Total Hip and Total Knee Arthroplasties: Trends and Disparities Revisited

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Abstract

Total joint arthroplasties are recognized as being effective in the treatment of joint disease and making a significant difference in patients' quality of life. Understanding the trends and disparities in use of these procedures is important for policy decisions. However, research on these issues has been limited because of the suboptimal samples used.

To study trends and racial and economic disparities associated with total hip and total knee arthroplasties, we used a large national database, Nationwide Inpatient Sample, 1996–2005, which may be best suited for elucidating trends and disparities in treatment use. Primary and revision hip and knee arthroplasties were the primary outcomes. Rates of use were computed by count per 100,000 persons in the population. Logistic regression was used to examine the associations between disparity factors and each outcome, where regressors included age, sex, race, regional income, hospital characteristics, payer, comorbidities, and obesity.

Between 1996 and 2005, primary arthroplasty rates have increased, but revision rates only minimally. Racial disparities were larger than income disparities. Our study also revealed that racial disparities were not confined to the elderly or to low-income populations. This may mean that there is an unmet need for these medical procedures among racial minorities.

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To create effective health policies, it is necessary to gain access to unbiased information, including trends of treatment use over time and notable disparities among patient populations. Proper understanding of these issues is a prerequisite for the establishment and the optimal implementation of equitable public health policies. Research conducted over the past 2 decades has shown that quality of care and health outcomes in the United States are inferior for minorities compared with their white counterparts across a wide range of medical specialties.[1-5] Multiple medical and health authorities and programs have emphasized elimination of disparities as a high priority in health care and policy agenda. Despite accumulating evidence on the toll of disparities on health, only in the past decade has concern about social inequalities become part of the mainstream public health agenda.[6-11]

Although various research initiatives have been conducted to explore the trend and disparity issues in the arthroplasty community, these studies have been largely based on Medicare data or relatively small nationally representative surveys, thus limiting the generalizability of findings to larger populations.[8,12-14]

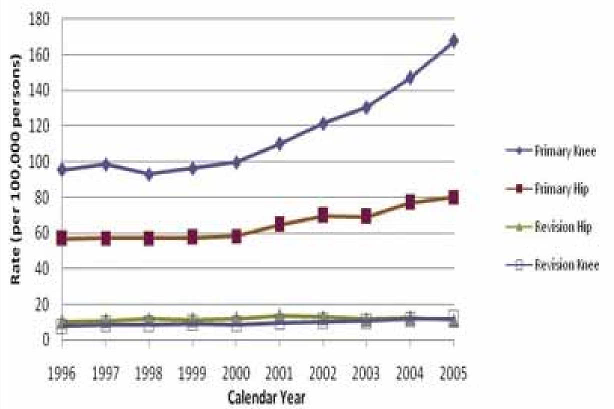

Figure 1. Rates of primary and revision hip and knee arthroplasties, 1996–2005. See Appendix for actual counts of procedures.

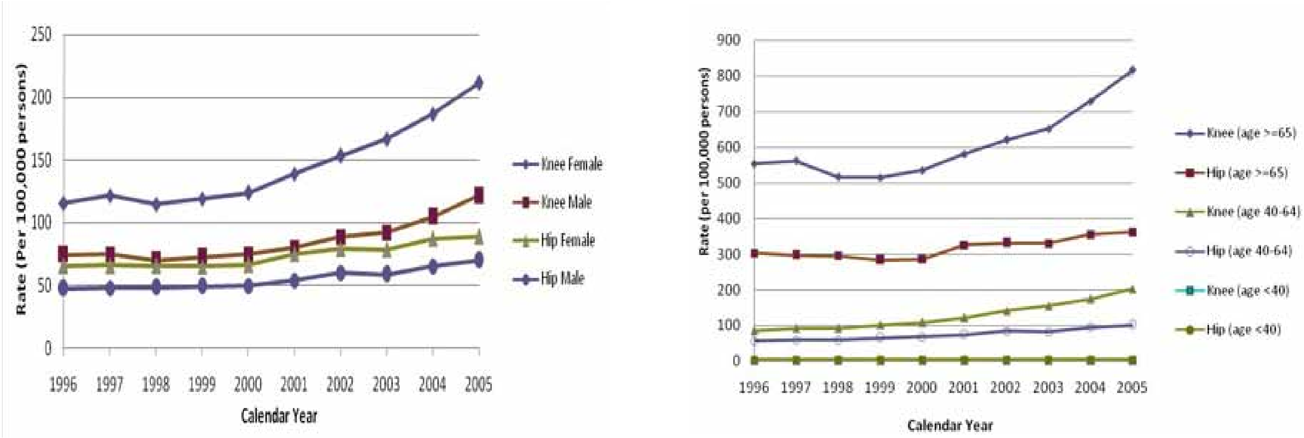

Figure 2. Rates of primary hip and knee arthroplasties, 1996–2005, by sex and age groups.

In addition, in our review of the literature on total joint arthroplasty (TJA), we found some conflicting results regarding trends and disparities. These inconsistencies might be explained by use of suboptimal data sources by prior investigations. Revisiting these issues using optimally suited datasets in the hope of resolving the inconsistencies, however, is important for policy decisions.

In the present study, we analyzed use trends, focusing on racial and economic disparities, with data collected from the Nationwide Inpatient Sample (NIS), a database that, before now, had not been used for these aims. The main advantage of using this database, instead of the National Hospital Discharge Survey (NHDS) or Medicare databases, is that the NIS is the largest national database of all payer inpatient care in the United States, and the NIS

Table I. Patient Characteristics: Sample Sizes, Means (Standard Errors) for Continuous Variables, and Percentages for Categorical Variables in 2004[a]

	Patients		
Characteristic	**Hip Surgery (n = 54,088)**	**Knee Surgery (n = 95,871)**	**All Others (n = 7,854,612)**
Age, y	66 (0.19)	67 (0.12)	47 (0.36)
Sex			
Male	42	36	41
Female	58	64	59
Race			
White	61	59	49
Black	4	5	11
Hispanic	2	3	10
Other	2	3	4
Missing	30	31	26
Income[b]			
Q1	19	22	29
Q2	26	28	25
Q3	24	24	21
Q4	29	24	22
Primary payer			
Medicare	57	60	36
Medicaid	3	3	19
Private	37	34	36
Other	3	3	8
Hospital control/ownership[c]			
Government, nonfederal	5	6	6
Private, nonprofit	20	23	20
Private, investor owned	8	9	10
Government or private	63	56	59
Private	4	6	4
Hospital setting			
Rural	11	13	13
Urban	89	87	87
Charlson Comorbidity Index[d]	0.52 (0.008)	0.61 (0.007)	0.72 (0.009)
Obesity	7	12	4

[a]Sample sizes are unweighted; means and percentages are weighted.
[b]Q = quarter. Median Zip code income for 1996 (Q1, $1K to $25K; Q2, >$25K to $30K; Q3, >$30K to $35K; Q4, >$35K), 2000 (Q1, $1K to <$25K; Q2, $25K to <$35K; Q3, $35K to <$45K; Q4, $45K or more), and 2004 (Q1, $1K to <$36K; Q2, $36K to <$45K; Q3, $45K to <$59K; Q4, $59K or more).
[c]Categorization rule has changed.
[d]Not all Charlson Comorbidity Index components were available, so the following definition was used. Charlson index (D'Hoore version): (1 x pulmonary disease) + (1 x rheumatologic disease) + (1 x history of peripheral vascular disease) + (1 x peptic ulcer disease) + (2 x diabetes) + (2 x renal insufficiency) + (2 x history of malignancy) + (1 x history of congestive heart failure) + (3 x liver cirrhosis).

Table II. Association of Hip and Knee Arthroplasties With Income and Race[a]

	1996 OR (95% CI)	1996 P	2000 OR (95% CI)	2000 P	2004 OR (95% CI)	2004 P
Hip Arthroplasties						
Income quartile[b]						
Q1	0.95 (0.86, 1.04)	.24	0.68 (0.60, 0.77)	<.0001	0.75 (0.64, 0.88)	.0004
Q2	1.05 (0.96, 1.14)	.28	0.87 (0.80, 0.96)	.0041	0.89 (0.76, 1.04)	.15
Q3	1.02 (0.94, 1.11)	.59	1.01 (0.94, 1.09)	.71	0.91 (0.78, 1.05)	.18
Q4	1		1		1	
Race						
Black	0.49 (0.44, 0.55)	<.0001	0.58 (0.52, 0.64)	<.0001	0.55 (0.49, 0.61)	<.0001
Hispanic	0.38 (0.31, 0.47)	<.0001	0.44 (0.35, 0.56)	<.0001	0.36 (0.31, 0.42)	<.0001
Other	0.67 (0.49, 0.93)	.02	0.53 (0.43, 0.64)	<.0001	0.55 (0.39, 0.79)	.001
Missing	1.04 (0.92, 1.18)	.53	1.08 (0.93, 1.26)	.32	1.05 (0.92, 1.19)	.49
White	1		1		1	
Area under the curve	0.73		0.73		0.77	
Knee Arthroplasties						
Income quartile[b]						
Q1	1.15 (1.04, 1.27)	.006	0.84 (0.75, 0.95)	.004	0.94 (0.82, 1.07)	.32
Q2	1.23 (1.12, 1.34)	<.0001	1.09 (0.99, 1.20)	.09	1.08 (0.97, 1.21)	.18
Q3	1.13 (1.04, 1.22)	.003	1.18 (1.10, 1.27)	<.0001	1.06 (0.96, 1.17)	.27
Q4	1		1		1	
Race						
Black	0.54 (0.48, 0.60)	<.0001	0.64 (0.57, 0.71)	<.0001	0.59 (0.53, 0.65)	<.0001
Hispanic	0.60 (0.50, 0.73)	<.0001	0.66 (0.57, 0.77)	<.0001	0.64 (0.53, 0.76)	<.0001
Other	0.72 (0.54, 0.96)	.03	0.57 (0.49, 0.68)	<.0001	0.77 (0.56, 1.05)	.10
Missing	0.98 (0.87, 1.11)	.76	0.96 (0.86, 1.08)	.52	1.09 (0.96, 1.23)	.18
White	1		1		1	
Area under the curve	0.74		0.74		0.78	

Abbreviations: CI, confidence interval; OR, odds ratio.

[a]Age, sex, payer, hospital control/ownership, setting, Charlson Comorbidity Index (2004) and obesity (2004) were adjusted in multiple logistic regression. Charlson and obesity variables were not available in 1996 and 2000.
[b]Q = quarter. Median Zip code income for 1996 (Q1, $1K to $25K; Q2, >$25K to $30K; Q3, >$30K to $35K; Q4, >$35K), 2000 (Q1, $1K to <$25K; Q2, $25K to <$35K; Q3, $35K to <$45K; Q4, $45K or more), and 2004 (Q1, $1K to <$36K; Q2, $36K to <$45K; Q3, $45K to <$59K; Q4, $59K or more).

surveys 10 to 20 times as many discharges as the NHDS does. The NIS and the NHDS have been compared and the advantages of the NIS well documented.[15,16] The NIS includes patients who are younger than 65 years—patients who are not available in the Medicare database and the group in which there is the largest percentage increase in the rate of TJA use. In addition, the NIS includes community hospitals, where most minority populations receive care. Therefore, we used the NIS to better evaluate the trends and disparities in TJA use in the United States.

Materials and Methods

Study Population and Sample

The NIS is a national database of inpatient discharge data from approximately 7 to 8 million hospital stays each year. NIS data are available from 1988, allowing for the analysis of trends over time. The NIS includes data from more than 1000 hospitals, representing approximately a 20% stratified sample of US community hospitals, excluding veterans and other federal hospitals. Data include information on patient demographics, hospital characteristics, up to 15 *International Statistical Classification of Diseases and Related Health Problems, Ninth Edition (ICD–9)* diagnostic and procedure codes, payer source, length of stay, and disposition status. The database is maintained by the Agency for Healthcare Research and Quality (AHRQ) as part of the Healthcare Cost and Utilization Project (HCUP). Because the data used in this study are sufficiently deidentified, they were exempted from review by our institutional review board. We selected recent 10 years (1996 to 2005) for trend analysis and 3 time points (1996, 2000, 2004) for disparity analysis using regression modeling that can examine associations over time. Details on study design and variable definitions are provided at the HCUP Web site.

Description of Variables

Outcomes. Primary and revision total hip arthroplasties (THAs) and total knee arthroplasties (TKAs) *(ICD–9* codes 81.51, 81.53, 81.54, 81.55) were selected. (Beginning with fiscal year 2006, *ICD–9–CM* [Clinical Modification] coding version, October 1, 2005, there was a change to the codes defining hip revisions. Codes 00.70, 00.71, 00.72,

Table III. Association of Hip Arthroplasties With Race by Age Group and Income Group[a]

Year	Race	Age Group: <65 Years OR (95% CI)	<65 Years *P*	≥65 Years OR (95% CI)	≥65 Years *P*
1996	Black	0.67 (0.59, 0.76)	<.0001	0.35 (0.31, 0.40)	<.0001
	Hispanic	0.41 (0.32, 0.53)	<.0001	0.40 (0.32, 0.50)	<.0001
	Other	0.74 (0.55, 1.00)	.05	0.69 (0.47, 1.02)	.06
	Missing	1.12 (0.96, 1.30)	.14	1.01 (0.89, 1.14)	.88
	White	1		1	
2000	Black	0.74 (0.66, 0.83)	<.0001	0.41 (0.36, 0.47)	<.0001
	Hispanic	0.54 (0.45, 0.66)	<.0001	0.39 (0.28, 0.55)	<.0001
	Other	0.60 (0.48, 0.74)	<.0001	0.52 (0.42, 0.65)	<.0001
	Missing	1.14 (0.96, 1.35)	.14	1.07 (0.93, 1.24)	.37
	White	1		1	
2004	Black	0.61 (0.54, 0.68)	<.0001	0.47 (0.40, 0.53)	<.0001
	Hispanic	0.44 (0.37, 0.51)	<.0001	0.37 (0.31, 0.44)	<.0001
	Other	0.57 (0.41, 0.79)	.0006	0.62 (0.42, 0.92)	.02
	Missing	1.10 (0.95, 1.27)	.20	1.01 (0.89, 1.15)	.84
	White	1		1	
Area under the curve		0.81–0.84		0.61–0.71	

Year	Race	Income Group: Below Median Income OR (95% CI)	Below Median Income *P*	Above Median Income OR (95% CI)	Above Median Income *P*
1996	Black	0.47 (0.41, 0.55)	<.0001	0.49 (0.42, 0.57)	<.0001
	Hispanic	0.32 (0.26, 0.39)	<.0001	0.45 (0.33, 0.61)	<.0001
	Other	0.76 (0.56, 1.03)	.07	0.61 (0.43, 0.87)	.007
	Missing	0.97 (0.84, 1.13)	.73	1.11 (0.96, 1.29)	.15
	White	1		1	
2000	Black	0.49 (0.43, 0.55)	<.0001	0.61 (0.53, 0.69)	<.0001
	Hispanic	0.32 (0.27, 0.39)	<.0001	0.51 (0.37, 0.71)	<.0001
	Other	0.65 (0.48, 0.87)	.004	0.47 (0.38, 0.59)	<.0001
	Missing	0.92 (0.79, 1.08)	.30	1.15 (0.97, 1.37)	.11
	White	1		1	
2004	Black	0.50 (0.44, 0.57)	<.0001	0.56 (0.49, 0.64)	<.0001
	Hispanic	0.35 (0.29, 0.42)	<.0001	0.35 (0.30, 0.40)	<.0001
	Other	0.65 (0.46, 0.92)	.02	0.49 (0.33, 0.72)	.0003
	Missing	0.96 (0.83, 1.11)	.56	1.12 (0.97, 1.30)	.14
	White	1		1	
Area under the curve		0.73–0.77		0.71–0.76	

[a]Age, income, sex, payer, hospital control/ownership, setting, Charlson Comorbidity Index, and obesity were adjusted in multiple logistic regression.

and 00.73 were added to define hip revisions, and codes 00.80, 00.81, 00.82, 00.83, and 00.84 were added to define knee revisions. Code 81.53 was changed to note only non-specified hip revisions. More details are provided at http://www.cdc.gov/nchs/icd9.htm.)

Independent Variables. We used the NIS database race variable, which uniformly codes race/ethnicity as white (non-Hispanic white), black (non-Hispanic black), Hispanic (all other Hispanic), all other races, and missing. Information on race was missing in approximately 30% of entries, as it was not collected from every state and every patient. Moreover, the definition of race and the method of assessment varied. Therefore, we defined "no race stated" as a distinct category and performed 2 analyses: using all available samples (primary analysis) and complete case analysis excluding subjects with missing race information for sensitivity checking (secondary analysis). To define income, we used the quartile-based categorization of median income for each Zip code for patient residence. Other covariates included in the analysis were age, sex, primary payer (Medicare, Medicaid, private, other), hospital control/ownership (government, private, public, etc), hospital setting (rural, urban), Charlson Comorbidity Index,[17] and obesity, which is not included in the comorbidity index but is considered an important risk factor for hip and knee arthroplasties. Comorbidity measures are assigned using the AHRQ comorbidity software. (The AHRQ comorbidity measures identify coexisting medical conditions that are not directly related to the principal diagnosis or the main reason for admission and that are likely to have originated before the hospital stay. They are identified using *ICD–9–CM* diagnoses and the diagnosis related group in effect on the discharge date. Specifically, *ICD–9–CM* diagnosis codes of 278.0, 278.00, 278.01, 649.10–649.14, 793.91, V85.30–V85.4, and V85.54 were used to construct the obesity variable.)

Table IV. Association of Knee Arthroplasties With Race by Age Group and Income Group[a]

Year	Race	Age Group: <65 Years OR (95% CI)	<65 Years *P*	≥65 Years OR (95% CI)	≥65 Years *P*
1996	Black	0.68 (0.59, 0.77)	<.0001	0.46 (0.41, 0.52)	<.0001
	Hispanic	0.60 (0.48, 0.75)	<.0001	0.66 (0.55, 0.79)	<.0001
	Other	0.73 (0.55, 0.96)	.02	0.76 (0.56, 1.05)	.09
	Missing	0.98 (0.86, 1.12)	.81	0.99 (0.87, 1.13)	.93
	White	1		1	
2000	Black	0.73 (0.65, 0.82)	<.0001	0.55 (0.49, 0.61)	<.0001
	Hispanic	0.65 (0.55, 0.78)	<.0001	0.71 (0.61, 0.83)	<.0001
	Other	0.54 (0.45, 0.66)	<.0001	0.63 (0.52, 0.75)	<.0001
	Missing	1.01 (0.88, 1.14)	.94	0.96 (0.85, 1.08)	.48
	White	1		1	
2004	Black	0.67 (0.60, 0.74)	<.0001	0.52 (0.46, 0.59)	<.0001
	Hispanic	0.67 (0.57, 0.80)	<.0001	0.75 (0.61, 0.91)	.004
	Other	0.75 (0.54, 1.04)	.09	0.88 (0.66, 1.18)	.39
	Missing	1.15 (1.00, 1.31)	.04	1.05 (0.93, 1.19)	.43
	White	1		1	
Area under the curve		0.88–0.89		0.64–0.73	

Year	Race	Income Group: Below Median Income OR (95% CI)	Below Median Income *P*	Above Median Income OR (95% CI)	Above Median Income *P*
1996	Black	0.50 (0.44, 0.58)	<.0001	0.60 (0.52, 0.68)	<.0001
	Hispanic	0.59 (0.47, 0.73)	<.0001	0.62 (0.49, 0.78)	<.0001
	Other	0.78 (0.54, 1.13)	.19	0.67 (0.52, 0.87)	.003
	Missing	0.90 (0.77, 1.06)	.20	1.10 (0.97, 1.25)	.14
	White	1		1	
2000	Black	0.59 (0.52, 0.67)	<.0001	0.62 (0.55, 0.70)	<.0001
	Hispanic	0.62 (0.53, 0.73)	<.0001	0.63 (0.51, 0.77)	<.0001
	Other	0.74 (0.57, 0.96)	.02	0.49 (0.41, 0.58)	<.0001
	Missing	0.85 (0.73, 0.99)	.04	1.02 (0.89, 1.16)	.79
	White	1		1	
2004	Black	0.53 (0.47, 0.60)	<.0001	0.65 (0.57, 0.73)	<.0001
	Hispanic	0.61 (0.48, 0.77)	<.0001	0.61 (0.52, 0.71)	<.0001
	Other	0.83 (0.61, 1.11)	.21	0.72 (0.50, 1.03)	.07
	Missing	0.98 (0.85, 1.14)	.81	1.23 (1.07, 1.40)	.003
	White	1		1	
Area under the curve		0.75–0.79		0.73–0.77	

[a]Age, income, sex, payer, hospital control/ownership, setting, Charlson Comorbidity Index, and obesity were adjusted in multiple logistic regression.

Statistical Analysis

For patient characteristics, means and standard errors were computed for continuous variables, and percentages were computed for categorical variables.

We analyzed THAs and TKAs separately. The arthroplasty rates were calculated by dividing the number of reported procedures by the corresponding US civilian resident population from the census data. In addition, rates were computed for age and sex subgroups. We omitted rates by race because it is almost impossible to estimate accurate population size for each race in the presence of a considerable proportion of missing data on race.

To assess the associations of income and race with arthroplasty use, we used multiple logistic regression for the binary endpoint for the reception of arthroplasty, adjusting for the independent variables. For example, in the hip analyses, patients who had undergone hip surgery were given the endpoint of 1, and patients who had not undergone hip or knee surgery were given the endpoint of 0 (Table I). We repeated the analyses with slightly different endpoint definitions to check for sensitivity; hip surgery patients (1) versus all others (0) in the hip analyses, and knee surgery patients (1) versus all others (0) in the knee analyses.

In addition, we fitted the same set of regression models in younger patients (<65 years) and older patients (≥65 years) to evaluate whether racial disparities differed by age group. The same subgroup analyses were also done in high- and low-income groups. For evaluating associations, odds ratio, 95% confidence interval, and statistical significance were computed. For regression analyses, we modeled each year separately. This approach enabled us to examine the pattern and consistency of the associations over years. We must note that NIS is not a community-based database but inpatient samples; the result is that nonevents in our logistic regression do not represent general healthy individuals.

A discrimination statistic, receiver operating characteristic area under the curve (AUC), was computed to assess the ability to distinguish TJA cases from noncases, where AUC of 1 means perfect discrimination and AUC of 0.5 means the discrimination ability is no better than chance.[18]

In all statistical analyses, we used survey procedures (eg, proc surveyfreq or surveylogistic in SAS version 9.1; SAS Institute, Cary, NC) to account for weights, clusters, and strata used in the complex survey design. We assumed 2-sided hypotheses for all statistical inferences. Given the very large sample size in this study, we did not rely on a conventional threshold of statistical significance (ie, $P<.05$) to draw interpretations from the study findings but instead focused on the pattern and consistency of the results.

Results

Table I summarizes the characteristics of THA and TKA patients compared with all other patients in the NIS for 2004. THA and TKA patients were aged 66 or 67 years, whereas the other patients were a mean age of 47 years. The proportion of women (64% vs 58%-59%) was highest in the TKA patients. Approximately 60% of patients were white and approximately 10% racial minorities; 30% of THA and TKA patients had unidentified or missing race information. The proportion of white patients was 60% in the THA and TKA groups and 49% in the other groups. Treatments were most commonly covered by Medicare (57% THA, 60% TKA) followed by private insurance (37% for THA, 34% TKA). Almost 90% of hospitals were in urban settings. Charlson Comorbidity Index scores were lower in THA and TKA patients than in other patients. Seven percent of THA patients and 12% of TKA patients, but only 4% of nonarthroplasty patients, were identified as obese (*ICD–9* codes).

Number and rate of THAs and TKAs increased between 1996 and 2005. Demand was much higher for TKAs than for THAs. Number and rate of revision procedures tended to increase, but the rate slopes were significantly attenuated compared with those of the primary procedures. Revision burden, which may be defined as the ratio of number of revisions to number of primary arthroplasties, was higher for hip than knee surgeries and was stable over the years, 14% to 15% for THA and 7% for TKA (Figure 1, Appendix). Increased use in women versus men and in older versus younger patients was evident. A steady increase of joint arthroplasties for hip and knee in people between ages 40 and 64 years is noteworthy (Figure 2).

Multiple regression models showed significantly lower odds of THA and TKA use in all non-white groups compared with whites. In relation to income, racial disparities were more pronounced. The lowest income quartile compared with the highest quartile showed a 5% decrease ($P = .24$) in 1996, a 32% decrease ($P<.0001$) in 2000, and a 25% decrease ($P = .004$) in 2004 in the odds of undergoing THA; the corresponding values for TKA were a 15% increase ($P = .006$), a 15% decrease ($P = .004$), and a 6% decrease ($P = .32$). Thus, association patterns are not uniform. In contrast, all racial minority patients were 23% to 64% less likely to undergo arthroplasties. Especially affected were blacks and Hispanics ($P<.0001$). Results are listed in Table II.

An important finding is that racial disparities were prevalent in younger patients (<65 years) and older patients (≥65 years), particularly lower rates for blacks and Hispanics. Racial disparities persisted in patients who lived in either high- or low-income regions. Disparity patterns in THA patients (Table III) and TKA patients (Table IV) were deemed consistent.

The discriminatory ability of the fitted model was superior in the younger patients (hip AUC, 0.81–0.84; knee AUC, 0.88–0.89) than in the older patients (hip AUC, 0.61–0.71; knee AUC, 0.64–0.73). Similar AUC values were observed in high- and low-income groups (0.71–0.79).

A secondary analysis based on data with complete race information (complete case analysis) did not materially change the findings. In addition, the results were almost identical when slightly different definitions for endpoints were used (eg, THA patients vs all other patients).

Discussion

This study used a nationally representative inpatient database to examine THA and TKA rates. Growing use of these procedures was clear. This phenomenon may be explained partly by increased life expectancies, active lifestyle, and increasing prevalence of obesity.[19,20]

Kurtz and colleagues[21,22] used the NHDS, a smaller national database with 300,000 discharge records per year, to quantify trends in THA and TKA use in the United States between 1990 and 2002. Using the NIS, they also projected increases in primary and revision TKAs of approximately 600% to 670% over the next 25 years, and increases in primary and revision THAs of approximately 140% to 170%.[22] These projections, however, depend largely on certain assumptions. For example, based on different modeling assumptions, it was estimated that 488,000 or 3,481,000 primary TKAs would be performed in 2030. These numbers might be too wide to be informative. Accurate projections would provide a quantitative basis for making policy decisions and establishing optimal strategies for resource allocation and physician training to adequately meet demand. However, projections in general and over the long term in particular can be difficult, even when using accurate past and current trend data with known predictors as a basis.

Racial disparities (white vs other races) were present in arthroplasty use, which is in concordance with findings for various other procedures.[23] We found that the magnitude of disparities between race and income is similar to that previously reported.[12] Using the National Health and Nutrition Examination Survey

III (conducted 1988 to 1994, unweighted N = 1926) and Medicare claims data, Skinner and colleagues[12] examined the relative effects of regional income and race on TKA and concluded that race is more influential than socioeconomic status (SES). Yet, we must note that regional income was used as an SES measure—common practice in research using administrative databases. If we had accurate measures of personal-level SES data in addition to regional income data, we would be able to evaluate racial and SES disparities better. The advantages of regional income as an SES marker, however, should not be ignored. Zip code income avoids measurement errors and better captures the overall housing price and costs of living.[12,24] Further, it has been reported that patients choose TJA on the basis of outcomes reported by neighbors and other people they know.[25]

Regarding the disparity and age interactions, Dunlop and colleagues[8] recently found significant disparities (black vs white) in arthritis-related hip/knee surgeries in adults 65 years or older—a finding consistent with that of other national studies—but noted no racial disparity in patients younger than 65 years. In our analysis, however, racial disparities were prevalent across age groups, so we reached a conclusion different from theirs. Our findings have significant public policy implications. Unequal use of TJA in patients younger than 65 years would result in a significant and inequitable burden to minority populations. If racial disparities persist in younger populations, this may suggest a failure of the medical system to correct an inequity that has been well documented for more than a decade. In addition, our data showed that blacks and Hispanics, like other groups, seemed to be most disadvantaged in our analyses. Continued attention to these groups and realistic action plans are needed. Moreover, the obesity epidemic in the United States is most pronounced among minority populations and may result in earlier joint failure and need for TJA. In fact, obesity at age 18 years was reported as the strongest modifiable predictor of later need for a hip arthroplasty.[26] Although Dunlop and colleagues' findings are important and interesting, it may still be premature to declare that THA and TKA rates do not differ for minorities and whites younger than 65 years. Racial disparities in younger populations persist in other diseases and treatments.[27,28] Further investigations of patterns of use of various medical treatments, and how and why these patterns vary by age, are warranted.

Limitations inherent to large administrative database research apply to our analyses. First, the large amount of missing race data demands that much caution be taken when making interpretations. Underreporting of race was a serious problem in the NHDS as well.[29] Second, for definitions of endpoints and comorbidities, we used *ICD–9* codes, but comorbidities tend to be underreported with this method.[30] The lower prevalence of obesity in our sample would be explained by this fact.[31] However, it is less likely that the general coding bias affects different groups differently within the same database. Third, as for any observational study, the associations observed are not necessarily causal relationships, and unaccounted-for confounders may come into play. Therefore, use of causal terms should be avoided in results interpretation. Further, there is a limited number of variables in the NIS database, thus making it impossible to control for other potentially important confounders, such as environmental, psychosocial, clinical, and genetic factors. Other factors not accounted for include knowledge and expectations about the surgeries and proximity to health care providers. Fourth, strictly speaking, the NIS data entries are not independent because a person can contribute more than one observation (ie, multiple hospital admissions). We did not account for correlation within patient, but we anticipated that within-individual correlations were very small.

In conclusion, in contrast to previous studies, we found that the TJA revision burden may not be as high as we had expected. We also found that race was strongly associated with underuse of TJA, independent of age and SES.

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Appendix. Procedural Counts of Primary and Revision Total Hip and Knee Arthroplasties in the United States, 1996–2005, Estimated From Nationwide Inpatient Sample

Year	Total Hip Arthroplasty		Total Knee Arthroplasty	
	Primary	Revision	Primary	Revision
1996	150,645	27,418	253,123	21,264
1997	153,080	29,649	264,331	23,503
1998	154,337	31,885	251,309	23,671
1999	156,706	31,124	262,687	24,971
2000	164,458	33,990	281,534	24,730
2001	184,646	38,918	313,618	27,802
2002	201,166	36,856	350,122	29,948
2003	201,545	34,688	379,719	31,274
2004	225,900	37,115	431,485	35,048
2005	237,645	37,231	497,419	39,985

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