthroplasty, internal fixation of bone, ostectomy, joint capsule division	'81.55', '78.67', '78.55', 77.86, 79.06, 80.46, 93.26, 93.16, 718.56, 718.36, 884.1, 996.40, 996.41, 996.42, 996.43, 996.44, 996.45, 996.46, 996.47, 996.49, 996.77, 996.78
Mechanical malfunction, hip (≤1 y)	A mechanical malfunction of the prosthetic joint such as loosening, dislocation, fracture, surface wear, osteolysis, or ankyloses/arthrofibrosis, that required revision hip arthroplasty, internal fixation of bone, ostectomy, joint capsule division	Any of ('996.40', '996.41', '996.42', '996.43', '996.44', '996.45', '996.46', '996.47', '996.49', '718.55', '718.35', '996.77', '996.78') OR any of ('81.53', '78.65', '78.55', '79.05', '80.45')

Table Appendix B
Charlson comorbidity index scoring.

CCI (Charlson Comorbidity Index)	MI = 1 point HF = 1 point Peripheral vascular disease = 1 point Cerebrovascular disease = 1 point Hemiplegia / Paraplegia = 2 points Chronic pulmonary disease = 1 point Diabetes, uncomplicated = 1 point Diabetes, with complications = 2 points Renal disease = 2 points Mild liver disease = 1 point Mod-severe liver disease = 3 points Peptic ulcer disease = 1 point Metastatic solid tumor = 6 points Other cancer = 2 points Dementia = 1 point Rheumatic disease = 1 point AIDS/HIV = 6 points Depression = 1 point Age 50-59 = 1 point Age 60-69 = 2 points Age 70-79 = 3 points Age >= 80 = 4 points