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Research Article

Total Knee Arthroplasty: Socioeconomic Disparities of Post-Operative Complications

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Abstract

Total knee arthroplasty (TKA) is one of the most performed orthopedic operations in the United States. Current projections are that by 2030, there will be 935,000 primary TKAs annually.1 Given the growing prevalence of this surgical procedure, it is important to evaluate the associated rate of morbidities and mortality. The Centers for Medicare and Medicare Services (CMS) reports the following TKA postoperative complications: strokes, deep vein thrombosis/blood clots, wound dehiscence, pressure sores, etc. It is widely understood that socioeconomic disparities can play a role in postoperative complications, but the extent to which these disparities affect health outcomes varies largely from region to region as well as from one surgery to another. For this reason and the growing prevalence of TKA, we are analyzing socioeconomic disparities in Florida and to what extent these disparities may be affecting health outcomes. Hardee County, a known health professional shortage area, and Osceola County had significantly higher complication rates compared to higher average income counties—Orange, Miami-Dade, Alachua, Lake and Collier. The middle-income counties were further analyzed to determine where the threshold of significance of complication rates becomes apparent. These staggering discrepancies highlight the need to identify complications of this surgery, their causes, and overall disparities among rural/low-income patient populations.

Keywords: Rural, Surgery, Orthopedics, Arthroplasty, Disparities

Introduction

A 2018 American Academy of Orthopedic Surgeons report predicts that TKA rates will increase by 189% in 2030 and by 382% in 2060.2 Current projections are that by 2030, there will be 935,000 primary TKAs annually.1 Healthcare disparities continue to be a concern for total knee arthroplasties (TKAs), and given the anticipated increase of TKAs, these disparities need to be addressed. Elderly patients undergoing TKA, such as the Medicare beneficiaries analyzed in this study, have an increased perioperative risk and require close interdisciplinary cooperation for success. For these patients, post-operative function depends significantly upon psychosocial factors in addition to a patient's preoperative health status.3 These psychosocial factors can create disparities within the total arthroplasty patient population. Such disparities relate to gender, race, socioeconomic status, and place of residence. Awareness of these disparities remains a crucial aspect to ensuring optimal post-surgical patient outcomes. For example, one particular study noted that minorities and non-private insurance holders had an increased likelihood of longer hospital stays and were more likely to be sent to institutional care after discharge.4 Longer hospital stays and institutional care stays can lead to increased rates of postoperative complications as well as increased overall costs to the healthcare system.

Furthermore, some studies have indicated that geographic location can impact the surgery incidence and complication rate. One study discovered that Medicare beneficiaries in rural areas are more likely to undergo a large array of surgical procedures, including total joint arthroplasty. The necessity of this surgery illustrates that rural areas may have an overall poorer quality of health.5 Although these general correlations about healthcare disparities are widely recognized, effective large-scale strategies have not yet been implemented due to the heterogeneous nature of healthcare disparities. Perhaps analysis of TKAs and their postoperative complication rates on a more local level may aid in choosing specific and effective strategies to address healthcare disparities. This study focuses on postoperative complications rates for TKAs in seven Florida counties that were selected based on their respective socioeconomic statuses. The purpose is to elucidate if first there was a difference in postoperative complication rate among the counties and then to investigate possible reasons as to why such a difference exists.

Methods

Seven Florida counties (Collier, Orange, Hardee, Miami-Dade, Osceola, Lake, Alachua) were selected based on three separate tiers of median income per capita in the state; Collier County is in the upper one-

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Table 1: *Population by Age in Collier, Hardee, Miami-Dade, Orange, and Osceola Counties*

Collier County Population	
Age	Population
60-64	26,220
65-69	26,458
70-74	26,162
75-79	21,355
80-84	15,096
Hardee County Population	
Age	Population
60-64	1,395
65-69	1,265
70-74	1,036
75-79	754
80-84	435
Miami-Dade County Population	
Age	Population
60-64	157,333
65-69	133,102
70-74	105,976
75-79	82,834
80-84	62,263
Orange County Population	
Age	Population
60-64	69,240
65-69	55,058
70-74	39,858
75-79	26,597
80-84	17,954
Osceola County Population	
Age	Population
60-64	19,386
65-69	15,987
70-74	12,236
75-79	8,254
80-84	5,325

third, Orange County, Miami-Dade, Lake, Alachua are in the middle one-third, and Osceola and Hardee County are in the bottom one-third. Median income level was viewed as a proxy for socioeconomic disparities. The population data stemmed directly from the Florida Department of Elder Affairs 2018 data, as seen below in Table 1. Due to a lack of available information on current TKA incidence per Florida county, the predicted probabilities of TKAs within each county's population were calculated based on a study that occurred from 1990 to 2010 by the U.S. Department of Health and Human Services Agency for Healthcare Research and Quality.6 Although this data may be slightly outdated, such a robust analysis over 20 years possessed profound data that the conclusions still were deemed appropriate. These surgeries were conducted from 2014-2017 at inpatient hospitals, and we defined complications per the same codes outlined by CMS. The included complications were those reported by the CMS per county and were not restricted to a time period. These complications include but by no means are limited to death, blood clots, infection, hemorrhage, kidney injury, respiratory failure, MI, stroke, etc.

County population data to predict total TKA per county paired with the reported number of counties' TKA complications from CMS, allowed the construction of a model to assess complication rate for each respective county. This was done as a ratio of total TKA (calculated) to all CMS documented TKA complications in a specific county. There was no discrimination amongst complications based on specificity or severity. All complications were defined by CMS codes and considered equally. This model's inputs were based on the stratified populations provided by the Florida Department of Elder Affairs and were organized based on the age ranges 60-69, 70-79, and 80-89 and each respective gender. The probabilities from the previously mentioned study were used to calculate the predicted number of annual cases in each county. Lastly, the complications defined by CMS for each county were then used to figure out the predicted postoperative complication rate. Sensitivity analysis was conducted through extensive permutations of adjusting predicted incidences of TKAs in females and males based on certain age ranges (60-69, 70-79, and 80-89). The sensitivity analysis results are reflected in the standard deviations of each county's complication rate.

Results

Post-TKA complication rates were 0.95±0.09% in Collier (high income). Middle income county rates were 0.85±0.08% in Orange, 1.67±0.15% in Miami-Dade, 1.87±0.18% in Lake, and 1.63±0.20% in Alachua. Low income county complication rates were 3.77±0.35% in Osceola and 9.70±0.91% in Hardee County (Table 2, Figure 1). Based on paired t-test analysis, Hardee County and Osceola had a statisti-

Table 2: *Post TKA Complication Rates in Seven Florida Counties*

	Hardee County	Osceola County	Miami-Dade County	Alachua County	Lake County	Orange County	Collier County
Mean	9.70%	3.77%	1.67%	1.63%	1.87%	0.95%	0.85%
St Dev	0.91%	0.35%	0.15%	0.20%	0.18%	0.09%	0.08%

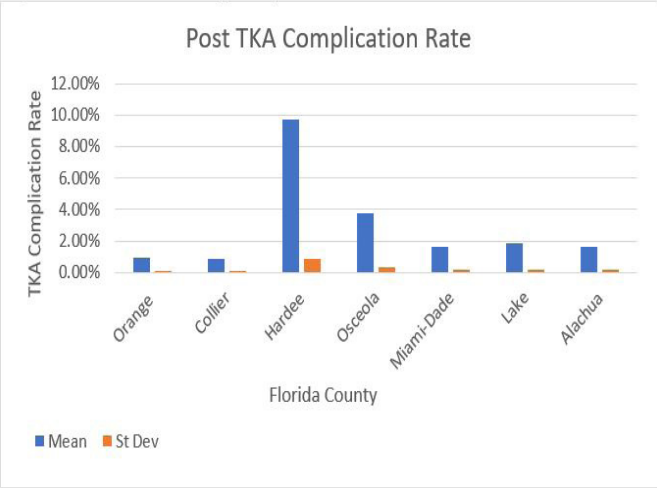

Figure 1: *Post TKA Complication Rate*

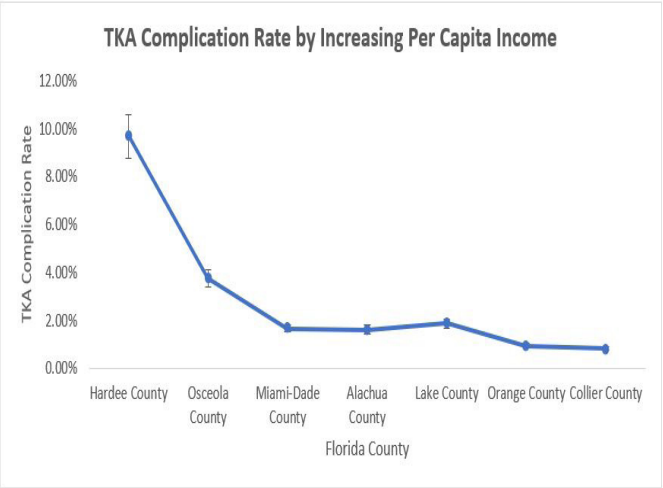

Figure 2: *Trends in TKA Complication Rate by Increasing Per Capita Income of County*

cally significant higher complication rates compared to high- and middle-income counties ($p<0.001$). There was an observable trend of decreasing complication rate with increasing per capita income (Table 2, Figure 2). Further analysis among middle income counties resulted in statistical significance between Alachua and Miami-Dade ($p>0.05$).

Discussion

It is a foregone conclusion that socioeconomic disparities can directly affect healthcare outcomes. The study supports this notion on a local geographic level by showing that Hardee County (66th poorest Florida county of 67 based on per capita income) and Osceola County (bottom one-third) have higher TKA complication rates compared to high- and middle-income counties. There is an observable trend that complication rate decreases as per capita income increases as seen in Figure 2. Further paired t-test analysis among middle income counties revealed statistical significance between Alachua and Miami-Dade, which are 28 and 33rd lowest in per capita income from out of 67 Florida Counties with no significance in the studied counties above and below these numbers. This suggests a point of significance in the population where complication rates begin to be influenced by income level. Despite the total number of post-TKA complications in Hardee County being lower when taking into consideration the smaller population of Hardee County, the complication rate was higher in comparison higher income counties.

Potential reasons for this discrepancy were researched. The United States Department of Health and Human Services designates Hardee County as a health professional shortage area and given the rural nature of the county, there are physical barriers to healthcare access and follow-up after TKA. This designation is important to consider because much of the healthcare service within this county is provided by physicians that predominantly work in neighboring counties and provide services electively. According to the 2018 Hardee County report by the Florida Department of Elder Affairs, there are six licensed medical providers. This pales in comparison to Collier (950) and Orange (4,119) counties. Even when accounting for the population differences within these counties, there is clearly a shortage of healthcare providers in Hardee County. Several studies have suggested that a hospital's surgical volume correlates to the risk of specific postoperative complications. In one study, low volume hospitals in Pennsylvania (<200 TKAs annually) were associated with higher risk of pulmonary embolism and 1-year mortality.7 The same effect, as mentioned by Singh et. al, of increased pulmonary embolism risk following TKAs was seen in low volume hospitals in California.7 Since this effect was seen in both California and Pennsylvania, regional geographic bias is lessened. At low volume hospitals, perioperative algorithms are not used as extensively compared to higher volume hospitals. This lack of familiarity may cause the increased risk because timing and choice of thromboprophylactic agents are important.8 In our study, venous thromboembolisms were one of the more common postoperative complications, but there were others too. The relative increase in Hardee County's postoperative complication rate can potentially be attributed to lack of practice with perioperative algorithms. Hardee County's shortage of healthcare providers may pertain to improper recognition of issues post-operatively.

Additionally, it is important to note that Hardee County has the highest rate of obesity in the entire state of Florida. Obesity has been clearly defined in the literature as an independent risk factor for osteoarthritis (OA) of the knee and hip, but more importantly, has been associated with worse clinical outcomes following joint arthroplasty surgery. Class III obese patients, also defined as morbidly obese patients by BMI >40 kg/m2, are more likely to have both superficial and deep surgical site infection (SSI) following arthroplasty.5 Other known postoperative complications in obese patients include poor wound healing, and joint stiffness. Bariatric surgery prior to TKA was mentioned as a possibility to help postoperative outcomes and complications; however, based on current literature, there is no clear evidence of bariatric surgery's benefit. Further studies are necessary to increase understanding of bariatric surgery's role with TKA.9 Moreover, overweight patients (BMI>25 kg/m2) negatively correlated with follow-up compliance.10

One of the limitations of this project results from using 1990-2010 data from Kremers et al. to determine the prevalence of TKA per age group. This data was then applied to Florida county population data from 2014-2017 to predict the number of TKAs per age group by county. Though it is a predicative model, we believe these numbers are in line with current number of TKA performed. Of note, the actual number is less important in our ecological study, than the highlighted trends seen per county. Since the same prevalence data was applied to each county with no change to predict TKA numbers, the trends should

reflect the true complication rates. Additionally, Kremers et al. performed a longitudinal multi-center study over 20 years to determine prevalence of TKA per age group and a study of such magnitude has not been performed with more recent population data.

The population dynamics suggest that rural patients are at increased risk for postoperative surgical complications, and since there are fewer healthcare providers per capita, many patients are most likely not receiving the necessary pre-operative and post-operative interventions. Though we are unable to draw firm individualized conclusions from population level data, this phenomenon illustrates the importance of primary care to ultimate surgical outcomes on a macro scale, applied to low-income populations. More consistent patient-physician contact would facilitate patients to have better healthcare lifestyle choices or perhaps initiate medical/surgical interventions. Based on the trends observed in this ecological study, it remains a critical public health issue to redirect healthcare resources to disadvantaged counties, decrease postoperative complications, and improve overall health and education on a population level.

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