

# How to Determine the Orthopaedic Surgeon Workforce in the United States: An Analysis Based on Projected Volume in Primary Total Joint Arthroplasty from 2020 to 2050

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**INTRODUCTION:** The volume of total hip (THA) and knee arthroplasties (TKA) has grown more than 132% and 148% in the last two decades and is predicted to continue to increase. Contrariwise, the orthopaedic surgeon workforce has remained stable over the same time-period. In a value-based healthcare model, outcomes must be optimized while costs controlled to improve value. The best evidence-based strategies for meeting the demand of total joint arthroplasties (TJA) in the future remains unknown. Therefore, we aimed to project the orthopaedic surgeons contributing to the arthroplasty workforce including active orthopaedic surgeons, residents, and adult reconstruction fellows. We also aimed to characterize historical primary TJA volume per total active orthopaedic surgeons in terms of procedure-to-surgeon ratios (PSR) and use these to model future projections for 2050.

## **METHODS:**

The National Inpatient Sample was retrospectively reviewed for all THAs and TKAs performed from 2000 to 2018 identified by International Classification of Diseases, Ninth and Tenth Revision (ICD-9 and ICD-10) codes for primary THA/primary TKA, respectively. The number of active orthopaedic surgeons from 2000 to 2019 was sourced from the Association of American Medical Colleges (AAMC) *Physician Specialty Data Reports*. The number of post-graduate year-one (PGY-1) orthopaedic residency positions filled was sourced from the National Resident Matching Program (NRMP). The number of Adult Reconstruction Fellowship positions filled was obtained from the American Association of Hip and Knee Surgeons. The projected annual volume of THA and TKA were modeled using negative binomial regression models with year, age, and sex as covariates while incorporating log-transformed population data for each age-sex-year subgroup as the offset term. THA and TKA were modeled separately, and the projected total volume was presented as the sum of THA and TKA. Linear regression analyses were performed with AAMC data from 2010 to 2019 to estimate the projected number of active orthopaedic surgeons until 2050. Procedure-to-surgeon ratios (PSR), defined as the number of annual TJA cases performed per total active orthopaedic surgeons, were calculated by dividing the number of actual (or projected) TJA by the number of actual (or projected) orthopaedic surgeons. The total number of primary TJAs in 2018 was 1,122,853.

## **RESULTS:**

In the period from 2000 to 2017, the volume of primary TJA increased by 130%, (2000: n=539,324 to 2017: n=1,238,634 procedures). The projected volume of primary THA in 2050 is 1,219,852 procedures (464,808-3,201,804; Figure 1). The projected volume of primary TKA is 1,037,474 procedures (464,808-3,201,804; Figure 1).

The number of active orthopaedic surgeons increased by 7.5% during the same period (2000: n=17,676 to 2017: n=19,001). TJA procedure-to-surgeon ratios (PSR) increased 110%, from 31 in 2000 to 65 in 2017. The projected numbers of orthopaedic surgeons contributing to the arthroplasty workforce are predicted to decrease 12.0% from 2025 to 2050 (2025: 18,393 to 2050: 16,189). The number of orthopaedic residents has increased 25.0% from 653 residents in 2010 to 866 residents in 2021. The projected increase in orthopaedic resident workforce by 2050 is 1,173. The number of adult reconstruction fellows increased from 109 in 2010 to 201 in 2021. The projected number of fellows in 2050 is 460.

Primary TJA volume is projected to increase 51% by 2050, (2020: n=1.27 million to 2050: n=1.91 million TJA cases). The number of active orthopaedic surgeons is projected to decrease 14% during the same period (2020: n=18,834 to 2050: n=16,189 orthopaedic surgeons). Based on these projections, TJA procedure-to-surgeon ratio will increase 97%, from 70.6 in 2020 to 139.4 in 2050 (Table 1).

## **DISCUSSION AND CONCLUSION:**

The shortage of healthcare providers during the COVID-19 pandemic served as a reminder to manage the pool of trained personnel via an evidence-based approach. While osteoarthritis may not surmount the morbidity and mortality of a devastating pandemic, orthopedic surgeon shortage may jeopardize quality of musculoskeletal care. Our conservative projections for future TJA volume indicate that the number of TJAs performed per surgeon will double by 2050 to meet projected demand. This may underestimate the actual shortage, given that certain highly subspecialized providers' practices may be entirely devoid of TJA. Managing this increased volume without compromising quality may require the increased use of high-volume surgical centers throughout and utilizing advanced practice providers like physician's associates and nurse practitioners.

Although the number of orthopaedic residents has increased, this increase has not translated into an increasing number of practicing orthopaedic surgeons likely due to the loss of orthopaedic surgeons to retirement. To meet the upcoming TJA demand, we must not only maintain, but increase the number of orthopaedic surgeons contributing to the arthroplasty workforce.

With the projected TJA procedure-to-surgeon ratio increasing at a rapid pace, the present study highlights the need for planning and allocation of resources in the training of orthopedic surgeons to meet the demands of TJA across the US. The question now becomes how do we best meet the demand while maintaining quality in a value-driven healthcare model: Increasing efficiencies and volume, or increasing the number of providers?

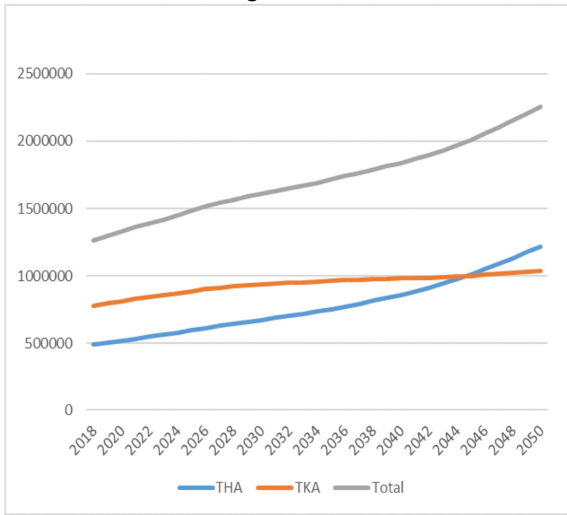


Fig. 1 Projected volume of primary THA/TKA until 2050.

Year	THA <sup>a</sup>	TKA <sup>a</sup>	TJA <sup>a</sup>	Orthopaedic Surgeons <sup>b</sup>	PSR (THA)	PSR (TKA)	PSR (TJA)
<i>Historical</i>							
2010	390,310	632,862	1,023,172	19,822	19.7	31.9	51.6
2015	474,615	712,779	1,187,394	19,145	24.8	37.2	62.0
<i>Projected</i>							
2020	517,845	811,964	1,329,809	18,834	27.5	43.1	70.6
2025	596,144	886,259	1,482,403	18,393	32.4	48.2	80.6
2030	673,643	937,803	1,611,446	17,952	37.5	52.2	89.8
2035	752,662	963,034	1,715,696	17,512	43.0	55.0	98.0
2040	858,782	980,279	1,839,061	17,071	50.3	57.4	107.7
2045	1,009,916	1,000,170	2,010,086	16,630	60.7	60.1	120.9
2050	1,219,852	1,037,474	2,257,326	16,189	75.4	64.1	139.4

<sup>a</sup> THA: Total Hip Arthroplasty, <sup>a</sup>TKA: Total Knee Arthroplasty, <sup>a</sup>TJA: Total Joint Arthroplasty,  
<sup>b</sup> Number of Active Orthopaedic Surgeons,  
<sup>c</sup> PSR: Procedure to Surgeon Ratio (Calculated Number of Annual Procedures Performed per Active Orthopaedic Surgeon)