The Journal of Rheumatology 2022;xx:xxxx
doi:10.3899/jrheum.220734
First Release December 1 2022

The Journal of Rheumatology

Research Letter

Surgeon Volume and Differences in Rates of Primary Total Knee Arthroplasty Across 3 US States

To the Editor:

Rates of total knee arthroplasty (TKA), one of the most common surgical procedures, vary markedly across regions, even after accounting for knee arthritis prevalence.[1,2] In the United States, TKA rates are generally higher in the Midwest and Mountain West, and lower in the Southeast and on both coasts.[2] For example, TKA rates are 1.5 times higher in Iowa, and 1.9 times higher in Utah, than in Florida.[3]

The factors responsible for these regional differences are poorly understood, but may include variation in access, patient willingness, and surgeon enthusiasm.[4,5] High-volume surgeons tend to view the benefits and risks of TKA more favorably than low-volume surgeons.[6] Previous studies have not examined how individual surgeon volumes relate to regional differences in TKA rates. It is not known if TKA rates are higher among most surgeons in regions with high rates, or if these rates are driven by a subset of high-volume surgeons.

Using state inpatient databases for 2016, I compared the distribution of TKA rates of individual surgeons in Utah and Iowa to those in Florida. These databases include administrative claims on all hospitalizations in nonfederal community hospitals.[7] These states were chosen because they had either very high or low TKA rates and could therefore inform the study question.[3] Data from 2016 predated increased use of outpatient TKA. The Healthcare Cost and Utilization Project (HCUP) databases conform to the definition of a limited dataset. A limited dataset is healthcare data in which 16 direct identifiers, specified in the Privacy Rule, have been removed. Under the Health Insurance Portability and Accountability Act, review by an institutional review board is not required for use of limited datasets.

Hospitalizations with primary TKA among adults aged ≥ 20 years were identified using International Classification of Diseases, 10th revision, procedure codes prefixed 0SRC or 0SRD. Hospitalizations with bilateral TKAs were credited as 2 TKAs. I excluded TKAs performed on out-of-state residents.

Each TKA was assigned to a hospital service area, based on the patient's zip code of residence. Hospital service areas are collections of zip codes in a local area served by a given hospital.[8]

Surgeons were identified by unique identifiers. The Iowa and Florida datasets included separate pseudoidentifiers for the operating physician and attending physician. These were the same person in 92.6% and 82.4% of hospitalizations in Iowa and Florida, respectively. The Utah database included only identifiers for the attending physician (in 93.6% of hospitalizations). I excluded 28 hospitalizations in Florida and 562 hospitalizations in Utah with missing physician identifiers.

The numerator of each surgeon's TKA rate was the number of TKAs performed. The denominator was the population (aged ≥ 20 yrs) of each hospital service area represented among the TKAs performed by each surgeon. For example, if a surgeon performed 10 TKAs among residents of 3 hospital service areas, the denominator was the population of the 3 hospital service areas, considering this as the area from which the surgeon had drawn their patients. The population of each hospital service area was based on 2016 US census estimates of the constituent zip codes.[9]

Crude rates of each surgeon were standardized by sex, race (White, Black, other), and 9 age groups to the distribution of the state population. To permit comparisons among states, rates were also standardized to the population distribution in Iowa. Violin plots were used to examine if the rate distributions were unimodal or multimodal.

The study included 10,355 TKA and 217 surgeons in Iowa, 8654 TKA and 133 surgeons in Utah, and 45,095 TKA and 964 surgeons in Florida (Table). The median number of TKA per surgeon was 23, 35, and 20 in Iowa, Utah, and Florida, respectively. Standardized rates were significantly higher in Iowa (median 74.8 per 100,000) and Utah (median 90.8 per 100,000) than in Florida ($P < 0.001$ for both comparisons), but not significantly different between Iowa and Utah ($P = 0.11$). Results were similar in analyses restricted to White individuals. Violin plots demonstrated similar unimodal distributions in each state (Figure).

One consideration for regional differences in TKA rates is that locally high rates may be driven by a subset of high-volume surgeons. The absence of a bimodal or multimodal pattern in surgeon TKA rates does not support this hypothesis. Rather, the higher rates in Iowa and Utah were due to a higher use across the population by most surgeons, suggesting general differences in decision making surrounding TKA. This study cannot determine whether patients, surgeons, or both were more predisposed to TKA in the high-rate states.

This study is limited by data for only 1 year from 3 states, but the large differences in rates among these states facilitated testing my hypothesis. Data from 2016 were useful because this predated increases in outpatient TKAs. A small percentage of Utah hospitalizations were excluded because physician identifiers were missing, and Utah provided data on attending physicians but not surgeons.

To my knowledge, this is the first analysis of geographic differences in primary TKA rates by surgeon. These results indicate that the high TKA rates in 2 states are due to higher rates among most surgeons, possibly reflecting a generally lower threshold for performing TKA.[10]

Michael M. Ward[1], MD, MPH
[1]Intramural Research Program, National Institute of Arthritis and Musculoskeletal and Skin Diseases, National Institutes of Health, Bethesda, Maryland, USA.

Table. Characteristics of TKA recipients and surgeons by state.

	Iowa	Utah	Florida
No. of TKAs	10,355 (100)	8654 (100)	45,095 (100)
Sex			
Women	6370 (61.5)	5056 (58.4)	27,269 (60.5)
Men	3985 (38.5)	3598 (41.6)	17,826 (39.5)
Age, yrs			
20-44	134 (1.3)	196 (2.3)	444 (1)
45-64	4481 (43.3)	3847 (44.4)	14,335 (31.8)
≥ 65	5740 (55.4)	4611 (53.3)	30,316 (67.2)
Race			
White	10,007 (96.6)	8109 (93.7)	38,836 (86.1)
Black	133 (1.3)	41 (0.5)	3791 (8.4)
Other	215 (2.1)	504 (5.8)	2468 (5.5)
No. of surgeons	217	133	964
TKAs per surgeon, median (range)	23 (1-354)	35 (1-535)	20 (1-763)
Correlation between no. of TKAs per surgeon and standardized rate	0.72	0.72	0.83
Hospital service areas per surgeon, median (range)	4 (1-35)	4 (1-17)	4 (1-45)
TKA rate per surgeon per 100,000, standardized to own state population, median (range)	74.8 (1.4-1557)	69.3 (2.1-1747)	22.5 (0.3-604)
TKA rate per surgeon per 100,000, standardized to Iowa population, median (range)	74.8 (1.4-1557)	90.8 (1.6-2263)	19.1 (0.02-594)
TKA rate per surgeon per 100,000 White population, standardized to Iowa population, median (range)	79.6 (0.3-1682)	95.8 (1.8-2434)	19.4 (0.03-628)

Values are n (%) unless indicated otherwise. TKA: total knee arthroplasty.

This work is supported by the Intramural Research Program, National Institute of Arthritis and Musculoskeletal and Skin Diseases, National Institutes of Health (ZIA-AR-041153).

The author has no financial conflicts of interest related to this work.

Address correspondence to Dr. M.M. Ward, NIAMS/NIH, Building 10CRC, Room 4-1339, 10 Center Drive, Bethesda, MD 20892-1468, USA. Email: wardm1@mail.nih.gov.

ACKNOWLEDGMENT

The views presented in this article are those of the author and do not necessarily represent those of the National Institutes of Health or the US Government. The funder had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication. Data were provided by the Healthcare Cost and Utilization Project, Agency for Healthcare Research and Quality, under a data use agreement. MMW had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

REFERENCES

1. Birkmeyer JD, Reames BN, McCulloch P, Carr AJ, Campbell WB, Wennberg JE. Understanding of regional variation in the use of surgery. Lancet 2013; 382:1121-9.
2. Ward MM, Dasgupta A. Regional variation in rates of total knee arthroplasty among Medicare beneficiaries. JAMA Netw Open 2020;3:e203717.
3. Ward MM. Geographic differences in rates of total knee arthroplasty in young and older adults. A comparison of three US states. J Rheumatol 2022;49:307-11.
4. Mota RE, Tarricone R, Ciani O, Bridges JF, Drummond M. Determinants of demand for total hip and knee arthroplasty: a systematic literature review. BMC Health Serv Res 2012;12:225.
5. Wright JG, Hawker GA, Bombardier C, et al. Physician enthusiasm as an explanation for area variation in the utilization of knee replacement surgery. Med Care 1999;37:946-56.
6. Wright JG, Coyte P, Hawker G, et al. Variation in orthopedic surgeons' perceptions of the indications for and outcomes of knee replacement. CMAJ 1995;152:687-97.
7. Healthcare Cost and Utilization Project. HCUP State Inpatient Databases (SID). Agency for Healthcare Research and Quality, Rockville, MD. [Internet. Accessed October 12, 2022.] Available from: https://www.hcup-us.ahrq.gov/sidoverview.jsp.
8. The Dartmouth Institute for Health Policy and Clinical Practice. Dartmouth Atlas Project. The Dartmouth Atlas of Health Care. [Internet. Accessed October 12, 2022.] Available from: https://www.dartmouthatlas.org/
9. United States Census Bureau. State population by characteristics: 2010 – 2019. [Internet. Accessed October 12, 2022.] Available from: https://www.census.gov/data/tables/time-series/demo/popest/2010s-state-detail.html
10. Ward MM. Osteoarthritis care and risk of total knee arthroplasty among Medicare beneficiaries. Arthritis Rheumatol 2021; 73:2261-70.

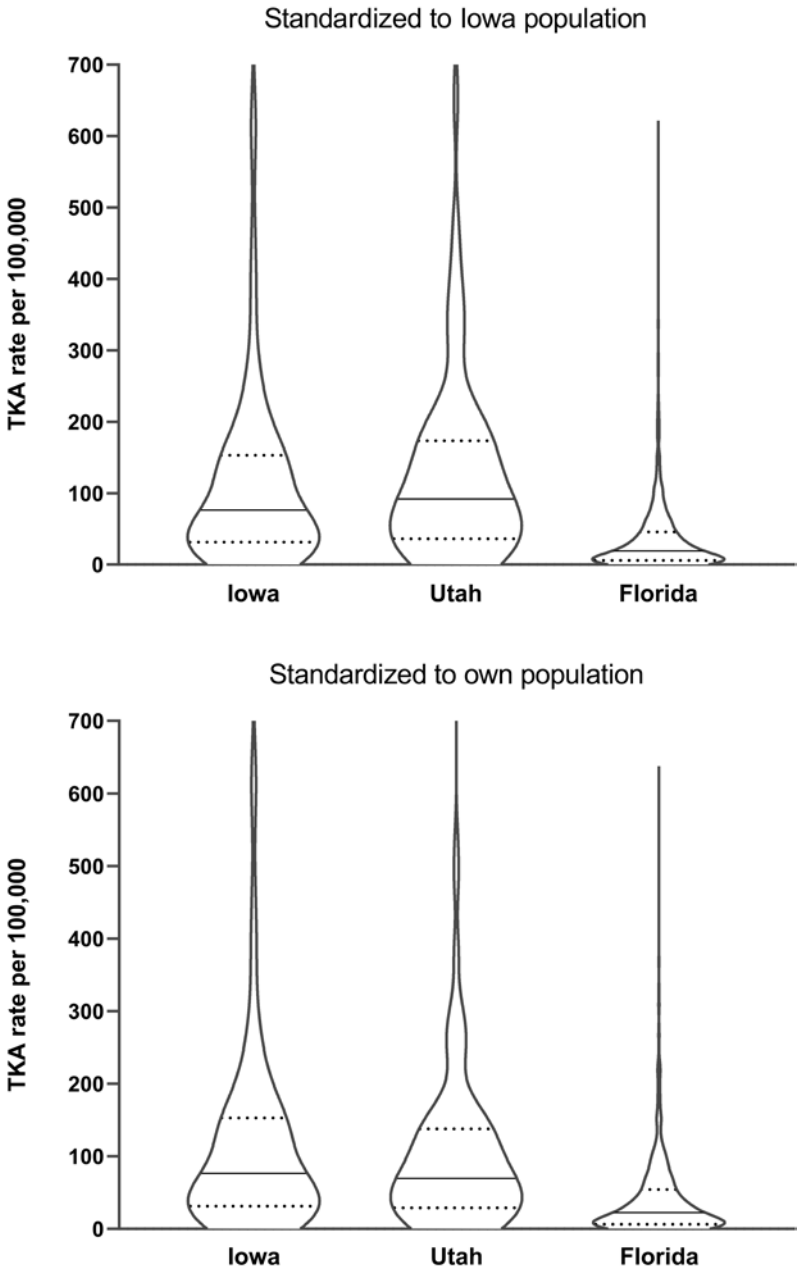

Figure. Distribution of total knee arthroplasty (TKA) rates per 100,000 population per surgeon in Iowa, Utah, and Florida. Rates were standardized to the sex, age, and race distribution of the Iowa population (top) or to their own state's population (bottom). The width of the violin plot at any location indicates the probability that given rates are represented in the samples. Horizontal dotted lines indicate the 25th and 75th percentiles, and the horizontal solid line indicates the median. Two outliers were omitted in the Iowa group (807 and 1557) and 1 outlier was omitted in the Utah group (2263).